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CPCEM Clinical Practice & Cases

The Proposed 48-Month Emergency Medicine Residency Requirement Demands Immediate Scrutiny

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The Accreditation Council for Graduate Medical Education's (ACGME) proposal to mandate 48-month training for all emergency medicine residency programs represents a significant departure from the current system where both 36- and 48-month formats successfully coexist.

The ACGME's justification relies on a methodologically flawed survey that never directly asked program directors about optimal training duration. Instead, it calculated totals by summing individual rotation estimates without considering integrated curricula or practical constraints. Even if these results were to be accepted, directors of three-year programs reported a mean desired duration of only 41.6 months—hardly justifying a universal 48-month mandate.

Current evidence contradicts the ACGME's rationale. Three-year graduates achieve higher board pass rates (93.1% vs 90.8%) and demonstrate equivalent clinical performance to four-year graduates. The mandate would impose substantial financial burdens on trainees—an opportunity cost exceeding $200,000-$250,000—while potentially deterring qualified applicants and discouraging fellowship training.

We urge the ACGME to pause implementation and provide compelling evidence that a 48-month mandate is necessary and demonstrably superior to the current model. [West J Emerg Med. 2025;26(4)763–766.]

The Accreditation Council for Graduate Medical Education (ACGME) recently proposed a radical revision to the Program Requirements for Graduate Medical Education in Emergency Medicine, mandating a standardized 48-month training duration for all residency programs, which would take effect in 2027.[1] This is a substantial departure from the current structure, where both 36-month and 48-month formats coexist. As we have previously argued, the value proposition of a fourth-year of training has historically lacked definitive supporting evidence.[2-3] Roughly three-quarters of emergency medicine (EM) residency programs perform successfully under the 36-month (postgraduate years [PGY] 1-3) model, yielding competent physicians who meet the demands of our challenging field.[4] While we all share the ACGME's goals of improving resident education and ensuring preparedness for independent practice, imposing a universal 48-month mandate appears premature and insufficiently justified by convincing evidence. The ACGME should not move forward with a mandate of this magnitude—one carrying significant potential drawbacks—without first providing clear evidence that it is both necessary and demonstrably superior to the current three-year training model.

This call for an evidence-based justification before such a significant change is implemented is echoed by major specialty organizations. The Emergency Medicine Residents' Association (EMRA) has urged the withdrawal of the proposed requirements, advocating for the continued accreditation of both three- and four-year programs based on evidence.[5] Similarly, the Society for Academic Emergency Medicine, representing a broad constituency including academic chairs and clerkship directors, has expressed concerns about the accelerated timeline and lack of consensus, requesting a pause in the implementation

process to allow for more thorough consideration and stakeholder engagement.[6]

The ACGME justifies this proposal by citing the need to accommodate an expanded curriculum.[1] The council identified this need through a survey administered to program directors (PD) by members of a designated Program Requirements Writing Group (PRWG), who designed the survey based on takeaways from their summit with stakeholders. A closer look at this process reveals many concerns with their methodology and resulting conclusions. The PRWG was comprised of eight emergency physicians, all previously or currently serving on the ACGME Review Committee for Emergency Medicine.[7] These eight physicians notably constituted 25% of the total "stakeholders" who joined the summit.[7] There is also a fundamental lack of detail describing specific expertise to opine on the educational domains involved across both the PRWG and the other stakeholders involved with the summit. The ACGME's over-representation in the summit could have introduced bias and excessively influenced the "consensus" on which it decided to build the ideal curriculum.[7] This is even more striking given the lack of clarity regarding the stakeholders' qualifications to influence such a consequential survey.

The survey itself suffers from methodological and interpretative issues. It did not directly ask PDs what they believed to be the optimal total program duration for EM residency. Consequently, the survey results do not necessarily and accurately represent respondents' views on the total duration required. Instead, the PRWG calculated a total by summing up PDs' estimates of the time needed for individual curriculum components derived from their summit, arguing that this approach avoided bias from current program formats.[7] The PDs were also explicitly asked to estimate the required time for these rotations "without considering current ACGME EM training requirements, your current curriculum, or your current program resources" to achieve "autonomous practice." By instructing PDs to estimate rotation durations without considering the broader context of that rotation within current training requirements, individual program curricula, or institutional resources, the survey restricted their ability to account for integrated curricular design. Specifically, it did not permit consideration of how multiple educational objectives might be addressed concurrently through combined rotations or interdisciplinary experiences.

Such integration has the potential to reduce the total number of required rotations while still achieving equivalent educational outcomes. Furthermore, this framing is based on idealistic rather than strictly essential criteria to achieve competency for autonomous practice, which could have significantly inflated the perceived time needed for the total program length. These questions also lacked any time constraint, allowing respondents to suggest unlimited durations for each rotation; the sum of these individual suggestions could easily exceed a practical or intended total program length. It would be critical to know the range of total suggested durations and analyze separately those responses that, when aggregated, would exceed a 48-month program. A more effective methodological approach might have been to individually inquire about appropriate durations for each of the four curricular sections and then follow up with the individual rotations. The median suggested duration for each section could then inform an agreement on overall residency duration.

Furthermore, the interpretation of these suggested durations must consider external variables. The respondents' suggested durations for rotations likely reflected their own institutions' patient loads, emergency department (ED) environment, and faculty experience. For example, PDs from high-volume institutions might propose shorter rotation durations due to an anticipation of sufficient patient exposure. In contrast, those from low-volume institutions may suggest longer durations to achieve the same. This variability needs to be accounted for when analyzing the survey results.

Even when taking these results at face value, the ACGME cites them unreliably. They point to a mean desired training length of approximately 43.4 months. This figure, however, is skewed by responses from existing four-year programs, whose directors desired over 50 months. This overall "average" overshadows that directors of three-year programs reported a mean of 41.6 months, which hardly indicates a universal demand for a 48-month mandate. Additionally, while the survey instrument is available as a supplement in the PRWG's complete publication, the significant details regarding question framing, the lack of direct inquiry about total program length, and the absence of analysis of confounding variables or excessively long cumulative durations are notably absent from the ACGME's proposed revisions to program requirements.

While surveys have value, a significant residency program change should ideally be informed by objective measures and more robust evidence. Given that both three- and four-year EM residency programs exist, evaluating their respective effectiveness using objective performance metrics would provide more reliable guidance. The appropriate residency duration for clinical experience primarily relates to case exposure stratified by patient type, with duration as only a surrogate measure. Therefore, the survey's conclusions supporting the mandate are derived from surrogate variables, which is not the optimal method when the possibility of directly comparing the performance outcomes of graduates from three- vs four-year programs exists.

The ACGME avoids this direct comparison in their proposal even beyond their concerns about curriculum. For example, they point to shortened shifts leading to decreased patient encounters. While this merits attention, increasing the required weeks in the ED is an indirect response; it does not guarantee reaching the desired quantity or quality of patient encounters.[8] The actual educational yield is heavily influenced by factors unrelated to program length, including patient volume and acuity, hospital boarding, the roles of non-physician practitioners, and individual resident experience and efficiency.[8-11] A more direct and potentially more effective method, as advised by the EMRA, involves establishing minimum encounter targets, such as 5,000-6,000 total patient

encounters, including specific targets for pediatric and critical care patients, that could demonstrably be met within a well-structured three-year program (eg, 94 ED weeks).[8]

Another troubling rationale involves the reference to declining American Board of Emergency Medicine (ABEM) pass rates.[1] While the ACGME acknowledges the general trend,[12] they have not presented comparative evidence showing that graduates from four-year programs achieve better results on these examinations than their three-year counterparts.[8] In fact, current data seems to indicate the opposite. A 2023 ABEM analysis of 2018-2020 outcomes found that three-year EM graduates achieved a statistically significant higher pass rate on the Qualifying Examination than four-year graduates (93.1% vs 90.8%).[8, 13] For the Oral Certification Examination, pass rates showed no statistically significant difference between the groups; the minor variations observed are unlikely to represent a meaningful difference in educational outcomes.[14]

Furthermore, recent studies evaluating early-career clinical performance have not identified an advantage for graduates of four-year programs. An extensive study by US Acute Care Solutions (USACS) detected no significant variations in performance indicators such as patients per hour, relative value units per hour, or 72-hour returns needing admission/transfer, between new third-year and four-year program graduates in their first year.[14-15] The USACS researchers concluded that overall performance concerning "efficiency, safety, and flow were largely similar" between the cohorts.[8, 15] Therefore, using the overall decline in board pass rates to justify mandating a fourth year appears inconsistent with the specific comparative evidence available.[8] The ACGME needs to provide straightforward data demonstrating the necessity of this mandate.

Mandating a fourth residency year would impose substantial financial burdens on trainees and potentially negatively impact EM recruitment. Comparing an average attending compensation of $385,554 and a PGY-4 salary ≈ $70,000 introduces a significant opportunity cost of at least $200,000-$250,000 and potentially over $300,000 for an additional year at a lower resident salary.[16-17] This compounds existing average medical student debt exceeding $200,000.[18] The increased time and financial commitment would likely reduce EM's competitiveness relative to three-year specialties like internal medicine or pediatrics, which is notable given program length's impact on medical student specialty interest.[19] This risks deterring highly qualified applicants, which appears unwise during a volatile match period for the specialty.[20] Furthermore, a mandatory fourth year could discourage graduates from pursuing fellowship training or academic careers. After a longer residency, factors such as the debt burden, burnout from training, and a desire to finally begin full practice may make the prospect of an additional one to two years of fellowship less appealing.[21-22] The proposal imposes unnecessary burden and could shrink the pipeline of future subspecialists and academic leaders.

The ACGME's proposal to mandate a 48-month training duration for all EM residency programs is a solution in search of a problem that has yet to be defined by compelling evidence. Their justifications for this mandate do not withstand scrutiny based on currently available data. It also imposes significant financial burdens on trainees and carries substantial risks of negatively impacting specialty attractiveness and the pursuit of fellowship training. We urge the ACGME to pause the implementation of this requirement and engage in a transparent process that presents complete data demonstrating why a universal 48-month mandate is necessary and how it will lead to measurable improvements in educational outcomes and patient care that outweigh its considerable costs. The future of EM training deserves decisions grounded in evidence, not assumption. Preserving flexibility and choice in program length, a structure under which most of our specialty currently trains successfully, should remain the standard unless irrefutable evidence proves otherwise. Major reforms in graduate medical education must adhere to the same evidence-based principles we demand in our clinical practice.

Link to Addtional Expert Commentary: https://escholarship.org/uc/item/4zb183gj

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Additional Commentary on "The Proposed 48-Month Emergency Medicine Residency Requirement Demands Immediate Scrutiny"

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This paper provides commentary on the accompanying publication, "The Proposed 48-Month Emergency Medicine Residency Requirement Demands Immediate Scrutiny." The ACGME Residency Review Committee for Emergency Medicine recently proposed a change to the required length of training to 48 months. Currently, there is a lack of objective data to support the optimal duration of emergency medicine residency training. One of the primary concerns regarding a mandated fourth year is the significant financial burden it would place on training programs. If sponsoring institutions are unable or unwilling to provide the necessary resources to support a prolonged curriculum, programs could be compelled to reduce resident class sizes. A reduction in class size would negatively impact the educational environment, including emergency department coverage and participation in external rotations. To better prepare physicians for independent practice, it may be time to consider a base training length of 36 months, followed by alternative pathways such as fellowships, focused practice designations, or targeted curricula—all of which may be more effective than extending the duration of residency training.[West J Emerg Med. 2025;26(4)767–768.]

The debate regarding the optimal duration and format for emergency medicine (EM) residency training has persisted for over three decades among program directors (PD) and professional organizations. Historically, discussions among PDs from both three- and four-year programs have often ended with a reluctant consensus: that three and a half years might be a reasonable compromise. This conclusion, however, was based largely on anecdotal experience. Some residents demonstrated readiness for independent practice at the end of three years, while others benefited from a fourth year. At the time, objective data were scarce, and no single organization had assumed the responsibility of establishing a standardized model for EM training.

As a result, individual programs—along with their PDs, sponsoring institutions, and affiliated clinical sites—have independently determined their educational goals, curricular designs, and resource allocations to be compliant with the requirements of the Accreditation Council for Graduate Medical Education. Although this approach lacks uniformity, it has largely served the specialty well. Over the past three decades, emergency departments (ED) have faced a growing array of clinical and operational challenges, including emerging diseases, evolving care paradigms, rising patient volumes, and increasing length of ED boarding times. Despite these mounting demands, most EM residency programs have continued to produce competent, practice-ready physicians while successfully integrating new technologies, managing public health crises, and addressing administrative responsibilities.

For the sake of transparency, the authors of this commentary collectively possess over 75 years of experience in EM education, curriculum development, clinical teaching, and training standard design. We have directed both three- and four-year programs and are well-versed in the respective strengths and limitations of each format. Our leadership roles span Program Director, Education Dean, Designated Institutional Official, and officer positions within the Council of Residency Directors in Emergency Medicine (CORD), including a past presidency. While it is reasonable to assume that members of the Program Requirements Writing Group and summit attendees also have considerable experience, the

omission of detailed qualifications in the methodology section weakens the transparency and credibility of the report.

One of the central arguments against a mandated fourth year of residency is the significant financial burden it would impose. Beyond compounding medical student debt, an additional year of training would likely strain institutional budgets. Although the Centers for Medicare & Medicaid Services (CMS) has indicated that longer EM training would proportionally increase federal funding for graduate medical education, many programs rely only partially on CMS support and depend on other, often limited, funding sources. If sponsoring institutions are unable or unwilling to provide additional resources, programs may be forced to reduce class sizes to accommodate a longer curriculum. This would not only be a financial concern but also an educational one.

Reduced class size could negatively affect residents' learning environments, including ED coverage and engagement in external rotations. For instance, when EM residents rotate consistently on trauma services, they become integral members of the team. This continuity fosters trust, increases access to procedures, and enhances learning opportunities. If fewer residents are available due to smaller class sizes, such continuity and integration may be compromised, diminishing the educational quality of these experiences. Although difficult to quantify, these impacts are nonetheless meaningful.

While it is true that the scope of EM is expanding into increasingly diverse and specialized areas, this evolution may call for a modified, competency-based approach to training. Rather than adhering to the traditional "Anyone, Anything, Any time" mantra, a more practical goal for core EM education would be to prepare physicians for safe, autonomous practice in the most common clinical settings. Training for more specialized environments—such as rural, austere, academic, or military practice—could be pursued through post-residency fellowships, targeted curricula for added qualifications or focused practice designations.

This model mirrors the pathway established in general surgery, where completion of a core residency may be followed by subspecialty training in acute care surgery, accredited by the American Association for the Surgery of Trauma. Similarly, EM training could consist of a standardized 36-month core curriculum, followed by an optional 12-month (or longer) period for individualized training in areas such as ultrasound, administration, global health, or critical care. This structure would preserve flexibility for both residents and residencies and allow programs to maintain their current duration of training while ensuring rigorous preparation for board certification and independent practice. Moreover, providing options for extended training would likely support recruitment by offering applicants greater alignment between program offerings and personal career goals. Our specialty is constantly evolving to meet the demands of a changing healthcare environment, so should our approach to educating our residents and determining their training requirements.

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Letter of Concern from the Association of Academic Chairs of Emergency Medicine Regarding ACGME Proposed Changes

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This letter, signed by over 50 academic chairs of emergency medicine, urges the ACGME to reconsider a proposed mandate requiring all emergency medicine residency programs to adopt a four-year training model. The authors argue that current three-year programs are supported by data demonstrating equivalent educational and clinical outcomes compared to four-year formats. They criticize the flawed survey methodology underpinning the proposal, note the loss of milestone-based training flexibility, and highlight the lack of added scholarly or clinical value in the fourth year. The letter also outlines negative consequences for fellowship participation, workforce development, trainee debt, and diversity. The signatories advocate for maintaining the current flexible training model to preserve excellence, equity, and innovation in emergency medicine education. [West J Emerg Med. 2025;26(4)769–772.]

To: Accreditation Council for Graduate Medical Education
401 North Michigan Avenue, Suite 2000
Chicago, IL 60611

May 1, 2025
Dear Members of the Accreditation Council for Graduate Medical Education,

We, the undersigned academic chairs of emergency medicine departments are writing to express our deep concerns regarding the recent proposal to mandate a transition from the current 3- or 4-year training format to a compulsory 4-year residency requirement in Emergency Medicine. This decision would impact 80% of all Emergency Medicine training programs and is of utmost concern to us.

Our objections to this decision are as follows:

Data from the American Board of Emergency Medicine and other reputable sources does not support the necessity of lengthening training to four years to achieve the knowledge thresholds sought. In fact, existing data supports the quality and competency of residents graduating from well-established 3-year programs. Mandating an additional year of training without clear empirical evidence undermines the proven efficacy of current training models. For example, studies by Beeson et al.[1], Hayden et al.[2], and Nikolla et al.[3] demonstrate that there are no significant differences in board examination performance or clinical competence between graduates of 3-year and 4-year programs.

The decision to implement this change appears to have been based on survey data that is fundamentally flawed. The survey methodology obscured the true intent behind the questions and included leading questions that biased the results. Such flawed data cannot serve as a reliable basis for making substantial changes to residency training requirements.

By mandating a 4-year training period, the new policy negates the milestone-based curriculum that has been a cornerstone of Emergency Medicine residency training. Program Directors currently have the discretion to graduate residents after 3 years upon achievement of all required milestones or to add individualized training as needed. This flexibility allows for tailored educational experiences that align with individual resident capabilities and career goals. A one-size-fits-all approach would erode this effective, individualized training model.

Moreover, the addition of a fourth year fails to introduce meaningful enhancements to scholarly activity or research requirements that would substantively advance our specialty. While we recognize that extended training may benefit select individuals, mandating a 4-year format for all residents should be accompanied by corresponding scholarly expectations and justifications—not just additional service time.

While Emergency Medicine physicians are well-prepared for careers beyond direct clinical emergency department care through the current 3-year format, mandating a fourth year is less efficient for learners, the specialty, and the healthcare workforce. Residents seeking non-clinical pathways typically pursue fellowships, and a streamlined 3-year residency followed by focused fellowship training offers the most efficient trajectory. A study by Ehmann et al.[4] revealed that transitioning from a 3-year to a 4-year Emergency Medicine residency format led to a reduction in the number of graduates pursuing fellowship training. This suggests that extended base training may dissuade residents from subspecializing, potentially diminishing the future pipeline of EM experts in critical areas such as toxicology, ultrasound, and critical care. Imposing a fourth generalized year risks discouraging fellowship participation and contradicts ongoing efforts to reduce unnecessary burdens on trainees. Maintaining the 3-year model supports individualized training, fosters lifelong learning and career satisfaction, and sustains a diverse and dynamic pipeline for future Emergency Medicine leadership.

The financial impact of transitioning to a mandatory 4-year model is also significant. For hospitals, adding an incompletely funded fourth year would further strain already thin margins threatened by reimbursement cuts. Arguments suggesting that increased low-acuity clinical time and reduced advanced practitioner staffing would offset these costs conflate service needs with educational priorities, undermining the true mission of graduate medical education. For trainees, the additional year would exacerbate their already considerable six-figure educational debt—a burden that disproportionately affects URiM (Underrepresented in Medicine) students and risks dissuading them from entering the specialty altogether.

In conclusion, we urge the ACGME to reconsider this decision in light of these concerns. Flexibility in residency training duration, grounded in evidence-based practices and responsive to the diverse needs of our trainees and specialty, is essential to advancing Emergency Medicine education and maintaining excellence in patient care.

Thank you for considering our perspectives on this critical matter. We remain committed to working collaboratively with the ACGME to ensure that any changes to Emergency Medicine residency requirements uphold the highest standards of medical education and service to our communities.

Sincerely,

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Impact of Medical Student Involvement on Emergency Department Outcomes: A Tertiary Center Analysis

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Introduction: Increasing patient use of emergency departments (ED) and overcapacity threaten both efficiency of the care provided and the teaching mission. We investigated the influence of medical student (MS) involvement on ED throughput, resource use, and clinical outcomes, and we addressed gaps in existing literature that primarily focus on resident physicians and singular throughput metrics.

Methods: We conducted a retrospective observational analysis of 123,503 encounters with patients >21 years of age at an urban, tertiary-care hospital, comparing cases with and without MS participation. We excluded patients seen by advanced practice practitioners. We compared continuous variables using *t*-tests with bootstrap, and categorical variables by chi-square tests. Continuous variables were reported with mean and standard deviation.

Results: We analyzed patient encounters both with and without MS coverage across various complexity levels from January 1, 2022–December 31, 2023. Of the 123,503 patient encounters, 9,635 (7.8%) involved MS participation, and 113,868 (92.2%) did not. Across all encounters, door-to-physician time showed no significant difference between encounters with (28.1 minutes ± 38.6) and without medical students (28.4 minutes ± 38.0; $P = .435$), while door-to-triage and arrival-to-disposition time (292.6 minutes ± 193.7 vs 270.4 minutes ± 532.8; $P < .001$) and doctor-to-disposition time (266.8 minutes ± 186.1 vs. 242.9 minutes ± 376.4; $P < .001$) were significantly longer. In high-complexity encounters, patients seen with medical students experienced shorter door-to-physician (26.6 vs 28.2 minutes, $P < .001$), door-to-triage (13.6 vs 14.5 minutes, $P = .03$), arrival-to-disposition (301.1 vs 307.7 minutes, $P = .02$), and doctor-to-disposition times (275.2 vs 281.3 minutes, $P = .02$).

Conclusion: We found that medical student involvement is associated with longer patient stays in low- to medium-complexity cases but improved efficiency in the management of high-complexity cases. Increased rates of some diagnostic imaging and higher admission rates occurred with medical students. Our single-center design highlights the need for multicenter validation of these findings to inform future resource allocation and educational strategies in the ED. [West J Emerg Med. 2025;26(4)773–780.]

INTRODUCTION

With healthcare access shortages, the role of the emergency department (ED) has evolved from its original mission of stabilizing and treating critically ill patients to encompass a broader function as a safety net for primary medical care.[1,2] This shift in medical infrastructure has significantly impacted the efficiency of care provided within the ED, contributing somewhat to crowding[3,4] with the acknowledgement that

hospital capacity constraints remain the primary driver of ED crowding.[5,6] In this milieu of meeting multiple community and hospital needs, rotations within the ED remain an integral facet of a medical student's (MS) educational development.[7] Consequently, MS involvement in patient care requires that emergency physicians dedicate additional time on shift toward student presentations, supervision, and teaching. While some studies have highlighted improved patient outcomes with MS participation, concerns persist regarding potential inefficiencies in clinical care environments that are inherently reliant on timely intervention.[8-11] The challenge posed to hospitals, and to EDs in particular, is how to properly balance an academic mission with high-quality care, timely throughput, and satisfactory patient metrics.

Previous investigations have attempted to quantify the impact of a learner on patient care, although these studies have primarily involved smaller cohorts and often used a singular throughput metric (eg, ED length of stay [LOS]).[12-15] A recent systematic review rated these studies as low-quality evidence with high risk of bias, highlighting the difficulty of isolating MS effects on the provision of care in a multicare model department.[16] While LOS is frequently used as an indicator of efficiency in the ED, relying on this metric alone has notable limitations. The LOS is heavily influenced by external variables such as boarding times and availability of inpatient beds.[17] These factors outside the control of ED processes can confound interpretations of LOS and obscure the true contributions of medical students. Furthermore, small sample size restricts the generalizability of findings and narrows the scope of potential outcome measures, limiting a comprehensive understanding of the role medical students play in ED efficiency and patient care.[8] Additional studies have focused on evaluating relative value units (RVU) and patients seen per hour and have noted no significant differences at the expense of MS teaching.[18,19] Although these metrics provide insight into productivity and throughput, they represent only a fraction of the complexity involved in assessing ED efficiency.

While the current literature mainly addresses the impact of resident physicians on ED throughput measures and patient care metrics, the limited studies pertaining to the impact of medical students have produced conflicting results. In this study we aimed to elucidate a more thorough understanding of the impact of a medical student through a more holistic lens of considering throughput, utilization, and outcomes metrics concurrently. This comprehensive evaluation could guide future resource allocation decisions, help enhance the balance between educational and operational priorities and ultimately improve both the quality of medical education and patient care in emergency settings.

Population Health Research Capsule

What do we already know about this issue?
Residents in the emergency department (ED) have variable effects on ED throughput, resource utilization, and clinical outcomes.

What was the research question?
What is the influence of medical students' involvement on ED throughput, resource utilization, and clinical outcomes?

What was the major finding of the study?
We found overall doctor-to-disposition time (266.8 minutes vs. 242.9 minutes, P < .001) was longer with medical students, but for high-complexity patients, doctor-to-disposition times (275.2 vs 281.3 minutes, P =.02) with medical students were shorter.

How does this improve population health?
Calculating the "true" impact of a learner in the ED is difficult. More research is needed to balance learner interaction and bedside education with efficient, effective patient care.

METHODS

Data Source

We conducted a retrospective observational study at an urban, tertiary-care hospital in the United States to compare patient throughput, resource utilization, and clinical outcomes between encounters with and without MS involvement. This study was carried out in the adult ED of a large, community tertiary-care hospital, which accommodates approximately 95,000 patient visits annually. This adult ED evaluates patients >21, while those ≤21 years of age are evaluated in the pediatric ED and, therefore, were excluded from this study. The ED is staffed predominantly by board-certified emergency attendings, advanced practice practitioners (APP), and attendings who supervise medical students. All MS were in their fourth year on their mandatory core clerkship from the same medical school.

Patient encounters from January 1, 2022–December 31, 2023, were included in the study. We extracted data using a Crystal Report (SAP SE, Walldorf, Baden-Württemberg, Germany), a structured query language-based service that pulls data from the electronic health record (EHR) (Epic Systems Corporation, Verona, WI). Medical student involvement was determined through billing codes. As students were assigned within the ED to attending physicians for the duration of a shift, they were added to the care team function in the medical record for those attendings' patients. This allows the billing/coders to be prompted to add the appropriate billing modifier (eg, GC modifier [treatment by a resident physician] on Medicare patients), which is a searchable, structured date-entry function in the EHR database. All clinical data were de-identified prior to analysis. All billing codes were derived from Current Procedural Terminology (CPT) codes and reflected the post-

care evaluation of the level of service provided. Consistent with previous studies, low-complexity encounters contained CPT codes 99281, 99282; medium-complexity encounters contained CPT codes 99283, 99284; and high-complexity encounters were defined as CPT codes 99285, 99291.[20,21] We applied the abstraction standards of Worster et al, which includes these elements: case-selection criteria definition; variable definition; abstraction forms (a database in which data was automatically abstracted from the EHR with no human review and all patient data scrubbed prior to entry into the database); blinding to hypothesis; medical record identified and scrubbed of identifying data in automated manner; a missing data plan, and institutional review board approval.[22]

Study Design and Outcomes

Throughput metrics included arrival-to-disposition time (from ED arrival to entry of a discharge disposition in the EHR); door-to-triage time (from ED arrival to completion of assessment by a triage nurse); door-to-physician time (from ED arrival to an initial evaluation by a physician); and doctor-to-disposition time (from physician evaluation to entry of a discharge disposition in the EHR). We analyzed rates of discharge, hospital admission (including both inpatient and observation level of care), and transfer to another facility. Additional metrics included the percentage of patients who left against medical advice (AMA) and the rate of return to the ED within 72 hours.

We measured resource utilization by the number of diagnostic imaging studies per 100 visits, including computed tomography CT, MRI, plain radiographs, and ultrasound. Outcome metrics were evaluated through the admission rate, transfer rate, and Current Procedural Terminology (CPT) code complexity. We compared continuous variables using *t*-tests with bootstrap and categorical variables by chi-square tests. We reported continuous variables with mean and standard deviation, and the 95% confidence interval (CI) of mean difference. Data analysis was performed using Stata Statistical Software, Release 17.0 SE (StataCorp LLC, College Station, TX, 2021). This study was approved by the institutional review board of Rochester Regional Health.

RESULTS

We analyzed patient encounters both with and without MS coverage across various complexity levels, as defined by CPT codes, from January 1, 2022–December 31, 2023. A total of 123,503 encounters were included in the analysis after excluding 42,578 due to age <21 and 23,945 seen only by APPs. Of these, 9,635 (7.8%) were MS-covered, and 113,868 (92.2%) were not (see Figure).

General Metrics Across All Patient Groups

Across all encounters, door-to-physician time showed no significant difference between encounters with MS (28.1 minutes ± 38.6) and without MS (28.4 minutes ± 38.0; P = .44). However, door-to-triage time was significantly shorter with MS involvement (14.3 minutes ± 15.0 vs 15.7 minutes ± 27.7; P < .001). Arrival-to-disposition time (292.6 minutes ± 193.7 vs 270.4 minutes ± 532.8; P < .001) and doctor-to-disposition time (266.8 minutes ± 186.1 vs. 242.9 minutes ± 376.4; P < .001) were both significantly longer with MS involvement. Utilization measures per 100 visits showed significant differences in computed tomography (CT) (45.2/100 visits with MS vs 41.0/100 without, P<.001) and plain radiographs, ie, all radiographs of all types (47.1/100 visits with MS vs 44.7/100 visits with, P <.001) but not in MRI, ultrasounds, or portable chest radiographs (as a subgroup of all plain radiographs). Patient outcomes included higher admission rates (23.1% vs 18.1%; P < .001) and higher rates of leaving against medical advice (AMA) (1.7% vs 1.1%; P < .01) for encounters with MS. However, the discharge rate was lower (56.6% vs 66.7%; P < .001), with no significant difference in the rate of patients returning to the ED within 72 hours (6.3% vs 6.4%; P = .55) (Table 1).

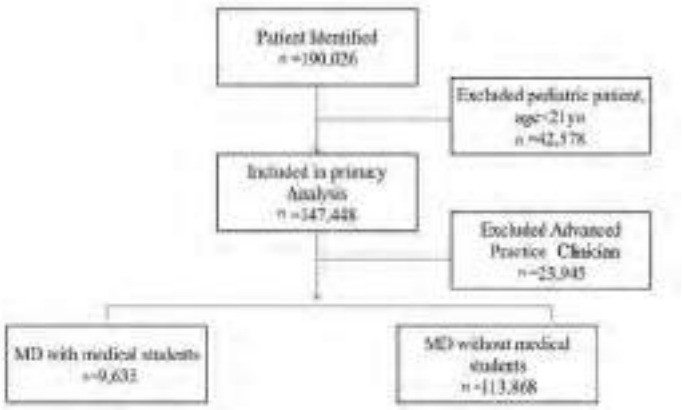

Figure. Patient selection flow chart.
MD, medical doctor; *yo,* year old.

Low-Complexity Encounters

Patients with medical students experienced longer door-to-physician times (32.3 vs 28.9 minutes, P = .12) and arrival-to-disposition times (186.5 vs 145.9 minutes, P < .001). Utilization measures showed no significant differences in CT, magnetic resonance imaging (MRI), or portable chest radiographs, but slightly higher ultrasound use (0.7 vs 0.3 per 100 visits, P = .37). Discharge rates were notably lower (28.5% vs.54.5%, P < .001), although the return to ED within 72 hours did not differ significantly (Table 2).

Medium-Complexity Encounters

For medium complexity encounters, all throughput measures were longer with MS involvement, notably arrival-to-disposition time (290.0 minutes ± 253.4 vs 262.8 minutes ± 440.3; P < .001) and doctor-to-disposition time (260.1 minutes ± 252.3 vs 236.1 minutes ± 439.3; P <

Table 1. Effect of medical students on emergency department throughout and utilization, comparative metrics across all patient groups with and without medical student coverage.

	Mean and SD in minutes with MS (n=9,635)	Mean and SD in minutes without MS (n=113,868)	*P*-value and 95% CI for mean difference
Throughput measures			
Door-to-physician time	28.1 (38.6)	28.4 (38.0)	*P* =.44 (95% CI: -1.1 to 0.5)
Door-to-triage time	14.3 (15.0)	15.7 (27.7)	*P* <.001 (95% CI -1.9 to 0.8)
Arrival-to-disposition time	292.6 (193.7)	270.4 (532.8)	*P* <.001 (95% CI 11.5 to 32.8)
Doctor-to-disposition time	266.8 (186.1)	242.9 (376.4)	*P* <.001 (95% CI 16.3 to 31.5)
Utilization measures			
CT/100	45.2 (76.5)	41.0 (73.7)	*P* <.001 (95% CI 2.7 to 5.7)
PR/100	47.1 (78.1)	44.7 (77.6)	*P* <.001 (95% CI 0.8 to 4.0)
MRI/100	1.4 (13.2)	1.3 (13.4)	*P* =.71 (95% CI: -0.2 to 0.3)
US/100	8.2 (28.5)	7.8 (28.2)	*P* =.25 (95% CI -0.2 to 0.9)
PCXR/100	9.5 (30.1)	9.4 (30.0)	*P* =.84 (95% CI -0.6 to 0.7)
Patient outcomes measures			
Admission rate (%)	23.1% (n=2,222)	18.1% (n=24,983)	*P* < .001 (95% CI 0.04 to 0.06)
Transfer rate (%)	0.3% (n=27)	0.3% (n=439)	*P* = .52 (95% CI: -0.001 to 0.0008)
AMA rate (%)	1.7% (n=162)	1.1% (n=1982)	*P* <.001 (95% CI 0.001 to 0.006)
Discharge rate (%)	56.6% (n=5,456)	66.7% (n=91,863)	*P* < .001 (95% CI -0.1 to -.09)
Return to ED within 72 hours rate (%)	6.3% (n=604)	6.4% (n=8,849)	*P* =.55 (95% CI -0.007 to 0.004)

ED, emergency department; *MS,* medical student; *CI,* confidence interval; *CT/100*, computed tomography per 100 visits; *PR/100*, plain radiographs per 100 visits; *MRI/100*, magnetic resonance imaging per 100 visits; *US/100*, ultrasound per 100 visits; *PCXR/100*, portable chest radiographs per 100 visits; *AMA*, against medical advice; *ED,* emergency department.

0001). Use of CT was significantly higher (13.7 vs 10.6 per 100 visits, *P* < .001), as were AMA rates; but the discharge rate was significantly lower with MS involvement (87.4% vs 90.8%; *P* = .001) (Table 3).

High-Complexity Encounters

For high-complexity encounters, medical student patients experienced shorter door-to-physician times (26.6 vs 28.2 minutes, *P* < .001) and door-to-triage times (13.6 vs 14.5 minutes, *P* = .03). Arrival-to-disposition (301.1 minutes with a MS vs 307.7 without, *P* =.02) and doctor-to-disposition times (275.2 minutes with MS vs 281.3 minutes, *P*=.02) were also shorter for the MS group. Utilization of CT and MRIs showed no significant differences, but there was a trend toward higher CT use, which did not reach statistical significance. Admission rates were equivalent (34.4% vs 33.6%, *P* =.22), and discharge rates were lower (45.4% vs. 48.4%, *P* < .001), with no significant differences in rates of leaving AMA or returning to the ED within 72 hours (Table 4).

DISCUSSION

By the concurrent analysis of multiple opportunity costs of a learner in the venue of a busy ED, we sought to derive more holistic data for leaders managing the staffing and supervision models of teaching EDs. Medical students appear to create a time inefficiency in disposition time metrics (arrival-to-disposition, doctor-to-disposition), which does not exist in door-to-clinician or door-to-triage times. Ambulatory patients are generally triaged by an advanced practice practitioner prior to physician/student involvement and, therefore, the student should not affect those metrics. However, it should be noted that the disposition time inefficiency is correlated with complexity of patient care: it is highest for both metrics in low-complexity patients, less so in medium-complexity patients, and is, in fact, a time efficiency with superior time-to-disposition measures in high-complexity patients. In short, the more complicated the patient's care, the more efficient the care. This contradicts findings in Delaney et al but is seen in one of the two medical centers in Corey et al.[8,20] Of note is that these studies occurred pre-COVID-19 pandemic, and post-COVID-19 pandemic, respectively, and differences in workflow from the pandemic cannot be separately evaluated. However, it is reasonable to assume that the added time a student takes to perform a history or perform a procedure on the less acutely ill patients and then present those findings to an attending accounts for the disparities at lower levels of acuity. In contrast, an attending may provide direct supervision and use the student as an extra data collector or procedural assistant on the higher acuity patients, resulting in time efficiency. From a staffing model perspective, it is possible that placing students predominantly in areas of high acuity may be a

Table 2. Effect of medical students on emergency department throughout and utilization, comparative metrics across patient groups with and without medical student coverage for low-complexity encounters, hospital Current Procedural Terminology (CPT) codes.

	CPT 99281, 99282 (n=4,326)		
	Mean and SD in minutes with MS (n=305)	Mean and SD in minutes without MS (n=4,021)	*P*-value and 95% CI for mean difference
Throughput measures			
Door-to-physician time	32.3 (47.4)	28.9 (35.7)	.12 (95% CI -0.9 to 7.8)
Door-to-triage time	22.6 (20.8)	21.5 (21.7)	.41 (95% CI: -1.5 to 3.7)
Arrival-to-disposition time	186.5 (157.2)	145.9 (197.0)	<.001 (95% CI 17.9 to 63.2)
Doctor-to-disposition time	156.3 (153.1)	119.1 (196.2)	<.001 (95% CI 14.2 to 60.2)
Utilization measures			
CT/100	0.3 (5.7)	0.7 (11.8)	.59 (95% CI -1.7 to 1.0)
PR/100	0.3 (5.7)	1.1 (13.1)	.32 (95% CI -2.2 to 0.7)
MRI/100	0	0.02 (1.6)	.78 (95% CI -0.2 to 0.2)
US/100	0.7 (11.5)	0.3 (5.7)	.37 (95% CI -0.4 to 1.1)
PCXR/100	0	0.07 (0.03)	.63 (95% CI -0.4 to 0.2)
Patient outcomes measures			
Admission rate (%)	0	0.07% (n=3)	.63 (95% CI -0.004 to 0.002)
Transfer rate (%)	0.3% (n=1)	0	<.001 (95% CI 0.002 to 0.005)
AMA rate (%)	1.0% (n=3)	1.8% (n=74)	.28 (95% CI: -0.02 to 0.01)
Discharge rate (%)	28.5% (n=87)	54.5% (n=2,192)	<.001 (95% CI -0.32 to -0.20)
Returned to ED within 72 hours (%)	13.1% (n=40)	11.9% (n=478)	.52 (95% CI -0.03 to 0.05)

MS, medical student; *CI,* confidence interval; *CT/100*, computed tomography per 100 visits; *PR/100*, plain radiographs per 100 visits; *MRI/100*, magnetic resonance imaging per 100 visits; *US/100*, ultrasounds per 100 visits; *PCXR/100*, portable chest radiographs per 100 visits; *AMA*, against medical advice; *ED,* emergency department.

facilitator of care, while simultaneously preserving both the richness of educational opportunity that complex patients provide and the ability to provide significant direct supervision for feedback and evaluation purposes.

In all-comers across utilization measures, patients cared for by a medical student received more CT and plain radiographs. This is most likely due to the patient selection process for medical students, as the physician will choose patients with more interesting and complex pathophysiology. The less "interesting" patients would be selected to be seen by attendings only since those patients may not provide as rich a learning experience. The increased number of CT and plain radiographs may be associated with a student's inexperience or lack of confidence in their examination skills, although this hypothesis cannot be proven in the format of this study. More resource-intensive testing (eg, MRI and ultrasound) rates were identical. However, on subgroup analysis, the only utilization rate that was significantly higher for medical student-covered patients was CT in the medium-complexity patient group. Low-acuity and high-acuity situations more typically follow a routine treatment algorithm/evaluation bundle and, therefore, these patients fall into an area where the inexperienced physician may generate more clinical certainty for themselves by relying on imaging. Additionally, this difference may be explained by an attending's influence and clinical acumen on a medical student's treatment plan. Further, higher acuity patients are more likely to get multiple radiologic images due to the need to evaluate their more complex state.

This utilization data contradicts previous studies of resident utilization data compared to attendings,[20,21] although it is similar to the limited subset of data available from a 1999 French medical student strike.[11] This may be explained by attendings having more direct impact on patient care with MS coverage rather than the model of encouraging residents to work toward independent practice.

Across patient outcome measures, MS-covered patients had higher admission rates and patients leaving AMA, although again this disappeared in high complexity encounters. As differences were contained within only the low- and medium-complexity patients, the prolonged time to disposition seen with MS coverage in those patients may explain this finding. There is limited literature with which to compare the data, but the medium-complexity patient data are similar to the small sample size in Jadhav et al, while contradicting Jadhav et al, for the low-complexity patients.[21] This, therefore, seems an area for further research.

LIMITATIONS

While this study included data from two years in a high-volume ED, there are several limitations. This was a

Table 3. Effect of medical students on emergency department throughout and utilization, comparative metrics across patient groups with and without medical student coverage for medium-complexity hospital Current Procedural Terminology (CPT) codes.

	CPT 99283, 99284 (n=39,121)		
	Mean and SD in minutes with MS (n=2,805)	Mean and SD in minutes without MS (n=36,316)	*P*-value and 95% CI for mean difference
Throughput measures			
Door-to-physician time	31.0 (41.8)	29.6 (38.8)	.08 (95% CI -0.2 to 2.9)
Door-to-triage time	15.2 (15.7)	15.6 (18.0)	.28 (95% CI -1.1 to -0.3)
Arrival-to-disposition time	290.0 (253.4)	262.8 (440.3)	<.001 (95% CI 8.7 to 41.7)
Doctor-to-disposition time	260.1 (252.3)	236.1 (439.3)	<.001 (95% CI 7.5 to 40.5)
Utilization measures			
CT/100	13.7 (47.7)	10.6 (42.3)	<.001 (95% CI 1.5 to - 4.7)
PR/100	32.8 (74.1)	32.2 (75.1)	.72 (95% CI -0.02 to 0.03)
MRI/100	0.07 (2.67)	0.1 (3.7)	.56 (95% CI -0.2 to 0.10)
US/100	0.6 (8.0)	0.4 (6.4)	.07 (95% CI -0.02 to 0.5)
PCXR/100	4.1 (19.9)	3.6 (19.2)	.25 (95% CI -0.3 to 1.2)
Patient outcomes measures			
Admission rate (%)	0	0.07% (n=24)	.17 (95% CI -0.002 to 0.0003)
Transfer rate (%)	0.1% (n=3)	0.2% (n=77)	.24 (95% CI -0.003 to 0.007)
AMA rate (%)	2.6% (n=73)	1.9% (n=691)	<.001 (95% CI 0.002 to 0.012)
Discharge rate (%)	87.4% (n=2,451)	90.8% (n=32,977)	<.001 (95% CI -0.05 to 0.02)
Returned to ED within 72 hrs (%)	8.4% (n=235)	7.8% (n=2,827)	.26 (95% CI -0.004 to 0.02)

MS, medical student; *CI,* confidence interval; *CT/100*, computed tomography per 100 visits; *PR/100*, plain radiographs per 100 visits; *MRI/100*, magnetic resonance imaging per 100 visits; *US/100*, ultrasound per 100 visits; *PCXR/100*, portable chest radiographs per 100 visits; *AMA*, against medical advice; *ED,* emergency department.

Table 4. Effect of medical students on emergency department throughout and utilization, comparative metrics across patient groups with and without medical student coverage for high-complexity hospital Current Procedural Terminology (CPT) codes.

	CPT 99285, 99291 (n=75,518)		
	Mean and SD in minutes with MS (n=6,407)	Mean and SD in minutes without MS (n=71,111)	*P* value and 95% CI for mean difference
Throughput measures			
Door-to-physician time	26.6 (36.4)	28.2 (38.0)	<.001 (95% CI -2.6 to 0.7)
Door-to-triage time	13.6 (14.2)	14.5 (33.7)	.03 (95% CI -1.7 to 0.7)
Arrival-to-disposition time	301.1 (160.0)	307.6 (218.4)	.02 (95% CI -12.0 to 1.0)
Doctor-to-disposition time	275.2 (147.4)	281.3 (212.9)	.02 (95% CI -11.5 to 0.8)
Utilization measures			
CT/100	61.8 (83.3)	59.8 (82.2)	.07 (95% CI: -0.2 to 4.1)
PR/100	56.3 (80.1)	54.8 (79.9)	.16 (95% CI -0.6 to 3.5)
MRI/100	2.1 (16.1)	2.1 (16.7)	.91 (95% CI -0.5 to 0.4)
US/100	10.4 (31.9)	10.6 (32.5)	.66 (95% C -1.0 to 0.6)
PCXR/100	14.0 (35.7)	14.8 (36.5)	.10 (95% CI -1.7 to 0.2)
Patient outcomes measures			
Admission rate (%)	34.4% (n=2,201)	33.6% (n=23,888)	.22 (95% CI -0.01 to 0.02)
Transfer rate (%)	0.3% (n=22)	0.5% (n=334)	.15 (95% CI -0.01 to 0.00)
AMA rate (%)	1.3% (n=85)	1.3% (n=955)	.91 (95% CI -0.003 to 0.003)
Discharge rate (%)	45.4% (n=2,910)	48.4% (n=34,447)	<.001 (95% CI -0.04 to -0.02)
Returned to ED within 72 hours (%)	4.9% (n=315)	5.4% (n=3,819)	.12 (95% CI -0.01 to 0.001)

MS, medical student; *CI,* confidence interval; *CT/100*, computed tomography per 100 visits; *PR/100*, plain radiographs per 100 visits; *MRI/100*, magnetic resonance imaging per 100 visits; *US/100*, ultrasound per 100 visits; *PCXR/100*, portable chest radiographs per 100 visits; *AMA*, against medical advice; *ED,* emergency department.

retrospective, single-center study, which limits the generalizability of the findings. Of the patients covered without a medical student, care was provided in a heterogeneous manner, with multiple treatment pathways involving advanced practice practitioners working alone or in tandem with an attending, as well as attending physician care alone. Differential practice patterns may have affected the results. In addition, given these differential pathways, it was not possible to directly compare RVU generation between the models. Given that medical students have a tendency to see the most-complex patients, it would be reasonable to assume that RVU generation would be higher on a per patient basis, but this would have been confounded by patient selection biases. Additionally, due to nursing and bed shortages in the geographic region, boarding rates in the ED dramatically increased over the course of the study, creating a boarding crisis and subsequently leading to extreme shifts in length of stay and patients seen per hour. As these changes did not have any relationship with the presence of a medical student and were of a nature external to the ED, these metrics were excluded. Finally, due to a large number of patient visits, small effect sizes may have been statistically significant but not clinically significant (eg, five minutes).

CONCLUSION

As reported in prior studies, calculating the "true" impact of a learner in the ED remains difficult; therefore, it remains an open discussion how to maximize learner interaction and bedside education with efficient, effective patient care. A model in which medical students predominantly care for higher acuity patients appears to be globally "less costly" than one in which they manage low- and medium-acuity patients. Validation of these findings in multicenter studies is necessary.

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Developing Interprofessional Immigrant Health Education for Emergency Physicians

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Background: As of 2021, there were 47 million immigrants in the United States. Immigrant populations are uninsured at higher rates than US citizens, leading many to rely on emergency departments (ED) for their healthcare needs. However, emergency physicians (EP) often lack training on the unique challenges faced by this population, necessitating educational interventions.

Methods: We implemented educational interventions for an urban emergency medicine residency program using Kern's six-step approach for curriculum development to inform EPs of existing immigration-specific patient resources; teach social-medical-legal best practices with regard to asking, documenting, and sharing immigration-specific health information; and increase awareness of ED-relevant local policies. We developed three educational interventions.in collaboration with legal organizations, and community experts. To evaluate the success of these interventions we administered a pre- and post-survey to 64 EPs (36% of 178 targeted learners)

Results: We found a significant increase in confidence and knowledge, with an average 5-point Likert scale score improvement of 1.47 ($P < .001$) in all responses and 1.40 ($P < .001$) in paired responses, and an improvement in test scores on the three knowledge-based questions of 30.66% ($P < .001$) in all responses and 33% ($P = .02$) in paired responses.

Conclusion: This study highlights a model for interprofessional collaboration in curriculum development and the importance of a multipronged educational approach to improve the care of immigrants in the ED. The curriculum offers a framework for other EDs aiming to address healthcare inequities for this population. Future research can explore long-term knowledge retention, detailed educational tool utilization, and the impact on patients. [West J Emerg Med. 2025;26(4)781–785.]

BACKGROUND

As of 2023, the United States had about 47.8 million immigrants, with over half of them being non-citizens.[1] Many studies have shown that immigrants are uninsured at disproportionately higher rates.[2–4] As a result, many lack access to primary care.[4,5] Lack of regular care renders this population more dependent on emergency departments (ED), and they are more likely to us EDs for less urgent healthcare needs.[6] Emergency physicians (EPs are not consistently trained on the unique stressors faced by this patient community. For example, EPs have expressed a lack of education on immigration policies and unfamiliarity with how to interact with immigration officials.[7,8] Having identified this gap (*Problem Identification*), there is a potential for immigrant health-focused educational interventions to address this problem. Using Kern's six-steps for curriculum development

of *Problem Identification, Targeted Needs Assessment, Objectives, Educational Strategies, Implementation*, and *Evaluation*, we implemented educational interventions to improve EPs' knowledge of immigration-related resources, medical-legal practices, and health-systems policies.[9]

OBJECTIVES

Following Kern's six steps, we developed five measurable objectives. The EPs should be able to do the following: 1) identify existing immigration resources and their referral process; 2) execute hospital guidelines for responding to immigration law enforcement in the ED; 3) describe their responsibilities when caring for immigrants; 4) apply social-medical-legal best practices around asking, documenting, and sharing immigration-specific health information; and 5) define local immigration-related policies and their impact on the practice of emergency medicine (EM).

CURRICULAR DESIGN

Setting

We targeted an EM residency program associated with a Level I safety-net trauma center, pediatric hospital, and academic quaternary-care center. As identified in the *Problem Identification* step, the program lacked an immigrant health curriculum. The *Targeted Needs Assessment* included identifying the program's 64 residents and 24 full-time residency faculty members as the targeted learners. The educational interventions were uploaded to E*Drive, the institution's centralized, open-access clinical information hub (accessible at https://edrive.ucsf.edu/).[10,11] The didactic was offered during the 2022-2023 and 2023-2024 academic years. The study was approved by the institutional review board (21-33252).

Interprofessional Curricular Design

Our design process was iterative, involved community experts, and incorporated interprofessional expertise. Using *Targeted Needs Assessment* strategies of formal interviews and focus group discussions, we invited 35 local legal organizations to provide input on educating EPs on immigration resources. Ultimately, through snowball sampling, we conducted nine 30-minute, semi-structured interviews consisting of three legal organization leaders, two city public health employees, two social workers, and two non-EPs with expertise in working with immigrant populations, and two focus groups with two multi-practice legal working groups. From this targeted assessment we identified themes that defined the curricular *Objectives*.

These partners also provided iterative feedback on the *Educational Strategies* (both "content and methods") that were later designed. Prior to *Implementation*, local EP-leaders and administrators reviewed the curriculum. The *Educational Strategies* were guided by Kern's principles of aligning with the objectives, involving multiple methods, and being resource-feasible. The interventions consisted of a customizable digital educational tool, an educational guideline handout, and an interactive didactic session. The strategies and their *Implementation* are detailed below (Figure 1).

Discharge Community Resource Educational Tool

To address Objective 1, we created a digital educational tool for immigration-specific resources: the Immigration Discharge Navigator (IDN) (accessible at https://dcnav.sfserviceguide.org/find-services/ucsf-immigration-resources). The IDN consisted of a comprehensive list of immigration legal resources available to patients and ranked them based on demographic information and geographic proximity. By inputting these components into the IDN, EPs were able to view which organization best served their patient, with a description of the organization specialization (ie, providing wraparound care for HIV-positive immigrants), location, and patient-friendly discharge handouts in seven languages—English, Spanish, Tagalog, traditional Chinese, Vietnamese, Russian, and Arabic. Previous resources were decentralized, less accessible (often relying on social workers who are not always available), and were static lists, unable to be tailored based on patient-specific factors, such as subgroups (eg, pediatric, pregnant, and elderly populations).

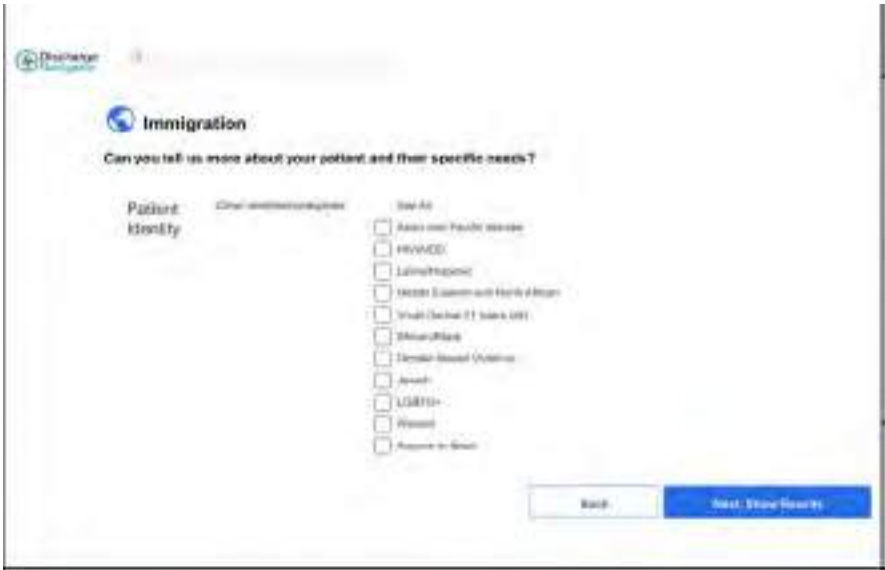
Prior to *Implementation*, 15 regional immigrant-serving organizations reviewed the IDN, approving the *Educational Strategy* and the relevancy and accuracy of resources. They emphasized its ease of usability and reiterated the need for further interventions, such as training on discussing and documenting sensitive information in the ED.

Immigration and Customs Enforcement Response Educational Guideline

To address Objective 2, we created an educational guideline detailing the EP's responsibilities and patient rights if US Immigration and Customs Enforcement officers (ICE) entered the ED. The regional Immigration Rapid Response Team (a group of attorneys and community groups), ED leadership, and physicians implementing a similar guideline in different clinical settings provided feedback on the educational guideline prior to *Implementation*. The handout was uploaded to E*Drive (accessible at https://edrive.ucsf.edu/immigration-and-customs-enforcement-ice-workflow) and was designed in the same format as other clinical guidelines on E*Drive, which has shown to facilitate ease of access, familiarity, and adherence to standards of care.[12,13]

Immigrant Health Didactic Session

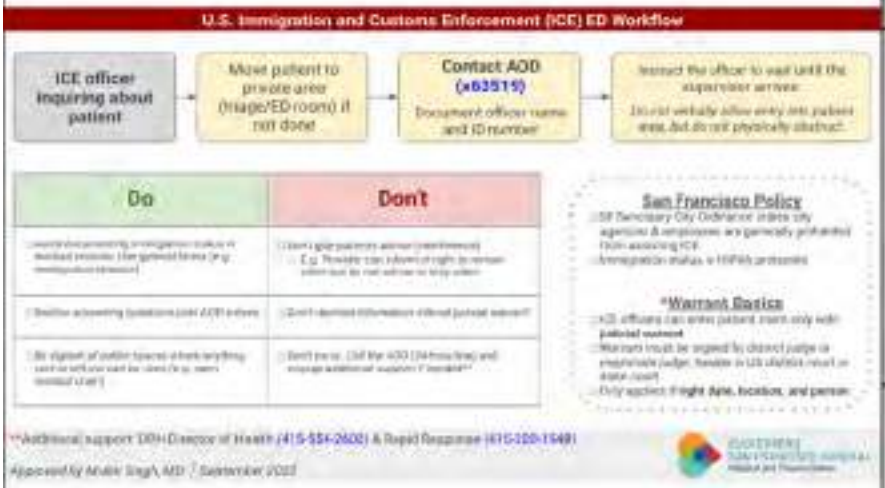
For the *Implementation* of these educational resources and to address Objectives 3-5, we designed a 30-minute didactic session. This was an interactive session (live and unrecorded) with anonymized real-life cases exemplifying the EP's role in caring for immigrants, including patient-centered documentation practices, hospital ED policies, and the



Resource Referral Tool

- Education on resources available to patients
- Focused on legal aid as the top needed resource for the population
- Simple digital tool that can be easily personalized to diverse patient needs

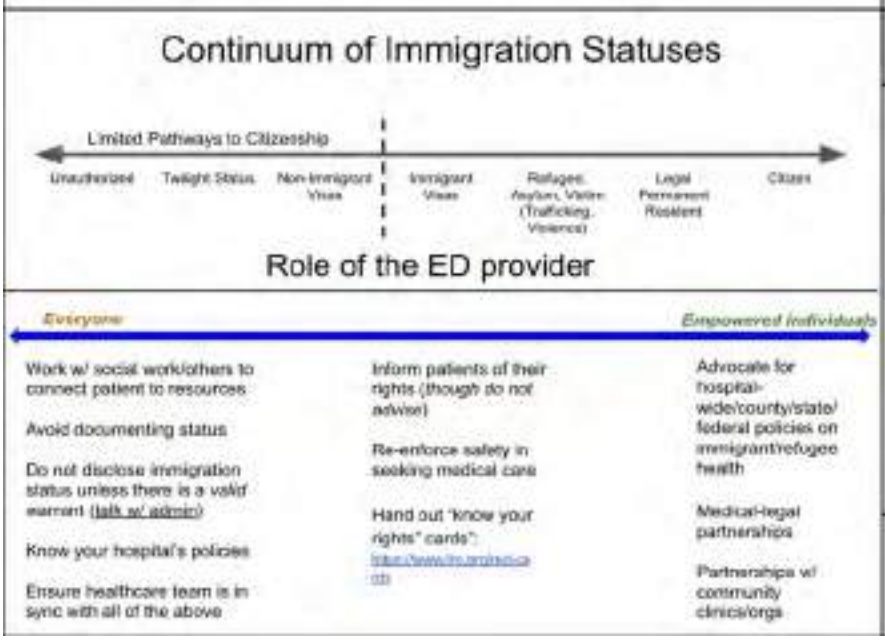
https://dcnav.sfserviceguide.org/find-services/ucsf-immigration-resources



ICE Response Tool

- Education focusing on police and law enforcement relevant to ED
- Informed by both hospital/city policy (sanctuary city) and legal recommendations
- Workflow in a standardized format to other clinical guidelines

https://edrive.ucsf.edu/immigration-and-customs-enforcement-ice-workflow



Educational Didactic Session

- Education on general immigrant topics, communication with immigrants, hospital/city policies, and tools available
- Developed in direct collaboration with resident physicians to ensure relevance
- Presented at weekly resident physician conference to reduce need for outside training time

https://ucsf.app.box.com/s/o4uaqyt2az8o23mnihspndhqa1adh24u

Figure 1. Educational strategies.
AOD, administrator on duty; *ED*, emergency department; *ICE*, US Customs and Immigration Enforcement.

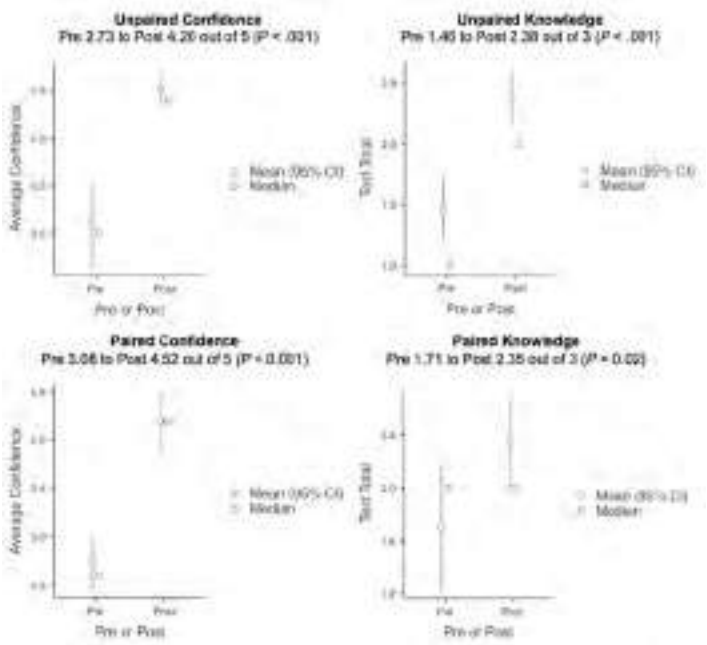


Figure 2. Pre- and post-survey results.
CI, confidence interval.

educational resources on E*Drive. An EP-attorney content expert provided feedback on the curriculum prior to *Implementation*. The session was presented annually at the weekly EM residency educational conference, thus incorporating it as an EM competency. For ease of access, the material was also uploaded to E*Drive (accessible at https://edrive.ucsf.edu/immigration-didactics).

IMPACT

The final step, *Evaluation*, is critical in capturing the curriculum's impact and informing iterative improvements. In addition to the previously discussed *Evaluation* from community partners, EM leadership, and EM content experts prior to *Implementation*, we developed a Qualtrics survey (Qualtrics International Inc, Provo, UT) for learners with five 5-point Likert scale questions to assess perceived knowledge confidence and three test-style, multiple-choice questions to assess acquired knowledge.[14,15] Questions examined learners' confidence in their familiarity with immigration-related patient resources (Objective 1); knowledge of the response to ICE in the ED (Objective 2); ability to advocate for and inform immigrant patients of their rights (Objective 3); and understanding of immigration-related hospital policies (Objective 5). The knowledge-based questions assessed understanding of immigration status being HIPPA protected (Objective 4); the risk of documenting immigration status in the chart (Objective 4); and basic information about immigration warrants (Objectives 2 and 5).

The pre-survey was administered to learners before the educational didactic session through email who were reminded at the start of the session. Learners were then asked to complete a post-session survey at the end of the session and reminded again through email. A unique identifier was used to pair the pre- and post-survey responses. Fifty-two EPs completed the pre-survey (20 in 2022, 32 in 2023), and 29 completed the post-survey (18 in 2022, 11 in 2023), with 17 completing both (8 in 2022, 9 in 2023). Ultimately, 47 targeted learners (27%) completed either the pre -or post-survey, and 17 (10%) completed both surveys, for a total response rate of 36%.

We analyzed the pre- and post-survey average confidence and knowledge scores using the Mann-Whitney U test for unpaired responses and the Wilcoxon signed-rank test for paired responses. We additionally compared the pre- and post-survey distributions of training level and individual question responses using the chi-squared test for association (Appendix A). There were no significant differences in training level between the pre- and post-survey responders (P=.07). Regarding confidence, there was a significant difference (p<.001) in responses to all of the confidence questions except for the fifth one (p=0.29). In terms of knowledge gained, there was a significant difference in responses to the first two of the three knowledge questions (P=.0001, P<.001, and P=.12, respectively). Overall, we saw a significant increase in overall confidence, with the average score across the five questions on the 5-point Likert scale increasing by 1.47 (P < .001) in unpaired responses and by 1.40 (P < 0.001) in paired responses, and a significant increase in the percentage of knowledge questions answered correctly by 30.66% (P < .001) in unpaired responses and 33% (P = .02) in paired responses, meeting the educational objectives (Figure 2).

LIMITATIONS

There are limitations to this study. First, the educational session did not include all targeted learners, as 100% attendance is not required at the residency educational conference. Second, the paired response sample size was limited, as several learners who completed the pre-survey were unable to ultimately attend. Moreover, although learners were asked to complete both surveys at the didactic session, there were still 12 unpaired post-survey responses. Third, while not a significant difference, there was a greater percentage of faculty members who responded to the pre-survey, potentially accounting for some of the differences. The paired survey responses help to control for this, showing similar improvements in scores. Finally, while our post-session data showed promising results in terms of confidence and knowledge acquisition, it does not adequately assess long-term knowledge retention. Although the small sample size makes it difficult to interpret statistical significance, the data consistently aligns

with the Kirkpatrick framework, level 2, showing learners' confidence and knowledge.[16]

CONCLUSION

Our study examined the development of immigrant health educational tools for emergency physicians and analyzed their impact. This curriculum design offers a collaborative, interprofessional approach to addressing the knowledge gap among EPs on immigration-related best practices, protocols, and policies. A multi-pronged approach is needed to address various topics within immigrant health (eg, discharge resources to medical-legal policy), accommodate different learning styles (eg, didactics, digital tools, guidelines), and allow for resources that are accessible when needed (eg, on a centralized, open-access clinical information hub such as E*Drive).

Our curriculum can serve as a starting point for EDs looking to improve care for immigrant populations. In designing these interventions, we emphasize the importance of interprofessional community partnership and iterative curriculum design to better ensure relevant and effective interventions. Future studies could assess knowledge retention longitudinally, educational tool utilization and favorability, and assess the impact of these interventions from the patient perspective for long-term conclusions and assessment of higher Kirkpatrick levels.[16]

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Emergency Medicine Scholarly Tracks: A Mixed- methods Study of Faculty and Resident Experiences

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Objectives: Emergency medicine (EM) scholarly tracks have been adopted for increased subspecialty exposure and training. However, current literature fails to elucidate the impact on faculty and resident careers and resident and faculty engagement opportunities or demonstrate barriers to continuation. The purpose of this study was to evaluate the perceived impact of EM scholarly tracks on participating faculty (eg, resident interaction/mentorship, career satisfaction, perceived barriers to implementation) and recent graduates (eg, faculty mentorship, reasons for track selection, perceived barriers to continuation).

Methods: This mixed-methods study includes a cross-sectional quantitative survey with 30 EM residents (who graduated between 2021–2023) and semi-structured, one-hour qualitative interviews with six faculty in a large, tertiary-care academic medical center with a university-based hospital and medical school. We conducted frequency analyses on demographics, timing of tracks, mentorship impact, and implementation barriers. Chi-square analyses were used to compare the most and least common reasons for track selection. We evaluated faculty data in a program evaluation framework, seeking commonalities and idiosyncratic experiences.

Results: *Resident Data*—Most participants pursued either academic or hybrid academic/community careers (18/30). Additionally, most participants reported a positive impact on mentorship (25/30). The most common reason for choosing a track was "area of clinical interest" (mean 2.93, $P < .001$). The least common reason was "lowest effort/amount of work" (mean 1.47, $P < .05$) when compared to half of the other choices. Most residents did not report barriers to track continuation. *Faculty Data*—Faculty frequently discussed how resident scholarly tracks led to increased one-on-one faculty: resident time. Additionally, they reported the opportunity for specialization of residents not seeking fellowships. A reported barrier to continuation of and resident engagement in tracks was the balance needed between teaching enough and over-teaching, which can discourage learner interest.

Conclusion: Recent EM graduates and current faculty members participating in scholarly tracks reported a positive impact on engagement and mentorship with minimal reported barriers to implementation and continuation. Scholarly tracks may offer more than educational benefits to participants, including individualized mentorship and career guidance. [West J Emerg Med. 2025;26(4)786–794.]

INTRODUCTION

Since emergency medicine (EM) was approved as a primary medical specialty by the American Board of Medical Specialties in 1989, opportunities for subspecialty training have gradually increased. Currently, there are seven fellowships recognized by the Accreditation Council for Graduate Medical Education (ACGME), 11 fellowships recognized by the American Board of Emergency Medicine (ABEM) (Table 1), and many more non-ACGME/ABEM fellowship training opportunities available to emergency physicians under other board specialties.[1-3] In 2017, a survey of US EM program directors found that approximately 40% of EM residency programs had subspecialty tracks available to trainees.[4] Track format varied widely, including required didactics, experiential learning models, and longitudinal electives.

A few studies have assessed the efficacy of EM track-based education and the association with residents' interest in fellowships.[5-8] Scholarly track-based learning is associated with pursuing a career in academic EM, and residencies often integrate tracks to enhance career guidance by inspiring residents to choose academic careers.[7] However, most of the studies that have looked at the benefits of tracks, such as faculty development and mentorship, are anecdotal and based on consensus literature from program director surveys. Research that directly assesses the perceived impact on participating EM residents and faculty is sparse.[7,9] Additionally, while some research describes best practices when implementing EM tracks and suggests why tracks may not exist (ie, lack of time, lack of faculty, limited administrative support), little research has investigated barriers to the continuation of EM subspecialty tracks after they have been established.[4,9] We aimed to evaluate how participating faculty members and recently graduated residents perceived track-based education. Given the benefits of robust mentorship for EM residents and faculty (eg, career success, professional growth, academic productivity, and opportunity to give back to the profession), we hypothesized that academic faculty and residents would report improved engagement (mentorship) opportunities and enhanced career satisfaction.[10,11] Additionally, we investigated EM residents' perceived barriers to track continuation.

Population Health Research Capsule

What do we already know about this issue?
Data show the benefits of subspecialty tracks, but no study has looked at the perceived benefits for both residents and faculty on a more granular level.

What was the research question?
We evaluated the perceived impact of tracks on participating faculty and recent EM graduates.

What was the major finding of the study?
Subjects mostly pursued either an academic or hybrid academic/commmunity care career (18/30) and most reported a positive impact on scholarly tract mentorhip (25/30).

How does this improve population health?
Scholarly tracks can lead to enhanced career satisfaction for both EM faculty and residency graduates, which in turn could result in better care for their patients.

Table 1. Subspecialty training tracks available to emergency medicine residents.

American Board of Emergency Medicine EM Subspecialties	Accreditation Council for Graduate Medical Education (ACGME) EM Subspecialties	Non-ACGME EM Subspecialties
Anesthesiology Critical Care Medicine	Addiction Medicine	Addiction Medicine
Emergency Medical Services	Clinical Informatics	Aerospace Medicine
Healthcare Administration, Leadership and Management	Emergency Medical Services	Emergency Ultrasound
Hospice and Palliative Medicine	Medical Toxicology	Wilderness Medicine
Internal Medicine Critical Care Medicine	Pediatric Emergency Medicine	
Medical Toxicology	Sports Medicine	
Neurocritical Care	Undersea and Hyperbaric Medicine	
Pain Medicine		
Pediatric Emergency Medicine		
Sports Medicine		
Undersea and Hyperbaric Medicine		

EM, emergency medicine.

METHODS

Study Design and Survey

We conducted this mixed-methods study, comprised of a cross-sectional quantitative survey of 30 EM graduates and semi-structured qualitative interviews with six faculty at an academic medical center in the northeastern US with a university-based hospital, a medical school, and >100,000 annual ED patient visits. We defined a career in academics as working in a medical center with a university-based hospital, university ownership/affiliation, and/or an affiliated medical school. Alternatively, we defined a career in community EM as working in a hospital with limited (or no) relationship with a university/medical school and with a limited numbers of (or no) learners. A hybrid career was defined as working any amount of time in both academic and community settings. Our department has a three-year, ACGME-accredited program with 14 residents per class, seven fellowships with 8-10 fellows per year, and approximately 80 faculty members.

We developed quantitative and qualitative survey questions using the process of iteration and literature review for research gaps, and by harnessing the research team's academic experience and experience with national grant funding, EM fellowship training (medical education), and residency administration. The team consisted of one medical student interviewer, two junior academic faculty, two senior academic faculty, and one research methodologist. Collectively, and through an iterative process, we capitalized on team expertise to design the survey, which we refined and subsequently pre-tested for errors and comprehension. While we did not formally assess construct validity, the survey was reviewed by an external content expert and the study team for face validity.[12] Although less widely accepted than construct validity, face validity is a complex paradigm used to evaluate how respondents perceive test items. It consists of many dimensions, including accuracy, acceptance (likeability) and relevance, and has been regarded as an acceptable form of validity in prior medical education curricula.[13-15]

We collected and managed survey data using Research Electronic Data Capture (REDCap) tools hosted at the University of Rochester. The survey questions sent via email to EM graduates included demographics (age, graduation year, completion of fellowship, career selection), critical review of track implementation (reasons for track selection, timing, barriers), and training impact (mentorship opportunities). They answered questions using a three-point Likert scale with a "strongly negative," "neutral," or "strongly positive" response (see Appendix A). The faculty data came from one-hour, semi-structured interviews conducted by a third-party person trained by a research team member. The faculty interviews targeted four areas: 1) demographics (additional degrees, years at the institution, scholarly track role such as director, creator); 2) resident interaction (opportunities for mentorship, engagement, and non-clinical evaluation); 3) impact on career (longevity, trajectory, opportunities for scholarly work); and 4) barriers to track perpetuation (See Appendix B).

Faculty were interviewed using a program evaluation framework, seeking evidence of common and distinctive feedback to improve the experience of the tracks program. We designed the interview questions to address tier 3 (understanding and refining the program), tier 4 (continuing progress toward desired outcomes), and tier 5 (broad program impact) of the five-tiered approach to program evaluation (Figure).[16] To maintain anonymity in feedback, interviews were not recorded or transcribed. Instead, the interviewer took notes on faculty responses, requesting confirmation from participants when summarizing or quoting. To further maintain confidentiality we did not collect faculty-associated tracks.

Recruitment, Consent, and Risk to Subjects

Resident Selection and Recruitment

Since our track learning began in 2019, inclusion for the study included any residents who graduated between 2021–2023. Exclusion criterion was any resident who did not graduate within this period. Eligible participants were emailed information detailing the project's objectives. Participation was voluntary. The email contained a link to the REDCap survey. All data collection was anonymous. Completion of the survey implied consent. We sent a reminder email two weeks after the initial email to maximize participation.

Faculty Selection and Recruitment

Inclusion for the study included any faculty deemed a scholarly track leader or creator. We excluded faculty who did not lead or create a scholarly track. Our goal was to obtain a representative sample with respect to tracks supervised, stage of academic career, and faculty sex. We emailed eligible faculty an information sheet that detailed the project's objectives and emphasized that participation was voluntary. We sent reminder emails two weeks and four weeks after the initial email. Interview scheduling and completion implied consent.

Tier 1	Preimplementation (Program Definition)	Document and justify the need
		Work with stakeholders to assess needs and describe objectives
Tier 2	Accountability	Examine if the program serves those it was intended to serve
		Identify and document stakeholders/participants
Tier 3	Program Clarification (Understanding and Refining)	Improve program by providing information to stakeholders
		Gather program satisfaction data and lessons learned to identify strengths and weaknesses
Tier 4	Progress Toward Objectives	Sort objectives by short-term and long-term outcomes and data measures
		Decide on design issues and data analysis
Tier 5	Program Impact	Plan to demonstrate long-term improvements and sustainability
		Document long-term outcomes, evidence of sustainability, and distribute findings

Figure. Five-tiered approach to program evaluation.[10]

There were no sex, race, or ethnicity-based restrictions. This project was undertaken as a quality improvement initiative. Per the University of Rochester's Guideline for Determining Human Subject Research, it did not meet the definition of research according to 45CFR46 and was exempt from institutional review board-approval. Data were anonymous for all participants, and there was minimal risk to participant confidentiality.

Track Structure

The tracks start at the beginning of postgraduate year (PGY)-2 year and culminate at the end of the PGY-3 year. The sessions, 60-90 minutes long, take place during didactic conference 9-10 times per academic year. Tracks are led by 1-3 faculty members and have a maximum of 1:3 faculty-to-resident ratio. Track curricula are 18-20 months long and incorporate required elements that are the same across all tracks, including basic research certification training, a medical student- or peer-teaching requirement, and choosing a research question. Other required elements are unique to each specific track, including didactics, journal clubs, community engagement (eg, partnering with local shelters to organize an activity), track-specific certifications (eg, advanced research training), or hands-on activities (eg, joining a Wilderness Medicine Society or local- event medicine). Similarly, the requirements for track completion vary based on the chosen subspecialty but with some overlap for all tracks (eg, teaching component and research projects). Given the intensity of the PGY-2 year in a three-year training program, residency leadership backloaded many of the requirement due dates to the end of PGY-2 and early/mid PGY-3 year. For residents who have any interests outside existing tracks, the "Education Track" empowers them to pursue these interests.

Analysis

We conducted frequency analysis on resident demographics, mentorship impact, timing of tracks, most common track choice, and implementation barriers. Chi-square analyses were used to compare reasons for resident track selection. The initial evaluation of faculty interviews was conducted by a non-clinical, research faculty team member (BA) in a program evaluation framework, seeking commonalities and distinctive experiences that might inform track revision. It has been reported that using deductive and inductive analytic practices provides the deductive tools to organize the data, allows findings to emerge from the data, and applies existing knowledge and theory to interpret and explain findings.[17] We used inductive coding and constant comparative analysis, which enabled us to analyze the responses to discover common themes among the data.[18,19] Due to limited numbers of participants, data were insufficient for more robust analysis methods, such as grounded theory analysis.

RESULTS

Resident Data

The response rate for the resident survey was 71% (30/42). Most participants were male (19/30) (corresponding to the demographics of the sample pool of residents), between 30-34 years of age (23/30), and had either academic or hybrid (academic/community) careers (18/30). A minority of participants had purely academic EM jobs (6/30) and one third (10/30) of all graduates had either completed or were completing a fellowship, with ultrasound the most common (4/10).

Eighty-three percent (25/30) of participants reported a positive impact on mentorship during residency. The most common reason for track selection was "area of clinical interest" (93% report this reason as "very important" (overall chi-square and each subsequent pairwise comparison <.001)). Most residents did not report barriers to track implementation and continuation, with only one third of residents (10/29) reporting that COVID-19 interfered with scholarly track implementation. (Table 2 lists complete results.)

Faculty Data

The response rate for the faculty interview was 75% (6/8). Most faculty members frequently discussed how the implementation of tracks led to increased one-to-one faculty-resident time and engagement with residents and provided opportunities to guide and observe resident skill development outside the clinical arena. One faculty member commented how faculty can use "[track] relationships to form new, deeper connections— to see a different way of [resident] thinking." Three faculty members discussed the opportunity that tracks provide for education in hands-on skills that are difficult to teach in large group settings, particularly to learners who are not particularly interested in the area of instruction (Table 3). Additionally, faculty favorably reported that tracks offered the opportunity for some specialization for non-fellowship seeking residents. For example, one faculty member noted, "[tracks] allow teachers to talk more about a specific advanced topic of interest and provide enthusiastic residents with a focused learning curriculum outside of the group setting." Shared and distinctive themes and supporting comments can be found in Table 3.

When discussing barriers to continuation, faculty suggested striking a balance between teaching too much to discourage interest and teaching enough to engage interested learners during a track meeting. There was no thematic saturation regarding the impact on faculty career longevity.

DISCUSSION

Among many factors in the complex decision of choosing a career, scholarly tracks have been associated with a higher likelihood of an academic career choice.[8,20] Although not directly investigated in this study, most graduates in our study worked in academic or hybrid

Table 2. Resident perceptions of the scholarly education tracks in emergency medicine.

	Strongly Disagree	Disagree	Agree	Strongly Agree
The scholarly EM tracks positively impacted mentorship from EM faculty	0 (0%)	5 (17%)	15 (50%)	10 (33%)
	0-30Minutes	31-60 Minutes	61-90 Minutes	91-120 Minutes
How much didactic time per month should be dedicated to EM scholarly tracks?	4 (13%)	11 (37%)	11 (37%)	4 (13%)
EM Track	Initial Choice[a]	Would choose a different track if could do it again[a]	Would have switched to this track[a]	
Research	2 (7%)	1 (3%)	0	
Toxicology	3 (10%)	1 (3%)	1 (3%)	
Education	9 (30%)	3 (10%)	0	
EMS	4 (13%)	2 (7%)	0	
Ultrasound	5 (17%)	1 (3%)	3 (10%)	
Pediatric Emergency Medicine	4 (13%)	2 (7%)	0	
Wilderness Medicine	3 (10%)	0 (0%)	1 (3%)	
Critical Care	0 (0%)	0 (0%)	4 (13%)	
Global Health	0 (0%)	0 (0%)	1 (3%)	
Reason for Initial Track Choice	Not Important	Somewhat Important	Very Important	
Self-identified area of clinical weakness	12 (40%)	14 (47%)	4 (13%)	
Area of clinical interest	0 (0%)	2 (7%)	28 (93%)	
Fellowship preparedness	15 (50%)	9 (30%)	6 (20%)	
Job market competitiveness	15 (50%)	9 (30%)	6 (20%)	
Aligned with previous academic interest (before residency)	7 (23%)	12 (40%)	11 (37%)	
Obligation to choose a track	11 (37%)	14 (47%)	5 (17%)	
Lowest effort/amount of required work[c]	18 (60%)	10 (33%)	2 (7%)	
Perceived Barriers to EM Tracks	Yes	No		
Insufficient faculty support	4 (13%)	26 (87%)		
Insufficient scholarly track options	7 (23%)	23 (77%)		
Insufficient resident participation	4 (13%)	26 (87%)		
Insufficient resident interest	5 (17%)	25 (83%)		
Conflicted with other academic obligations	8 (27%)	22 (73%)		
Conflicted with clinical obligations	6 (20%)	24 (80%)		
Conflicted with work-life balance	5 (17%)	25 (83%)		
COVID-19 pandemic[b]	10 (33%)	20 (67%)		

[a] Initial choices and interest in switching tracks was partially influenced by new tracks offered to later cohorts.
[b] Potential for differential perceptions of COVID-19 pandemic was influenced by residency cohort timing.
[C] Paired-samples comparisons showed that scores on the lowest effort/amount of required work item were significantly lower than the (a) area of clinical interest, (b) aligned with previous academic interest, and (c) obligation to choose a track score, all *P*-values < .05.
EM, emergency medicine; *EMS,* emergency medical services.

careers.[5] Additionally, one-third of the participants entered or completed academic fellowships, consistent with Jordan et al's reported percentages of track-trained residents entering fellowships in 2018.[5] Both results are logical, as scholarly track training can inspire residents to choose fellowships, and fellowship-trained graduates may be more likely to look for jobs and are often sought out by academic institutions. As supported by a study by Jordan et al in 2024, track exposure is one of several factors that guide residents down their career paths as it increases exposure to and involvement with faculty scholarly work and mentorship.[20]

On the contrary, an older study from 2008 contradicts our findings, reporting only that 23% of residents accept academic jobs and 5% fellowship entry. This discrepancy

Table 3. Selected faculty qualitative feedback regarding scholarly tracks programs in emergency medicine.

How do you feel involvement with tracks has affected your interaction with residents?	
More 1:1 time with residents in their track (4/6)	"…Helped residents identify areas of interest and give them the opportunity to explore those."
Opportunity for greater depth of training (3/6)	"…Allow teachers to talk more about a specific advanced topic of interest."
Benefits those who are motivated (4/6)	"Provide enthusiastic residents with a focused learning curriculum outside of the group setting"
	"If a resident is motivated, track can provide an additional benefit of guidance. This is a specific [type of resident], and not all residents will benefit from the tracks if they are not motivated to learn more in a specific area"
Deeper relationships with residents (3/6)	"[allow us to] form new, deeper connections."
	"Get to know residents outside of medical setting."
Allows for better evaluation of residents (1/6)	"…see skills outside of clinical progress… [can] use track relationships to help with choice of chief resident."
How has involvement with tracks changed your opportunity for mentorship?	
Focus on fellowship-interested students (1/6)	"We can [guide] these students to be prepared for this fellowship... They can see the career trajectory in reality and be guided in next steps. [They get a] realistic understanding of what a career in [redacted] looks like."
Opportunity for focused, hands-on mentorship (3/6)	"Harder to teach [redacted] to large group because it is a hands-on skill."
More focused career guidance (3/6	"[Offers] ability to talk about my career [path]."
Greater resident collaboration and networking (4/6)	"Increased opportunities for residents to network with each other (connection between second and third years, which doesn't always happen without tracks) … "Residents become closer to each other. [They] have their own group chats."
How has involvement with tracks affected how you feel about your career in academic EM?	
No impact (3/6)	"It has had no effect. More beneficial to junior faculty and fellows to find [their] teaching style or work on research projects."
Increased satisfaction (3/6)	"Being involved in something else has helped prevent burnout."
	"Adds variety [and] shifts focus outside of clinical work."
	"[Incorporation of] tracks has made work fun."
How has involvement with tracks affected your career trajectory or anticipated career longevity?	
None (4/6)	
Expanded scope (1/6)	"Added mentorship and teaching into clinical medicine."
Extended duration (2/6)	"Has added years to career due to burnout prevention."
	"I stay up to date because [I am learning] alongside the residents about changes in the field."
How has involvement with tracks changed the level of involvement in other professional activities?	
Tradeoffs due to time commitments (2/6)	"Juggling schedule between med students, residents, clinical schedule and teaching [is challenging]."
	"Time consuming meeting with residents, preparing learning materials and objectives"…
Were there barriers to implementation and participation that diminished your overall experience?	
Too many residents in their track (1/6)	"Originally believed as a track leader, I would be responsible for guiding residents through QA and research projects. I cannot possibly do this for [a high number of'] residents."
Scheduling difficulties in tracks (1/6)	"Sometimes, it is difficult to schedule events as having 1-2 residents on vacation makes the group too small to invite a guest lecture or to plan an event."
None (3/6)	

Note: Fractions in left column indicate how many faculty members expressed this theme. [Redacted] indicates EM track or division that was eliminated from the text for sake of participant anonymity.
EM, emergency medicine.

Table 3. Continued.

Additional Feedback Offered	
Long-term planning of activities needed (2/6)	"Want to see a curriculum that is 24 months in the making—residents and faculty can know what is coming far in advance."
	"Must have structure. By having a structured program, the track program will provide benefit to the residents instead of being another box they must check."
Tracks should not be mini-fellowships (2/6)	"Want to find balance between teaching those who want to learn and not discouraging learners from pursuing fellowship by teaching too much."

Note: Fractions in left column indicate how many faculty members expressed this theme.
EM, emergency medicine.

may be due to the Lubavin study design; they included community- and academically-trained EM residents, with community-trained EM residents less likely to pursue academic EM careers. Additionally, the 16-year time difference between that study and ours reflects potentially more contemporary motivators to pursue academics, including more fellowship options and an increased emphasis on wellness through balance of clinical and academic (research, leadership, teaching, and mentorship) roles.[8,21,22]

Over 80% of our graduated residents noted the increased opportunities for mentorship. Given the excellent faculty-to-resident ratio, additional time for interaction, and shared passion for an academic interest, this is one of the most important aspects of track training. Although nearly all the previous EM program director literature has perceived this and it has been documented by participating residents in other specialties, to our knowledge this is the first study with direct feedback from EM residents who participated in tracks during residency.[23,24]

The most common reason for track choice was "area of clinical interest." This is a logical finding, given the increased desire to learn from like-minded people with common interests and goals. The least common reason for track selection was "lowest effort/amount of work." In an academic residency, this finding may be related to residents being more motivated to pursue scholarly work during their training. To our knowledge, these motivations have not been measured in participating EM residents until now.

Overall, most residents did not report barriers to track continuation. Given the structure of the tracks (eg, backloaded due dates to avoid adding to high-intensity training periods and dedicated time during didactics), there was minimal reported impact on clinical obligations or work-life balance. Additionally, resident participation and interest were not reported as barriers to track continuation. This may have been influenced by the program's dedication and faculty interest in track implementation. Also, subspecialty tracks are not new, and we likely benefited from previously published literature on the perceived benefits, as well as pitfalls to avoid when creating tracks. To our knowledge, these have not been measured directly by participating EM residents until now.

Participating faculty had a favorable view of the impact of the subspecialty track on interaction with residents. The faculty reported increased time with residents and the potential to inspire and educate non-fellowship seeking residents. Although this study did not establish causality, this additional time and mentorship from participation in subspecialty tracks are consistent with current literature as two of the many factors that help guide graduates in their career-decision process and to stay focused on academic careers.[20] Also, faculty used track sessions to observe non-clinical skill development, including time management, project execution, and communication. This allowed for a deeper understanding of the residents' development, which fostered enhanced career guidance through more individualized coaching and mentorship. One reported barrier to the continuation of tracks was the need to establish a balance between teaching and "over-teaching" to keep learners engaged and cultivate curiosity but prevent them from feeling overwhelmed. Notably, overwhelming learners has been shown to reduce active learning/engagement and has proven to be time-consuming (and detrimental) for the instructor.[25]

LIMITATIONS

First, this study measured recently graduated EM resident perceptions of track impact over a limited period (three years) and did not measure impact directly. Additionally, we did not have access to comparative data from the three years preceding the establishment of tracks, making it insufficient to establish causation. Second, the study was conducted at a single academic institution, potentially limiting generalizability to smaller (or community) institutions without a robust core faculty with dedicated time for or expertise and interest in track implementation. Additionally, the lack of standardization of implementation and design of educational tracks across programs makes it difficult to generalize our results to other institutions. Also, single-center studies can overestimate effect in comparison to multicenter studies.[26] Third, a limited set of faculty members provided qualitative feedback about the program, and a single research team member was responsible for collating responses in a program evaluation framework.

Subsequent evaluation work might benefit from a larger faculty sample and the use of more extensive qualitative analysis methods (eg, transcription, grounded theory analysis).[27]

Fourth, pre-selection bias may have influenced our results as residency applicants who are interested in pursuing subspecialty fellowships may have initially chosen our residency program due to existing fellowships. Consequently, these trainees may have been more likely to positively review and participate in scholarly tracks. Fifth, self-selection bias may have influenced qualitative results, given that the faculty chosen to participate may have been more apt to favor the scholarly track work and highlight its benefits. It may have also influenced some of the resident data; specifically, the least common reason for choosing a track was "lowest effort/amount of work," as recently graduated residents may not have wanted to be perceived as lazy or uninterested in learning during a study conducted by former colleagues/mentors. Lastly, non-response bias may have been present; it is important to acknowledge that any patterns uncovered in analyzing a non-random sample do not provide valid grounds for generalizing about a population.[28,29]

CONCLUSION

Recently graduated EM residents reported that scholarly tracks positively impacted mentorship. While this study did not assess causation between tracks and academic careers, most participating residents chose academic careers and reported few implementation barriers. The impact on faculty engagement (mentorship) with residents was reported to be high. Participating faculty reported a more holistic view of resident development, suggesting that scholarly tracks may offer more than educational benefits to participating residents, including individualized mentorship and career guidance. This work was conducted at a single site, and track-related education is dynamic, both locally and at other EM residencies. Future multisite research should build upon our evaluative work by investigating potential causation of track integration on resident career choice including comparative data analyzing pre- and post- track implementation.

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Effects of the COVID-19 Pandemic on Anxiety and Depression among Medical Interns

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Introduction: The demanding nature of emergency medicine (EM), requiring immediate responses to emergencies, and presents significant challenges, particularly for new trainess specialty. Our goal was to evaluate levels of anxiety and depression among EM intern doctors, with focus on the impact of the COVID-19 pandemic.

Methods: We conducted this study at Istanbul University-Cerrahpasa, Department of Emergency Medicine, from December 29, 2019–May 2, 2021. In Türkiye, the six year medical education program has the first three years preclinical, the fourth and fifth years comprised of clerkships, and the sixth year is internship training. In this final year, these intern doctors rotate through various departments, including an 8-week EM internship. A total of 203 medical interns participated in the study, 50.2% male. We assessed participants using the State-Trait Anxiety Inventory (STAI 1-2) and the Beck Depression Inventory, both prior to starting their EM internship and upon completion. Intern doctors were divided into two groups: 51 who completed their internship before the COVID-19 pandemic (December 29, 2019–March 11, 2020) and 152 during the pandemic (March 11, 2020–May 2, 2021). We compared pre- and post-internship scores within each group and between the two cohorts.

Results: Anxiety scores (STAI-1) increased significantly in both groups during the internship. In the pre-COVID-19 group, median STAI-1 scores rose from 47 (IQR: 38–53) to 51 (IQR: 45–56) ($p<0.001$), and in the COVID-19 group, from 41 (IQR: 35–48) to 47 (IQR: 42–52) ($p<0.001$). However, depression scores (BDI) showed a significant increase only in the pre-COVID-19 group: from 9 (IQR: 2–14) to 26 (IQR: 15–32) ($p<0.001$). In contrast, the COVID-19 group's depression scores remained relatively stable, increasing only from 7 (IQR: 2–13) to 8 (IQR: 3–16) ($p=0.345$).There were no significant differences between the groups in trait anxiety (STAI-2) scores ($p=0.221$) or pre-internship BDI scores ($p=0.408$). However, post-internship BDI scores were significantly lower in the COVID-19 group compared to the pre-COVID-19 group (median: 8 vs. 26; $p<0.001$).

Conclusion: The EM internship was associated with an increase in anxiety levels among intern doctors. Depression scores did not show a significant increase in the COVID-19 group, whereas depression scores significantly increased in the pre-COVID-19 group by the end of the internship. These findings suggest that, while anxiety increased across both groups, depression levels were more stable in the COVID-19 group, with lower post-internship scores compared to those in the pre-COVID-19 group. [West J Emerg Med. 2025;26(4)795–803.]

INTRODUCTION

Emergency medicine (EM) is a rapidly evolving specialty that addresses and manages acute medical conditions across various disciplines. The demanding nature of this field, requiring immediate responses to emergencies of varying urgency, presents significant challenges, particularly for

individuals new to the specialty. Unlike postgraduate trainees in EM in other countries, intern doctors in Turkey undergo practical training across multiple specialties during their sixth and final year of medical education. These challenges are particularly prominent for interns as they rotate through different departments, including EM. Numerous studies have highlighted the physical and psychological toll on them, emphasizing their experiences of anxiety, depression, and overall stress while working in the high-pressure environment of EM rotations.[1-7]

Anxiety disorder is characterized by an emotional state of unprovoked anxiety, accompanied by distress and restlessness. This condition can manifest through worries spanning various aspects of life, including health, work, interpersonal relationships, and daily activities, often leading to physical symptoms according to the *Diagnostic and Statistical Manual of Mental Disorders,* 5th *Ed* (DSM-5). [8] Such anxiety can disrupt daily functioning, impairing sleep, appetite, and overall quality of life. [9] Additionally, anxiety is closely associated with depression and an increased risk of suicide. [2,10] The incidence of mental health issues and substance use disorders has risen as a result of anxiety.[5, 11]

Depression is a mood disorder marked by persistent feelings of sadness, hopelessness, and a lack of interest in activities previously enjoyed. Depression is characterized by a range of symptoms, including feelings of worthlessness, fatigue, changes in sleep and appetite, and difficulty concentrating. These symptoms can significantly impair an individual's daily functioning and well-being.[8] Depression not only affects the individual but can also compromise the quality of care provided to patients.[12] Physicians suffering from depression, for instance, have been shown to be 6.2 times more likely to make medication errors than their non-depressed counterparts.[13]

Studies focusing on healthcare professionals have consistently highlighted the substantial stress faced by those in the field, with emergency clinicians experiencing particularly high levels of stress compared to other occupational groups.[7] It has also been reported that physicians working in emergency departments have a higher propensity for alcohol and substance use disorders than the general population, often as a means of coping with escalating depression levels.[14,15]

A search of PubMed revealed a notable gap in research addressing the prevalence of anxiety and depression among interns. Despite the publication of 60 studies related to anxiety among EM interns and 83 studies on depression, there remains limited research focusing specifically on the well-being of interns during their EM rotations. We investigated the prevalence of anxiety and depression among intern doctors at Istanbul University-Cerrahpaşa Faculty of Medicine, with a specific focus on comparing the levels of these conditions both before and after completing their eight-week EM internship.

We further evaluated the impact of internship year on the participants' anxiety and depression levels. Given the emergence of the COVID-19 pandemic during the study, we also wanted to examine how the pandemic may have influenced these outcomes. By comparing data from both the pre-pandemic and pandemic periods, this research provides insights into the challenges faced by intern doctors and contributes to the existing literature. Our findings help clarify whether the pandemic exacerbated or altered the levels of anxiety and depression among intern doctors.

Population Health Research Capsule

What do we already know about this issue?
Anxiety and depression are serious but largely unrecognized issues among interns in emergency medicine.

What was the research question?
Does the internship year elevate anxiety and depression levels in intern doctors?

What was the major finding of the study?
We found significant increases in the Beck Depression Inventory ($P < .001$, CI 1.032-1.079) and the State-Trait Anxiety Inventory I ($P < .001$, CI 1.037–1.083).

How does this improve population health?
This study highlights the psychological impact of EM internship and the need for mental health support to improve medical interns' well-being.

MATHERIAL AND METHODS

Ethics and Consent

This study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki. It was approved by the Clinical Research Ethics Committee of Istanbul University-Cerrahpasa Faculty of Medicine (approval number: 83045809-604.01.02, date: 24/03/2020). Written informed consent was obtained from all participants before we began to collect data.

Study Design and Setting

This prospective cohort study was conducted at Istanbul University-Cerrahpasa Faculty of Medicine, Department of Emergency Medicine. The primary objective was to evaluate the effects of the EM internship on anxiety and depression levels in final-year medical students during the COVID-19 pandemic. Outcomes were measured using validated psychological tools to assess state and trait anxiety, as well as depressive symptoms. State anxiety refers to a person's temporary emotional response to stress,

while trait anxiety reflects a more permanent predisposition to be anxious.

Outcomes

- Primary outcomes: Changes in anxiety (measured by the State-Trait Anxiety Inventory 1 and 2 [STAI]) and depression (measured by the Beck Depression Inventory [BDI]) scores from pre-internship to post-internship, comparing the pre-COVID-19 and COVID-19 groups.
- Secondary outcomes: Changes in trait anxiety (measured by STAI-2) scores pre-internship, as well as post-internship changes in depression and anxiety scores (STAI-1, BDI) by sex (female vs male).

Participants and Recruitment

Participants were final-year medical student/intern doctors completing their mandatory EM internship between December 29, 2019–May 2, 2021. The EM internship is a required component of the medical curriculum, lasting eight weeks, during which interns typically work 16 day shifts and 16 night shifts. During their internship, intern doctors were responsible for assessing patients, history-taking, assisting in emergency procedures, and participating in patient care under the supervision of attending physicians. The duties of intern doctors became more varied during the pandemic, with increased telemedicine consultations and less direct patient contact.

The first COVID-19 case in Türkiye was reported on March 11, 2020. Based on this date, intern doctors were divided into two groups: the pre-COVID-19 period (December 29, 2019–March 11, 2020) and the COVID-19 period (March 11, 2020–May 2, 2021). Cases of COVID-19 peaked in late 2020/early 2021, and reached the highest spike between December 2021–February 2022, followed by a sharp decline.[16] To minimize the risk of COVID-19 exposure, the shift schedules of interns were temporarily reorganized into eight extended 24-hour shifts during the pandemic period.

Recruitment involved inviting all intern doctors assigned to the emergency department (ED) during the study period to participate. Recruitment emails were sent out twice: one initial invitation and a follow-up reminder a week later. Participation was voluntary, and no incentives were provided. Of 600 eligible intern doctors, 450 consented to participate in the study (75% participation rate). After excluding 97 individuals due to pre-existing psychiatric conditions or inability to perform night shifts and an additional 150 due to incomplete data, the final analysis included 203 intern doctors (33.8% of the initial eligible population).

Exclusion criteria for the study were as follows: interns who declined participation; were unable to maintain their scheduled shifts (either day or night) during the EM internship due to chronic illness; individuals with substance use disorder, and those with known history of psychiatric disorders. Although anxiety and depression are included as psychiatric disorders in the DSM-5,[8] we made this exclusion to enhance the validity of the study and specifically examine the effects of medical education-related stress. Substance use and psychiatric disorders are often linked to stress in medical students and may introduce confounding variables that affect anxiety and depression levels.[17,18] Including participants with these conditions could have complicated the analysis by introducing factors unrelated to educational stress, making it difficult to isolate the specific impact of medical education on anxiety and depression levels. Therefore, to ensure a clear focus on the effect of educational stress on anxiety, we excluded participants with substance use or psychiatric disorders.

Psychological Assessments

We used the BDI and the STAI-1 and STAI-2 to measure psychological outcomes:

1. The BDI is a 21-item questionnaire measuring depressive symptom severity, taking approximately 10 minutes to complete. Scores classify symptoms as minimal, mild, moderate, or severe. We used a validated Turkish version of the BDI[19] administered before and after the internship to evaluate immediate changes in depression levels.
2. The STAI-1 and STAI-2 consists of two subscales: STAI-1 assesses state anxiety (temporary emotional responses to stress), while STAI-2 evaluates trait anxiety (a person's general tendency to experience anxiety). Each subscale contains 20 items, rated on a 4-point scale, with adjustments for positively and negatively worded items. Final scores range from 20-80, with higher scores indicating greater anxiety levels. The average anxiety score typically falls between 36-41. The Turkish version has been validated for use in research and clinical settings.[20]

These tools were chosen over alternative scales such as the Patient Health Questionnaire-9 (PHG-9) and Generalized Anxiety Disorder-7 scale (GAD-7) based on their validity, reliability, and previous use in similar research contexts.[19-24] The BDI and STAI-1 were administered to assess fluctuations in depressive symptoms and state anxiety throughout the internship, while STAI-2 was used to measure trait anxiety, providing a more stable evaluation of baseline anxiety levels.

Timing of Assessments

Participants completed the STAI-1, STAI-2, and BDI assessments two days before starting their first shift and within two days after completing their final shift. This timing ensured that the measurements reflected changes specifically related to the internship experience.

Confidentiality

All data were anonymized, and only the research team had access to the assessments. Faculty members in the ED were

not informed of participants' involvement in the study to prevent potential bias or coercion.

Sample Size Calculation

A power analysis using the G*Power 3.1 software (Heinrich Heine University Düsseldorf , Germany) determined that a minimum of 179 participants was required to detect a medium effect size (d = 0.25) with 90% power and a 5% significance level. The final sample size of 203 participants exceeded this threshold, ensuring adequate statistical power.

Statistical Analysis

We conducted all statistical analyses were conducted using SPSS Statistics 22.0 (SPSS Statistics, IBM Corp, Armonk, NY). Continuous variables were summarized as medians and interquartile ranges (IQR) for non-normally distributed data and means with standard deviations for normally distributed data. Categorical variables were presented as frequencies and percentages.

1. Normality testing: We evaluated data distribution using the Kolmogorov-Smirnov and Shapiro-Wilk tests, along with skewness and kurtosis assessments.
2. Comparisons: For normally distributed variables, we used the Student t-test. For non-normally distributed variables, the Mann-Whitney U test or Kruskal-Wallis test was applied as appropriate.
3. Categorical variables: We assessed differences using the Pearson chi-square test or Fisher exact test, where applicable.
4. Significance level: A *P*-value < .05 was considered statistically significant.

RESULTS

During the study period, a total of 600 intern doctors were eligible to participate. Of these, 450 provided informed consent, resulting in a 75% participation rate. After excluding interns with psychiatric disorders and other ineligibility criterias, the final analysis included 203 intern doctors, representing 33.8% of the initial eligible population (Table 1).

Of the 203 intern doctors who participated in our study, 49.8% were female and 50.2% were male. The median age of males and females was 23 (23-24). Interns scored 44 (38-51) on the STAI-2 scale and showed moderate anxiety; significantly higher anxiety was observed in females than in males (*P*<.001). It was determined that there was no difference between the sexes in STAI-1 both before (*P*=.13) and after (*P*=0.23) the internship Before the EM internship, moderate anxiety was observed with a score of 43 (36-49) on the STAI-1 scale. At the end of the internship, a high degree of anxiety was observed with a score of 48. Male (*P*<.001), female (*P*<.001) and total (*P*<.001) had a statistically significant increase in anxiety levels.

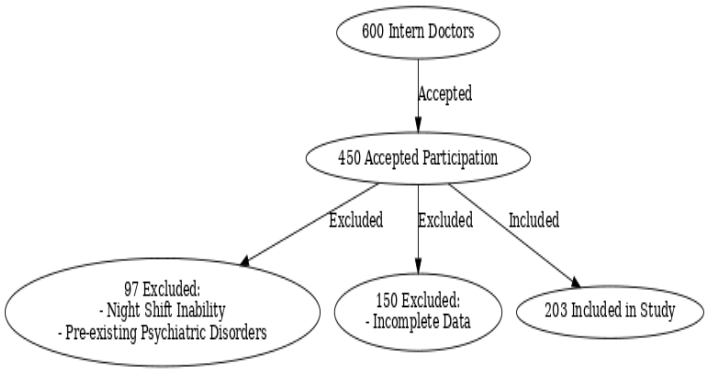

Figure. Flowchart of recruitment and selection of medical interns to participate in the study.

Before their EM internship, interns scored 7 (2-14) on the BDI scale and showed minimal depression; significantly higher depression was observed in females compared to males (*P*<.001). At the end of the internship, they scored 11 (4-23), demonstrating mild depression, with levels of depression in females still significantly higher than in males (*P*=.035). Depression levels increased statistically significantly in males (*P*<.001), females (*P*=.03), and total (*P*<.001). Table 2 shows the depression and anxiety levels of intern doctorss before and after their EM internship according to the STAI-1 and BDI, and their distribution according to their percentages is given. Statistically significantly increased depression was observed in males (*P*<.001), females (*P*=.01), total (*P*<.001). Statistically significantly increased anxiety was observed in males (*P*<.001), females (*P*<.001), total (*P*<.001). It was observed that COVID-19 did not lead to a significant change in STAI-2 and BDI scores before the EM internship (*P*=.08,

Table 1. State-Trait Anxiety Inventory and Beck Depression Inventory Scale scores by demographic information and sex.

	Male (N = 102)			Female (N = 101)			TOTAL (N = 203)				
	Median	Per 25	Per 75	Median	Per 25	Per 75	Median	Per 25	Per 75	U	*P*
STAI-2	40	36	47	46	40	54	44	38	51	3.495	**<.001**
BDI Pre	6	2	10	9	5	17	7	2	14	3.823	**.001**
BDI Post	9.5	4	20	14	4	25	11	4	23	4.271	**.04**
STAI-1 Pre	41	33	47	45	37	50	43	36	49	4.520	.13
STAI-1 Post	47	43	53	49	43	54	48	43	53	4.650	.23

STAI, State-Trait Anxiety İnventory; *BDI, Beck Depression Inventory*; *U,* Mann-Whitney U; *Per 25,* 25th percentile; *Per 75,* 75th percentile.

Table 2. State-Trait Anxiety Inventory and Beck Depression Inventory Scale scores before and after the internship.

		Pre-Internship (N = 203)				Post-Internship (N = 203)					
		Min	Mild	Mod	High	Min	Mild	Mod	High	Z	P
BDI	Male	74.5%	13.7%	9.8%	2.0%	50.0%	19.6%	20.6%	9.8%	14.900	**<.001**
	Female	50.5%	23.8%	22.8%	3.0%	41.6%	16.8%	27.7%	13.9%	6.092	**.01**
	Total	62.6%	18.7%	16.3%	2.5%	45.8%	18.2%	24.1%	11.8%	20.838	**<.001**
STAI_1	Male	33.3%		31.4%	35.3%	13.7%		17.6%	68.6%	21.102	**<.001**
	Female	27.7%		18.8%	53.5%	6.9%		21.8%	71.3%	12.612	**<.001**
	Total	30.5%		25.1%	44.3%	10.3%		19.7%	70.0%	33.238	**<.001**

STAI, State-Trait Anxiety İnventory; *BDI, Beck Depression Inventory*.

P=.22). However, after the EM internship, the median BDI score was 26 (IQR 15-32) before the COVID-19 period, indicating moderate depression, whereas after COVID-19, the median score decreased to 8, reflecting minimal depression. This reduction in depression levels was statistically significant (*P*<.001). Before the EM internship, intern doctors had high anxiety levels, with a median STAI-1 score of 47 (IQR 38-53). After the internship, anxiety remained high, with a median score of 51 (IQR 45-56). During the COVID-19 period, anxiety levels were lower both before and after the internship, with median scores of 41 (IQR 35-48) and 47 (IQR 42-52), respectively. These reductions were statistically significant (*P* = .02). Table 4 summarizes multivariate regression analysis we conducted while controlling for sex and COVID-19 process factors, which we identified as potential confounding variables in our study, using logistic regression. The results indicated that BDI and STAI-1 scores were associated with increases during the EM internship (*P*<.001). These findings suggest a relationship between the internship and changes in the scores, although causality could not be definitively established.

DISCUSSION

In this study our goal was to compare the anxiety and depression levels of interns at the beginning and end of their EM internships and to determine the impact of the internship on these parameters. Given that the study period coincided with the COVID-19 pandemic, we anticipated that the pandemic could have had a confounding effect, and we sought to identify and control for this influence. Our findings indicate a significant increase in both anxiety and depression scores throughout the internship, with differences observed between male and female interns. While both sexes experienced a notable rise in anxiety and depression levels, the increase in anxiety was more pronounced among male interns, whereas depression levels showed a comparable rise across sexes. Interestingly, COVID-19 pandemic reduced anxiety and depression levels among intern doctors by the end of their EM internships.

Ina study conducted by Aslan et al in which 358 students from 14 universities participated, using the GAD-7, the Satisfaction with Life Scale, the Perceived Stress Scale, and the Physical Activity Scale. In 52% of the students, they found generalized anxiety disorder and major depression in 63% of them and that females and physically inactive students were more anxious and depressive than their counterparts.[25]

Although different assessment tools were used compared to our study, similar sex-related findings were observed. The reasons behind these findings remain unclear; however, a study conducted in Korea examining adolescent populations also found that females exhibited higher levels of depression than males. In their study, the authors suggested that hormonal factors, emotional burden, parenting styles, and

Table 3. State-Trait Anxiety Inventory and Beck Depression Inventory Scale scores before and after COVID-19.

	Pre COVID-19 (N = 51)			COVID-19 (N = 152)				
	Median	Per 25	Per 75	Median	Per 25	Per 75	U	*P*
STAI-2	24	23	24	23	23	24	3.432	.22
BDI Pre	9	2	14	7	2	13	3.576	.41
BDI Post	26	15	32	8	3	16	1.348	**<.001**
STAI-1 Pre	47	38	53	41	35	48	2.999	**.02**
STAI-1 Post	51	45	56	47	42	52	2.999	**.02**

STAI, State-Trait Anxiety İnventory; *BDI, Beck Depression Inventory*; *Per 25,* 25th percentile; *Per 75,* 75th percentile.

Table 4. Risk of change in State-Trait Anxiety Inventory and Beck Depression Inventory Scale scores as a result of the internship.

		OR	Low	Upper	*P*
BDI	*Sex*	*1.145*	*0.762*	*1.721*	*.51*
	BDI	**1.055**	1.032	1.079	**<.001**
	COVID-19	*0.686*	*0.418*	*1.125*	*.14*
STAI_1	*Sex*	*1.124*	*.747*	*1.691*	*.57*
	STAI-1	**1.060**	1.037	1.083	**<.001**
	COVID-19	*0.819*	*0.510*	*1.316*	*.41*

OR, odds ratio; STAI, State-Trait Anxiety İnventory; *BDI, Beck Depression Inventory*.

communication problems could contribute to this sex disparity in depression.[26] These factors may also help explain the differences observed in our study in BDI and STAI-2.

Importantly, no significant difference was observed between male and female intern doctors in STAI-1 scores, both before and after the EM internship. This finding may be attributed to the nature of situational anxiety, which is often triggered by acute stressors that affect individuals regardless of their sex. The high-stress environment of EM, characterized by unpredictable cases, critical decision-making, and fast-paced conditions, may have created a uniformly stressful experience for all interns, thus overshadowing potential sex-related differences.[27]

In such high-pressure situations, the immediate, situational stress may not be as differentiated by sex, as both male and female interns may exhibit similar coping mechanisms and stress responses to acute stressors in the short term.[12] However, this contrasts with trait anxiety (STAI-2), which reflects more enduring, personality-related tendencies. Sex differences in trait anxiety are often more pronounced, with females generally exhibiting higher baseline anxiety levels than males.[28] This suggests that while females may have higher predispositions toward anxiety, the intense and immediate stressors of the EM environment could exert a more equalizing effect on situational anxiety in males and females.[29]

Depression, Anxiety, and Stress Scales were applied to the participants at the beginning and end of the internship to determine the effect of EM internship on the levels of anxiety and depression in EM service internship.[3] However, another study conducted by Erdur et al on emergency physicians found that as the time spent in the ED increased, depression and anxiety increased, and our findings aligns with their results.[30] The chaotic nature of the ED, exacerbated by witnessing events such as patients who died, working in the ED for the first time in a role of responsibility, increased workload, worries about the future, and night shifts may have made interns more anxious.[30-34]

Another important reason for increased anxiety is the incidence of violence in healthcare. It has been reported that violence against healthcare workers globally, as well as in Türkiye, is a serious occupational hazard.[35] Violence experienced in the ED has long-term negative effects on health professionals, including loss of energy, decreased job satisfaction, anxiety, stress disorder, feelings of insecurity and depression, alcohol use disorder, smoking, suicide, and deterioration in inner life.[36-38] Smoking, for example, is a significant issue among healthcare professionals, as it not only affects their physical and mental health but also undermines their role as health advocates. Bayramlar et al highlighted that medical students, as future healthcare professionals, have the potential to act as role models in tobacco control. However, their study also revealed concerning smoking prevalence rates among medical students in Istanbul, Türkiye, emphasizing the need for targeted interventions to address smoking and its associated risks in this population.[39]

Several studies have reported that among interns, females were more anxious than males.[6,30,40,41] Koçak et al also found the same results in interns as we did, even though both sexes practiced in similar conditions and had the same training.[3] This aligns with findings from Bayramlar et al, who demonstrated that female medical students exhibited higher levels of empathy and social awareness, often resulting in an increased emotional burden. These findings suggest that sex differences in anxiety may be partially explained by the greater emotional and social responsibilities usually shouldered by females in healthcare.[42,43] Furthermore, studies have shown that medical interns are particularly vulnerable to depression due to the unique stressors associated with the transition into clinical practice. The adjustment to new responsibilities, fear of making medical errors, and lack of support and recognition can contribute to feelings of isolation and burnout. Additionally, stress and anxiety related to the competitiveness of medical school are closely linked to the development of depression.[27,33,44]

Another finding of interest in our study was that while females experienced higher depression and anxiety levels than males, the increases in anxiety levels was greater inr males but the increase in depression levels was the same for both sexes. Reasons for this are complicated; some studies suggest that females are more likely than their male counterparts to engage in help-seeking behaviors when facing stress and to maintain better social support networks, which facilitate active coping strategies.[45,46]

Interestingly, when Koçak and colleagues administered the BDI to interns at the beginning and end of their EM internship they found that depression levels had decreased by the end of the internship, which contrasts with our findings. This discrepancy may be due to differences in the internship structure, work conditions, or the specific support mechanisms available to the participants in the Koçak study. Factors such as coping mechanisms, the nature of stressors, or the overall support provided during the internship may have influenced the outcome, with some interns in the Koçak study potentially benefiting from more structured support or less exposure to high-stress situations.[3] This highlights the complexity of

mental health outcomes in EM internships and suggests that interventions aimed at reducing depression should consider these individual and situational factors.

The global COVID-19 pandemic may have increased the level of anxiety among medical interns, as the disease put both healthcare professionals and their loved ones, whom they could have infected, at risk. In this regard, Xiao et al[47] studied healthcare workers in Wuhan, China, and other centers to determine how the COVID-19 pandemic impacted them; 55.1% of the study participants stated they experienced higher anxiety in the COVID-19 pandemic compared to the severe acute respiratory syndrome period. It was found that 54.2% showed symptoms of anxiety and 58% showed symptoms of depression.[47] In our study, we saw no significant change in the STAI-2 scores of the participants, which indicates the trait anxiety state. There were significant decreases in the STAI-1 score, which indicates situational momentary anxiety, and in the BDI, which indicates the level of depression. This reduction may be attributed to the reduced workload in the hospital in Türkiye.[42] Furthermore, in line with hospital policies to reduce COVID-19 exposure, shifts were temporarily halved during the pandemic period.

LIMITATIONS

The study has several limitations that should be acknowledged. First, the single-center design and absence of a control group limit the generalizability of our findings. Additionally, the unexpected impact of the COVID-19 pandemic introduced complexity, making it difficult to isolate its effects and to distinguish pre-existing mental health symptoms from those newly developed during the pandemic. The reliance on self-reported questionnaires, such as the STAI and BDI, rather than clinical evaluations or psychiatric diagnoses, further constrains the validity of the findings.

Moreover, the study does not sufficiently explore sociodemographic factors, such as socioeconomic status, family support, and previous mental health history, which are likely to influence anxiety and depression levels. It also lacks a detailed analysis of specific stressors in EM such as violence, workload, and night shifts. It is also worth mentioning that physical activity has been associated with improvements in cognitive and academic performance, as well as reductions in depression levels. However, these findings remain a topic of discussion, and we did not explore this subject.[25,48-50] Nor did we ask participants why they felt anxious or depressed. Understanding the reasons behind their feelings would have provided more insight into the factors contributing to their mental health challenges.

Future research should address these gaps by incorporating qualitative data, clinical evaluations, and a more detailed exploration of stress factors and sociodemographic influences to provide a more comprehensive understanding of the mental health challenges faced by healthcare workers in emergency settings.

CONCLUSION

Our study highlights the significant psychological impact of an EM internship, showing an increase in anxiety and depression levels among medical interns, with female reporting higher levels than their male counterparts. Interestingly, depression scores did not show a significant increase in the COVID-19 group, while depression scores significantly increased in the pre-COVID-19 group by the end of their internship. Furthermore, the COVID-19 group exhibited lower post-internship STAI-1 and Beck Depression Inventory scores compared to the pre-COVID-19 group. While these results suggest an association between EM internships and increased psychological distress, it is important to note that causality cannot be definitively established due to the multifactorial nature of mental health. Although we focused on senior medical students in Turkey, the study offers valuable insights that may be applicable to medical student well-being globally. Given the increasing recognition of mental health challenges in medical education, similar studies in other countries could yield important cross-cultural comparisons and offer a broader understanding of the challenges faced by medical interns worldwide. More multicenter studies with control groups are required to better understand these relationships and guide future interventions aimed at supporting the mental well-being of medical interns.

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Time Motion Analysis of Emergency Physician Workload in Urgent Care Settings

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Introduction: The Predictors of Workload in the Emergency Room (POWER) study, published in 2009 using data from 2003, examined the workload of emergency physicians using the Canadian Triage and Acuity Scale (CTAS) as a surrogate marker. Many hospitals use a case-mix formula incorporating annual census and POWER's study data to determine staffing levels. However, significant changes in emergency medicine have occurred since its publication, including the implementation of electronic health record systems, increased patient complexity, real-time dictation software, and human health resource challenges due to the COVID-19 pandemic. In this study we aimed to quantify the time required to perform tasks during the care of ambulatory emergency department (ED) patients. Our secondary objective was to stratify these times based on CTAS and clinician factors.

Methods: We conducted a prospective observational time-motion study in the urgent care section of a tertiary-care, academic ED with 90,000 visits annually, 70% of which are ambulatory. Research assistants shadowed physicians on two 8-hour shifts daily (8 AM-12 AM) from July 12–August 14, 2022, tracking the time taken by physicians to perform tasks. We calculated aggregate task times per patient.

Results: We observed 1,204 patient encounters over 65 shifts by 37 unique physicians. The mean treatment time was 21.6 minutes (95% confidence interval [CI] 19.9 - 23.3) for ambulatory CTAS 2 patients; 22.5 minutes (95% CI 21.2 - 23.6) for CTAS 3 patients; 19.7 minutes (95% CI 17.9 - 21.6) for CTAS 4 patients; and 17.4 minutes (95% CI 14.9 - 19.9) for CTAS 5 patients. Compared to the previous 2003 POWER study data, CTAS 4 and 5 patient assessment times took 31% and 58% longer, respectively. Total assessment time by CTAS was statistically significant only comparing CTAS 5 patients to all others (P = .02). Physicians who dictated their charts spent 34% less time (2.1 minutes per patient) charting than those who typed them.

Conclusion: The average time to see an ambulatory ED patient was 21.7 minutes. Low-acuity urgent care patients take longer to assess now than 20 years ago. The CTAS alone is a poor marker of workload for ambulatory patients, necessitating a reassessment of staffing and compensation formulas. [West J Emerg Med. 2025;26(4)804–809.]

INTRODUCTION

Emergency departments (ED) in Canada are facing unprecedented levels of strain and crowding.[1] Emergency departments must find ways to become increasingly efficient with fewer relative resources to meet the demands they face. As patient wait times increase, ensuring appropriate physician staffing of the ED is critical. Currently, physician staffing in many Ontario hospitals is based on a case-mix formula that combines ED census and acuity[2]; the Canadian Triage and Acuity Scale (CTAS) is used to determine acuity. The CTAS is a five-level system with level 1 representing the most acute patients and level 5 representing non-urgent patients.[3] This formula allows a set number of minutes of emergency physician time for each patient based on their CTAS score. This ultimately translates into the number of annual hours of coverage that physicians are paid to provide.

The Predictors of Workload in the Emergency Room (POWER) study,[4] published in 2009 using data from 2003, attempted to understand emergency physicians' workload for the first time in Canada. The study tracked physicians over their entire shift and timed various activities related to patient care, ultimately describing the time spent on various tasks and the total time spent assessing and treating all ED patients by CTAS level. While this was the first study in Canada to provide a data-driven emergency physician workload by CTAS, the authors questioned the accuracy of CTAS alone as a predictor of workload.

Previous studies have demonstrated significant changes to the practice of emergency medicine since the POWER study's publication in 2009, including delays in care due to medical complexity,[5] the use of electronic health records (EHR),[6,7] the widespread adoption of real-time dictation software for documentation,[8] and the effects of the COVID-19 pandemic on human healthcare resources.[9] However, the overall difference in time spent to manage low-acuity patients has not been robustly assessed since the original POWER study. Further, the POWER study considered ED patient factors affecting physician workload but did not collect data on the physicians themselves. There has since been research that questions physician gender differences in assessment[10] and documentation times[11] in ambulatory clinics. Hypothetically, there may also be differences in care times based on physician seniority.

Our study objective was to quantify the time required to perform tasks in the care of ambulatory ED patients. Our secondary objective was to stratify these times based on assigned CTAS and by clinician factors.

Population Health Research Capsule

What do we already know about this issue?
Emergency department workload is often estimated using outdated triage-based models and informs staffing models leading to understaffed EDs.

What was the research question?
How much time do physicians spend on low-acuity ambulatory ED patients, and how does this vary by acuity and clinician factors?

What was the major finding of the study?
The mean treatment time was 19.7 minutes (95% CI 17.9 - 21.6) for Canadian Triage and Acuity Scale (CTAS) 4 patients, and 17.4 minutes (95% CI 14.9 - 19.9) for CTAS 5 patients.

How does this improve population health?
Ambulatory, low-acuity ED patients now take significantly longer to treat. It is time to reassess ED workload-based compensation and staffing models.

METHODS

Study Design and Time Period

We conducted a prospective, observational, time-motion study to track the amount of time taken by physicians to perform tasks in the care of patients in the urgent care area of a tertiary-care, academic ED with 90,000 patient visits per year. This study took place from July 12–August 14, 2022. This study received research ethics board exemption.

Study Setting and Population

This study took place at The Ottawa Hospital, General Campus ED, in the urgent care area. The urgent care area sees low-acuity ambulatory patients not requiring heavy nursing resources or cardiac monitoring. It has 24 assessment spaces open 24 hours/day with up to quadruple (50-64 hours/day) physician coverage. There are 3-4 nurses in the area depending on time of day, and the unit sees ~160 patients per day, 65-70% of our entire ED daily volume. The emergency physician group at The Ottawa Hospital consists of approximately 90 physicians and provides physician services between both campuses. Both EDs are part of tertiary-care, academic teaching hospitals.

The Ottawa Hospital, General Campus, is a teaching hospital. Most shifts have 1-2 learners assigned to them including medical students and residents from all postgraduate training programs. The hospital uses Epic's EHR (Epic Systems Corporation, Verona, WI), and Dragon dictation software (Microsoft Dragon, Microsoft Corporation, Redmond, WA) is available for staff use. No scribes are employed in the ED.

Intervention

Our study protocol was adapted from the previous POWER study.[4] Research assistants (RA) were assigned to

follow staff physicians on two shifts each day over the study period, from 8 AM-12 AM (ie, 16 hours per day). The first shift ran from 8 AM-4 PM and the second shift from 4 PM-12 AM. At the beginning of the shift, the RAs would collect information on physician age, sex, years in practice, years working at The Ottawa Hospital, their training stream (Canadian College of Family Physicians vs Royal College of Physicians and Surgeons of Canada), and charting type (dictating, typing, or mix). Following this, they would shadow staff physicians without interacting with them for the duration of the shift while timing the tasks of interest. The RAs did not enter patient rooms and had no direct contact with patients. Neither did they directly shadow postgraduate medical trainees, medical students, or nurse practitioners assigned to work with the staff physician. Night shifts were not tracked as there was no RA shift covering the urgent care area, which started at midnight, precluding the entire shift from being observed.

Before the initiation of the study, an email was sent to all physicians explaining the purpose of the study and gave the option to not participate. Only one physician chose not to participate; however, this physician was not scheduled to work the study shifts during the study period.

Outcome Measures

We designed a custom application to operate on a handheld Galaxy S8 tablet (Samsung Electronic Corporation, Ltd, Suwon, South Korea). The application allowed RAs to input patient information (age, CTAS score, and presenting complaint) and record the time spent on tasks attributable to that patient. The application allowed for a dynamic list of patients under the care of the observed physician. Patients were added as they were signed up for and removed from the list after they were physically discharged from the ED and their chart had been fully completed by the physician. Patients with incomplete data by the end of the RA's shift were right censored.

The primary outcome measures were task times per patient in eight pre-defined tasks, in seconds. These tasks were as follows: 1) initial assessment—time the staff emergency physician spent on initial assessment of the patient; 2) re-assessment—time spent with the patient after an initial assessment had already taken place; 3) discussion with learners—time spent reviewing learners' cases and teaching, outside the patient room; 4) seeing learners' patients—time spent in the room assessing the learner's patient; 5) charting—any time spent documenting, billing, or entering orders; 6) reviewing information on the computer—any time spent reviewing past documentation, triage notes, medications, and past medical history; 7) phone—any time spent on the phone in consultation with specialty services (obtaining collateral history on the phone was captured under initial assessment); and 8) not related to patient care—any time spent that was not related to patient care such as down time, eating, attending the restroom, socializing, etc.

The raw data included the summation of time, in seconds, spent on each task per patient with the associated patient and emergency physician characteristics.

Data Analysis

Task times were tracked in seconds and analyzed with descriptive statistics. We conducted Wilcoxon rank-sum tests for comparing task times with non-parametric distributions and *t*-tests to compare task times with normal distributions. Linear regression analysis was conducted to compare task times and total patient assessment times by CTAS and for physician characteristics. We performed all analyses using SAS 9.4 (SAS Institute Inc., Cary, NC).

RESULTS

We gathered data on 1,204 unique patient encounters over 65 shifts by 37 unique physicians. Characteristics of the study physicians are presented in Table 1. Twelve (32.4%) study physicians were women. Five (13.5%) physicians typed their charts as opposed to dictating or using a mix of typing and dictating. Twenty-five (67.6%) of the physicians were trained in emergency medicine in a Royal College residency program with the remaining 12 (32.4%) trained by the College of Family Physicians. Twelve (32.4%) of the physicians had been practicing for < five years. The amount of physician time spent on an individual task is shown in Table 2. On average, physicians spent 93.5% of their time on shift related to patient care activities. The mean assessment time of any patient was 21.7 minutes (95% CI [confidence interval] 20.6 - 22.2). When performing an initial assessment of a patient themselves, staff physicians spent 7.4 minutes doing so. As a teaching hospital, a significant amount of time is spent on teaching and reviewing learners' patients (5.9

Table 1. Characteristics of the 37 unique physicians observed by research assistants during the study period.

Physician characteristic	
Sex	
Male	25/37, 67.6%
Female	12/37, 32.4%
Years practicing emergency medicine	
Median (IQR)	9 (4 -23)
Years working at The Ottawa Hospital	
≤5	12/37, 32.4%
>5	25/37, 67.6%
Training Stream	
RCPSC	25/37, 67.6%
CCFP-EM	12/37, 32.4%
Charting Method	
Dictate	14/37, 37.8%
Type	5/37, 13.5%
Mix	18/37, 48.6%

IQR, interquartile range; *RCPSC*, Royal College of Physician and Surgeons of Canada; *CCFP-EM*, Canadian College of Family Physicians Certification in Emergency Medicine.

minutes) and then seeing their patients (7.6 minutes), when this occurred; 32% of patients were initially seen by learners, and 62% of patients seen by a learner were also seen by a staff physician. For patients seen by a staff physician only, the mean total assessment time was 27.8 (SD 14.6) minutes. For patients seen by learners, the mean total staff physician time overseeing this was 15.6 (SD 13.7) minutes. Of all patients observed, 0% were categorized as CTAS 1; 20.6% as CTAS 2; 52.4% as CTAS 3; 17.4% as CTAS 4; and 7.3% as CTAS 5 Table 3 presents the data from individual tasks and total assessment times by CTAS. The mean treatment time was 21.6 minutes (95% CI 19.9 - 23.3) for ambulatory CTAS 2 patients; 22.5 minutes (95% CI 21.2 - 23.6) for CTAS 3 patients; 19.7 minutes (95% CI 17.9 - 21.6) for CTAS 4 patients; and 17.4 minutes (95% CI 14.9 - 19.9) for CTAS 5 patients. Total assessment time by CTAS score was only statistically significant when comparing CTAS 5 patients to all others ($P = 0.022$). There was significant variability of assessment times within each CTAS category. However, the sample size of our study resulted in narrow 95% CIs for the point estimates.

There was a significant difference by sex in the overall time spent on any given patient, with female physicians spending 23.3 minutes and males spending 21.0 minutes (+10.9%, $P = .03$). There was no significant difference in any individual task measured, with the exception of charting in which women spent on average 7.4 minutes per patient compared to men who spent 6.3 minutes (+17.7%, $P = .002$). Physicians who dictated their charts spent the least amount of time charting (6.1 minutes) per patient compared to a mix of typing/dictating (6.3 minutes, $P = .54$), or typing alone (8.2 minutes, $P < .001$). We found no differences in task times when comparing physician seniority (≤ 5 years vs > 5 years as staff) or training stream (RCPSC vs CCFP-EM).

Table 2. Amount of emergency physician time spent on individual tasks, in minutes.

Task (n)	Time to Complete Task in Minutes Mean (SD)
Initial assessment n = 601	7.4 (4.4)
Re-assessment n = 496	4.8 (4.6)
Discussion with learners n = 797	5.9 (5.3)
Seeing learner's patient n = 259	7.6 (6.7)
Charting n = 1,026	6.7 (5.2)
Reviewing info on computer n = 939	3.2 (3.7)
On phone n = 277	3.7 (3.3)

*Not all tasks were performed for each patient observed.

Table 3. Univariate linear regression of individual task durations by Canadian Triage and Acuity Scale, in minutes.

Task		Estimate (min)	Standard error	P-value
Initial assessment	Reference (CTAS 2)	7.6	0.41	
	CTAS 3	-0.1	0.48	.82
	CTAS 4	-0.3	0.59	.67
	CTAS 5	-1.1	0.81	.21
Re-assessment	Reference (CTAS 2)	5.6	0.48	
	CTAS 3	-0.7	0.55	.19
	CTAS 4	-1.1	0.70	.13
	CTAS 5	-2.0	0.92	.03
Discussion with learners	Reference (CTAS 2)	6.2	0.40	
	CTAS 3	-0.1	0.47	.77
	CTAS 4	-1.1	0.58	.06
	CTAS 5	-0.8	0.78	.30
Seeing learner's patient	Reference (CTAS 2)	8.2	0.79	
	CTAS 3	-0.5	0.94	.60
	CTAS 4	-1.8	1.24	.16
	CTAS 5	-3.0	1.47	.04
Charting	Reference (CTAS 2)	6.6	0.35	
	CTAS 3	0.0	0.41	.99
	CTAS 4	0.3	0.52	.56
	CTAS 5	-0.5	0.69	.47
Reviewing info on computer	Reference (CTAS 2)	2.9	0.26	
	CTAS 3	0.6	0.30	.06
	CTAS 4	-0.5	0.38	.23
	CTAS 5	-0.3	0.54	.59
On phone	Reference (CTAS 2)	3.3	0.38	
	CTAS 3	0.1	0.46	.76
	CTAS 4	0.6	0.65	.36
	CTAS 5	1.3	0.97	0.18
Total assessment time	Reference (CTAS 2)	21.6	0.93	
	CTAS 3	0.9	1.10	.44
	CTAS 4	-1.9	1.38	.18
	CTAS 5	-4.2	1.82	.02

CTAS, Canadian Triage and Acuity Scale.

DISCUSSION

Interpretation of Findings

Our study showed that the CTAS is not a good indicator of expected workload times for emergency physicians when studying ambulatory patients, with only CTAS 5 patients having

a statistically significantly lower workload demand and ambulatory CTAS 2-5 patients being nearly equal in their workload demands. This is the first study to our knowledge that has examined clinician factors associated with the workload demands of attending emergency physicians. One previous study assessed fully licenced attending physicians vs trainees and found that trainees spent significantly more time with patients.[12] In this, study we focused only on attending physicians.

We found no difference in physician training stream or seniority in the time spent on any task or total time caring for patients. We did find differences based on clinician charting method: Those who typed their charts spent 34% longer charting than those who dictated. Interestingly, we did find differences by sex in our study, but these were limited to charting time and total assessment time. The differences in charting time between men and women did not account for the full difference in total assessment time, suggesting other factors or tasks that differed; however, we did not examine those factors. This may include time talking to families after initial patient assessment or interruptions by staff, patients, or families while walking to and from patient assessment rooms.

Comparison to Previous Studies

The POWER study captured the workload of emergency physicians per patient, by CTAS level. The dataset from this study is now 20 years old; yet the same case-mix formula to calculate emergency physician staffing hours remains. Our study, which captured an updated set of data, showed significant differences in the workload of emergency physicians now compared to 2003. While the POWER study examined all patients in the ED and our study examined ambulatory ED patients, it is a fair assumption that almost all the CTAS 4 and 5 patients captured in the POWER study were triaged to ambulatory areas of an ED. The POWER study showed that physicians took 15 minutes and 11 minutes to care for these patients, respectively. Our study showed that these times have increased and now take 19.7 minutes and 17.4 minutes, respectively. This represents a 31% increase (4.7 minutes) in workload for CTAS 4 patients and 58% increase (6.4 minutes) for CTAS 5 patients. We hypothesize that the increase in workload reflects increasing patient complexity, workload increases associated with use of EHRs, and ED crowding.

With respect to CTAS 2 and 3 patients, it is more difficult to generalize these to the POWER study. A significant portion of CTAS 2 and 3 patients are triaged to non-ambulatory care areas of an ED, which we did not study. It is expected that higher acuity, non-ambulatory patients would take longer to assess as these patients are often sicker, undergo more studies, and have higher admission rates. This was reflected in the POWER study with all CTAS 2 patients taking 39 minutes to care for and all CTAS 3 patients taking 26 minutes, while we showed ambulatory CTAS 2 patients to require 21.6 minutes and ambulatory CTAS 3 patients to require 22.4 minutes to care for.

Strengths and Limitations

This study was conducted in a single Canadian, tertiary-care academic ED, which may limit its generalizability to other EDs; however, triage systems in other countries have been shown to be valid at identifying low-acuity patients[13] and similar changes have occurred in the practice of emergency medicine throughout the United States and elsewhere over the last 20 years. Further, many triage systems have been shown to be valid at identifying low-acuity patients. Our study was also brief, with observations occurring over a one-month period, which may not have reflected the seasonality that occurs with EDs. Finally, we examined patients in the urgent care area of our ED only, which limits its comparison to the POWER study, which examined all ED patients.

Clinical Implications

This study provides an updated workload analysis of low-acuity, ambulatory ED patients in a tertiary- care, academic ED. It highlights increases in workload times in comparison to previous studies, which ultimately should translate into increased physician staffing to better match ED demand. Finally, physician characteristics impact assessment times: those who type their charts could consider dictating to improve efficiency.

Research Implications

To our knowledge, this study was the first to look at attending physician characteristics in determining workload variables in emergency physicians. We found significant differences in charting times between those who dictate and those who type. Further studies could examine the workload impact of scribes compared to those who dictate their charts. iDfferences by sex were observed in charting and total assessment times in our study. The differences in charting times between men and women did not account for the entirety of the difference in total assessment times, indicating an untracked variable making up some of this difference. Future studies could be conducted to further examine this difference. Low-acuity patients take significantly longer to assess and manage than they did 20 years ago during the time of the POWER study; future studies could examine the factors that have contributed to the longer treatment times.

CONCLUSION

The mean time to care for a patient in the urgent care area was 21.7 minutes, ranging from 17.4 minutes for CTAS 5 patients to 22.5 minutes for CTAS 3 patients. Compared to the POWER study conducted 20 years ago, ambulatory, low-acuity ED patients now take significantly more time to treat. Given we now have electronic health records, physicians should be encouraged to dictate notes. Finally, these findings suggest a need for reassessment of workload-based compensation models in ED settings due to the increased amount of time it takes to care for patients now than 20 years ago.

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Real-time Patient Experience Surveys Lead to Better Scores

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Introduction: The patient satisfaction survey is a controversial fixture of modern emergency care. Patients who are satisfied are more likely to adhere to the treatment plan and less likely to pursue legal action. However, the current surveys are susceptible to recall bias. This study uses an analysis of data collected in a separate study to assess how patients rated their physicians' care when asked key questions in person by a trained volunteer versus in the Doctors section of the Press Ganey (PG) survey.

Methods: This was an analysis of prospectively collected data obtained in a separate study evaluating how patients experience their emergency care when learners are present. Trained medical student volunteers administered the survey to a convenience sample of patients slated for discharge at a single, community, tertiary-care hospital emergency department (ED) for a total of 12 weeks between June–October 2022. We compared this with the hospital's PG data for the questions on which the survey was based.

Results: A total of 625 patients were approached over the study period with 313 agreeing to participate (response rate 50.1%). There were 8,460 patients discharged from the ED during those times (overall rate 3.70%). During the contemporaneous PG study quarter, the ED received 266 responses during the shifts for which the study enrolled patients, of a total 8,460 discharged from the ED during those times (response rate 3.14%). All key questions favored the in-person survey vs mailed PG survey: "I felt informed" score 79.2 (262) vs 75.6 (265), $P = .02$; "I felt like my [doctor] took time to listen" 85.0 (261) vs 79.6 (266), $P = .05$; and "satisfaction with care team" 83.0 (263) vs 74.7 (265), $P = .0013$.

Conclusion: This study shows higher satisfaction scores with an in-person survey. There was also a dramatically improved response rate compared with mail in PG forms, suggesting less recall bias. An absolute 5-point difference in PG score could lead to a relative 30-point change in percentile rank. This was a limited, single-site study whose results are hypothesis-generating but suggest a new pursuit for administrations seeking to improve their scores and possibly better understand patients' experience of their care. [West J Emerg Med. 2025;26(4)810–814.]

INTRODUCTION

Background

The patient satisfaction survey is an ubiquitous feature of modern medical practice and healthcare administration. As practitioners we want our patients to be satisfied with their care. Multiple studies have demonstrated that satisfied patients are more likely to complete the recommended treatment course and less likely to pursue litigation.[1,2,3] Whether increasing satisfaction leads to better outcomes is controversial.[1] Furthermore, hospital reimbursement and revenue generation are tied to these scores.[1]

The default industry standard is the Press Ganey (PG) survey, which is mailed to patients after their visit to the emergency department (ED). Their large database allows comparison within the hospital between physicians, over time, and between peer institutions. However, this is a survey tool,

and response rates are generally poor; additionally, since the form is sent through the mail, responses are subject to recall bias.[4,5] Some studies suggest responses to these surveys are biased against female and minoritized physicians vs their counterparts.[5,6] Because many departments use these results for promotion and compensation, mitigating bias is paramount.

Importance

All stakeholders want their patient satisfaction scores to reflect the actual patient experience of their care without bias, while keeping them as high as possible. A survey design that minimizes bias and results in an increased response rate has the potential to help administrators make changes and allow for more robust feedback to individual clinicians. If changing the delivery of the survey can do that at minimal cost, this is an avenue administrators may wish to pursue.

Goals of This investigation

Understanding the limitations of the current industry standard survey tools, we investigated whether there might be a better way to capture our patients' experience of their care. Our research team, which was conducting a study to explore how the presence of learners affects perceptions of care, hand-delivered the survey to each patient. We performed a reanalysis of that in-person survey data and compared it to our institution's PG scores. Our initial hypothesis was that surveys administered in person would return better scores with a higher response rate with respect to the three satisfaction questions related to the corresponding "Doctors" questions on the PG survey.

Population Health Research Capsule

What do we already know about this issue?
Patient experience surveys are a feature of modern emergency care and used to determine reimbursement and sometimes physician bonuses and promotion.

What was the research question?
Were in-person surveys associated with a higher experience rating?

What was the major finding of the study?
All key questions favored the in-person vs mailed survey: "I felt informed" score 79.2 (262) vs 75.6 (265), P = .02; "I felt like my [doctor] took time to listen" 85.0 (261) vs 79.6 (266), P < .05.

How does this improve population health?
More accurate evaluation of ED patient experience can allow for meaningful improvement in ED care.

METHODS

Study Design, Setting, and Participants

This study was based on data from a single, suburban Level I trauma center community ED averaging over 50,000 visits annually. Patients eligible to be enrolled in the parent study were adults ≥18 years of age who were slated for discharge from the ED. For reasons of informed consent, they could not have been seen for a behavioral health or substance use diagnosis and could not have been incarcerated at the time of enrollment. Patients were also excluded if they were made a trauma alert, triaged as Emergency Severity Index (ESI) level 1, or were seen by an advanced practice practitioner (APP). This was to prevent confounding with multiple participants on the care team to prevent misperception of a learner.

Our PG data does not include individual level characteristics, and it is possible some patients returned both surveys. Additionally, patients seen by advanced practitioners, triaged to ESI level 1 and discharged, and seen as a trauma alert and subsequently discharged all would be eligible to receive a PG survey, but would not have completed the parent research survey. The survey was administered by a trained research assistant (RA), not part of the care team, who obtained consent for inclusion in the parent study at the time of enrollment. The survey was delivered electronically on an iPad, using REDCap electronic data capture tools hosted at Geisinger Wyoming Valley Medical Center.[7] The RA was available to answer questions and could input responses for the patient if requested. We enrolled a convenience sample of participants. Both the parent study and this supplement were reviewed and deemed exempt by the institutional review board of our healthcare system.

Measures

The parent survey asked, among other items, how people perceived their care with respect to time spent, feeling listened to, and overall satisfaction. Relevant survey questions are provided in the appendix. These differ slightly from the PG questions for reasons of copyright. Patients were asked to rank these values on a 1-5 Likert scale.

Procedure

Using the data provided to our institution by the PG corporation, as well as local statistics kept for quality assurance, we determined the number of patients seen and discharged on the days for which we were enrolling, considering the relative exclusion criteria, and we used this number as the denominator for total people available. As part of the parent survey, we kept track of the response rate for those people who were specifically approached for enrollment. The PG data can be analyzed by the shift during which the

patients were seen. Because we did not enroll patients overnight, we excluded data from those shifts.

Specific determination of our eligible patient denominator was as follows: Our department tracks numbers for total check-ins as well as admissions/observations and left before treatment complete (elopements, left without being seen, and against medical advice). We also track the ESI level 4 and 5 visits, which in our ED are seen almost exclusively APPS and, therefore, would have been excluded from the parent study. Although we didn't enroll for the parent study overnight, we did not subtract the patients who checked in overnight as some of these may have waited and been seen by students in the morning.

Analysis

We performed basic statistics using Microsoft Excel (Microsoft Corporation, Redmond, WA). Individual level data is not available from the PG surveys; however, they provide measures of central tendency including means and standard deviation for the quarter, which allowed us to perform statistical testing. Specifically, we used the mean and SD on from the PG surveys to perform Student *t*-statistic for the relevant questions. The PG survey converts the Likert scale into a 100-point score where 1 = 0, 2 = 25, 3 = 50, 4 = 75, and 5 = 100; therefore, we applied this conversion to our scale to give a final score for comparison.

Table 1. Demographics of patients who completed the survey for the parent study.

Patient Age at Time of ED Visit	
Mean (SD)	49.5 (20.52)
Median (IQR)	47.0 (31.0, 66.0)
Range	18.0, 93.0
Missing	4
Patient Sex, n (%)	
Female	180 (58.6%)
Male	127 (41.4%)
Missing	4
Patient Racial Affiliation, n (%)	
Black	22 (7.2%)
White	280 (91.2%)
Other	3 (1.0%)
Unknown	2 (0.7%)
Missing	4
Patient Ethnicity, n (%)	
Non-Hispanic/Latino	285 (92.8%)
Hispanic/Latino	21 (6.8%)
Unknown	1 (0.3%)
Missing	4

ED, emergency department; *IQR,* interquartile range.

RESULTS

Demographics

Demographic information is summarized in Table 1. The PG corporation does not provide demographic information for who completes their surveys but given that these are drawn from a similar population of patients, it is likely similar. Respondents were predominantly female (58%) and white (91%).

Response Rate

During the study period from June–October 2022, a total of 625 patients were approached for enrollment in the parent study with 313 responses (rate 50.1%). Of the total 8,460 patients who were theoretically eligible on days we enrolled, this represents 3.70% of all possible patients. There was missing data on many of the surveys returned; only the ones with answers to the key questions were used for analysis. During the contemporaneous quarter, the hospital received a total of 266 responses to the PG survey during shifts 1 and 2 for an overall response rate of 3.14%.

Patient Satisfaction

Results are summarized in Table 2. With respect to "I felt informed" the in-person score was 79.2 (of 262) vs 75.6 (265) for the mail in, $P = .02$. For "I felt like my [doctor] took time to listen" the in-person score was 85.0 (of 261) vs 79.6 (266) for the PG, $P = .05$. Finally, "satisfaction with care team" scored 83.0 in person of 263 vs 74.7 of 265 for the mail-in, $P = 0.001$.

DISCUSSION

Patients rated their care more favorably when approached in person, and at a higher response rate. Although absolute numbers are important in terms of statistical and practical validity, the percentile rank is most important to hospital administration as this is the comparison they are held to for reimbursement.[1,2] An absolute improvement of 5 points in score could lead to a 30-point increase in percentile rank, which is hugely significant for hospital administration, showing that these results have both statistical and real-world impact. However, given the current landscape of patient-experience survey collection, no hospital could unilaterally implement the in-person survey method to bolster their PG metrics. The value may lie in more robust data to inform incentives or more accurately provide feedback.

The in-person survey resulted in a greatly improved response rate in terms of people approached. Even in terms of overall numbers of responses, over the same amount of time there were a similar number of answers to the key questions returned for the in-person surveys despite the fact that the RAs typically only enrolled patients for 8-10 hours a day, weekdays only. Additionally, our overall response rate to the survey includes patients registered in the late evening and overnight

Table 2. Responses to survey questions delivered in-person versus by mail.

Question	In Person Survey Score (N)	Press Ganey Score (N)	*P*-value
I felt informed about my treatment and diagnosis after my visit.	79.2 (262)	75.57 (265)	0.02
I felt like my [doctor](s) took time to listen to me during my visit.	84.98 (261)	79.6 (266)	0.05
How would you rate your satisfaction with your care team on this visit?	83.03 (263)	74.67 (265)	0.001

who were not approached for enrollment; so, if someone were always available the expected response rate would be higher. Hospital Consumer Assessment of Healthcare Providers and Systems requires 300 surveys to be returned for the facility annually. The PG internal analysis states that 30-50 surveys are required to make comparisons between physicians, but for the ED as a whole this would provide a 50-55% confidence interval (CI). The number required to generate a 95% CI is ≈200 surveys.[2]

A positive patient experience is profitable. There is a strong correlation between negative patient experience and decreased revenue.[8] Prior research efforts on the topic have shown that increasing the rating in the "Doctors" section evaluated here results in improvements in other domains as well.[9] To this end, many organizations have attempted interventions such as scripting and customer service training, which require investment of physicians' thinly stretched time, to improve their scores.[2,10] Some studies of satisfaction used an in-person survey model and found increased response rates, consistent with our findings here.[10]

It is not possible to determine from this method whether the favorable response rate and ratings were the result of the human helping administer the survey vs the real-time delivery. Implementing an in-person system would be expensive, assuming dedicated personnel administered the survey. Our RAs were present in the department for an average of 8 hours/day, 5 days/week, over a 12-week period, representing 480 hours of work to enroll 313 people. Assuming a wage of $10/hour (minimum in our state is $7.25),[11] this equates to $4,800 spent over the study period, or close to $20,000 annually. Put another way, each survey returned took 1.5 hours of labor. Many hospitals are investing in smart technology such as digital whiteboards; so, further research is needed to determine whether similar results would occur if these were used to deliver real-time surveys.

LIMITATIONS

This study has several limitations. Importantly this was not a trial, and any conclusions are hypothesis-generating, at best. This also represents data from a single hospital and may not be generalizable. Because of the study design and the anonymous PG survey it is possible that different groups of people were answering each survey type. Different patients may have responded to different surveys, or possibly they decided not to return a mailed survey because they believed they had already completed one for the parent study. Both suffer from a low response rate. There is certainly a non-response bias in the in-person data, which favors more positive results for the in-person survey. However, completion of the mailed PG survey is subject to recall and multiple other types of bias[3,4,6,12]; however, the healthcare industry has accepted this as the way we evaluate our patients' experience of their care. It is possible that the positive effect is not from eliminating recall bias but having a physical person administer the survey. Any future trial based on this study would do well to compare both. Regardless, as hospitals compete to "strive for 5" any potential advantage is worth using.

This study design did not have the ability to detect the effect of implicit or explicit bias on patients' responses. Further investigation into this realm is needed. Our own internal quality control found evidence of non-response bias favoring more positive results. Multiple patients commented to the person enrolling that they didn't want to answer the survey because they were dissatisfied with their care. As discussed above, this may mean that the positive results are from a theoretical representative of the hospital administering the survey rather than an effect of decreased recall bias. For individual hospitals seeking to gain an advantage, this is a desired effect. However, if applied more broadly, likely those systems with more resources will be able to devote the manpower to deliver an in-person survey to all discharged patients, favoring the already well-resourced hospitals.

CONCLUSION

Patients administered an in-person survey answered the questions pertaining to the "Doctors" section on the Press Ganey survey rated their care more favorably than when they were mailed a survey to complete later, and with a higher response rate. Although this was not a trial and was subject to the limitations of survey studies and its design, the tool by which hospitals and ourselves as physicians are compared shares all these flaws with higher potential for non-response and recall bias. Using a real-time survey is another strategy that administrators may consider useful, as even small improvements in scores can lead to a dramatic change in percentile rank. A trial is needed to definitively answer this question. In this age of ED crowding and frustration interested leaders with the means to deploy such a tool should consider its use.

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Influence of Previous Emergency Department Visit Information on Care of Current Patients

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Introduction: Past patient data from health information exchanges (HIE) can enhance physician-patient interactions, although how and how often is unclear. We sought to determine how and how often past medical records provided by an HIE impacts current decision-making by emergency physicians.

Methods: We identified qualifying emergency department (ED) visits between September 24-26, 2022. The primary feature of a qualifying visit was a separate ED visit within three days prior at a separate hospital system. Fifty-five charts with essential details of each patient's most recent visit were reviewed in duplicate by 22 emergency medicine residents. Reviewers accessed prior medical records for each patient via an HIE clinical viewer. The primary outcome was the influence of knowledge from prior records on interactions during the most recent visit, measured with 11 Likert-scale ratings. Reviewer agreement was used as an indicator of confidence.

Results: Reviewers most frequently agreed that the information from the prior visit was valuable "a moderate amount" (25% of all reviewer pairs) and agreed that the information would cause them to change their approach (69%). They would adjust treatment protocols because of understanding what had been tried previously (67%) and ask the patient different questions (78%). There was also agreement that they would further compare laboratory tests or imaging between visits (67%) and better understand patient behavioral patterns (73%).

Conclusion: Access to patients' previous medical records (diagnoses, imaging reports, discharge reports, etc) via HIEs impacts how emergency physicians communicate with patients, evaluate cases, and make medical decisions. [West J Emerg Med. 2025;26(4)815–822.]

INTRODUCTION

Health information exchanges (HIE) have the potential to increase the efficiency and effectiveness of health systems. With the widespread adoption of electronic health records (EHR), the confidential sharing of patient information among clinicians responsible for treating a patient should be simple. However, differences in proprietary EHRs and the way that individual clinicians fill them out, as well as the fact that records may be available only within closed systems mean they are not being used to their full potential.[1] The HIE harnesses and leverages the benefits of EHRs by connecting multiple organizations and creating a more robust healthcare network, so that clinicians can easily access relevant, timely, and accurate patient information.[2] Other benefits of HIEs include improved quality, efficiency, cost-effectiveness, emergency response, research, and public health support.[3-5] One setting where HIEs can have a significant impact is the emergency department (ED), where patients often present with urgent and complex conditions that require coordinated and informed care.

Emergency departments have challenges in providing efficient services. These challenges include time limitations, staff shortages, extended stay visits, crowding, low patient satisfaction, and clinical documentation.[6-8] Several observational studies show the benefit of HIEs in emergency settings. Ben-Assuli et al collected 281,750 ED referrals from seven different hospitals. The study concluded that an HIE reduced the number of single-day and seven-day readmissions for all patients. Unnecessary admissions also decreased due to access to past medical history because the clinician did not have to repeat in-depth examinations that had already been recently completed.

A similar study found that between non-affiliated hospital EDs in a region, use of a HIE would lower the cost per patient, as well as reduce overall ED costs, by preventing duplication of lab tests and imaging studies and decreasing ED length of stay and admissions.[9-13] The same studies reported that more than 70% of patients perceived an improvement in the quality of care because of HIE use. Other studies were more specific in studying the impact of HIE in reducing the need for imaging in some of the most common ED chief complaints such as headache and back pain.[14] Using an HIE was associated with decreased odds of unnecessary diagnostic neuroimaging (odds ratio 0.38, confidence interval [CI] 95% 0.29-0.50) and 64% lower odds of repeated diagnostic imaging for back pain.[15]

Despite evidence of the benefit of using HIEs in EDs, they are not widely adopted, and many emergency physicians with HIE access do not regularly use them because they do not perceive it as important.[16,17] We sought to determine the impact of how accessing an HIE could change emergency physicians' perceptions and behavior patterns in patient care delivery when they obtain patients' information from a recent ED visit at another hospital.

Population Health Research Capsule

What do we already know about this issue?
Health information exchanges (HIE) can improve emergency department (ED) care by providing access to prior patient records and reducing redundant tests and admissions.

What was the research question?
How does access to prior ED visit data via HIE affect emergency physicians' decision-making and interactions with patients?

What was the major finding of the study?
69% of reviewers agreed that prior visit data would influence their approach during the current visit.

How does this improve population health?
Access to prior medical records via HIEs can influence emergency physicians' communication, case evaluation, and decision-making, potentially improving care efficiency.

METHODS

We conducted this study in El Paso, Texas, using the Paso del Norte Health Information Exchange (PHIX). The PHIX is available to all clinicians in the area. Medical residents regularly receive login credentials to view patient information via PHIX's secure portal. The PHIX clinical viewer allows clinicians to access their patients' health records electronically. The shared data encompasses diagnoses, lab results, radiology and pathology reports, immunizations, medications, and various clinical notes from physicians and nurses, such as discharge summaries, admission history and physicals, progress notes, and consult notes. We used data from PHIX to attempt to recreate the decision-making process when emergency physicians are presented with a new case. Study procedures were approved by the institutional review board at Brigham Young University.

Recruitment

We enrolled 22 emergency medicine residents from the Texas Tech University Health Sciences Center El Paso. Residents who attended the weekly department meeting were invited to take part in the study. Those who agreed to participate were instructed by the study personnel about the process of conducting the chart reviews. Each patient was reviewed in duplicate. Residents in postgraduate (PGY) years (PGY 1, PGY 2, and PGY 3) participated as reviewers.

Inclusion and Exclusion Criteria

We collected the most recent 60 cases from the PHIX system that met the following criteria: 1) visit occurred between September 24-September 26, 2022; 2) the patient visited a hospital-associated ED in the city of El Paso; 3) was discharged with a completed discharge report and 4) visited another hospital-associated ED within three days; and 5) both visits had at least one reported *International Classification of Diseases, 10th Rev*, (ICD-10) code. We did not include patients who went from independent EDs to hospital-associated EDs because those visits are often due to direct referrals for specific treatment. By selecting the most recent cases rather than selecting the cases that met some kind of criteria regarding severity of the case, we aimed to estimate how often the residents would identify the HIE as being helpful for patients in the common situation of visiting multiple EDs within a short period of time.

Clinical Data Review Procedure

Residents were asked to review two sets of clinical information. The first set included ED charts that were printed out from the records found in the PHIX system. The charts contained the following details: history of present illness; medical history; medications; vital signs; review of systems; physical examination; assessment; diagnosis; and management. We referred to these charts with details of the patient's most recent visit as "current visit." The second set of information consisted of details from the prior three-day visit, referred to as the "prior visit," which was reviewed directly from the online PHIX clinical viewer (see Figure). We used the same terms to describe each visit, including tables and figures. Each patient was assigned an anonymous identifying number for data analysis.

Survey Instrument

We created a brief survey to be completed by resident reviewers for each reviewed chart using the Qualtrics survey platform (Qualtrics International Inc, Provo, UT). We collaborated with clinical partners and internal members of PHIX with clinical experience to hone the survey questions and ensure clarity. Reviewers entered an assigned personal ID as well as the patient's anonymous ID. First, reviewers were given up to seven minutes to review the information from the current visit. The seven-minute time window was selected based on tests done with clinical staff who work with PHIX. Seven minutes was estimated to be enough time for a physician to review a patient's medical history, while not being overlong and delaying patient care.

The reviewers were asked whether this was a case with which they were already familiar. If they answered yes, then they recused themselves from further review. They also were asked to pretend they were managing this patient in real time. Residents responded to questions regarding the current visits and how often they see similar cases, whether a consultation would be required or helpful to the case, and if so, what type of consultation. (The survey is provided as supplemental material.)

The reviewers were then informed that the patient had been in another ED within the prior three days. They were given four minutes to review data from that prior visit via the PHIX clinical viewer. They were then asked four follow-up questions detailing 1) whether there was evidence in the chart from the current visit that the treating physician was aware of the prior visit; 2) five options to describe the relationship between the data from the prior visit and the current visit; 3) 11 Likert scale-based questions describing how the information from the prior visit would influence their interactions, diagnosis, or treatment during the current visit; and 4) "overall, how valuable the information from the prior visit was to treating the patient during their the current visit", with the options "very little," "a moderate amount," and "a great deal."

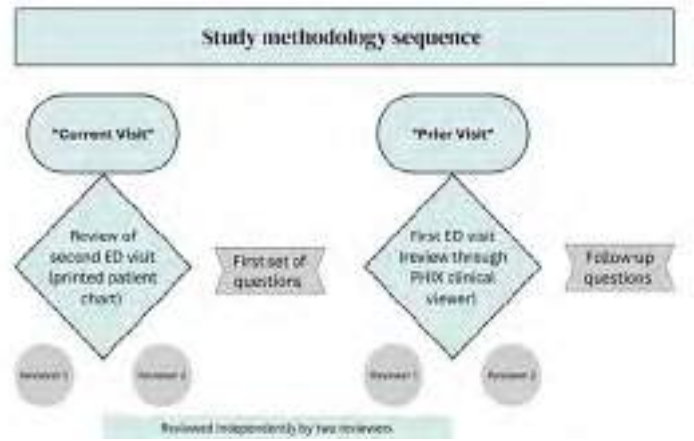

Figure. Diagram of the study design.
ED, emergency department; *PHIX,* Paso del Norte Health Information Exchange in El Paso, TX.

Analysis

We analyzed the data using measures of Kendall W, using the KendallW command in the DescTools package in R v4.3.1 (R Foundation for Statistical Computing, Vienna, Austria). Kendall W is typically calculated as a measure of the reliability of chart reviews when categorizing patients. Herein, we use it as a measure of agreement between reviewers. Variability was expected in how reviewers rated the same chart, as there is subjectivity in the questions, and they were responding from their own perspectives regarding how they would act. However, it was of interest how often the residents did agree with one another as an indicator of the confidence that, yes, further information might cause a physician to respond in a different way.

To analyze the responses to the 11 Likert-scale questions relative to how information from a prior visit might influence physician-patient interactions in the current visit, the Likert-scale answers were collapsed into three groups: 1) strongly or somewhat agree; 2) strongly disagree, somewhat disagree or neither agree nor disagree; or 3) did not answer (NA). These collapsed responses were compared between both reviewers of the same chart. We calculated and reported the percentage of time they agreed. For example, if reviewer 1 strongly agreed with a statement and reviewer 2 somewhat agreed, both would be counted as being in the affirmative on that statement for that patient.

RESULTS

Descriptives

A total of 133 surveys were logged. Of these, residents recused themselves six times because they were already familiar with the case. One survey was not fully completed. Four surveys were mistakenly reviewed in triplicate, in which case only the first two completed surveys were kept for

analysis, and six were reviewed once (reviewers ran out of time and did not finish). There were 110 complete observations remaining, or 55 patients reviewed in duplicate. Most reviewers completed reviewing charts from 5-6 patients.

When asked how often the reviewers saw similar cases in their practice, 54 (49%) of the 110 reviews were marked as daily, 37 (34%) as weekly, 21 as monthly (19%), one as yearly (0.01%), and two as rarely (less than once a year) (0.02%). When reviewers were asked whether they were likely to request a consultation on a particular case, they said no 101 (92%) times and yes 14 (8%) times. The types of desired consults listed were cardiology, otolaryngology, orthopedics, obstetrics/gynecology, the patient's surgeon, urology, or vascular. Urology was the only consult mentioned twice.

Rater Agreement Patterns

The Kendall inter-rater reliability values ranged between 0.44-0.66 (0 means no agreement between reviewers, 1 means perfect agreement), indicating that reviewers agreed with one other a moderate amount. There were mixed levels of agreement between reviewers as to whether there was evidence that the actual treating physician had the information from the prior visit during the current visit. Reviewers agreed that the physician did not have the prior information 16 (29%) times; they agreed that the physician did have the prior information 16 times (29%); and disagreed 21 (38%) times.

Raters agreed that in 20 visits (36%) the most common way the prior and current visits were related was through a presentation of the same symptoms. They agreed that the visits were not related two times (4%). Reviewers never agreed that the visits were related to new symptoms that may have been related to behavioral information described during the prior visit. There was one patient for whom reviewers agreed they had worse symptoms related to a procedure or medication from the prior visit, and none who agreed that there were worse symptoms related to diagnoses from the prior visit. For the rest of the patients (60%), the raters disagreed. The most common disagreement between pairs was for 11 visits (20%) that were related to either the same symptoms or worse symptoms relative to the prior diagnosis.

The Likert-scale questions with the lowest inter-rater reliability (0.44) was: "Please indicate your agreement with each of the below statements regarding [whether] knowing the information from the prior visit would impact your interactions, diagnosis, or treatment during the current visit: "I would adjust treatment or recommendations based on known comorbidities." The statement with the highest inter-rater reliability (0.66) was under the same category, "I would ask different questions of the patient."

Influence on Current Physician-Patient Interactions

As described, the Likert-scale data for the key question relative to how patient-physician interactions would be influenced were collapsed into three main categories of agreement (agreed in the affirmative, disagreed, or agreed in the negative). This helped reduce the possible number of combinations of answers between reviewers. The reviewers gave the same answer most consistently regarding whether they would ask different questions of the patient. The reviewers gave differing answers the most when asked whether they would be more or less likely to keep the patient for observation and when asked whether they would be more or less likely to admit the patient for inpatient care. When reviewers gave the same answer, they were much more likely to give the same answer in the affirmative, either strongly or somewhat agreeing with the question (Table 1).

Reviewers most commonly agreed in the affirmative when reporting they would ask different questions of the patient (78% of pairs) if given the information about the prior visit. The statements on which the reviewers most disagreed were those regarding how likely they were to recommend inpatient treatment or staying in the ED for observation (53% of pairs for each). The same statements regarding inpatient treatment or ED observation also yielded the most frequent agreement in the negative (5% of pairs for each). Agreement in the negative was uncommon across all Likert-scale items. Most reviewer pairs agreed in the affirmative that knowing about the prior visit would change their approach during the current visit (69%), they would further investigate prior diagnosis (65%), further compare lab tests or imaging (67%), understand the behavioral patterns of the patient (73%), change whether they requested additional imaging (56%), and adjust treatment or recommendations based on known comorbidities (55%).

When asked overall how valuable the information from the prior visit was to treating the patient during the current visit, the reviewers agreed it was valuable "a moderate amount" (14 pairs, 25%). They agreed that the prior data was valuable "very little" seven times (13%), and "a great deal" five times (9%) (Table 2). The second most common response pairing was for one reviewer to say, "a moderate amount" and a second reviewer to say, "a great deal" (18% of pairs). Thus, 52% of reviewer pairs found the prior record to be valuable a moderate amount or a great deal.

DISCUSSION

Our study examined inter-rater agreement and the perceived clinical relevance of prior visit information in ED encounters. A total of 110 complete chart reviews, representing 55 patients, offer perspectives on the variability and consistency in how resident doctors interpret and respond to data from previous emergency visits when making medical decisions during current visits. The findings indicate that while reviewers generally found prior records moderately valuable, the variability in responses reflects the inherent subjectivity in clinical decision-making, particularly in cases where prior patient information might or might not influence treatment decisions. Inter-rater reliability for the question on modifying treatment based on comorbidities was moderate (Kendall W =

Table 1. Frequency and percentage (rounded) of reviewers who gave the same or different answers regarding how the information from prior medical records would impact their interactions and decisions during a current emergency department visit (N=55 reviewer pairs).

	Reviewer responses (N, rounded %)		
Likert Scale Item	Disagreed	Agreed in the affirmative[1]	Agreed in the negative[2]
Knowing what happened in the prior visit would impact my approach during the current visit.	16 (29%)	38 (69%)	1 (2%)
I would ask different questions of the patient.	11 (20%)	43 (78%)	1 (2%)
I would further investigate their prior diagnoses. *(NA=1)*	16 (29%)	36 (65%)	2 (4%)
I would further compare laboratory tests or imaging between visits.	11 (29%)	37 (67%)	2 (4%)
I would adjust my treatment protocol because of understanding what prior medications or treatment were tried.	18 (33%)	37 (67%)	0
I would better understand behavioral patterns of the patient.	15 (27%)	40 (73%)	0
It would change whether I requested additional imaging. *(NA=2)*	22 (40%)	31 (56%)	0
It would change whether I requested additional laboratory tests. *(NA=2)*	27 (49%)	25 (45%)	1 (2%)
I would adjust treatment or recommendations based on known comorbidities.	24 (44%)	30 (55%)	1 (2%)
It would change how likely I was to recommend inpatient treatment.	29 (53%)	23 (42%)	3 (5%)
It would change how likely I was to recommend they stay in the ED for observation.	29 (53%)	23 (42%)	3 (5%)

[1]Both reviewers either strongly or somewhat agreed.
[2]Both reviewers either strongly or somewhat disagreed, or neither agreed nor disagreed.
ED, emergency department; *NA,* missing value.

0.44), yet the highest reliability was observed for inquiries on altering patient questioning (Kendall W = 0.66). This suggests that while prior visit information is considered valuable by many residents, its influence on clinical decisions varies depending on the type of action being considered.

Rater Agreement Patterns

Revisits to the ED are a common and costly problem in healthcare systems. They indicate a possible failure in the quality or continuity of care, and they may expose patients to crowding or to experience increased wait times and unnecessary risks of infection or adverse events.[18,19] This group of patients is also described by the term "bouncebacks" and can carry some of the highest risk of misdiagnosis.[20] In this study, the raters agreed that the most common way the prior and current visits were related in 20 cases (36%) was by presenting with the same symptoms. The ED revisit rate in the US within three days is 8.2%, with 32% occurring at a different institution.[19] According to a large observational study, revisits can occur for various reasons, such as lack of follow-up care, medication errors, misdiagnosis, or incomplete treatment.[21] The American College of Emergency Physicians encourages high-quality ED health records to enhance patient care via improved evaluation, management, decision-making, and disposition related to an emergency encounter.[22,23]

There were mixed levels of agreement between reviewers as to whether there was evidence that the actual treating physician had the information from the prior visit during the current visit. Emergency clinicians may be able to improve the quality and clarity of notes by clearly documenting when or whether prior records were reviewed. Raters agreed that the physician did not have the prior information 16 (29%) times. The HIE can play a vital role in improving the outcomes and satisfaction of ED patients by increasing access to past ED visit information. Evidence indicates that by enabling access to patients' medical history, medications, allergies, test results, and other data, HIEs can help emergency physicians make better decisions, avoid duplication of services, coordinate care transitions, and prevent unnecessary hospitalizations.[3–5,16] The HIEs can also facilitate communication and collaboration among emergency clinicians and other healthcare professionals involved in patient care.[2] Other studies concluded that more than 70% of patients perceived improved quality of care when HIE systems are used.[9,10,12] The reasons for this improvement could be explained by the handiness of detailed information available through HIEs.

Influence on Current Physician-Patient Interactions

Physicians use a patient's medical history to diagnose and treat patients effectively, as well as to prevent potential complications and risks.[24] A patient's medical history can reveal the relevant comorbidities and prior disease states for which the patient may or may not be under treatment. A study that explored physicians' decision-making in hospital readmissions concluded that the main causes of readmission were the lack of communication, inadequate continuity, and poor information flow.[25] Using an HIE can influence physicians' decision-making process in various ways, such as improving the quality and safety of care by improving information flow and communication for primary care follow-up.[26] Additionally, it is believed that HIEs can reduce costs and errors, enhance coordination and collaboration between clinicians, facilitate

Table 2. Responses recorded by reviewers (N=55 pairs) for the question "Overall, how valuable would the information from the "prior visit" be in treating the patient during the "current visit"? Percents are rounded to the nearest whole number.

		Reviewer 2		
	Reviewer 1	Very little	A moderate amount	A great deal
Overall, how valuable would the information from the "prior visit" be in treating the patient during the "current visit?"	Very little	7 (13%)	5 (9%)	3 (5%)
	A moderate amount	4 (7%)	14 (25%)	5 (9%)
	A great deal	2 (4%)	10 (18%)	5(9%)

research and innovation, and reduce avoidable admissions.[27,28]

In this study, the reviewers most frequently agreed that the information from the prior visit was valuable a moderate amount, with 52% of reviewer pairs saying the information was valuable a moderate amount or a great deal. They further strongly or somewhat agreed in 69% of cases that the information would cause them to change their approach. They also reported they would adjust their treatment protocols because of understanding what had been tried previously, and they would ask the patient different questions. There was agreement that they would further compare lab tests or imaging between visits and better understand the patient's behavioral patterns. On the other hand, the reviewers most often gave differing answers when asked whether they would be more or less likely to keep the patient for observation and would be more or less likely to admit the patient for inpatient care. This likely reflects individual practice patterns and comfort with options for treatment and follow-up care and highlights the potential variations in these patterns among clinicians.

A study surveyed 216 emergency physicians and found that 63% believed more than one-quarter of their patients could benefit from a HIE system. And 85% of them also found it difficult to obtain patients' external information without an HIE, which could take over 60 minutes in some cases. The physicians concluded that having access to currently siloed data at outside institutions could improve patient care and the efficiency of healthcare delivery.[17] Most of the studies explored in this paper highlighted the benefits of HIEs in preventing duplication of diagnoses or follow-up tests, reducing unnecessary admissions or readmissions, and increasing perceived satisfaction with healthcare services. However, some physicians found HIE systems to be unreliable and disruptive to workflow, which could have been due to structural or design issues.[3,29,30] The design of HIEs must be carefully considered to increase effective use.

LIMITATIONS

The study involved only participants from one teaching hospital, which may limit how broadly the results can be applied. However, the method used in the study could be easily replicated in other settings and HIEs to gather more information. The subset of patients selected for this study is also unlikely to match the general patient population as they were all well enough for discharge from an ED within the prior three days. The indication that 92% of the time the reviewers were not in need of a consultation for the case aligns with the fact that they were stable enough for discharge after their first visit.

In this study, anchoring bias is not necessarily a limitation but rather an intentional component in assessing the value of HIE data in clinical decision-making. The structured study setting prompted residents to consider and potentially alter their approaches based on recent visit data, allowing us to observe the impact of accessible historical information on treatment decisions. We acknowledge that real-world scenarios may present a higher risk of anchoring, particularly in high-stress situations, time-constrained environments, or when patients present with symptoms similar to those in previous encounters. In such cases, residents might default to prior visit information as a cognitive shortcut, potentially overlooking new or contextually unique factors. Thus, while anchoring is less of a concern within this study's design, understanding its role in actual emergency settings is essential.

The strength of this study is that it generated hypotheses for how HIEs affect physicians' decision-making and patient interactions when prior patient information is accessible, an area which has been strikingly absent from the current literature. Our study further shows that more research is necessary to identify the factors that influence the adoption and use of HIEs, particularly in emergency situations. These findings can also offer guidance in designing and implementing HIE systems that meet the requirements and expectations of physicians and other stakeholders.

The PHIX, the HIE we used for this study, is structured to provide detailed medical records including physician notes, lab and imaging records, immunizations, and medication histories. Health information exchanges use a variety of data structures and sharing methods . Some offer similar record access to the PHIX while many others do not, choosing instead to highlight or restrict to specific information such as previous ICD-10 codes. It is, therefore, important to note that how and how often HIE access influences patient interactions and treatment will likely vary based on the structure and data provided by the HIE.

CONCLUSION

The study shows how previous records accessed through a health information exchange significantly impact clinical understanding and influence patient care in the ED. Notably, reviewers were most often in agreement that the information from prior visits allowed them to ask more targeted and relevant questions and adapt their diagnostic approach. Additionally, most reviewers saw value in using prior visit information to compare lab tests, understand patient behavioral patterns, and make more informed decisions regarding imaging and treatment adjustments based on known comorbidities. These positive agreements emphasize the role of HIEs in facilitating more comprehensive and precise patient assessments, lowering the requirement for redundant procedures, and ultimately contributing to more efficient and organized healthcare.

However, the variability seen in inter-rater agreement, particularly in treatment adjustments, suggests a more complex integration of past medical records into therapeutic decisions. This variability underscores that although HIEs offer clear benefits, the development of standardized guidelines and training to staff on how to effectively use the EHR's features for informed decision-making could further optimize their use. The results of this study contribute to the body of literature on the cost-effective and quality-improving potential of HIEs, reinforcing the need for more widespread adoption and system refinements to maximize their impact. Future research should explore how different HIE structures and training protocols might address these variabilities and further improve clinical outcomes, considering patient-specific needs in diverse healthcare settings.

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Scoping Review of Adult Emergency Department Discharge Interventions

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Introduction: The discharge process is a crucial component of the emergency department (ED) encounter, with poor discharge quality often leading to negative patient outcomes. While numerous interventions have been implemented to improve this process, a comprehensive review of these interventions has not been conducted. This study provides a scoping, summative review of adult ED discharge interventions to date, evaluating the literature for potential best practices and future directions.

Methods: We conducted a scoping review of published literature on MEDLINE ALL (Ovid), Embase (Ovid), the Cochrane Central Register of Controlled Trials (Wiley), and CINAHL (EBSCOhost) on February 7, 2023, for articles reporting on ED-based discharge interventions. We excluded the following: studies involving pediatric patient populations; discharge from non-ED settings; in-ED risk screening and/or case management as the primary intervention; interventions occurring mostly after the ED encounter (even if initiated at time of discharge); and studies not written in English.

Results: The initial electronic database search yielded 3,842 unique titles and abstracts. After applying inclusion/exclusion criteria at various screening stages, we included 100 papers and abstracts in the final review. These studies, published between 2003 – 2023, predominantly originated from the US (66%). Using narrative synthesis, we summarized ED discharge intervention themes to form seven concept subgroups by consensus: mode of discharge; additional resource provision; addition of a discharge coordinator; follow-up assistance; pharmaceutical intervention; patient-centered education; and clinician/discharger-centered education. Effective strategies included enhanced discharge discussions and education by dedicated personnel, structured discharge checklists, and delivery of instructions at an appropriate reading level. However, because few studies have examined long-term patient-centered outcomes, such as ED return visits, hospitalizations, and mortality, cost-benefit analysis for interventions is lacking. Furthermore, the experiences of vulnerable populations who have limited-English proficiency are under-represented in current attempts to innovate ED discharge.

Conclusion: We found that interventions aimed at improving patient comprehension of discharge instructions were the most frequently studied and had the greatest impact on patient outcomes. This review highlights promising directions for patient-centered innovation; it also underscores the need for more research to optimize the adult ED discharge process and warrants a call to action. [West J Emerg Med. 2025;26(4)823–834.]

INTRODUCTION

Discharge is the release of a patient following the formal completion of a healthcare evaluation, procedure, or course of treatment. The emergency department (ED) discharge process provides post-ED care information to patients by the ED care team, typically in both verbal and written form or electronic documents. This final step in the ED encounter gives emergency clinicians the chance to conceptually "land the plane," completing an encounter that frequently includes multiple diagnostic and therapeutic interventions, as well as complex medical decision-making and risk stratification. The ideal structured, inclusive, and comprehensive approach to "closing" the ED encounter would ensure a patient understands what transpired during their ED evaluation and empower them with the appropriate information and comprehension of their post-ED care plan. This is distinct from care coordination, which organizes and facilitates longitudinal patient care and communication among all participants in patients' healthcare needs; however, the ED discharge process is one step in that coordination continuum.

The Agency for Healthcare Research and Quality (AHRQ) along with emergency medicine (EM) organizations (Academy of Emergency Physicians and Society of Academic Emergency Medicine) recognize the significance of a high-quality ED discharge.[1-3] These agencies have developed summative guidelines for optimal discharge processes that include discussion of the patient's ED diagnosis; expected course of illness; home care instructions; medication use; follow-up care; reasons to return to the ED; and opportunities for the patient to ask questions and/or confirm understanding.

Despite this consensus, ED space, resources, and time constraints frequently challenge patient-centered processes,[4-7] with research demonstrating deficiencies in current ED discharge. Quality of discharge instruction content is frequently variable, often missing key components.[8] Moreover, as many as 50% of US adults have low health literacy, leading to comprehension issues when content delivery is not at the appropriate reading level or in the appropriate language.[9] Additionally, patients are often given insufficient time to ask questions, and comprehension is rarely assessed.[10]

Inadequate ED discharge quality can lead to poor outcomes; poor comprehension of and low adherence to post-ED care instructions contribute to high ED return rates and adverse events.[11-13] Limited comprehension of ED discharge instructions has also been shown to positively correlate with low post-ED care compliance.[14] Encouragingly, recent efforts to improve the quality of ED discharge has significantly reduced the odds of ED return visits and increased compliance with taking newly prescribed medications.[15]

The increasing focus on health equity in EM has led to extensive work on transitions of care and integrated health systems. Despite the importance of the ED discharge process, discharge instructions are often not of consistently high quality, and these limitations may lead to poor patient outcomes. To date, no scoping review has examined the breadth of adult ED interventions with the goal of improving this process. Previously published reviews have examined ED discharge risk-stratification[16] and the relationship between the way discharge instructions are conveyed and patient comprehension.[17] The AHRQ commissioned an extensive environmental overview of the ED discharge process, focusing on risk factors leading to poor-quality discharge.[18] That overview included pediatric populations as well as care coordination and after-ED care. In this study we provide a scoping, summative review of adult ED discharge interventions, evaluating the literature for potential best practices and future directions.

Population Health Research Capsule

What do we already know about this issue?
Poor ED discharge quality leads to adverse outcomes. While interventions exist, no comprehensive review has evaluated their effectiveness.

What was the research question?
What adult ED discharge interventions exist, and which are most effective?

What was the major finding of the study?
We analyzed 100 studies, categorizing ED discharge interventions into 7 themes. Most focused on patient comprehension, but few assessed long-term outcomes.

How does this improve population health?
This review highlights gaps in research on discharge interventions and could guide future efforts to develop evidence-based strategies for better patient outcomes.

METHODS

We constructed this scoping review using the Preferred Reporting Items for Systematic Reviews and Meta-Analysis – Scoping Reviews (PRISMA-ScR) guidelines.[19] The PRISMA checklist can be found in Supplement 1. We searched MEDLINE ALL (Ovid), Embase (Ovid), the Cochrane Central Register of Controlled Trials (Wiley), and CINAHL (EBSCOhost), limiting our search to articles published from 2000 to February 7, 2023 (the date we conducted our search). The year 2000 was chosen to reflect the current state of practices, including technology-based interventions. We imported the de-duplicated results using *Covidence systematic review software* (Veritas Health Innovation, Melbourne, Australia), focusing on two concepts:

discharge from the ED, and a list of specific discharge interventions. Searches incorporated both free-text keywords and, where available, controlled vocabulary; proximity operators were incorporated to retrieve variations of phrases. Where appropriate, controlled vocabulary terms were "exploded," a technique that expands the search results. Further detail, including search strategies for all databases, can be found in the Supplementary Material and on the Open Science Framework website at https://osf.io/rtbfk.[20]

MKG, GH, and SB independently screened the imported titles and abstracts using Covidence. Discrepancies were resolved by consensus, with PS and LJ serving as tiebreakers. All citations were reviewed against predefined inclusion/exclusion criteria. Inclusion criteria were studies reporting on ED-based discharge interventions. We excluded non-English language articles. Additional exclusion criteria were as follows: pediatric (<18 years of age) patient population; discharge from inpatient, outpatient, non-clinical, or other non-ED setting; interventions including in-ED risk screening and/or case management as the primary intervention; and interventions where the majority of the primary intervention occurred after the ED discharge process, even if the intervention was initiated at discharge. Our final exclusion criteria enabled us to focus specifically on interventions occurring at time of discharge, as opposed to those in which the primary intervention occurred after the patient left the ED or earlier in their ED evaluation course.

A full-text review followed the initial title and abstract screening phase. Studies were selected for inclusion using the criteria outlined above. MKG, GH and SB extracted data using Covidence. Using the narrative synthesis approach described by Snilstveit et al,[21] we grouped articles with similar ED interventions thematically. This methodology has been used in other ED-based scoping reviews.[22-24]

RESULTS

See the figure for study selection workflow. The initial electronic database search yielded 3,842 unique titles and abstracts. Of these, 278 appeared to meet the inclusion criteria and were imported for full-text review. Of these, we included 100 papers and abstracts published between 2003–2023; 66% were published in the US.

Using narrative synthesis as described by Snilstveit et al, we summarized ED discharge intervention themes to seven concept subgroups by consensus (MKG, GH, SB, PS, LJ). The table lists the subgroups and their descriptions. Some studies were included in more than one subgroup.

Mode of Discharge

Of 25 studies that examined mode of discharge, 18 (72%) were full-text studies. The most common study types were quasi-experimental (12/25, 48%) or randomized controlled trials (RCT) (9/25, 36%). A large proportion (13/25, 52%) investigated standardized discharge instructions. Standardization can partially automize writing discharge instructions, saving significant time, and can lead to improved quality.[12,25,26] Interventions included creating a list of symptoms that should prompt re-evaluation, as well as simplifying [27-30] and creating templated discharge instructions.[31-33] One study implemented a new template to encourage inclusion of ED diagnosis, follow-up care plan, and key results, which led to nearly universal comprehensive documentation including these important discharge aspects.

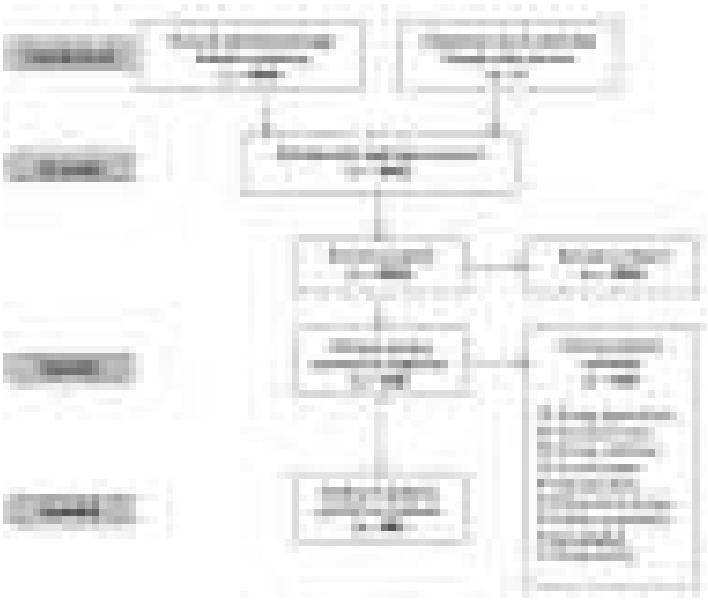

Figure. PRISMA* flowchart.
**PRISMA,* Preferred Reporting Items for Systematic reviews and Meta-Analyses.

As familiarity with technology continues to increase,[34] smartphones have become an important tool for delivery of discharge instructions due to the ease by which information and/or media can be relayed to patients.[35-37] Several (10/25, 40%) papers investigated the use of electronic adjuncts for discharge instructions. Results showed patients preferred electronic delivery[38-42] and appreciated video supplementation to the discharge instructions. Two studies examined the use of electronic delivery of patients' discharge instructions to primary care clinicians, demonstrating an additional mode of discharge delivery leveraging technology.

The computerization of healthcare documentation improves quality of instructions and makes quality easier to achieve. These studies demonstrate novel ways to effectively streamline the process of writing quality discharge instructions and enhance their delivery with adjunctive media, as well as improve communication to primary care clinicians, However, those studies do not evaluate the effectiveness of these interventions on patient satisfaction, ED revisit rates, and follow-up rates.

Providing Additional Resources

Three studies included an additional resource to assist in discharge. All were full-text studies with two prospective studies

Table 1. Descriptions of discharge intervention subgroups.

Subgroup title	Subgroup description
Mode of discharge	Interventions focusing on the various methods of delivering discharge instructions
Additional resource provision	Adding social resources and services, either trained medical professionals or volunteers, to the discharge process
Addition of discharge coordinator	Repurposing ED staff or hiring new employees whose primary role is to perform ED discharges
Follow-up assistance	Facilitating the scheduling of outpatient follow-up appointments with primary care and/or specialty clinicians
Pharmaceutical intervention	Interventions focusing on discharge prescriptions
Patient-centered education	Altering the discharge process to improve patient understanding and comprehension of discharge instructions and/or diagnoses
Clinician/discharger-centered education	Interventions centered on teaching and educating clinicians/dischargers on best practices of delivering discharge instructions

*ED, e*mergency department.

and one cross-sectional. Two focused on vulnerable patient populations. One study focused on elderly patients, leveraging discharge nurses and an already well-validated assessment tool to determine out-of-hospital resource needs.[43] The nurse then provided these resources, making relevant referrals to home care services, outpatient clinics, community centers, and/or making arrangements with patients' families. The second study involved county hospital volunteers who provided discharged patients with an educational intervention, medications, and follow-up appointment review, as well as individually tailored information for social and medical resources, including prescription discounts, low-cost clinics, rental assistance programs, and subsidized transportation.[44] The interventions in both studies resulted in reduced ED return visits. The third study focused on ED patients with acute lower back pain, providing in-ED physical therapy evaluation and discharge exercise recommendations.[45] Results from this study, however, did not show significant at-home compliance with the exercises.

Overall, while few studies incorporated additional resources and there was variety in study designs and outcomes examined, results show that it may be helpful to have personnel dedicated to particular patient subgroups to help coordinate care, follow-up, and comprehensive needs assessments. Finances may be an implementation barrier, as additional resources tend to require personnel, which increases costs. None of the studies addressed a cost-benefit analysis.

Adding A Discharge Coordinator

Inclusion criteria that focused on discharge coordination interventions were aimed at improving the discharge *process*. Excluded were care-transition interventions that included in-ED risk screening and/or case management as the primary intervention. Seven studies, conducted in the US and interationally, met these criteria. There was variability in study type including descriptive methodological, quasi-experimental, case control, cohort, and a single RCT.

Five of seven studies (71%) implemented a dedicated nurse to coordinate patient discharge[46-49]; the nurse reinforced the discharge instructions, facilitated follow-up appointments, and provided medication education. In two studies, non-nursing coordinators were used. In one, a non-clinical patient advocate administered a patient survey prior to discharge; this was reviewed by the clinician with the goal of closing the gap between expected and planned discharge information.[50] Notably, non-English speaking patients were excluded. Another study used volunteers to connect ED patients to outpatient clinics and facilitate social services and financial assistance applications, if needed.

Of the four discharge nursing interventions that measured patient outcomes, two of three found a reduced number of ED return visits,[48,51] two of two reported increased understanding of the discharge instructions,[48,49] zero of two found increased new-prescription medication adherence, and one of three found increased post-ED appointment compliance.[49] Results of the patient advocate intervention showed enhanced understanding of the discharge instructions, while the volunteer intervention resulted in increased post-ED appointment compliance. No studies measured patient satisfaction or any additional patient-centered outcomes.

Follow-up Assistance

This subgroup included 10 articles, all except one from the US. Study design was primarily quasi-experimental (5/10, 50%), followed by cohort (4/10, 40%) and RCT (1/10, 10%). Full evaluation of the proposed interventions was limited as over half (6/10, 60%) were not full-text articles. Proposed interventions primarily focused on improving connection to and adherence with post-ED discharge outpatient follow-up appointments. Patients were connected to an appointment scheduler who specifically helped them obtain appointments. When compared to patients who were instructed to schedule

their own appointments, there were higher rates of confirmed appointments and increased appointment adherence rates. Having a confirmed appointment prior to ED discharge appeared to have the most significant positive effect on follow-up adherence.[52,53]

When patients self-scheduled appointments, follow-up rates improved but not to a statistically significant level and did not change overall patient satisfaction. Additionally, follow-up rate improvement was only seen when a scheduled appointment was confirmed prior to discharge rather than the patient self-scheduling from home.[54] Despite expressing interest in obtaining follow-up, when instructed how to make these appointments, patients did not appear to read these instructions, leading to poor scheduling and follow-up rates.[54,55]

Only one study examined improving communication between ED and outpatient clinicians. This study leveraged the electronic health record to facilitate communication of patients' follow-up needs post-ED discharge. Both primary care and emergency clinicians perceived this as useful, allowing for best practices of standardized processes and closed-loop communication.[56] In general, however, there was limited evaluation on the effect of proposed interventions on ED use and return visits or hospitalizations. The only study performing this analysis found an almost 50% reduction in subsequent ED use.[52] No studies followed up long term or examined hospitalization rates.

Pharmaceutical Intervention

Of the 16 studies examining pharmaceutical interventions, 12 (75%) were conducted in the US. Study design ranged from quasi-experimental (6/16, 38%), RCT (4/16, 25%), and cohort (3/16, 19%) to case control studies (1/16, 7%).

Involvement of ED pharmacists was at the center of many of these studies with five implementing ED pharmacist review of discharge prescriptions and all demonstrating successful prevention of medication errors.[57-62] Four studies included bedside medication education by ED pharmacists, but with more varied results. Of three studies that examined ED return visits as outcomes, two showed no reduction while one led to significant reduction.[63,64] Patient satisfaction did improve; however, one study showed no reduction in return visits.[63]

Some of the pharmaceutical studies (6/16, 38%) focused on classes of medications (ie, opiates or anti-coagulants)[57,58,65-68] with interventions involving ED pharmacist review of prescriptions and/or patient education on side effects and safety precautions. These studies showed a decrease in medication errors[57,58,66] and an increase in patient awareness.[65,67] Only one study examined longer term patient outcomes, demonstrating lower ED-return visits or hospital readmissions after patient education by an ED pharmacist on new prescription dosing and side effects.

Six studies (6/16, 38%) addressed patients' access to discharge medication. Four interventions provided medications to patients at ED discharge,[65,69-71] with variable results. Two demonstrated a decrease in return visits[65,70] while one demonstrated an *increase* in return visits.[71] The study that found an increased return visit occurred in an ED where clinicians were encouraged to provide in-hand medications to patients enrolled in financial assistance programs, with the hypothesis that these patients with fewer resources at baseline may already be more likely to use the ED as a usual source of care.

Interventions focusing on pharmacists and discharge medication reduced medical errors, improved patient comprehension, and expanded medication access. Using ED pharmacists for future discharge interventions is likely to be successful; however, this comes at an expense, requiring further cost-benefit analysis. Notably, these studies did not consistently examine long-term, patient-centered outcomes such as admissions related to medication errors or medication adverse-reaction rates.

Patient-centered Education

Of 28 papers and abstracts that examined interventions focused on patient-centered education, 17 (61%) were conducted in the US. Study design was variable, with 12 RCTs (43%) and eight quasi-experimental studies (29%) making up the largest proportion. Seventeen (64%) focused on four primary interventions: standardizing discharge instructions; using the teach-back method; focusing on disease-specific intervention; and tailoring instructions to patients' needs.

Standardizing discharge instructions involves predeveloped, written content for common ED presentations. The ED is often busy, with competing interests limiting the emergency clinician's time to write quality instructions and discuss them with the patient.. Standardized, pre-written instructions ensure that discharge content is up to date, evidence based, thorough, and in plain, simple language for patients to understand. This, in theory, ensures quality instructions regardless of the ED environment. Of the seven studies using this approach, four demonstrated an improvement in patient understanding;[72-74] two showed no change, and one described but did not implement the intervention.[75]

Seven studies (7/28, 25%) examined the use of "teach-back" in providing discharge instructions and found improved comprehension and recollection but decreased patient satisfaction. One study showed that patients found this to be "condescending."[75] While using "teach-back" may be effective in conveying key information, patient discontent with the ED encounter could have rippling effects on both the patient-clinician relationship and the patient's likelihood in heeding their discharge instructions. Five studies (5/28, 18%) centered on disease-specific instructions.[76-79] Each study examined different disease foci and outcomes. Although these studies found positive results, the variability of study design made it difficult to assess generalizability.

Four studies (4/28, 14%) tailored discharge instructions to patients' needs. Two (50%) focused on healthcare literacy[80,81]and one (25%) used cartoons,[82] both demonstrating

improvement in patient comprehension. One (25%) focused on language[83] but did not measure patient comprehension. Patient-centered education is a frequent focus of discharge interventions, but with varied and inconsistent results. Consideration should be given to patient satisfaction and generalizability in future studies.

Clinician/Discharger-Centered Education

This subgroup included 17 articles. Most (10/17 59%) were from the US with study designs including quasi-experimental (7/17, 41%), RCTs (3/17, 18%), cross-sectional (2/17, 12%) and cohort (2/17, 12%).

Several studies found inconsistent and varied discharge processes, leading to limited verbal and written quality of instructions.[73,84] Several studies created formalized discharge guidelines.[85-89] Stake-holder feedback from clinicians and patients created consensus[88-90] on inclusion of the most important components: discharge diagnosis; self-care instructions; follow-up planning; and return precautions.[89] Clinician re-education on quality discharge instructions led to improved patient comprehension, satisfaction, and reduced ED return visits.[73] While one study found that a structured workflow doubled the time needed for discharge, overall interaction time with clinicians was still less than five minutes.[85]

While several studies proposed a structured discharge process, only two examined implementing a checklist. In these interventions, clinicians received formal instruction on appropriate discharge processes and a comprehensive list of essential components.[85,86] This led to improved clinician adherence and patient comprehension and satisfaction.[85,86] Similar standardization was used to propose a standardized written discharge summary in one study, which found that while this led to clinician adherence, there was overuse of medical terminology and poor follow-up advice, suggesting this method alone is not sufficient for quality discharge instructions.[73,91]

Almost none of the studies examined return visits/hospitalizations or outpatient follow-up, limiting understanding of how streamlined discharge processes affect clinical outcomes. The one study examining this found no improvement in patient adherence to follow-up plans.[86] One study found that patients did not follow up because they did not understand their discharge instructions and either forgot to or felt uncomfortable seeking clarification.[92]

Some studies focused on educating clinicians to provide discharge instructions that are easily understandable. One study examined templates to help tailor the instructions to patients' reading level,[80,93] which led to a decrease in ED return visits and readmission.[80] One study showed a persistent gap in appropriate language translation even when using Google Translate for written instructions.[94] Another used clinician education sessions to empower them to provide similar education to patients. This intervention improved clinician recall and understanding, the rate of patient education on these topics, and patients' self-reported comprehension and health-related practices.[95,96]

DISCUSSION

Our review included a broad range of study design, methodologies and outcome measures, reflecting both the multidimensional components and impact of ED discharge, as well as a lack of consensus on which patient- and healthcare-centered outcomes best represent discharge quality and effectiveness. This finding contrasts with the extensive literature on post-inpatient[97,98] transitions of care, as well as pediatric ED discharge,[99-101] represented through systematic reviews in a variety of these patient populations.

While the diversity of proposed discharge interventions demonstrates the complexity of factors influencing high-quality ED discharge processes, patterns of sufficiently similar interventions across the 100 studies included inventions that allowed for thematic analysis. Improving the patient's understanding of discharge instructions was the most frequently examined and demonstrated the greatest impact on patient outcomes. Individual interventions with the greatest impact on improving comprehension included enhanced discharge discussion and education with dedicated personnel (both discharge nurses and pharmacists); a structured discharge "checklist"; and/or ensuring instructions were delivered at an appropriate reading level by using a variety of written and visual modalities. Most of these interventions led to improved patient comprehension of their follow-up plan as well as more positive perceptions of their ED care and discharge experience.

Interventions standardizing or automating written discharge instructions were the most studied, leveraging technology to help standardize this element of the discharge process, as well as improve patient understanding through simplified language or modes of instruction. While some studies found the intervention increased patient comprehension, a critical gap in assessing the impact of these findings is the fact that patient-centered outcomes, such as adherence to discharge instructions, were not concurrently measured. The few studies that did examine these outcomes did not reliably demonstrate post-intervention improvements in these areas, suggesting that patient comprehension alone may not be a comprehensive outcome measure to determine ED discharge intervention efficacy. We do note, however, that a promising correlation was found between confirming follow-up appointments at time of ED discharge and increased appointment attendance and use of a discharge nurse to connect patients to medical and social outpatient resources and decreased ED return visits. While evaluation of outcome measurements is currently limited, these two interventions warrant further exploration, including refinement of processes, scaling, and validation across healthcare systems and patient populations.

The lack of studies examining intervention effects on long-term outcomes is perhaps the most significant gap in

post-ED transitions-of-care literature. Most research on post-ED transition interventions has focused on short-term outcomes, such as follow-up attendance and patient satisfaction, typically within days or weeks of discharge. However, critical patient-centered outcomes, such as unplanned ED visits, hospitalizations, adverse events, and long-term morbidity and mortality, are often overlooked. Emergency department transitions are recognized as high-risk periods for adverse health events; without studying these outcomes, it is difficult to assess the full impact of discharge interventions. As previously mentioned, the importance of examining long-term outcomes in improving ED discharge processes is underscored by a key finding in several of the reviewed studies: despite improvements in patient comprehension of instructions, these gains did not always translate into better adherence to those instructions. This discrepancy highlights a critical gap between patients' self-reported understanding of their care plan and their actual behavior in following it.

While educating patients about their diagnoses, medications, and follow-up care is a fundamental component of discharge interventions, comprehension alone may not be sufficient to drive the behavior changes necessary for improved clinical outcomes. Factors such as lack of social support, limited health literacy, and other social determinants of health can undermine a patient's ability to act on the information provided at discharge, even if they grasp it conceptually. Future studies should prioritize long-term cohort studies and RCTs that track both short-term effects and long-term outcomes, including hospitalization, adverse events, and mortality over follow-up periods (eg, 30-90 days). Without this analysis we have limited understanding of the broader and perhaps more consequential implications of discharge interventions on long-term patient health, morbidity, and potential mortality. Additionally, examining how patient factors such as age, comorbidities, and social determinants of health interact with long-term outcomes will help tailor interventions to diverse patient populations.

Consideration of long-term outcomes also plays a crucial role in the cost-benefit assessment of ED discharge interventions. Many of the high-impact interventions identified involve adding specialized personnel, such as discharge coordinators and ED pharmacists, to improve medication adherence and patient comprehension. Addition of personnel is a significant cost; however, none of the studies examined the financial costs of these interventions, creating a gap in understanding their economic feasibility and sustainability. This is particularly relevant in healthcare systems with budget constraints or where these roles have not yet been established. And without including long-term outcomes such as fewer ED visits and readmissions, it is difficult to assess whether the benefits of these intervention outweigh the additional costs incurred from hiring and maintaining these roles.

If future cost-effectiveness and outcomes work does not demonstrate significant return of investment for personnel-related interventions, the role of digitally based interventions may have further promise as they can often be scaled up at lower cost. Future research should integrate cost-effectiveness analyses with long-term, patient-centered clinical outcomes to better balance clinical impact and economic considerations. These types of analyses could enable the development of sustainable discharge interventions and wide adoption across diverse healthcare settings.

Likely contributing to the gaps above was a demonstrated lack of consensus on the most effective outcome measures to assess the quality and impact of current ED discharge interventions and how future ED discharge innovations could demonstrate measurable returns on investment through improved patient and population health outcomes. Given this, future research should focus on standardized, patient-centered outcomes that capture both short- and long-term impacts. Short-term patient-centered outcomes might include not only patient comprehension and satisfaction, but also adherence to discharge instructions as measured through medication adherence, follow-up appointment attendance, and rates of ED return visits for related complaints. Long-term patient-centered outcomes should encompass metrics such as 30- to 90-day ED return visits and hospitalizations, clinically significant adverse events (eg, worsening of disease conditions or medication side effects), and mortality.

In addition to these clinical outcomes, it is crucial to examine implementation outcomes such as the feasibility, cost, adoption, and sustainability of proposed interventions to fully assess their efficacy and potential for widespread use. One current limitation is that there are no consensus-based methods or tools to assess either objective outcomes (eg, ED visits, hospital readmissions, medication adherence) or subjective outcomes such as patient comprehension and satisfaction). Overall, standardizing outcome measures and developing consensus-based tools to evaluate these outcomes could provide more consistent and reliable data, allowing for more robust evaluations of the impact of proposed discharge interventions.

The goal of creating feasible and sustainable discharge interventions is also limited because much of the existing research has focused on individual components of the discharge process rather than comprehensive, integrated interventions. While optimizing individual components of the ED discharge is important, and may impact downstream outcomes, ED discharge is a complex, multidimensional, and multifaceted process. The critical lack of studies examining ED discharge in its entirety and the piecemeal approach may overlook the complexity of post-ED transitions, where multiple factors—ranging from medication management to social support—interact to influence patient health. The previously limited scope of discharge evaluation may explain some of the variation in measured effects observed across different studies. Addressing the full spectrum of needs during the discharge process, while

ensuring that interventions are practical and resource-efficient, is key to developing interventions that are not only clinically effective but also feasible and scalable.

Finally, our review revealed a critical gap in studies including non-English speaking patients, who are a vulnerable ED population. Most studies had non-English as an exclusion criterion, especially when measuring patient understanding of discharge instructions, and the perspectives of low-English proficiency (LEP) patients is particularly under-represented in ED discharge improvements.[102,103] The LEP patient faces additional communication barriers, reporting poor understanding of their care,[104-106] which led to clinically significant adverse safety events[4,14] with missed medications and follow-up appointments and higher likelihood of unplanned ED revisits.[11,16] A relatively small number of studies focused on other vulnerable populations such as older adults and patients with lower socioeconomic status. Older age is associated with elevated medication and follow-up appointment nonadherence and higher discharge failure risk.[107,108] A greater burden of comorbid illness and higher prevalence of cognitive impairment already increases non-comprehension risk. By not including these patient populations, this significant gap in discharge process improvement risks disproportionately affecting our most vulnerable patients. Diverse representation is essential as attempts to improve healthcare processes without representative patient involvement means innovations fail to reflect the realities of these patients' experience.[109,110]

LIMITATIONS

There are limitations to our study and its applicability. We identified only 100 studies examining discharge interventions in adult ED patients. The majority were retrospective cohort studies with few RCTs or prospective study designs and high variability of methodologies and outcome measures. Consequently, systematic review or meta-analysis methodology was not possible. As this was a scoping review that included articles representing a diverse range of methodologies, we did not conduct a formal assessment of the included article and abstract quality or risk of bias, limiting reliability of the studies' findings. Our review was conducted to include both published and gray literature; however, there may be effective discharge interventions used in EDs that have not been described or publicized in the literature.

For pragmatic reasons, our inclusion criteria also limited the scope to studies written in English, which could potentially have excluded relevant global contributions as well as restricted the generalizability of our findings to global audiences and environments. Furthermore, the review was limited to studies published from 2000 onward, which might have excluded some potentially relevant older interventions and practices.

CONCLUSION

The EM community has long recognized ED discharge as a complicated and critical aspect of the unscheduled, acute care episode. However, significant gaps in current research methodology exist, including limited prospective studies, lack of consensus on appropriate ED-discharge quality metrics and outcome measures, absence of long-term outcome studies, and scarcity of studies examining the discharge process as a whole, particularly in vulnerable populations. This review identifies some of the promising directions and opportunities for patient-centered innovation, but in comparison to prehospital or inpatient care, innovation and associated research to better understand how to optimally close the adult ED encounter is limited and warrants a call to action. With recent improvements in digital technologies to engage and communicate with patients and across healthcare systems, as well as the appropriate focus on health equity for disproportionately vulnerable ED populations, the time is now. More comprehensive and longitudinal innovations to optimize adult ED discharge processes, with a focus on rigorous evaluations of their impact with standardized metrics, could yield significant improvements in post-ED patient-centered outcomes.

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The Effect of Pain on the Relationship Between Triage Acuity and Emergency Department Hospitalization Rate and Length of Stay

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Objectives: Little is known about the effect of pain on the relationship between triage and patient outcomes in United States emergency departments (ED). In this study we aimed to describe pain-associated ED visits and to explore how pain modifies the ability of ED triage to predict patient outcomes (hospitalization and ED length of stay [EDLOS)].

Methods: We obtained data from the National Hospital Ambulatory Medical Care Survey (NHAMCS), 2010-2021. Adult ED visits without missing data on pain score or triage level were included. We assessed pain scores at triage using a numeric rating scale (NRS) of 0-10. We further categorized the NRS scores into no (0), mild (1-3), moderate (4-6), and severe (7-10) pain. The five-level Emergency Severity Index was used for ED triage. The primary outcomes were hospital admission during the ED visit and EDLOS. For the analyses we used descriptive statistics and multivariable regression accounting for NHAMCS's complex survey design.

Results: Over the 12-year study period, there were 132,308 adult ED visits (representing 773,000,000 ED visits nationwide). Approximately 50% were triaged to level 3, followed by 30% to level 4. Approximately 45% reported severe pain, 21% moderate pain, 9% mild pain, and 25% no pain. Triage level 1 was associated with the highest rate of hospitalization (35%), with a gradual decrease in hospitalization rate from levels 2 to 4. Triage level 2 was associated with the longest mean EDLOS (5.6 hours), with a gradual decrease in EDLOS from levels 3 to 5. When stratified by pain intensity, the pattern of hospitalization altered in the mild and moderate pain groups. In these two pain-intensity groups, triage level 1 was associated with lower-than-expected odds of hospitalization, a 31% reduction suggested by the interaction term (adjusted odds ratio 0.69; 95% confidence interval .51-.92, $P = .01$). By contrast, the pattern of EDLOS persisted across all pain-intensity groups.

Conclusion: Mild and moderate levels of pain intensity appear to negatively impact the ability of triage to predict hospitalization, resulting in overtriage among patients in these two pain-intensity groups. Pain intensity in the ED should be carefully evaluated to avoid overtriage and ensure the appropriate allocation of resources. [West J Emerg Med. 2025;26(4)835–842.]

INTRODUCTION

Approximately 70-78% of emergency department (ED) visits involve acute pain.[1-3] Thus, pain assessment plays a crucial role in the ED. The American Pain Society introduced pain as a "fifth vital sign" in the 1990s to improve the quality of patient care.[4] Both the numeric rating scale (NRS) and the visual analog scale are commonly used to measure pain intensity in ED triage; however, these pain scales rely primarily on patients' self-report.[5,6] Previous studies have shown that pain measurement may not necessarily enhance pain treatment or improve clinical outcomes.[4,7,8]

Triage is another crucial component of ED workflow. The ED triage system is used worldwide to identify life-threatening conditions, thereby allocating appropriate resources. The Emergency Severity Index (ESI) in the USA, the Canadian Triage and Acuity Scale (CTAS) in Canada, and the Manchester Triage Scale in the United Kingdom, have been validated against hospital admission, ED length of stay (EDLOS), and resource utilization.[9-11] However, previous research on the CTAS and the Korean Triage and Acuity Scale (KTAS) has raised concerns that using self-reported pain intensity for triage might lead to overtriage.[2,12] Overtriage might lead to prioritizing patients with severe pain over sick patients without a pain complaint. [2,12] To the best of our knowledge, the question of whether pain modulates triage decision-making (ie, pain serving as an effect modifier in the relationship of triage and patient outcomes) in the setting of ESI has not been studied. In epidemiology, effect modification occurs when the effect of a single exposure (ie, triage) on an outcome (eg, hospitalization) depends on the values of another variable (ie, pain). In this context, pain may lead to overtriage (ie, artificially increased triage level without a higher hospitalization rate), modifying the relationship between triage and patient outcomes. The conceptual diagram of our study question is shown in Figure 1.

To fill this knowledge gap, we analyzed 12-year ED data from the National Hospital Ambulatory Medical Care Survey (NHAMCS). Our goal was to describe pain-associated ED visits and explore how pain modifies the ability of the triage system to predict patient outcomes (ie, hospitalization and EDLOS) in the ED.

Figure 1. Conceptual diagram of the research question. *ESI*, Emergency Severity Index; *ED*, emergency department; *LOS*, length of stay.

Population Health Research Capsule

What do we already know about this issue?
Research using triage systems other than the Emergency Severity Index (ESI) has shown that self-reported pain might negatively affect the ability of triage to predict patient outcomes.

What was the research question?
We aimed to explore how pain modifies the ability of ED triage to predict hospitalization and ED length of stay.

What was the major finding of the study?
A 31% reduction in odds of hospitalization for ESI 1 in mild to moderate pain (adjusted OR, 0.69; 95% CI .51 - .92, P=.01).

How does this improve population health?
The study highlights the importance of meticulous evaluation of pain intensity in the ED, as mild to moderate pain may result in overtriage.

METHODS

Study Design and Setting

The National Hospital Ambulatory Medical Care Survey (NHAMCS) is a cross-sectional, multistage probability sample of visits to non-institutional general and short-stay hospitals located in the 50 US states and the District of Columbia, excluding federal, military, and Veterans Administration hospitals.[13] The NHAMCS is conducted annually by the National Center for Health Statistics (NCHS). The survey covers geographic primary sampling units, hospitals within primary sampling units, EDs within hospitals, and patients within EDs. The number of EDs sampled is approximately 300-400 per year. Trained research staff collected clinical information during a randomly assigned four-week period for each of the sampled EDs using a structured patient record form (PRF). Data collected included patient demographics, triage level, pain score, reasons for visit, diagnoses, procedures, medications given at the visit, and basic characteristics of the hospital. Quality control was performed using a two-way independent verification procedure for a 10% sample of the records. The non-response rate for most items was less than 5%. The coding error rates were <2%.[14] Because the NHAMCS contains de-identified data only, our institutional review board

exempted this study from review. The study was presented following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[15]

Study Population

We used the NHAMCS data from 2010–2021 in this analysis. First, we excluded ED visits made by patients <18 years of age. We further excluded patient visits with missing data on pain score or triage level. In other words, adult ED visits without missing data on pain score or triage level comprised the study population.

Variables

Pain scores were assessed at triage using a numeric rating scale (NRS) of 0 to 10. We further categorized the NRS scores into no (0), mild (1-3), moderate (4-6), and severe (7-10) pain. The five-level Emergency Severity Index (ESI) was used for ED triage. To preserve consistency across years, race/ethnicity was recoded as non-Hispanic white, non-Hispanic black, Hispanic, and other. Up to five diagnosis fields in the NHAMCS were coded according to the *International Classification of Diseases*, 9th and 10th Revisions, Clinical Modification. For the current analysis, we used the primary ED diagnosis field when examining triage and pain group-specific diagnoses. Visit disposition was recorded for each ED visit, including admission to the hospital and EDLOS. The EDLOS in the NHAMCS was defined as the time difference between ED triage and ED departure.

Outcome Measures

The primary outcomes were hospital admission during the ED visit and EDLOS.

Statistical Analysis

We used Stata 16.0 (StataCorp, College Station, TX) to adjust the variances for the NHAMCS estimates to account for the complex design of the survey. Standard errors (SE) were calculated for the NHAMCS estimates. All statistical tests were based on estimates that had at least 30 cases and a relative SE of <30% (ie, the SE divided by the estimate expressed as a percentage of the estimate) in the sample data, according to the NCHS recommendations. We present descriptive statistics as proportions (with 95% confidence intervals [CI]) or means [with SE]). Multivariable logistic regression analysis was performed to assess the triage level-specific odds ratios (OR) of hospitalization across the pain-intensity groups, adjusting for age, sex, and race/ethnicity. We tested two-way interactions between the pain-intensity groups and triage levels by adding an interaction term in the model. The ORs are presented with 95% CIs. All *P*-values are two-sided, with $P<.05$ considered statistically significant.

RESULTS

The selection process of the study is presented in Figure 2. From 2010–2021, 272,170 ED visits were recorded in the NHAMCS. After excluding visits made by patients <18 years of age or visits with missing data on triage level or pain score, 132,308 adult ED visits were included in the analysis.

Table 1 demonstrates ED visits by triage level or pain-intensity group. After weighting, a total of 773 million visits were included in this analysis. A total of 7,160,000 (0.9%) patients were triaged to level 1, 98,700,000 (12.8%) to level 2, 396,000,000 (51.2%) to level 3, 235,000,000 (30.4%) to level 4, and 37,000,000 (4.8%) to level 5. Regarding pain score, most patients were in the severe-pain group (350,000,000, 45.2%), followed by the pain-free group (193,000,000, 24.9%), the moderate-pain group (165,000,000, 21.4%), and the mild-pain group (65,600,000, 8.5%). Table 2 shows the proportion of admission and EDLOS stratified by pain-intensity group or triage level. Patients at triage level 1 had the highest proportion of admission (2,485,000, 34.7%), followed by level 2 (31,300,000, 31.7%), level 3 (54,800,000, 13.8%), and level 4 (7,081,000, 3.0%). By contrast, patients triaged at level 2 had the longest average EDLOS of 5.6 hours, followed by level 1 (4.9 hours), level 3 (4.4 hours), level 4 (2.7 hours), and level 5 (2.5 hours). Stratified by the pain-intensity group, the pain-free group had the highest proportion of admission (36,100,000, 18.7%) and the longest mean EDLOS of 4.4 hours. Of note, the severe-pain group had the lowest proportion of hospital admissions.

Patient outcome #1: Hospital admission

The relationship between triage level and admission rate, stratified by the pain-intensity group is shown in Table 3. In the pain-free group, the triage level 1 patients had the highest admission rate (45.1%), followed by level 2 (36.1%), level 3 (19.3%), and level 4 (4.5%). By contrast, in the mild pain group, triage level 1 patients had a lower admission rate than triage level 2 patients, resulting in a "dip" in the admission rate in Figure 3.

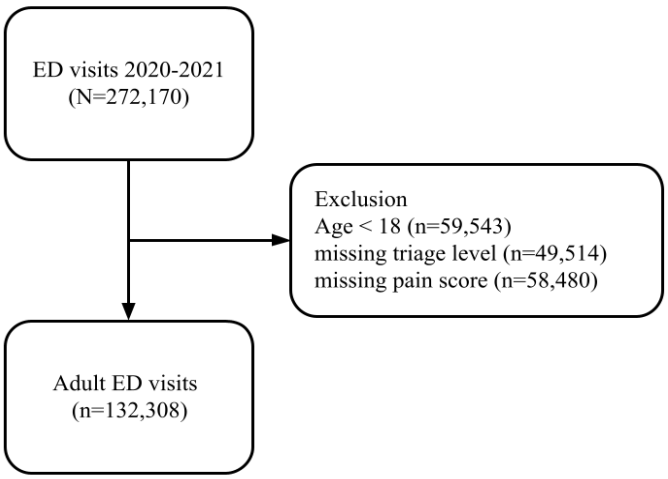

Figure 2. The patient selection process.
ED, emergency department.

Table 1. Emergency department visits stratified by triage level or pain-intensity group.

Variable	Weighted Number	Weighted percentage (95% CI)
Total number of visits	773,000,000	
Triage level, n (%)		
1	7,160,000	0.9 (0.7-1.2)
2	98,700,000	12.8 (12.0-13.5)
3	396,000,000	51.2 (50.1-52.3)
4	235,000,000	30.4 (29.3-31.5)
5	37,000,000	4.8 (4.3-5.3)
Pain-intensity group, n (%)		
No pain (0)	193,000,000	24.9 (24.0-25.8)
Mild (1-3)	65,600,000	8.5 (8.2-8.8)
Moderate (4-6)	165,000,000	21.4 (20.9-21.9)
Severe (7-10)	350,000,000	45.2 (44.3-46.2)

CI, confidence interval.

Table 2. The proportion of hospital admission and mean emergency department length of stay stratified by triage level or pain-intensity group.

Variable	Weighted proportion of admission N (%)	Weighted EDLOS, mean (95% CI), hour
Triage level, n (%)		
1	2,485,000 (34.7)	4.9 (4.2-5.5)
2	31,300,000 (31.7)	5.6 (5.3-5.8)
3	54,800,000 (13.8)	4.4 (4.2-4.5)
4	7,081,000 (3.0)	2.7 (2.6-2.8)
5	1,325,000 (3.6)	2.5 (2.3-2.7)
Pain score, n (%)		
No pain (0)	36,100,000 (18.7)	4.4 (4.2-4.5)
Mild (1-3)	7,718,000 (11.8)	3.7 (3.5-3.9)
Moderate (4-6)	17,700,000 (10.7)	3.8 (3.7-3.9)
Severe (7-10)	35,400,000 (10.1)	3.8 (3.6-3.9)

EDLOS, emergency department length of stay; *CI,* confidence interval.

Multivariable adjusted odds ratio (aOR) for this subgroup also indicated a less-than-expected likelihood of hospitalization (1.5 for triage level 1 vs 2.4 for triage level 2). In the moderate-pain group, the admission rate for triage level 1 patients was the same as that of level 2 patients, resulting in a "plateau" in the admission rate (not higher than level 2 as one would expect). The interaction term between mild-to-moderate pain and triage level 1 indicated a 31% reduction in the odds of hospitalization (aOR for the interaction term, 0.69; 95% CI .51-.92, *P*=.01). In other words, the effect of triage level 1 on hospitalization was reduced by 31% among patients with mild-to-moderate pain compared with other patients. In the severe-pain group, the patients at triage level 1 still had the highest admission rate of 28.8%, followed by level 2 (27.9%), and level 3 (11.9%).

For the "dip" in admission rate in the mild-pain group, the most common diagnoses for patients who were triaged at level 1 were "open wound of scalp, forehead or hand" (17%) or "chest pain, unspecified" (9%). For the "plateau" of admission rate in the moderate-pain group, the most common diagnoses for patients who were triaged at level 1 were "chest pain, unspecified" (15%) or "head injury, unspecified" (6%).

Pain itself did not increase hospitalization rates (Figure 3), nor was it associated with a higher hospitalization rate at the same triage level. Given the same triage level, the pain-free group consistently had the highest hospitalization rate compared with other pain-intensity groups.

Patient outcome #2: EDLOS

Table 3 shows how EDLOS changes with triage levels, stratified by the pain-intensity group. All four groups exhibited a consistent pattern, with triage level 2 having the longest EDLOS. For patients triaged at levels 3-5, EDLOS gradually decreased as the triage severity decreased. For example, in the pain-free group, the EDLOS for triage level 2 was 6.1 hours, followed by 4.6 hours at level 3, 2.8 hours at level 4, and 2.5 hours at level 5. The EDLOS for level 1 patients was slightly shorter than that of level 2 patients, except for a deeper drop in EDLOS for level 1 patients in the mild-pain group (Figure 4).

DISCUSSION

In this study, we analyzed 12-year ED data from the NHAMCS to examine the impact of pain on triage's ability to predict subsequent patient outcomes. Our analysis showed three major findings: 1) approximately three-quarters of ED visits were associated with pain, representing a major ED subpopulation; 2) pain itself did not increase hospitalization rates; conversely, mild-to-moderate pain intensity appeared to negatively impact the ability of triage to predict hospitalization; and 3) the relationship of triage level with EDLOS was not affected by pain intensity.

Pain Assessment and Triage Decision

Pain is one of the most common complaints observed in the ED.[16-20] Our results indicated that the national estimate of the prevalence of pain in the ED was approximately 75.1%, a finding that was consistent with previous smaller studies (70-78%).[21,22] Given that pain assessment has become an important part of ED patient evaluation, research has shown that subjective, self-reported pain might interfere with the triage's predictive validity with respect to patient outcomes. For example, Davis et al analyzed a sample of patients at a tertiary ED and simulated a "pain-free" CTAS for each visit, assuming

Table 3. Admission rates and emergency department length of stay associated with triage levels stratified by the pain-intensity group.

Variable	Weighted proportion of admission, %	Adjusted odds ratio (95% CI)	Weighted EDLOS, mean (95% CI), hour
No pain (pain score = 0)			
Triage level, n (%)			
1	45.1	3.0 (2.4-3.6)	5.5 (4.4-6.7)
2	36.1	2.3 (2.1-2.4)	6.1 (5.8-6.5)
3	19.3	1.0 (reference)	4.6 (4.5-4.8)
4	4.5	0.3 (0.3-0.3)	2.8 (2.6-3.0)
5	4.2	0.3 (0.2-0.4)	2.5 (2.2-2.7)
Mild pain (pain score = 1-3)			
Triage level, n (%)			
1	21.6	1.5 (0.9-2.4)	3.9 (2.7-5.0)
2	31.0	2.4 (2.1-2.8)	5.4 (4.8-6.0)
3	13.1	1.0 (reference)	4.2 (3.9-4.4)
4	3.1	0.3 (0.2-0.3)	2.6 (2.4-2.8)
5	2.3	0.2 (0.2-0.4)	2.1 (1.8-2.4)
Moderate pain (pain score = 4-6)			
Triage level, n (%)			
1	29.8	2.5 (1.8-3.6)	4.8 (3.4-6.2)
2	29.8	2.5 (2.3-2.8)	5.1 (4.8-5.4)
3	12.0	1.0 (reference)	4.3 (4.2-4.5)
4	2.8	0.3 (0.2-0.3)	2.6 (2.5-2.8)
5	3.1	0.4 (0.3-0.5)	2.4 (1.9-2.8)
Severe pain (pain score = 7-10)			
Triage level, n (%)			
1	28.8	2.7 (2.1-3.4)	4.4 (3.6-5.3)
2	27.9	2.5 (2.3-2.7)	5.3 (5.0-5.6)
3	11.9	1.0 (reference)	4.3 (4.1-4.4)
4	2.6	0.2 (0.2-0.3)	2.7 (2.6-2.8)
5	3.7	0.4 (0.4-0.5)	2.6 (2.3-2.9)

Multivariable model adjusted for age, sex, race/ethnicity, triage level, and pain intensity.
EDLOS, emergency department length of stay; *CI,* confidence interval.

that the patient had not reported any pain. They found that the removal of the pain scale from CTAS did not reduce its ability to predict hospital admission, intensive care unit (ICU) consultation, or 72-hour mortality.[2] Moon et al evaluated the triage accuracy using the KTAS by comparing the triage results with those determined by three triage experts. They found a small degree of disagreement between the two, most of which resulted from the misapplication of the pain scale to the KTAS algorithm.[12] Similarly, Lee et al also reported that the incorporation of pain into KTAS led to an overestimation of patient severity, negatively impacting the predictability of KTAS for urgent patients.[23] Along these lines, Ku et al also disclosed that self-reported pain seemed to diminish the predictive accuracy of triage for hospitalization in a single-center study. [19] However, those studies were conducted in one or two hospitals without using the ESI for triage purposes. The current study extended the results to US EDs where the ESI is commonly used.

Hospital Admission Rate

Patients with a higher triage level (eg, level 1) should have a higher admission rate, and this general concept holds true in the pain-free group in our study. However, patients in the mild-pain group exhibited a different pattern, in which the admission rate of triage level 1 patients was lower than expected. This "dip" in admission rate comprised many patients with diagnoses of head/hand wounds and chest pain. Similarly, in the moderate-pain group, many triage level 1 patients had diagnoses of chest pain and head injury. Chest pain can be a dangerous symptom indicative of myocardial infarction. It is likely

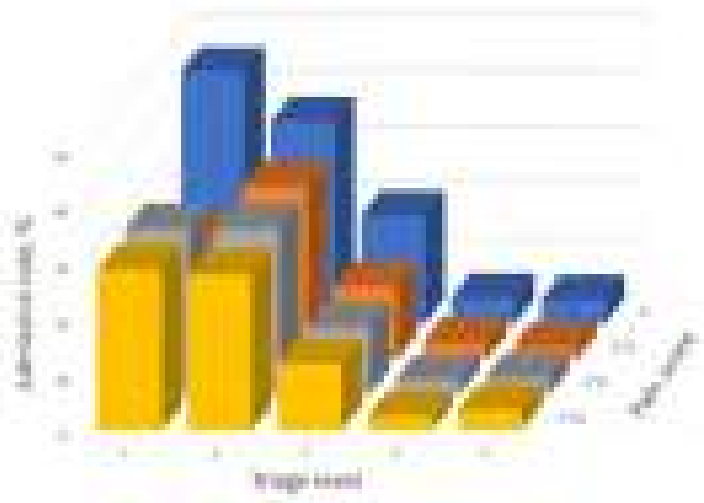

Figure 3. Admission rates associated with triage levels, stratified by the pain-intensity group.

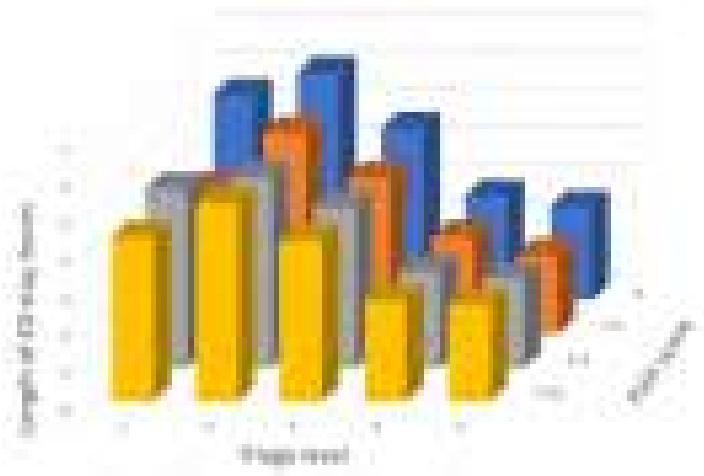

Figure 4. Emergency department length of stay associated with triage levels, stratified by the pain-intensity group. *ED,* Emergency Department.

that in certain circumstances, triage nurses would "err on the side of caution" by triaging patients to level 1, but later these patients were discharged after workup. It may be more difficult to discern the true urgency of chest pain in the mild-to-moderate pain groups than in the severe-pain group, resulting in some degree of overtriage. This held true even when controlling for factors relating to overtriage, such as age, sex, and race/ethnicity,[24] suggesting that pain itself was a strong factor for overtriage.[25] Another pain-related factor for overtriage may be traumatic injuries at triage, as open wounds or head injuries were mistriaged to level 1 with relatively low admission rates.[24]

Emergency Department Length of Stay

Patients triaged to level 2 usually have a longer EDLOS than those triaged to other levels. The possible reason is that patients triaged to triage level 1 have life-threatening conditions and are quickly stabilized and leave the ED for hospitalization. In addition, patients at triage level 2 typically require more examinations and treatments than those at lower triage levels, resulting in a longer EDLOS. Consistent with other ED studies,[26-30] our study showed a similar pattern of EDLOS by triage levels, regardless of pain intensity. This is different from the trend observed in hospitalization. Patients who were mistriaged to level 1 in mild-to- moderate pain groups left the ED sooner due to their lower acuity, preserving the trend of EDLOS by triage levels.

LIMITATIONS

This study has several limitations. First, various factors can affect pain assessment and triage decisions. Although we attempted to control for patient-level variation in pain expressions, we did not control for nurse-level (eg, experience) and ED-level variations (eg, local triage practice pattern). Despite the extensive data collected by NHAMCS, this nuanced information is still lacking. Notably, the admission rate for ESI 1 patients was 34.7%. This low admission rate may result from overtriage due to pain or local triage practice patterns in smaller EDs. Nonetheless, similar admission rates have been reported in the literature using the same NHAMCS data.[31] Second, many patients were missing either a triage level or pain score, suggesting that our results should be interpreted with caution due to variations in ED practice. Third, the EDLOS recorded in the NHAMCS was from ED triage to ED departure (as opposed to the decision to admit), and the version of EDLOS was affected by ED boarding. Finally, we excluded patients <18 years of age who may have different ways to express pain. Thus, our results may not be generalizable to children.

CONCLUSION

In this 12-year study representing 773 million adult ED visits in the US, different levels of pain intensity appear to modulate the ability of triage to predict hospitalization but did not alter the relationship of triage with ED length of stay. The results underscore the importance of meticulous evaluation of pain intensity in the ED setting, as it may negatively impact the predictive validity of a triage system, resulting in overtriage among patients with mild-to-moderate pain. Further research may delve into mechanisms by which pain affects triage ability at various levels, including in patients, nurses, and ED practice patterns. Until the development of an objective tool for pain assessment, training of triage personnel and continuous quality improvement of ED triage may be key. A more standardized and effective triage system would ultimately benefit patients in the ED and improve patient outcomes.

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Implementation of a 3-Tier Priority System for Emergency Department Patients' Follow-up in Orthopaedic Surgery

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Introduction: Increasing demand for emergency department (ED) services and strained specialty-care access requires referral precision and was the impetus for a collaborative redesign of referrals between the Department of Emergency Medicine and Department of Orthopaedic Surgery.

Methods: Guided by root cause analysis of delays in post-emergency department (ED) specialty follow-up in our academic health system, the intervention targeted the finding that all ED referrals were marked "*urgent*" without differentiation by acuity of orthopedic issues. After implementation, referrals were triaged into three tiers—*immediate*, *urgent*, and *routine*—with stipulated follow-up timeframes. We evaluated differences in completion of scheduling and realized visits, across five calendar months (July–November) pre- and post-implementation (2021 vs 2022). Logistic regression assessed the relationship between patient demographics and outcomes. We report medians and interquartile ranges.

Results: Compared to the 393 *urgent* referrals to the Department of Orthopaedic Surgery pre-implementation, there were 463 total referrals post-implementation as follows: 11/463 (2.4%) marked as *immediate;* 123/463 (26.6%) u*rgent;* and 329/463 (71.1%) r*outine.* Similar proportions successfully scheduled pre- and post-implementation (41.5% vs 45.1%; *P* = .28). On average, *immediate* referrals completed scheduling within 1.0 (0.0 - 1.0) day and were seen in 4.0 (2.0 - 8.0) days, *urgent* referrals completed scheduling within 2.0 (1.0 – 4.0) and 7.0 (5.0 - 15.0) days, and *routine* within 3.0 (1.0 - 6.0) and 12.0 (6.0 - 19.5) days. Race/ethnicity and insurance were related to odds of successful scheduling; Black patients had lower odds than all other groups (odds ratio [OR] 0.3 - 0.4). All insurance categories had higher odds of successful scheduling relative to Medicaid out-of-network (OR 3.5 - 7.2).

Conclusion: A three-tier ED-to-orthopedics referral triage system was quickly adopted and differentiated referrals by urgency but did not impact time to follow-up or loss to follow-up. Structural inequities in access to follow-up care remain. [West J Emerg Med. 2025;26(4)843–852.]

THE BOTTOM LINE

Despite rising emergency department (ED) patient volumes and specialty service shortages, timely referrals and care coordination are critical. We evaluated a three-tier system aimed at improving scheduling and follow-up for orthopedic surgery follow-up post-ED visit. Quickly adopted by

clinicians, the system prioritized referrals by urgency and facilitated closed-loop communication between ED and schedulers but did not impact overall rates or timeliness of scheduling or follow-ups. It revealed disparities in post-referral access, notably for Black patients and out-of-network Medicaid patients. respectively. This highlights the need to investigate structural barriers to follow-up visit access to inform equity-enhancing, patient-centered solutions.

Population Health Research Capsule

What do we already know about this issue?
Despite rising ED volumes and limited specialty services, such as orthopedic surgery, prompt referrals and care coordination are critical but inconsistent.

What was the research question?
Our goal was to evaluate the adoption and impact of a 3-tier system for follow-up referrals from the ED to orthopedic surgery.

What was the major finding of the study?
Immediate referrals were scheduled in 1 (0 - 1) day [median (IQR)], urgent within 2 (1 - 4) days, and routine within 3 (1 - 6) days.

How does this improve population health?
Our streamlined 3-tier referral system effectively prioritized without overburdening the ED or orthopedic clinics for precise allocation of follow-up care.

INTRODUCTION

Background and Importance

Recent increases in patient volumes in EDs[1] and simultaneous shortages in specialty services, including orthopedic surgery, in the US and internationally continue to make referrals and care coordination challenging.[2–4] Difficulty in accessing specialty care after ED visits can lead to repeat ED visits or hospitalizations, further exacerbating record-high hospital volumes and increasing medical costs.[5] Efforts are needed to improve precision in specialty service utilization through appropriate and timely referrals after ED discharge.

While some musculoskeletal injuries and orthopedic concerns require hospital admission, most can be managed in outpatient settings.[4] Timely follow-up after ED discharge has been shown to lower likelihood of 30-day revisit and unplanned hospitalizations.[6–8] Efforts to improve coordinated specialty care after ED visits have been broadly attempted, including ED screening and navigator programs, Medicare managed care programs, virtual consults to avoid ED visits,[9] referral appointment scheduling in the ED, and transitional care nurses.[9–17] Coordination and management programs, however, have had mixed effects.[18] Many of these interventions target specific populations, require extensive resources to implement and sustain, and may not be generalizable to all settings.

Goals of This Investigation

Here we describe a collaborative intervention between the Stanford Department of Emergency Medicine and Department of Orthopaedic Surgery to redesign the referral process, which included the following: 1) a three-tier priority system; 2) improved ED referral discharge order/instructions; and 3) closed-loop communication between ED and orthopedic schedulers. The adoption of the referrals and its impact on the intervention on both scheduling and completing a follow-up visit (being seen in clinic by an orthopedic surgeon) after referral from ED were our primary outcomes. As a secondary aim, we explored relationships between patient characteristics and outcomes to identify potential inequities in care.

METHODS

Overview

The Department of Emergency Medicine and Department of Orthopaedic Surgery at our academic health center collaborated on a quality improvement (QI) project to redesign ED referrals to maximize time-appropriate scheduling and completion of post-ED visits. This project received non-research determination by Stanford University's Institutional Review Board (IRB68792).

Institutional Setting

This QI project was a collaboration between the Department of Emergency Medicine and Department of Orthopaedic Surgery of Stanford Medicine (Palo Alto, CA). Stanford Health Care's ED is a Level I trauma center staffed by 90 full-time attending physicians and 60 resident trainees and conducts over 95,000 patient encounters annually. Stanford Health Care's Orthopaedics and Sports Medicine service line has five outpatient clinics focused on orthopedic injuries with 60 clinicians conducting 135,000 outpatients encounters annually. Orthopedic surgery is the most referred-to specialty from the Stanford ED with, on average, 64 ED referrals per month to its clinics (including Orthopaedic Surgery, Hand and Spine Surgery, Rehabilitation, and Sports Medicine).

Intervention Origin

In 2021, the ED conducted a root cause analysis based on informal interviews to determine causes of delay in outpatient follow-up after referral from the ED (Figure 1). One identified cause was that all referrals were labeled as *urgent*, without differentiation between high- and low-acuity orthopedic issues or recommended follow-up timing. Thus, schedulers' work queue could not be organized by urgency of need for follow-up care.

Furthermore, all ED referrals were directed internally to the Stanford Department of Orthopaedic Surgery, but the schedulers did not have a consolidated method for determining whether a patient could feasibly follow up with Stanford given their insurance coverage. There was also a lack of available appointment slots in clinics even when a patient was identified as having an acute, time-sensitive need for follow-up. Finally, there was no process for closed-loop communication with patients who were not able to follow up at Stanford. For example, patients who subsequently discovered their insurance would not cover an outpatient visit to Stanford Orthopaedics would not receive communication to offer options for other services.

As part of Stanford's formal QI system, the Improvement Capability Development Program, the Department of Emergency Medicine aimed to address these root causes in collaboration with the Department of Orthopaedic Surgery.[19]

Intervention

A comprehensive, multidisciplinary team was convened, which included physicians, nursing, operations personnel, and electronic health record (EHR) information technology staff from both departments along with representatives from the institution's centralized scheduling center, billing, and a project manager. The team determined that an intervention needed to have the following: 1) clearly displayed priority levels; 2) a specified workflow for each priority designation; and 3) a fallback care plan if patients could not be scheduled within specified timelines.

The resulting intervention was a three-tiered referral system based on the urgency of ED-to- Orthopaedic Surgery referrals with recommended follow-up timelines (Figure 2). Referrals could be marked as *routine*, *urgent*, or *immediate* by the emergency physicians based upon the expected time demand of the related injury. *Emergent* follow-up was for those conditions that required orthopedic evaluation and/or management within 48 hours (eg, unstable fractures), *urgent* for those requiring evaluation within one week (eg, fractures reduced and splinted in the ED but requiring casting as an outpatient), and *routine* for those that did not meet the prior criteria and could be seen at a later date (eg, sprains, which may only require conservative management).

All referral orders were sent to the scheduler's inbox. The scheduler would then prioritize referrals by urgency. If labeled as *immediate*, schedulers attempted expedited insurance review and clearance. If no appointment slot was available in the next 48 hours, they were allowed to overbook a maximum of two patients per week in the Orthopaedic Clinic. If the patient could not make the scheduled appointment or was not able to follow up with Stanford Orthopaedics, the case was sent to the ED callback nurse who would evaluate whether there was another viable follow-up option at a different outpatient location or if the patient would need to return to the ED for further in-patient management. Finally, if there was any question with follow-up plans, the callback nurse shared the case with the emergency telemedicine physician who determined the acuity of follow-up needed based on the injury pattern and prior attempts at scheduling.

The three-tier referral system and workflows for *immediate* referral were implemented June 15, 2022, in the adult ED and its associated observation unit (clinical decision unit). The intervention targeted all referrals to Orthopaedic Surgery. However, musculoskeletal injuries to the hand and spine (1% of referrals to orthopedics) were not included as they have idiosyncratic coverage by rotating services (eg, plastic surgery or hand orthopedic services, and orthopedics or neurosurgery) and, thus, they have unique, institution-specific follow-up plans determined by the on-call service for the day of injury. Similarly, some Orthopaedic Surgery referrals at our institution were sent to the Sports Medicine clinic, which has limited coverage and institution-specific follow-up plans; so they were not included in this more generalized discharge follow-up process. The ED faculty and residents were educated on the new referral-priority categories and how to use them during June/July faculty and resident meetings.

Figure 1. Root cause analysis of emergency department to orthopedic referrals.

Figure 2. Screenshot of the view of the emergency department-to-the-Department of Orthopaedic Surgery referral priority options within the electronic health record.
ED, emergency department.

Design and Data

We used post hoc, EHR data to capture ED-to-Orthopaedic Surgery referrals and timeliness of scheduling and follow-up care during two seasonally matched consecutive periods: 1) pre-implementation (July 16–November 30, 2021); and 2) post-implementation (July 16–November 30, 2022). Outcomes included as successful were completed scheduling and completed clinic visit by an orthopedic surgeon within 90 days of ED discharge; those with completed scheduling or seen in clinic >90 days post-discharge were deemed unlikely related to the index ED encounter.

We also used EHR data to capture patient characteristics, including age, race, ethnicity, preferred language, and insurance coverage type. Patient age at time of the ED encounter and referral was calculated and categorized into three groups: 17-39; 40-64; and ≥65 years of age. We categorized race into the following groups: White, Hispanic, Asian, Black, and other (Native American, Pacific Islander, mixed race, other, and unknown). We used the Hispanic group, the largest non-White racial ethnic group in our study, as the reference group for race and ethnicity in alignment with recent recommendations for quantitative equity research.[20–22] Patient preferred language was grouped into the following categories: English; Spanish; and other language. The patients' insurance coverage at the ED encounter were categorized into 4 groups: (1) private and military; (2) Medicare; (3) Medicaid out-of-network; and (4) Medicaid in-network, which consisted only of Health Plan San Mateo (HPSM). HPSM is a public Medi-Cal/Medicaid insurance plan for San Mateo County low-income residents. Military was grouped with private insurance due to the limited number of patients (n=7) possessing this insurance and their access to follow-up care was believe to be comparable to patients having private insurance.

Outcomes

We assessed adoption of the three-tier referral system with two outcomes: 1) number of ED-to-Orthopaedic Surgery referrals placed pre- and post-implementation; and 2) proportion of *routine*, *urgent*, and *immediate* referrals placed post-implementation. The impact of the three-tier referral systems on completed scheduling and being seen in clinic by an orthopedic surgeon was described for the pre- and post-implementation period with two proportional outcomes: 1) referrals with completed scheduling for follow-up; and 2) referrals with patients successfully seen in clinic. Completion of scheduling is dependent on both the health system (ie, schedulers) and patient actions but were considered together here. Timeliness of scheduling and follow-up care was measured with two outcomes: 1) days from referral date to follow-up appointment scheduling date ("completed scheduling" date); and 2) days from referral date to date follow-up encounter was attended ("seen in clinic" date).

Data Analysis

We calculated descriptive statistics to describe differences in the outcomes across the two time periods. We reported medians and interquartile ranges because data were not normally distributed. Descriptive results are presented as bi-weekly averages pragmatically to address the half month in July and to be amenable to small numbers in some referral categories. Statistical significance was estimated by using chi-square test, the Fisher exact test, and the Monte Carlo estimate of the Fisher exact test, with seed set to one for categorical variables. We determined differences in timeliness between *routine* and *urgent* referrals with the Wilcoxon-Mann-Whitney test as the outcomes were not normally distributed; the *immediate* referral priority was not included due to small numbers. We used univariate logistic regression models to assess the odds of completed scheduling by implementation period.

For secondary analyses, we collapsed data across all patients' pre- and post-implementation periods as the sample size for some key patient characteristics was small. First, unadjusted logistic regressions with each patient characteristic variable were conducted to assess odds of completing scheduling and odds of being seen in clinic. Finally, we performed multivariable logistic regressions with all patient characteristics. Hispanic was used as the reference group in analyses to de-center Whiteness as the standard experience and avoid "othering."[20–23] Further, we included all pairwise comparisons in the multivariate model to compare racial and ethnic differences in having scheduling completed. Results of these analyses prompted sensitivity analyses that focused on Black patients; a similar statistical approach was used. *P*-values < .05 were considered statistically significant. Mean (interquartile ranges at 25th and 75th percentiles) are reported. We performed analyses using SAS v9.4 (SAS Institute, Inc., Cary, NC).

Data Availability Statement

The data that support these findings are available from the corresponding author upon reasonable request.

RESULTS

Adoption: Referral Utilization

Figure 3 shows the number of referrals placed in the pre- and post-implementation periods and the priority of referrals to Orthopaedic Surgery (excluding Hand, Spine, and referrals that were redirected to Sports Medicine). In the pre-implementation period, the ED made a total of 393 referrals to Orthopaedic Surgery, 45.0 (IQR 39.0-46.0) referrals bi-weekly (every two weeks), all of which were *urgent* (100%) (Figure 3). Post-intervention, there were a total of 463 ED-to-Orthopaedic Surgery referrals, a median of 52.0 (IQR 45.0-56.0) referrals bi-weekly; 329 referrals (71.1%) were *routine*, 123 (26.6%) were *urgent*, and 11 (2.4%) were *immediate*. Table 1 shows characteristics of referred patients for those who did and did not complete scheduling; results are discussed in the "Scheduling by Patient Characteristics" section below. Figure 4 displays the number of referrals placed and their priority. In the

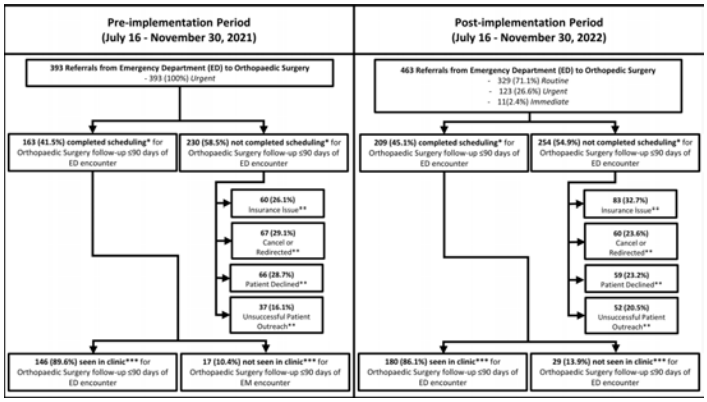

Figure 3. Number (%) of referrals from the emergency department encounter to Orthopaedic Surgery for follow-up, and number (%) of referrals with completed scheduling and follow-up visit attendance. All referrals were marked as *urgent* pre-implementation, whereas referrals could be marked as *routine*, *urgent*, or *immediate* with defined follow-up timelines post-implementation. There were no significant differences in proportion of referrals with completed scheduling (**P* = .28; chi square), a recorded reason for referral not being scheduled (***P* = .13; Monte Carlo estimate of the Fisher exact test), and follow-up visit attendance (****P* = .82; Fisher exact test). *EM,* emergency medicine.

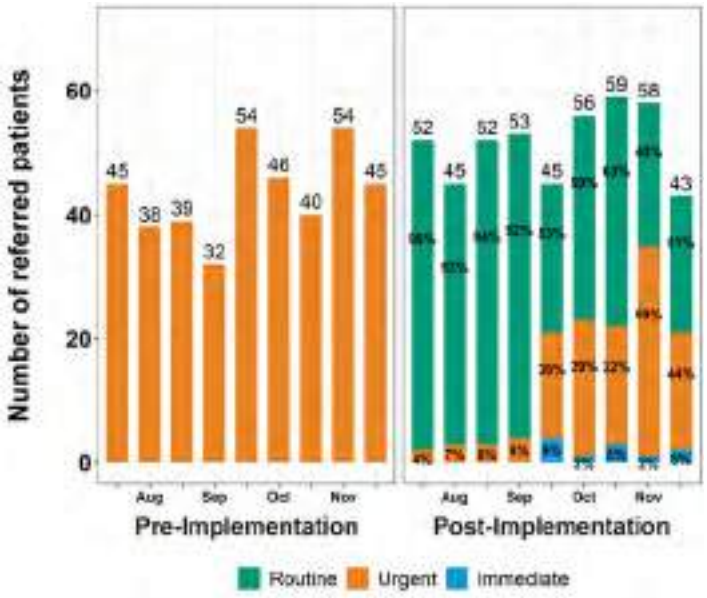

Figure 4. Number of Emergency Department (ED) to Orthopaedic Surgery referrals placed every two weeks (bi-weekly) and emergency department clinicians' use of referral priorities before (pre) and after (post) implementation of a 3-tiered referral priority system. The number of Emergency Department to Orthopaedic Surgery referrals is provided above each bar. The percentage of referrals that are *Routine*, *Urgent*, and *Immediate* are provided within the green, orange, and blue portion of the bars, respectively.

first two months of implementation, emergency clinicians used the *routine* priority for almost all referrals to Orthopaedic Surgery whereas the *urgent* priority was rarely used. Use of the different type of referrals changed in the latter 2.5 months of the post-implementation period; use of the *routine* referral decreased the number of *urgent* referrals, and emergency clinicians used the *immediate* priority sparingly.

Referral to Completed Scheduling of Follow-up

Approximately the same proportion of referrals were successfully scheduled; 163 of 393 (41.5%) referrals were scheduled in the pre-implementation period, and 209 of 463 (45.1%) in the post-implementation period (*P* = .28 (Figure 3)). Odds of referrals being scheduled did not differ between periods (OR 1.2; 95% confidence interval 0.9-1.5). Scheduler-documented reasons for incomplete scheduling are shown in Figure 3 and did not vary significantly between periods (*P* = .13).

Figure 5A shows the time from referral to completed scheduling of follow-up for r*outine*, *urgent*, and *immediate* referrals for the pre- and post-implementation periods. Overall, time from referral to completed scheduling of follow-up with Orthopaedic Surgery did not differ between the two periods; schedulers were able to connect with patients to schedule an appointment within 2.0 (IQR 1.0-4.0) days and 2.0 (IQR 1.0-5.0) days pre- and post-implementation, respectively (*P* = .24) (Supplemental Materials A). Instead, the three-tier referral system, which was designed to categorize patients by urgency of follow-up needs, did show granular differences in scheduling of patients by prioritized category. As described in Figure 5A and Supplemental Materials A, time from referral to scheduling generally followed the expected pattern: *immediate* referrals were successfully processed fastest by schedulers, faster than *urgent* referrals, which were scheduled faster than *routine* referrals. *Urgent* referrals were scheduled significantly faster than *routine* referrals (*P* = .02) (Supplemental Materials B).

Referral to Being Seen in Clinic

Approximately the same proportion of patients who completed scheduling were seen in clinic; 146 of 163 (89.6%) of scheduled follow-up encounters were seen in clinic during the pre-implementation period, and 180 of 209 (86.1%) were seen in clinic during the post-implementation period (*P* = .82; Figure 3).

Figure 5B shows the time from referral to seen in clinic date for *routine*, *urgent*, and *immediate* referral priorities for the pre- and post-implementation periods. Overall time from referral to date seen in clinic did not differ between the two periods; patients were seen in clinic after referral within 8.0 (IQR 4.0-15.0) days during pre-implementation and 10.0 (IQR 5.0-18.0) days during the post-implementation period (*P* = .09) (Supplemental Materials A). Instead, the three-tier referral system showed granular differences by referral category (Figure 5B), and *urgent* referrals were seen significantly faster than *routine* referrals (7.0 [IQR 5.0- 15.0] vs 12.0 [IQR 6.0-19.5 days]; *P* = .02 (Supplemental Materials B)).

Table 1. Demographic characteristics of emergency department patients referred to Orthopaedic Surgery, stratified by success in completing scheduling, with logistic regression estimates of odds of completed scheduling.

				Odds of Completed Scheduling	
	Did Not Complete Scheduling	Completed Scheduling		Unadjusted Model	Adjusted Model
Demographic Characteristics	n (%)	n (%)	*P*-value	OR (95% CI)	OR (95% CI)
All	484 (56.5%)	372 (43.5%)			
Age			<.001[a]		
65+ (reference)	122 (25.2%)	145 (39.0%)		-	-
50-64	115 (23.8%)	78 (21.0%)		0.6 (0.4 - 0.8)	1.0 (0.6 - 1.6)
30-49	153 (31.6%)	83 (22.3%)		0.5 (0.3 - 0.7)	0.9 (0.5 - 1.5)
17-29	94 (19.4%)	66 (17.7%)		0.6 (0.4 - 0.9)	1.0 (0.6 - 1.9)
Race			<.001[a]		
Hispanic (reference)	139 (28.7%)	89 (23.9%)		-	-
White	189 (39.0%)	166 (44.6%)		1.4 (1.0 - 1.9)	0.9 (0.5 - 1.4)
Asian	55 (11.4%)	62 (16.7%)		1.8 (1.1 - 2.8)	1.1 (0.6 - 2.0)
Black	39 (8.1%)	9 (2.4%)		0.4 (0.2 - 0.8)	0.3 (0.1 - 0.7)
Native American, Pacific Islander, mixed race, other	62 (12.8%)	46 (12.4%)		1.2 (0.7 - 1.8)	1.0 (0.6 - 1.8)
Language			.40[a]		
English (reference)	388 (80.2%)	305 (82.0%)			-
Spanish	70 (14.5%)	43 (11.6%)		0.8 (0.5 - 1.2)	1.2 (0.7 - 2.2)
Other	26 (5.4%)	24 (6.5%)		1.2 (0.7 - 2.1)	1.0 (0.5 - 1.9)
Insurance			<.001[a]		
Medicaid out-of-network (reference)	103 (21.3%)	19 (5.1%)		-	-
Medicaid in-network	62 (12.8%)	41 (11.0%)		3.6 (1.9 - 6.7)	3.5 (1.9 - 6.6)
Medicare	105 (21.7%)	143 (38.4%)		7.4 (4.3 - 12.8)	7.2 (3.7 - 14.3)
Private and Military	181 (37.4%)	165 (44.4%)		4.9 (2.9 - 8.4)	4.8 (2.7 - 8.4)
Missing	33 (6.8%)	4 (1.1%)		-	-

[a]Chi-square test.

OR, odds ratio; *CI,* confidence interval.

Scheduling by Patient Characteristics

To identify disparities as areas of potential inequity, we explored differences in scheduling after referral from ED to Orthopaedic Surgery by patient characteristics; this analysis was done across the pre- and post-implementation periods due to the small sample size for some characteristics of interest. In adjusted models (Table 1), every other insurance type was associated with a higher odds of completing scheduling relative to Medicaid out-of-network insurance (Medicaid in-network, OR 3.5; 95% CI 1.9-6.6; Medicare, OR 7.2; 95% CI 3.7-14.3; private and military, OR 4.8; 95% CI 2.7-8.4). Notably, of the patients with Medicaid out-of-network who did not have completed scheduling, 53 of 103 (51.5%) were Hispanic. As shown in Table 2, Black patients had lower odds of having scheduling completed compared to all other race and ethnicity groups, OR 0.3, 95% CI 0.1-0.7 relative to Hispanics, for example.

We hypothesized that insurance or a particular reason for not scheduling might be over-represented in this population; however, Black patients were evenly distributed across insurance types: 14 of 48 (29%) for private and military; 9 of 48 (19%) for Medicare; 10 of 48 (21%) for Medicaid out-of-network; and 14 of 48 (29%) for Medicaid in-network. Even within only private and military insurance, Black patients were less likely to be scheduled in both the unadjusted and adjusted models (both OR 0.1; 95% CI 0.0-0.9 (Supplemental Materials C). In regard to reason for not scheduling, schedulers indicated that patient outreach was unsuccessful in 12 of 48 (25%) Black patients: 8 of 48 (17% had insurance issues; 9 of 48 (19%) declined referral; and 10 of 48 (21%) had an inappropriate referral.

Since 326 of 372 patients (87.6%) who had completed scheduling were seen in clinic, the outcome of not being seen in clinic was too rare and cell sizes of patient characteristics were too small (ie, ≤5 patients) to meaningfully evaluate the relationship between the outcome and patient characteristics.

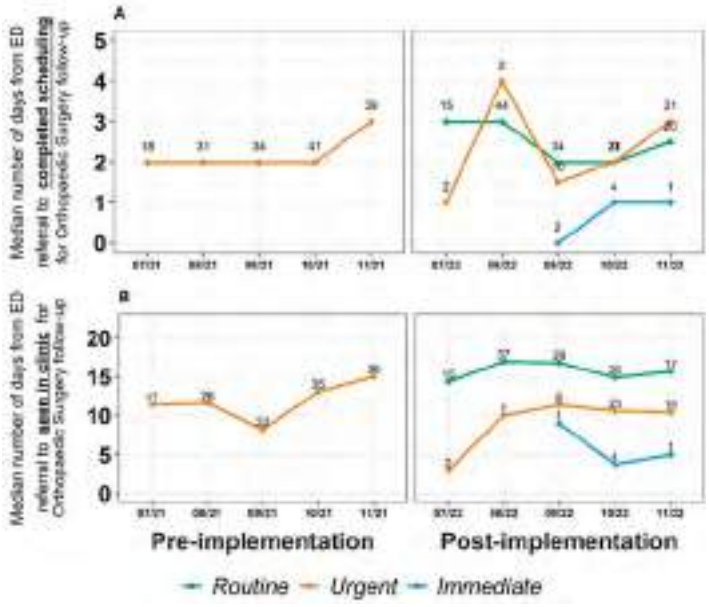

Figure 5. A: Days from referral from the emergency department (ED) to completion of scheduling for Orthopaedic Surgery follow-up encounter pre- and post-implementation of a three-tiered referral priority system. Number of referrals is provided above each data point. B: Days from referral from the ED to seen in clinic for Orthopaedic Surgery follow-up encounter pre- and post-implementation of a three-tiered referral priority system. Number of referrals is provided above each data point.
ED, emergency department.

DISCUSSION

With the number of ED visits in the US continuing to rise—reaching 131.3 million in 2020—optimizing connections to timely outpatient specialty care is crucial to avoid unnecessary hospitalizations or repeated ED visits.[2–4] At the same time, specialty shortages, including within the Department of Orthopaedic Surgery, are growing, exacerbated by the strains that the COVID-19 pandemic put on our health system.[24] This QI initiative created more precise communication of needed follow-up timelines from the ED to Orthopaedic Surgery. It also purposefully secured appointment availability for patients needing *immediate* follow-up with closed-loop communication between the ED and schedulers. The system was adopted relatively quickly by clinicians, and outcomes followed expected patterns based on referral priority, while the overall average time to follow-up remained unaffected.

Notably, at initial implementation, emergency clinicians switched from the default of designating all referrals as *urgent* (when presented with three options), essentially designating all as *routine* priority for the first two months after implementation. There was no default option for follow-up; however, over time, and consistent with ongoing faculty and resident education and socialization efforts of the new system, referrals transitioned to a combination of *routine*, *urgent*, and *immediate* priorities indicating gradual transition to a new system. This finding is consistent with other EHR implementations, which often require exploration and experience before full adoption of a new system or workflow.[25] Notably, this system did not rely on consultation with the specialty services as it was designed to allow the emergency physician to determine priority level based on the injury and practice patterns. If, however, a consultant was contacted by the emergency physician, the priority level could be discussed and agreed upon at that time as necessary.

The three-tier referral system also resulted in expected patterns in the timelines from referral to scheduling and referral to being seen in clinic. *Immediate* referrals were successfully processed fastest by schedulers and seen sooner in clinic, faster than *urgent* referrals that were scheduled and seen faster than *routine* referrals. The median time to scheduling or time to clinic for each referral category, however, did not always align with the timelines prescribed when placing the referrals. This variation in expected vs actual timelines could be due to appointment availability, inability to schedule on the weekends, and patients' preferred appointment day and time. Further, for *immediate* referrals, orthopedic physicians could have determined that an immediate follow-up timeline was not necessary after reviewing the referral and ED work-up.

Our streamlined three-tier system not only effectively prioritized urgency but did so without overburdening the ED or

Table 2. Pairwise comparison of odds of completing scheduling by race and ethnicity of emergency department patients referred to Department of Orthopaedic Surgery.

	Hispanic OR (95% CI)	White OR (95% CI)	Asian OR (95% CI)	Black OR (95% CI)	Native American, Pacific Islander, Mixed race, other OR (95% CI)
Hispanic	-	-	-	-	-
White	0.9 (0.5 - 1.4)	-	-	-	-
Asian	1.1 (0.6 - 2.0)	1.3 (0.8 - 2.1)	-	-	-
Black	0.3 (0.1 - 0.7)	0.4 (0.2 - 0.8)	0.3 (0.1- 0.6)	-	0.3 (0.1 - 0.7)
Native American, Pacific Islander, Mixed race, Other	1.0 (0.6 - 1.8)	1.2 (0.7 - 1.9)	0.9 (0.5 - 1.6)	-	-

OR, odds ratio; *CI,* confidence interval.

specialty clinics. Other interventions to improve ED-to-outpatient follow-up have had mixed results and/or require extensive resources.[12,16,17,26,27] Higher tech solutions, like machine-learning models, might seem like a good solution in the current EHR paradigm, but input data can be haphazard and predictions inaccurate, meaning that physicians must retain ultimate responsibility for referral choices.[28] Our findings demonstrate a simple, sustainable system that successfully triaged patients based on the emergency physician's perceived urgency without requiring additional staffing or data needs.

As with any such intervention targeting timely access, it is crucial to assess whether it potentially reduces or creates care disparities. Notably, this intervention did not negatively impact the total proportion of patients who scheduled or completed follow-up appointments or the overall median timeliness of these activities. The intervention was designed to better triage patients by medical urgency and, thus, more precisely allocate services where and when needed as opposed to a simple first-come-first-served approach. However, since the intervention did not significantly influence the proportion of patients scheduling or completing follow-up appointments, or the timeliness of these activities, it indicates that not all key drivers were addressed across all patient populations for scheduling, completion, and punctuality of follow-ups. Thus, such efforts to meet the realities of varied patient needs and access to follow-up is a key element of equitable, timely delivery of healthcare resources.[29]

To determine whether ED referrals were having differential impacts on subgroups, we pursued exploratory analyses to better understand the qualities of who did and did not ultimately schedule follow-up orthopedic visits. This analysis revealed disparities; Black patients, although contacted by schedulers, had lower odds of ultimately being scheduled for a visit relative to all other race and ethnicity groupings. Insurance status was studied to determine whether scheduling was driven by type of coverage, and we found that those with out-of-network public insurance—a predominantly Hispanic/Latino population—had lower odds of being scheduled than privately insured patients. Insurance coverage and type of insurance have been shown to impact discharge and transfer rates across EDs, with patients who are uninsured or insured through Medicaid experiencing lower care quality than patients with private insurance.[30,31]

Perverse financial incentives influence insurance coverage, hospital payment models, care quality, and policymaking efforts, which may be exacerbated for historically marginalized populations who have been excluded from insurance and healthcare access.[32] The results of this study highlight similar associations between type of insurance coverage, in particular out-of-network Medicaid, and racial/ethnic identity, respectively, and access to care. As a result, efforts to address inequities in emergency care must simultaneously highlight structural inequities influencing care access and quality, while also focusing care team attention on structural barriers that require culturally sensitive, multifaceted interventions to support equitable care for all patients. In this case, our QI effort aimed to ensure that all patients needing orthopedic referral, regardless of their insurance status, were given the option of a follow-up appointment with Orthopaedic Surgery. Our analysis revealed that patients with out-of-network Medicaid (ie, Medicaid options not contracted with the healthcare system) were largely unable to schedule follow-up. However, our analyses also found that some patients chose not to schedule follow-up appointments. Determining whether this was a result of insurance status vs patient attitudes or experiences that potentially vary by racial or ethnic group toward care options warrants further exploration through qualitative efforts to learn more about the experiences influencing scheduling decisions among patients in this group.

This study of a discrete intervention to improve timeliness of ED-to-Orthopaedic Surgery care transitions demonstrates that while structured referrals improve *precision of* referrals, interpersonal-level QI alone may not be sufficient in promoting health equity. Policy-level and further qualitative work to understand the experiences of patients of color and patients with Medicaid insurance coverage will be crucial to promote equitable care access. Further attention to how similar simple but impactful process changes impact equitable access is crucial, and formal assessments can illuminate disparities and opportunities to redress them.[33–35]

LIMITATIONS

This evaluation was conducted at a single institution, which may limit generalizability. Further, the institution did not have a comparable ED to serve as a control, and thus, we were limited to a pre/post design. The relatively small sample size for *immediate* referrals limited our ability to fully assess the impact on scheduling and follow-up for this sub-group. Also, for *immediate* referrals, we did not have measures of how often appointments were overbooked or how often the case was sent back to the ED callback nurse, two key components of the workflow to enable follow-up care within 24-48 hours. Neither were we able to investigate differences between patients with in-network private insurance and out-of-network private insurance in this retrospective analysis; future work should consider tracking this in real time. Similarly, we were unable to include patient-level factors in our primary analyses due to small sample sizes for characteristics of interest. Furthermore, investigating why patients did not schedule follow-up was limited as documentation of such detail in the EHR is manual and varied across schedulers; however, mistrust of healthcare institutions has been a widely described as a reason for not using healthcare services.[36,37,38]

CONCLUSION

This QI initiative demonstrated the feasibility and value of a streamlined three-tier referral system for orthopedic follow-up after ED discharge. The system was readily adopted by clinicians and appropriately stratified patients based on urgency. Notably, it did not impact overall rates of scheduling or time to follow-up but

allowed for precise and tailored prioritization and communication of patient needs. Importantly, our analysis revealed disparities in access after referral. Black patients had lower odds of scheduling compared to patients of other races and ethnicities. Further, patients with in-network Medicaid, private, and Medicare coverage, respectively, were more likely to be scheduled than patients with out-of-network Medicaid. Further research should investigate structural barriers to follow-up visit access, and patient-centered solutions to support vulnerable populations in accessing timely and appropriate follow-up care.

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Reducing Repeat Emergency Department Visits for Low-Acuity Patients Using a Healthcare Connection Program

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Background: Emergency department (ED) utilization for non-emergent issues has been a longstanding issue in the United States, especially in service areas with high Medicaid enrollment. The Medical Home and Specialty Care Connection Program (MHSCC) at University of Chicago Medicine (UCM) supports patients recently seen in the ED with follow-up care by assisting patients with follow-up appointments, establishing a medical "home" and providing education on primary care utilization via working with a patient advocate. These types of programs have inconsistent results throughout the literature and a dearth of study periods. We conducted a program evaluation to assess the association of the MHSCC in reducing low-acuity ED utilization for program patients.

Methods: This program evaluation used retrospective data from the MHSCC program dataset from 2012–2020 and matched with electronic health records of low-acuity ED visits at UCM ED from 2010–2022 for each patient. Pre- and post-low-acuity ED visit rates were calculated based on the patients first program enrollment and compared using the Wilcoxon signed-rank test.

Results: In total 5,482 ED patients enrolled in the program were included in the sample, 537 of whom were enrolled more than once. These patients had 41,530 low-acuity ED visits. The rate of low-acuity ED visits after the program enrollment was significantly lower than before with a mean of 2.5 visits per year before program intervention to 1.38 after, a 45% decrease (P<.0001). This resulted in an estimated 9,487 fewer low acuity ED visits over nine years. Patients with multiple enrollments (up to four) further resulted in a slightly lower ED visit rates. Patients who benefitted the most in both proportion and mean analyses were of low acuity.

Conclusion: We found a significant reduction in program patient's ED visit rates for low-acuity needs. Further evaluation on the outcomes of the program, mechanisms of physician referrals and attributes of the patient population are recommended to understand what drives these findings. [West J Emerg Med. 2025;26(4)853–862.]

INTRODUCTION

Emergency department (ED) usage across the United States has a track record of increasing in number of patients through 2019, outpacing growth in population, and cost.[1-5] From 2010–2016 there was a significant increase in both ED visits and mean charges for patients (129 million visits per year to 145 million, and $2,061 per visit to $3,516, respectively).[2] Although, ED expenditure is a small proportion of overall health spending, it increased in amount and overall proportion during this same time period.[1,2] Even with COVID-19 related ED use reductions through 2022, many patients still frequent the ED with low severity of illness or exacerbations preventable through consistent primary care.[4,6-9] Furthermore, the high usage of EDs can lead to negative outcomes due to ED crowding and long wait times, which are both inconvenient for patients and can lead to patients leaving without being treated.[10] Modern data surveillance and monitoring identifies potential drivers of this situation, as in 2016, 14% of Americans reported "not having a regular source of care" and "barriers to accessing primary care" as top reasons for visiting the ED, particularly among Medicaid enrollees.[11-14] A frequent intervention of many hospital systems for reducing ED revisits is through patient assistance, education, and linkage to care programs.

At the University of Chicago Medical Center (UCMC) ED, this response is carried out by the Medical Home and Specialty Care Connection Program (MHSCC). As the flagship program of the Urban Health Initiative (UHI), the main program objectives are to assist patients with scheduling follow-up care appointments, establishing a medical "home," and providing education on primary care utilization. These objectives are implemented by patient advocates. Patient advocates, who are trained similarly to community health workers, incorporate a broader focus on patient medical and social determinants of health (SDoH) support beyond the ED. Although existing literature has shown some similar programs have yielded beneficial results in meeting these objectives, the overall landscape has shown variable, inconsistent findings regarding statistically significant reductions in ED revisits with a few studies reporting increased ED revisits.[15-27] As interest in these types of programs increases, it will be important to understand their impact on ED utilization.

Our goal in this study was to evaluate the impact of the MHSCC program on repeat, low-acuity ED visits, hypothesizing that patients who accepted help from a patient advocate through the MHSCC program would result in a reduction in their low-acuity ED visit rate.

Population Health Research Capsule

What do we already know about this issue?
ED use for non-emergent concerns continues to be an issue in the US. Medical home connection programs have inconsistent results throughout the literature.

What was the research question?
Was there a reduction in low-acuity ED utilization for program patients from before and after their program intervention?

What was the major finding of the study?
Low-acuity ED visit rates were lower after the program with a mean of 2.5 visits/year before to 1.38 after, a 45% decrease, P<.0001.

How does this improve population health?
Implementing these program models in similar settings could improve local health care connection and reduce reliance on the ED for low-acuity needs.

METHODS

Program Details and Study Population

UCMC is a Level I trauma center that is part of a large, tertiary-care hospital system. It houses the largest ED on the South Side of Chicago, a community affected by many SDoH.[28] The MHSCC program stationed within this system identified patients through various means. Originally, patients were screened by patient advocates based on acuity level and need for a primary care physician. Starting in 2014, a paper-based physician referral pathway was created for those times when patient advocates were not staffed (nights, holidays, weekends, etc). This transitioned into the electronic health record (EHR) via a physician order in 2018 (comparable to any other consultation request) without any strict inclusion criteria.

This EHR system change likely led to a substantial increase in physician referrals and overall demand for the program during the study period, respectively, and eventually eliminated ad hoc screening by patient advocates. As the team size did not grow during the study period, it is probable there were patients who were not outreached to due to program capacity. Patients were approached by patient advocates for program enrollment both in person during their ED visit and over the phone after being discharged from the ED. The intervention consisted of providing assistance with scheduling primary and specialty care appointments, healthcare access resources and healthcare navigation education. Follow-up phone calls were often conducted two days before the patient's scheduled appointment as a courtesy reminder. Most work occurred within one week of a patient's discharge from the ED, and patient advocates did not follow patients for an extended period. Because of the brevity of the program, program enrollment, participation, and intervention are used interchangeably depending on context.

In this retrospective cohort study we used data collected in the MHSCC program activity database (MHSCC dataset) from January 2, 2014–July 24, 2020 to track program operations. The data includes variables on patient index visits (ED visit when program enrollment took place), support and intervention provided, and other information on the patient and program enrollment. From this database, the study sample included adult ED patients during this period. Several other inclusion criteria were selected to further define the scope of the study. For some patients, it was unclear whether the program enrollment was associated with an adult ED visit because the time between the last ED visit and enrollment was greater than 30 days. We excluded those cases from the study. Additionally, an extensive literature review showed that similar programs had mixed results regarding the effectiveness of these interventions for high-frequency ED users and, thus, those users were removed from our sample dataset a priori.[9,22] We defined high-frequency ED use as patients with more than 21 visits over the study period (above the 95th percentile of the sample). Although the ED in question is an adult ED, patients as young as 16 are treated under certain circumstances, and this study included 18 patients ages 16-17 in the analysis. Lastly, patients without a valid medical record number and those who were deceased within the study period were removed from the dataset.

The MHSCC dataset was merged with data from our EHR (Epic Systems Corporation, Verona, WI) from January 1, 2012–December 31, 2022. Data from the EHR included all patients' ED visits, demographic information and other relevant data such as ED visit acuity levels, and dates of each respective ED visit. Index ED visit dates were then matched to patients based on the program enrollment date. We included prior and subsequent ED visits from the EHR data only if they were recorded as low acuity (Emergency Severity Index level 4 or 5).[29] We included all low-acuity ED visits two years before and two years after the MHSCC dataset included in the merged dataset to evaluate ED visit rates for patients enrolled at the beginning and end of the MHSCC dataset. All index visits were included regardless of acuity level.

When reviewing medical records for the study, we followed several criteria for retrospective chart review best practices: abstractor training; aforementioned case selection criteria; variable definitions; monitoring abstractors' work; interobserver reliability discussions; and sampling methodology for program participants.[30] Furthermore, only patients with complete data were used in the statistical analysis. Approval for this study was obtained from an institutional review board, which deemed the study exempt with no stipulations and consent waived.

Overall, the study was outlined by analyzing three parameters: 1) effectiveness of the program in reducing low-acuity ED use; 2) effectiveness of multiple program enrollments for a patient; and 3) description of patient characteristics associated with the success of this intervention.

Data Analysis

We reviewed and compared study population descriptive statistics between groups respective to both main and sub-analyses. Demographic and medical information analyzed included age, sex, race, ethnicity, insurance status (payor group), and number of low-acuity ED visits. Demographic frequencies were compared with proportions, testing for significance using chi-square test for categorical variables (the Yates correction for continuity was used for tables with a value of zero), while means were compared using *t*-test and analysis of variance. For patients with multiple enrollments, the demographics during their first index visit were used in descriptive tables. Although not part of the analysis methodology, we evaluated both the MHSCC dataset and EHR data to develop a control group. Alpha for significant values was set at .001 due to the large sample size. Data cleaning occurred in R 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria) and Microsoft Excel 2016 (Microsoft Corporation, Redmond, WA), and statistical analyses and graphs were done in R (4.2.2).

Main Analysis

For the primary analysis, we made a comparison between a patient's low-acuity ED visit rates before and after program enrollment. This included calculating the rate of low-acuity visits before the program intervention (pre) and the expected rate of low-acuity ED visits afterward (post) (adjusted for time after the enrollment). We calculated the post rate by taking the observed ED visit rate before program intervention and multiplying it by the number of months afterward in two methods: 1) 12 months post; and 2) until the end date of study period (December 31, 2022). The rate of observed low-acuity ED revisits was then compared to the expected value using the Wilcoxon signed-rank est.

Further comparison of different demographics characteristics were made on the outcome of interest based on whether the patient had any reduced visit rate using bivariate analysis ("reduced low-acuity ED visit rate" vs "no reduced low-acuity ED visit rate"). These comparisons were also done with separating out patients who had a "near zero" difference in their ED visit rate. The "near zero" group included any patients having a change in low-acuity ED visit rate between -0.5 and 0.5 visits per 12 months when looking at the entire study period. We calculated mean low-acuity ED visit rate changes post-program intervention for demographic categories that demonstrated significant differences.

Subanalysis

The subanalysis investigated whether multiple program enrollments with a patient advocate during the evaluation period further reduced the rate of low-acuity ED visits. This was analyzed with multiple tests of the Wilcoxon signed rank test among subgroups of patients: those with one enrollment; and those with two or more enrollments. We compared

demographic and frequency data for patients with one and two or more program enrollments. Both main and subanalyses were used to estimate the number of ED visits prevented over the course of the study. This was done by summing the individual differences in observed vs expected low-acuity ED visits.

Program Healthcare Cost Prevention

To assess the impact of the MHSCC program on healthcare costs, we performed an analysis of the average total variable cost for program patients. Patients who were referred to the MHSCC program from July 2021– June 2022 with low-acuity ED visits were used to calculate an average direct variable cost. This was calculated by internal hospital finance teams. This average was then multiplied by the estimated total number of low-acuity ED visits prevented for each year in the study. Direct variable costs are those accrued during the patient's ED visit and treatment excluding fixed costs such as labor (nurse, physician salary, etc).

RESULTS

From 2014–2020, 50,206 patients were enrolled by patient advocates. Of these patients, 9,626 were eligible for the study, of whom 5,482 (57%) participated in program interventions and 4,144 (43%) declined assistance. The 5,482 eligible patients who accepted patient advocate services were mainly Black (95%) and female (62%) with a mean age of 38.4 (SD 16.2) years. The largest proportion of index visits were designated as acuity level 4 (56%), followed by level 3 (30%). Payor groups for patients included private insurance (17%), Medicaid (54%), Medicare (9%), uninsured (13%), and other (6%). Descriptive and demographic data for the program sample is outlined in Table 1.

From the 2012–2022 EHR data, there were 41,530 low-acuity ED visits for the 5,482 patients in the sample. This accounted for 26% of all low-acuity ED visits during this period, with an average of 3.27 low-acuity ED visits per patient in this sample. Overall, 3,693 (66.3%) patients had a lower ED visit rate after their program enrollment and 3,162 (58%) had at least 0.5 fewer visit per year. The mean number of low-acuity ED visits per patient was 1.73 pre- and 1.41 post-enrollment (P<0.001) across the entire study period. Furthermore, the mean expected ED visit rate post-enrollment was 2.5 visits per year and reduced by 1.12 visits per year (P<0.001) in observed rate, a 45% reduction.

Among patients "with a reduced low-acuity ED visit rate" after program enrollment, a smaller proportion were Black (94% vs 96% of those "without a reduced ED visit rate," P<0.001) and used Medicaid (54% vs 64%, P<0.001), and a larger proportion had private insurance (18% vs 14%, P<0.001) or no insurance (14% vs 12%, P<0.001).

For acuity levels at index visits, patients with higher acuities (2 and 3), had a lower proportion "with a reduced low-acuity ED visit rate" (27%) compared to patients "without a reduced low-acuity ED visit rate" (65%).

Table 1. Demographic breakdown and proportions of evaluation sample size: patients who engaged with a patient advocate.

Patient Descriptive Categories		Total Patients
N		5,482
Sex		
	Male	2,070 (38)
	Female	3,412 (62)
Race		
	Black	5,183 (95)
	Not Black	299 (5)
Ethnicity		
	Hispanic or Latino	126 (2)
	Non-Hispanic or Latino	5,356 (98)
Age		
	16 -18	158 (3)
	19 - 33	2,487 (45)
	34-48	1,353 (25)
	49 - 64	1,080 (20)
	65 - 78	306 (6)
	79 +	98 (2)
	Mean	38.4
Insurance/Payor Status		
	Private	936 (17)
	Medicaid	3,322 (61)
	Medicare	507 (9)
	Uninsured/Self-Pay	717 (13)
Acuity Level of Patients during Index Visit		
	1	3 (<1)
	2	513 (9)
	3	1,658 (30)
	4	3,076 (56)
	5	225 (4)

Conversely, patients with acuities 4 and 5 had greater proportions "with a reduced low-acuity ED visit rate" (73%) vs patients "without a reduced low-acuity ED visit rate" (35%) (P<0.001). None of the patients with the highest acuity of 1 (3) saw a reduced ED visit rate (Table 2). When analyzing proportions by excluding patients whose ED visit rate change was "near zero," we found there was no longer a significant difference by race. All other proportions and significant differences remained the same across the same comparisons with no other notable changes.

For mean ED visit rate changes, uninsured patients had the highest reduction in average visit rate at 1.52 fewer visits per 12 months, post-enrollment. Medicaid and privately insured patients had similar mean reductions (1.08 and 1.15 fewer visits

Table 2. Demographic and frequency statistic comparisons of patients who had a reduced low-acuity emergency department visit rate to those who did not. This includes all patients with either an ED visit rate change of less than 0 (had reduced visit rate) or greater than 0 (did not have a reduced visit rate).

Patient Descriptive Categories	Patients with Reduced Low- Acuity ED Visit Rate, Post Enrollment	Patients without a Reduced Low Acuity ED Visit Rate, Post Enrollment	P-values
N	3,639	1,843	
Sex			
Male	1,409 (39)	661 (36)	.04
Female	2,230 (61)	1,182 (64)	
Race			
Black	3,414 (94)	1,769 (96)	<.001*
Not Black	225 (6)	74 (4)	
Ethnicity			
Hispanic or Latino	93 (3)	33 (2)	.07
Non-Hispanic or Latino	3,546 (97)	1810 (98)	
Age			
16 -18	106 (3)	52 (3)	.71
19 - 33	1,646 (45)	841 (46)	
34 - 48	903 (25)	450 (24)	
49 - 64	711 (20)	369 (20)	
65 - 78	213 (6)	93 (5)	
79 +	60 (2)	38 (2)	
Mean Age	38.5	38.5	-
Insurance/Payor Status			
Private	673 (18)	263 (14)	<.001*
Medicaid	2,134 (59)	1,188 (64)	
Medicare	332 (9)	175 (9)	
Uninsured/Self-Pay	500 (14)	217 (12)	
Acuity Levels of Patients during Index Visit			
High acuity (2 and 3)	982 (27)	1,189 (65)	<.001*
Low acuity (4 and 5)	2,654 (73)	647 (35)	

Significant findings (*) are for *P*-values of < 0.001.
ED, emergency department.

per 12 months, respectively). Lastly, Medicare patients had the lowest reduction in ED visit rate at 0.78 fewer visits per 12 months. Although interesting, these mean changes among payor groups were not statistically significantly different ($P < .01$). By acuity level at index visit, patients with low acuity (4 and 5) had a significant reduction in mean ED visits post-enrollment at 1.81 fewer per 12 months compared to higher acuity patients (2 and 3) at 0.074 fewer visits per 12 months ($P<.001$) (Table 3).

Subanalyses

Of the 5,482 patients in the study sample, 537 (10%) were enrolled multiple times, often during a subsequent ED visit. Among the sample, 4,945 (90%) patients were enrolled once, 446 (8%) were enrolled twice, 72 (1%) three times, and 19 (<1%) were enrolled ≥4 times (maximum 11), totaling 6,137 program enrollments. When comparing those with "one enrollment" (4,945, 90%) vs "two or more'" enrollments (537, 10%), patient demographics were largely the same with the exception of two significantly different categories outlined in Table 4: payor status and acuity level. Patients with "one enrollment" compared with "two or more" had higher proportions of private insurance (18% vs 13%) and uninsured patients (13% vs 11%) and a lower proportion of patients with Medicaid (53% vs 70%). For acuity level at index visit, for those with "one enrollment" vs "two or more" proportions were lower for acuity level 2 (9% vs 14%), 3 (30% vs 36%) and 5 (4% vs 5%), whereas they had a higher proportion of acuity 4 (57% vs 45%). On average patients who enrolled multiple times had a reduction of 0.36 ED visit rate per year compared to a reduction of 0.15 for those with only one program enrollment. Difference between groups with one through four enrollments and their reduced ED visit rates are shown in Figure 1.

Table 3. Summary of mean change in ED visit rates per 12 months for descriptive categories from Table 2 with statistical significance between patients with a reduced ED visit rate and those without (excluding Race).

Mean Rate of Change for ED Visits, Post-Program Enrollment (per 12 Months)			
Patient Descriptive Categories		Mean Change Visits (per 12 Months)	P-values
N	5,482		
Payor Status			
	Medicaid	-1.08	<.01
	Private	-1.15	
	Medicare	-0.78	
	Uninsured	-1.52	
Acuity			
	Low Acuity (4 and 5)	-1.81	<.0001**
	High Acuity (2 and 3)	-0.074	

Significant findings (*) are for p-values of < 0.001 and (**) for <0.0001.

The overall reduction in ED visit rates resulted in an estimated 9,447 fewer low-acuity ED visits. Averaged over the entire study period (2012–2022), the UCMC patient advocate intervention program resulted in 1,050 visits prevented per year. Furthermore, the average number of prevented visits increased each subsequent year until 2020, after which a consistent rate of 1,495 low-acuity ED visits prevented per year was observed from 2020–2022 (Figure 2).

Healthcare Cost Analysis

The average direct variable cost for low-acuity patients referred to the MHSCC was $307 from July 2021–June 2022. When applied to the estimated 9,447 low-acuity ED visits prevented, this totaled $2,900,229 in healthcare expenditure avoided. Annually, this equated to an average of $322,247 per year. However, if applied to the stabilized rate of ED visits prevented at 1,495, this would prevent healthcare costs of $458,965 per year assuming maintenance of this prevention rate over time.

DISCUSSION

This study identified a significant reduction in ED visits post-intervention among a subset of MHSCC program patients. This reduction was greater among patients with multiple program enrollments, and patients who had this reduction were more likely to be low-acuity at index visit and have private insurance or be uninsured. However, the overall intervention benefit by mean ED visits was only statistically different by acuity level. This continues the development of evidence on the effectiveness of like programs in an ED setting and among patients with attributes that are more likely effected by the program (payor group and acuity level).

The overall finding of reduced ED visits is not unique in the literature, yet it varies methodologically due to our use of a longer than standard time frame of seven years compared to the shorter outcome periods common in literature, such as 72 hours and 30 days for ED revisits and monitoring ED revisits for a median of six months post-intervention.[15,17,31] Therefore, our findings also begin to demonstrate the longevity of overall program effectiveness by low-acuity ED visits prevented. Nevertheless, longevity of the program's effectiveness was not directly analyzed in this study and requires further research. This longitudinal style design can also help account for unstudied confounding variables such as ED clustered visits by normalizing the data over a long period of time. Furthermore, we did not use a control group and/or propensity score matching (common in the literature) as there was a higher baseline of mean ED visits in the sample than the general UCMC ED population.[31] This indicates some unknown factor or attributes of patients who were referred to this program by physicians, which is not accounted for by standard matching methods, potentially leading to selection bias.

Many similar program evaluations and research that do not develop control groups have had the overall quality of their studies called into question.[14] In this case, for the development of a control group there were three different populations or samples available. This included the overall ED population; patients referred to the program who had not been assisted; and patients who refused assistance during attempted program enrollment. These presented various levels of selection bias. In the case of the general ED population, there was no clear index visit from which to calculate pre- and post-low-acuity ED visit rates. For patients who may not have been assisted (unable to reach, voicemail left, etc.) or had not been. reached out to at all, the MHSCC dataset had limitations for data on these patients and we could not delineate these two scenarios. For patients who refused assistance we realized that the overwhelming majority stated they already had an appointment set up/had a medical "home" or they wanted to call and schedule it themselves, indicating they did not need help getting established into a medical "home" and could represent a dedicated sample of patients who do not need help. Overall, this made it difficult to develop a matched control group from the general ED population.

The significant findings from this impact evaluation of the MHSCC reinforce program efforts toward reducing ED visit rates and highlights specific caveats and applications. This includes focusing on low-acuity patients and non-high ED users, although there is no agreed upon definition of high ED users.[17] Patients with private insurance were more likely to benefit from this program; this finding could reflect a multitude of well- documented inequities in healthcare access and availability associated with patients on Medicaid and public insurance leading to reduced appointment adherence.[13]

Table 4. Demographic and frequency statistic comparisons between patients who had one program enrollment and those who had two or more.

Descriptive Category		Patients with one program enrollment	Patients with two or more program enrollments	*P*-values
N		4,945	537	
Sex				
	Male	1,880 (38)	190 (35)	.21
	Female	3,065 (62)	347 (65)	
Race				
	Black	4,661 (94)	522 (97)	<.01
	Not Black	284 (6)	15 (3)	
Ethnicity				
	Hispanic or Latino	122 (2)	4 (1)	.02
	Non-Hispanic or Latino	4,823 (98)	533 (99)	
Age				
	16 -18	145 (3)	13 (2)	.03
	19 - 33	2,276 (46)	211 (39)	
	34-48	1,213 (25)	140 (26)	
	49 - 64	951 (19)	129 (24)	
	65 - 78	275 (6)	31 (6)	
	79 +	85 (2)	13 (2)	
	Mean Age	40.3	40.7	
Insurance/Payor status				
	Private	882 (18)	54 (10)	<.001*
	Medicaid	2,624 (53)	378 (70)	
	Medicare	460 (9)	47 (9)	
	Uninsured/Self-Pay	659 (13)	58 (11)	
Acuity level of patients during index visit				
	1	2 (<1)	1 (<1)	<.001*
	2	439 (9)	74 (14)	
	3	1,465 (30)	193 (36)	
	4	2,836 (57)	240 (45)	
	5	196 (4)	29 (5)	

*Indicates statistically significant comparisons with $P < .001$.

Patients with Medicaid still had reduced ED visit rates, which has also been seen with prospective, randomized control trial research, and the mean reduction among Medicaid patients was similar to private payors.[26] Although not significantly different, patients under the uninsured/self-pay group showed good response from the program, which aligns with research in a quasi-randomized trial.[32] This is an important finding as many patients across the US lose health coverage if it is not provided by their employer, although further research needs to be done to examine patient advocate programs as avenues for securing reliable insurance for their patients.[33] Other interesting findings include the accrual and stabilization of estimated low-acuity ED visits prevented per year over the course of this evaluation and magnitude of improvement from multiple program enrollments. It was expected that the ED prevention would fall off after enrollments had stopped in 2020 and during the two years afterward. However, this could have been influenced by COVID-19 pandemic responses and a national reduction in ED visits from 2020–2021.[4,7-9] This phenomenon could have confounded the result by showing a greater ED visits prevention than would otherwise have been seen during these years.

When hypothesizing the drivers of the MHSCC's impact, the broader context of the program's institution must be considered. The South Side of Chicago has been experiencing higher disparities in healthcare access, ED usage (particularly for mental health emergencies), disability, poverty, unemployment, violent crime, food access, chronic disease

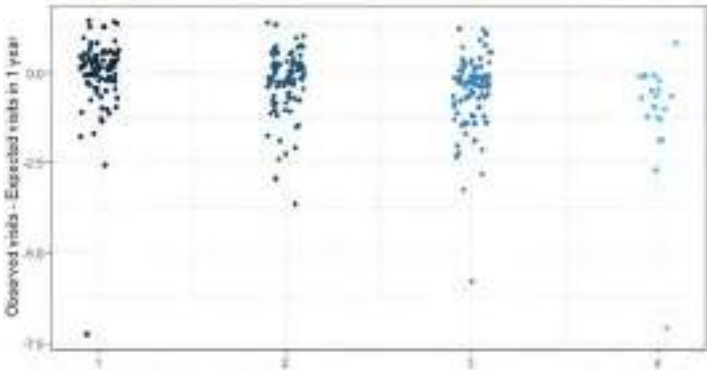

Figure 1. Change in low-acuity emergency department visit rate visits per 12 months for patients with multiple enrollments with a patient advocate from 1-4 or more (X-axis). Change in visit rate is calculated by observed visits post-program enrollment minus expected visits.
ED, emergency department.

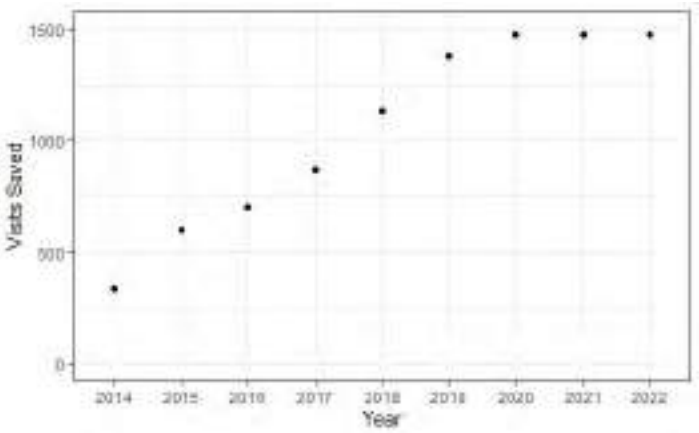

Figure 2. Estimated low-acuity emergency department visits prevented each year during the evaluation period. Points on the graph are inclusive of visits prevented.

mortality rates and other SDoH needs for the past few decades compared to the State of Illinois and the rest of the city of Chicago, potentially catalyzing the impact found.[28] The MHSCC also connected to broader healthcare ecosystem initiatives, such as the Southside Health Collaborative and the Southside Healthy Community Organization, which have worked to establish a network of community-based healthcare clinics and hospitals to partner with University of Chicago Medicine to support patients across the South Side.[16] Further evaluation on other outcome measures need to be investigated such as health literacy, appointment adherence or healthcare navigation knowledge; however, there is established literature on similar programs improving appointment adherence.[20,31]

The cost analysis done was comparable to former studies; however, several studies seen in review papers used fixed costs as a part of their healthcare cost-prevention estimates.[17,34] We did not use this method as there was no known reduction in staff or units-closed event that would have reflected actual reduced spending on fixed costs such as physicians, staff or maintenance of a department or section of the hospital. Because the Urban Health Initiative is the main Community Benefit sector and oversite at UCMC, this is not a defined, expected or intended benefit of the program. The purpose of the MHSCC is to benefit patients and healthcare ecosystem on the South Side of Chicago. These findings are an unintended benefit indicating financial sustainability congruent with what similar programs have shown. That said, these referenced programs were focused on older populations and overall, there are uncertain conclusions throughout literature as there are limited in depth, statistical cost savings analyses.[17,22,35,36]

In continuing a cost-benefit analyses, there is an unintended threat to the ecosystem of healthcare on the South Side in that many patients seek to be treated at UCMC who are "out of network" (their health insurance plan is not contracted with the hospital), putting strain on both UCMC (did not accept their insurance policy) and safety net, community and federally qualified hospitals that are missing the reimbursement from treating these mostly Medicaid-insured patients. There is an unknown cost benefit and protections of patient billing by preventing patients from seeking care outside their network and helping them maintain quality care in institutions that are in their payor-group network.[37]

LIMITATIONS

This study had several limitations. Because the program and study were conducted at a single-site our findings are not generalizable beyond the sample. Furthermore, data from other hospitals was not included, meaning it is unknown whether patients visited other EDs over the course of the study. However, UCMC is the most frequented ED on the South Side of Chicago by a significant margin for both high- and low-acuity patients, which could help lessen the effect of this limitation.[38] The retrospective data used was for programmatic purposes and was not collected in a rigorously standardized way or complete manner throughout the study period. From 2018 onward, there was not a clearly defined or understood decision-making process for emergency physicians to refer patients to the program. Due to program staff turnover and lack of documentation, there was also limited knowledge on what guidelines or general information was provided to physicians during this time period. Although this created the foundation for a validated tracking system of program referrals, this was not incorporated into the MHSCC dataset. Currently the program uses emergency physician champions, quarterly ED resident physician conferences, and moderating clauses on referral orders in the EHR system for communication and tracks referrals to program outreach ratios.

The study also did not control for a wide range of covariates including COVID-19 ED visit reductions, Area Deprivation Index, chronic illness, mental illness, substance use disorder, specialty care follow-up services provided, and ED visit patterns including post-traumatic injury visits or other cluster visits, using the Poisson regression model. Additionally, UCMC opened their adult Level I trauma center in 2018, which changed the setting and potential patients approached for the program.

Although the MHSCC started in 2005, there was only program data available beginning in 2010. This means patients included in the study may have enrolled before the study period. Also, EHR data was only available from 2012 onward, limiting use of the program dataset to 2014–2020 so that there would be adequate time before the index visit to calculate pre-ED visit rates. Due to such a long period other considerations may have been missed such as accounting for census data (eg, urban, county or state migration).

CONCLUSION

Emergency department use in the United States is still an immense healthcare burden with many visits being low acuity or treatable outside an ED.[1,2,11] This evaluation study found a significant reduction in patients' low-acuity ED visit rate for Medical Home and Specialty Care Connection Program participants and provides evidence that patient advocate and navigation programs can be effective and sustainable for providing services to ED patients. The MHSCC warrants further evaluation on the outcomes of the program, the mechanisms of physician referrals, and attributes of the patient population to understand what specifically drives success of this intervention.

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Evaluation of an Emergency Department Sexually Transmitted Infection Empiric Treatment and Linkage-to-care Program

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Introduction: Rates of sexually transmitted infections (STI), remain high in Hillsborough County, FL. As the emergency department (ED) is frequently used for STI diagnosis and treatment, a local hospital ED implemented a linkage-to-care program using a callback system to ensure that patients with chlamydia, gonorrhea, and/or syphilis received treatment. Our primary aim in this paper was to evaluate implementation of an ED-based STI treatment program by describing empiric, follow-up, and overall treatment rates in STI-positive patients by disease and sex. A secondary aim was to evaluate reasons for undertreatment during the acute-care encounter.

Methods: We conducted this quality assurance project, including a retrospective chart review of electronic health records from 2019–2022, at an urban ED in Hillsborough County, Florida. During this period, we reviewed all records reflecting positive results for chlamydia, gonorrhea and/or syphilis to determine whether empiric treatment was administered in the ED or the patient required coordination for follow-up care. Patients who received empiric treatment or successful follow-up treatment were classified as treated, while those who did not receive successful follow-up treatment were classified as untreated.

Results: A total of 1,170 patients were diagnosed with an STI at an urban, quaternary-care hospital in the county. Of these, 689 (58.9%) had chlamydia, 324 (27.7%) had gonorrhea, 133 (11.4%) had dual gonorrhea-chlamydia, and 24 (2.1%) had syphilis. Rates of STI empiric, follow-up, and overall treatment were 47.1%, 86.1%, and 92.6%, respectively. Empiric and overall treatment rates were highest for male patients (72.3% male, 33.4% female) and patients presenting with gonorrhea (67.6% gonorrhea, 63.9% chlamydia). Follow-up treatment rates were highest for female patients (87.1%) and patients presenting with gonorrhea (87.6%).

Conclusion: Our findings emphasize both the successes and opportunities for improvement of a linkage-to-care protocol to provide treatment access for patients in the ED who test positive for sexually transmitted infections. Given the significant strain on the public health infrastructure in the United States and on our local Department of Health, ED-based linkage programs fill an important gap in healthcare delivery. Going forward, improving overall treatment rates in females and patients with chlamydia or syphilis is warranted. [West J Emerg Med. 2025;26(4)863–868.]

INTRODUCTION

Chlamydia, gonorrhea, and syphilis are three of the most common and curable sexually transmitted infections (STI). In 2018, the STI incidence in Hillsborough County, FL, for chlamydia, gonorrhea, and syphilis were 619.0, 161.6, and 16.8 per 100,000 population, respectively.[1] Each

rate represents an increase from the preceding year (excluding gonorrhea). Of Florida's 67 counties, Hillsborough ranked ninth highest in these rates.[1] High-risk groups include females and individuals 20-24 years of age for chlamydia; males and individuals 20-24 for gonorrhea; and males and individuals 25-29 for syphilis.[2] Between 2008–2010 and 2011–2013, there was a 2% increase in the number of ED visits but a 39% increase in visits by patients with an STI diagnosis.[3]

Screening for STI is routine during ED encounters, and this setting remains effective for reaching high-risk groups. However, results may not be readily available due to long lab turn-around times, delaying treatment and risking loss to follow-up after discharge.[4-6] Therefore, empiric STI treatment is recommended for those experiencing symptoms, those who have engaged in sexual activity with a recently infected partner, and those at high risk of becoming lost to follow-up.[7] Empiric treatment can reduce transmission and prolonged morbidity.[7]

Previous studies have reported a low sensitivity and specificity for STI diagnosis by emergency physicans and advanced practitioner diagnosis, resulting in both overtreatment and undertreatment.[9-11] Overtreatment is concerning given the concern for antibiotic resistance, while undertreatment perpetuates transmission and disease complications.[2,7,12] Specifically, untreated women are susceptible to pelvic inflammatory disease, ectopic pregnancy, infertility, and chronic pelvic pain.[2]

In our ED we treat STIs empirically and use a linkage-to-care program to ensure treatment access for STI-positive patients. The purpose of this quality assurance (QA) study was to assess this ED's performance in treating identified STIs by evaluating empiric, follow-up, and overall treatment rates in STI-positive patients by disease and sex. A secondary aim was to evaluate reasons for undertreatment. We did not evaluate whether patients were compliant with treatment.

Population Health Research Capsule

What do we already know about this issue?
Lab results for sexually transmitted infections (STI) tests may return post-ED discharge, complicating downstream linkage to care if not treated empirically.

What was the research question?
What are current patterns of ED-based STI treatment? Can an ED-based linkage program improve STI treatment rates?

What was the major finding of the study?
47.1% received empiric treatment. Gonorrhea led in empiric treatment (67.6%), follow-up (87.6%), and total treatment (96.0%).

How does this improve population health?
There are opportunities to increase ED-based empiric treatment. Post-discharge linkage systems can improve care beyond local Department of Health limitations.

METHODS

Study Design

We conducted this QA project, which included a retrospective chart review from the electronic health record (EHR) (Epic Systems Corporation, Verona, WI), between September 2019–October 2022 at a large, urban, academic, Level I trauma center in Hillsborough County, FL. The study design and reporting adhered to the Standards for Quality Improvement Reporting Excellence guidelines[13] and followed the guidelines of Worster and Bledsoe.[14] Chart abstractors were trained by the medical director of the ED infectious disease linkage-to-care program. They were familiarized with the US Centers for Disease Control and Prevention (CDC) guidelines for STI treatment and use of the EHR to review inbox messages, physician notes, treatments during the clinical encounter, and prescriptions at discharge. Inclusion and exclusion criteria were clear to the abstractors (participants with positive STI testing in late-results inbox), and the variables were well defined (age, EHR-identified sex, results of STI testing, medications in ED, prescriptions at discharge, diagnosis). They used an electronic data capture form for chart abstraction, and the abstracted results were reviewed by the senior author. Because the study was a QA project and not a research hypothesis, blinding was not necessary. The data were objective with no specific areas of interpretation prone to interobserver variation. If a non-standard antibiotic was used, the abstractors asked the senior author whether the antibiotic met the criteria for appropriate STI treatment. Since there were no interpretive abstracted data susceptible to inter-rater reliability, we did not test for inter-rater reliability. The EHR was used for chart abstraction. The sampling was a predefined time range for analysis. If data were not easily found or recognized in the EHR, the abstractor discussed this with the senior author.

Screening in the ED for STIs is done for all patients with a suspected STI; in this study we focused on patients ≥13 of age who were positive for the non-HIV STIs chlamydia, gonorrhea and/or syphilis. Minors were included because parental consent for STI examination and treatment is not required in the State of Florida. Persons who screened positive for HIV in addition to

non-HIV STIs or were living with HIV were not specifically included or excluded in this study. Our ED has a robust, non-targeted, opt-out, serum-based HIV screening program. The HIV and syphilis test results are managed by a linkage team, but we did not analyze those linkage rates in this review. The linkage navigator was made aware of positive STI testing results through an automated pool in Epic that provides notification of all positive test results. Initial data collection was completed by the linkage navigator through manual chart review. The chart abstractors were not blinded to the study hypothesis.

Ethical Considerations

The University of South Florida Institutional Review Board deemed the projected to be quality improvement/QA.[14]

STI Workflow

In the ED, patients underwent STI screening at the discretion of the treating clinical team. A urine polymerase chain reaction test was used for gonorrhea and chlamydia. The reverse screening algorithm using a serum sample for treponemal antibody testing followed by rapid plasma reagin was used for syphilis.[7] Presence of prior STI was not standardized in approach to STI testing or empiric treatment decision-making. However, clinicians may have used previous STI information when making treatment decisions based on general CDC recommendations and guidelines. We did not interview treating physicians, physician assistants, and nurse practitioners in real time; neither did we conduct qualitative chart review.

Linkage navigators share a pooled Epic inbox. All gonorrhea, chlamydia, HIV, hepatitis C virus (HCV), bacterial vaginosis, and syphilis results are sent to that inbox. Each weekday morning, linkage navigators review the inbox. Our ED uses linkage navigators to follow STI results after patient discharge. They confirm whether empiric treatment was provided in the ED. If no treatment was provided, the linkage navigators provide a prescription to the patient's pharmacy or arrange linkage for further treatment at the Department of Health (DOH) or return to the ED. The linkage navigators, who are funded as part of Gilead Sciences Frontlines of Communities in the United States (FOCUS) HIV- and HCV-screening program, spend 25% of their time using the EHR to follow STI results and coordinate linkage. They communicate their actions via Epic notes in the EHR. If a physician opted for another treatment course, a response via secure chat or Epic inbox messaging was available (eg, return to ED instead of outpatient prescription). Our linkage navigators are often peers who cross work in our opioid use disorder program or are graduate students in public health or anthropology. Ultimately, these tasks will be integrated into our ED pharmacist and hospital transition-of-care late-results process.

We classified STI-positive patients into the empiric or follow-up group. The empiric group included patients who received appropriate treatment during the encounter based on the clinician's clinical judgment. The follow-up group included patients who did not receive treatment in the ED, thus requiring downstream linkage to treatment. The linkage navigator contacted follow-up patients to provide STI-positive status and counseling regarding treatment options including visiting the ED, the DOH, or their primary care physician. Patients with chlamydia could have had a prescription sent to their pharmacy. Three call attempts were made to the patient's primary and secondary contact within 72 hours of the visit. Patients who were not successfully contacted were sent a certified postal letter. The linkage navigator reported all cases to the DOH.

The STI treatment was compliant with the 2015 Sexually Transmitted Diseases Treatment Guidelines 2015 and, later, the updated 2021 guidelines.[7,8] To assess the ED's performance in treating STIs, patients who received empiric treatment or access to follow-up treatment were classified as "treated"; those who did not receive treatment were classified as "untreated."

Analysis

We used descriptive statistics to evaluate demographics and treatment rates. Empiric rates were determined by the number of patients treated empirically within the sample. Follow-up rates were determined by the number of patients treated/untreated within the follow-up group. We determined overall rates by the total number of patients treated within the sample. We performed data analyses using SPSS Statistics v29.0 (IBM Corporation, Armonk, NY)

RESULTS

Patient Characteristics

Between 2019–2022, 1,170 patients were STI-positive at this ED. The mean age was 26 (range: 13-70), 758 (64.7%) were female, and 63 were pregnant (8.3%). Of these patients, 689 (58.9%) had chlamydia, 324 (27.7%) had gonorrhea, 133 (11.4%) had dual gonorrhea-chlamydia and; and 24 (2.1%) had syphilis. The most common infection in females was chlamydia (523, 69.0%), and in males gonorrhea (173, 42.0%).

Main Results

A total of 551 (47.1%) patients received empiric treatment. Gonorrhea patients had the highest empiric (67.6%), follow-up (87.6%) and overall treatment rates (96.0%). Treatment rates by disease are represented in Table 1. By sex, males had higher empiric (72.3%) and overall treatment rates (94.9%), while females had a higher follow-up treatment rate (87.1%). Treatment rates by sex are represented in Table 2. Overall, 1,084 of 1,170 (92.6%) patients were treated; 533 of 619 (86.1%) follow-up patients were treated. However, 86 patients (7.4%) remained untreated. Of those, seven (8.1%) were contacted but not treated; 21 (24.4%) could not be contacted via telephone or certified letter; 41 (47.7%) could not be contacted via telephone only; 11 (12.8%) had incorrect documentation of telephone number(s); two (2.3%) did not have documented

Table 1. Treatment rates for sexually transmitted infections by disease.*

Treatment rate	Chlamydia n = 689	Gonorrhea n = 324	Dual Gonorrhea-Chlamydia n = 133	Syphilis n = 24
Empiric treatment group – n (%)	246 (35.7%)	219 (67.6%)	85 (63.9%)	1 (4.2%)
Follow-up group – n (%)				
Treated	382 (86.2%)	92 (87.6%)	40 (83.3%)	19 (82.6%)
Untreated	61 (13.8%)	13 (12.4%)	8 (16.7%)	4 (17.4%)
Overall treatment – n (%)	628 (91.1%)	311 (96.0%)	125 (94.0%)	20 (83.3%)

* Treatment rates represent the number of STI-positive patients within each group who received the specified treatment by disease.
STI, sexually transmitted infections.

contact attempts; three (3.5%) were incarcerated, and one (1.2%) was in residential addiction treatment.

DISCUSSION

Our results emphasize the need for an ED linkage-to-care process, as empiric treatment was not the treatment modality for all patients. The findings of a relatively low empiric treatment rate, with greater rates in males and for gonorrhea infections, align with what ha been reported in previous studies.[9,11,15-16, 17] This is likely because STI-positive females and patients with chlamydia are more likely to present asymptomatically.[2,17] Alternatively, symptomatic females are at greater risk of being misdiagnosed.[15] Typically in this ED, gonorrhea/chlamydia and chlamydia test samples are collected via pelvic exam and cervical swab collection. Vaginal self-swabs, urine samples, throat, and rectal samples were not commonly collected. Thus, sample type is unlikely to explain the low rate of empiric chlamydia treatment in women. These low rates may be secondary to lack of clear signs and symptoms on exam compared to those in gonorrhea-positive patients.

Multiple EDs have implemented follow-up infrastructures to link non-empirically treated STI-positive patients to treatment. Some EDs require patients to return to the ED, while others allow patients to receive treatment elsewhere.[6,10,15,18] However, most studies are limited to female populations and/or patients with gonorrhea and chlamydia only.[6,10-11,15-16,18] To our knowledge, our results represent treatment rates of one of the largest ED-based sample sizes of STI-positive patients including syphilis diagnoses, minors and adults, and females and males.

Our ED had high follow-up and overall treatment rates using a linkage protocol. This high treatment rate may be related to our use of secondary contact information and a certified letter after failed call attempts. Additionally, patients were not limited to our ED for treatment. The follow-up protocol was similar to that in one other study that, to our knowledge, had the highest follow-up (93.2%) and overall (96.8%) treatment rates for gonorrhea and chlamydia.[16] Overall, 7.4% of patients remained untreated and undertreatment was greatest for females and patients with chlamydia or syphilis. To improve ED treatment rates, accurate and rapid point-of-care tests are needed to give physicians and advanced practitioners the ease of verifying test results prior to treatment decisions.[11,15,18-19] However, these tests are not yet available.[19] For now, lowering the empiric threshold while enhancing the follow-up protocol may be optimal.[11,20] Lowering the threshold to include those with no STI history may be beneficial, as a previous study found this factor to be associated with undertreatment during follow-up.[16,20]

To improve our follow-up protocol, we may consider providing patient activation cards and using a call + text message system as both methods have been associated with improving the rates of successful STI notification and subsequent treatment.[21-22] Patient activation cards provide clear discharge instructions and include the linkage navigator's contact information.[21] Or, since most patients remained untreated because of failed call attempts, using a call + text message system may be beneficial.[22]

Our local DOH is ultimately responsible for STI follow-up. However, our DOH, like many, is understaffed. The staff is simply unable to maintain close follow-up and rapid treatment options for STI patients. This scenario can increase patient morbidity and transmission, leaving an opportunity for the ED to plug another hole in healthcare delivery in our local community.

Table 2. Treatment rates for sexually transmitted infections by sex.*

Treatment Rate	Male n = 412	Female n = 758
Empiric treatment group – n (%)	298 (72.3%)	253 (33.4%)
Follow-up group – n (%)		
Treated	93 (81.6%)	440 (87.1%)
Untreated	21 (18.4%)	65 (12.9%)
Overall treatment – n (%)	391 (94.9%)	693 (91.4%)

* Treatment rates represent the number of STI-positive patients within each group who received the specified treatment by sex.
STI, sexually transmitted infections.

LIMITATIONS

This study had several limitations. First, we did not analyze clinician encounter notes, which could have provided greater insight into the decision-making process. Qualitative review of the clinical encounter notes may offer further insight into the decision not to empirically treat patients or to deviate from CDC guidelines. Second, untreated patients may have received treatment elsewhere, but it could not be verified. Alternatively, for patients with chlamydia, although a prescription was sent, we were unable to determine whether the prescription was received. However, clinicians commonly send prescriptions with the understanding that patients receive them. We must also consider that there were additional STIs that were undiagnosed in this sample given the reference point for positive test results.

Lastly, our results apply to one urban ED population and are not intended to be generalizable. Clinician-level interviews or feedback at time of encounter may add future insights into the gap in guideline implementation. We did not incorporate that level of analysis in this study. Neither did we consider outpatient treatment completion and ED bounceback rates, which could be analyzed in a future study. Those rates are important when considering prescription barriers, bacterial resistance, or more complicated disease states, such as pelvic inflammatory disease, that may not be treated with outpatient oral antibiotics.

CONCLUSION

Our findings represent the successes and opportunities to improve the linkage-to-care protocol to provide treatment access to STI-positive patients in this ED. Given challenges of healthcare delivery and the burden on the public health infrastructure in many communities, the potential benefits of coordinated downstream linkage programs in similar ED settings that frequently diagnose STIs should be further explored. Going forward, exploring ways to improve treatment rates in females and patients with chlamydia or syphilis is warranted.

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Changes in Veterans Health Administration Emergency Department Visits During Two Years of COVID-19

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Introduction: To better understand the impact of the COVID-19 pandemic on emergency department (ED) utilization, we examined two years of Veterans Health Administration (VHA) ED visits. Emergent and non-emergent ED visits were examined separately to understand the impact of systems-level changes in healthcare delivery.

Methods: In this retrospective, observational cohort study we examined ED visits in 111 EDs within the VHA from March 2018–February 2022. Primary outcome was the count of emergent and non-emergent ED visits, using incident rate ratios (IRR) with 95% confidence intervals (CI) to examine ED visits during the first two years of the COVID-19 pandemic in eight separate quarters, compared to two years of seasonally equivalent quarters before COVID-19.

Results: Over the four-year period, US veterans made 8,057,011 ED visits, with 54.7% in the eight pre-COVID-19 quarters, and 45.3% in the first eight quarters during the COVID-19 pandemic. Both emergent and non-emergent visit counts decreased in each of the first eight quarters during COVID-19 when compared to their respective pre-COVID-19 baseline. The change in emergent visits ranged between -26.9% (March-May 2020; IRR 0.73, 95% CI 0.72-0.74) and -7.0% (June-August 2021; IRR 0.93, 95% CI 0.92-0.94). The change in non-emergent visits ranged between -33.0% (March-May 2020; IRR 0.67, 95% CI 0.67-0.67) and -5.7% (June-August 2021; IRR 0.94, 95% CI 0.94-0.95). After the first six months of the pandemic, emergent ED visits had a sustained greater decrease compared to non-emergent visits.

Conclusion: As of 2022, ED visits had not returned to pre-pandemic baselines, and our results suggest that emergent visits have sustained a greater decrease even in the second year of the pandemic compared to their respective, seasonally equivalent pre-pandemic quarters from March 2018–February 2020. The finding that emergent visits decreased more than non-emergent is notable given that system-level changes in care delivery, particularly a shift toward use of telehealth, would be expected to have a greater impact on non-emergent care. More work is needed to understand whether acute care is being forgone altogether, as well as the subsequent impact. [West J Emerg Med. 2025;26(4)869–875.]

INTRODUCTION

During the COVID-19 pandemic, disruptions including lockdowns, fears of virus transmission, and restrictions on non-emergent medical services, broadly impacted healthcare delivery in both the outpatient and inpatient settings.[1] As emergency department (ED) utilization is intricately linked to care in those settings, this created an environment in which EDs became a crucial point of access to emergent and non-emergent healthcare for many, including veterans of the United States military.[2] Similar to community settings, previous work in the Veterans Health Administration (VHA) suggested that even with a large shift in outpatient care from in-person to telehealth settings during the first year of the pandemic, overall numbers of scheduled outpatient appointments still declined.[3,4] Given this decline, it is important to understand how known disruptions in both acute and chronic care during the COVID-19 pandemic impacted ED utilization for both emergent and non-emergent care.

Previous work looking at ED visits in the community has demonstrated decreases in specific emergent diagnoses (eg, stroke, acute myocardial infarction), largely during the initial year of the pandemic.[5-8] Other studies from the early phase of the pandemic also demonstrated fewer admissions from the ED.[9] More recent work looking at the impact of COVID-19 on ED outcomes beyond the first year of the pandemic has focused on ED boarding and in-hospital mortality but has not examined the types of ED visits seen during these periods.[10-12]

However, as COVID-19 cases continue to fluctuate, a better understanding of comprehensive trends in ED utilization for emergent and non-emergent care is needed beyond specific types of ED presentations. This approach can better represent the impacts of system-level changes in healthcare delivery outside the ED during the pandemic. In this study we aimed to add to this body of literature by examining changes in ED visit rates for emergent vs non-emergent ED visits in a national health care system over two years. With data spanning beyond the pandemic's initial phases, this study will contribute to a better understanding of the long-term impacts of changes in healthcare delivery in both outpatient and inpatient settings on ED utilization during the COVID-19 pandemic.

METHODS

This was a retrospective, observational, cohort study of ED visits within the VHA from March 2018– February 2022. The VHA represents the largest integrated health system in the US, with 111 EDs, and provides services to more than nine million enrolled veterans. This study was approved by the Stanford University Institutional Review Board (IRB) and by the VA Palo Alto Research & Development Committee. This study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines (Supplemental Materials). Additionally, while our study was based on administrative data, we adhered to several established criteria to enhance methodological rigor in medical record review studies in ED research.[13] These included case selection criteria, variable definition, medical record identified, sampling method, and IRB approval.

The ED encounter and sociodemographic data were retrieved from the VA Corporate Data Warehouse. The overall study sample included all VA ED encounters by veterans who were ≥18 years of age. We defined ED encounter diagnoses for emergency care-sensitive conditions (ECSC) by the International Classification of Diseases, 10th Rev, Clinical Modification (ICD-10-CM) code. The ECSCs, for which timely access to emergency care impacts morbidity and mortality, were defined previously by a multidisciplinary review panel with emergency medicine, primary care, and hospitalist experts, using a modified Delphi method. The ECSCs encompass 51 condition groups with associated ICD-10-CM codes, such as sepsis or systemic inflammatory response syndrome, chronic obstructive pulmonary disease, pneumonia, asthma, and heart failure, among others.[14] We excluded from this analysis ED visits clearly attributable to COVID-19 illness (those with an ED encounter diagnosis of U07.1 and U07.2). We collected baseline patient characteristics including age, sex, race, ethnicity, VA priority group, driving distance to closest VA ED, residential location, marital status, and Elixhauser Comorbidity Index score.[15] Veterans Administration priority groups, which are used to determine the costs a veteran has to pay toward their care, are calculated using veterans' military service history, service-connected disabilities, and other factors.

The primary outcome was the count of ECSC and non-ECSC ED visits. We generated incident rate ratios (IRR) with 95% confidence intervals (CI) to examine changes in ECSC and non-ECSC ED visits across eight quarters (three-month intervals) spanning the initial two years of the COVID-19 pandemic. For each quarter during those two years, the IRR presented is a ratio that compares the daily rate of ECSC or non-ECSC ED visits during that single COVID-19 quarter to the average of two daily rates observed in corresponding quarters (meaning the same calendar months) before the pandemic in 2018 and 2019. This approach provided a meaningful comparison, allowing us to gauge the impact of COVID-19 on ED visit rates while also accounting for seasonal variations in the pre-COVID-19 years, and is consistent with other pre/post-COVID-19 ED utilization comparisons in the literature.[5,16-17] Pre-COVID-19 periods spanned March 2018–February 2020, and during-COVID-19 periods were March 2020–February 2022. For example, March-May 2020 (COVID-19 quarter 1) is compared to the average of March-May 2018 and March-May 2019. Similarly, March-May 2021 (COVID-19 quarter 5) is compared to the average of March-May 2018 and March-May 2019. June-August 2021 (COVID-19 quarter 6) is compared to the average of June-August 2018 and June-August 2019. Encounter-level demographic characteristics are described using summary statistics. We compared both ECSC and non-

ECSC visits between pre-COVID-19 and during-COVID-19 periods with standardized mean differences. For all analyses, significance was set at $P< 0.05$. We conducted all analyses in R version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Over the four-year period, US veterans made 8,057,011 ED visits, with 4,410,123 (54.7%) in the eight pre-COVID-19 quarters, and 3,646,888 (45.3%) in the eight quarters during the COVID-19 pandemic. The overall enrollee population increased by approximately 1.1% over this time period, with counts as follows: fiscal year (FY) 2018–9,898,266; FY 2019–9,929,810; FY 2020–9,888,475; and FY 2021–10,010,358. For both ECSC and non-ECSC visits, there were no significant imbalances in patient characterisitics when comparing the pre-COVID-19 and during-COVID-19 periods. When comparing ECSC to non-ECSC ED visits, patients were older, more likely to be male, and had higher mean Elixhauser Comorbidity Index scores (Table).

Table. Demographic and clinical characteristics of Veterans Health Administration patients by emergency department visit type.

	ECSC visits (n=1,136,248)			Non-ECSC visits (n=6,920,763)		
	Pre-COVID-19[a] (n=626,801)	During COVID-19[a] (n=509,447)	Standardized mean difference for ECSC visits[b]	Pre-COVID-19[a] (n=3,783,322)	During COVID-19[a] (n=3,137,441)	Standardized mean difference for non-ECSC visits[b]
Age, mean (SD)	67.80 (13.5)	68.22 (13.6)	0.031	60.09 (16.2)	60.29 (16.3)	0.012
Age, years, n (%)			0.05			0.045
18-44	41,837 (6.7)	35,845 (7.0)		746,569 (19.7)	647,837 (20.6)	
45-64	173,028 (27.6)	130,657 (25.6)		1,347,560 (35.6)	1,058,425 (33.7)	
65-84	347,342 (55.4)	292,642 (57.4)		1,480,791 (39.1)	1,268,603 (40.4)	
85+	64,594 (10.3)	50,303 (9.9)		208402 (5.5)	162,576 (5.2)	
Sex, n (%)			0.015			0.013
Male	590,550 (94.2)	478,209 (93.9)		3,360,542 (88.8)	2,773,861 (88.4)	
Race, n (%)			0.046			0.044
American Indian or Alaska Native	4,852 (0.8)	4,073 (0.8)		31,232 (0.8)	26,627 (0.8)	
Asian	3,194 (0.5)	2,882 (0.6)		29,881 (0.8)	28,246 (0.9)	
Black	146,660 (23.4)	126,138 (24.8)		1,082,916 (28.6)	928,593 (29.6)	
Native Hawaiian or other Pacific Islander	4,308 (0.7)	3,749 (0.7)		29,968 (0.8)	26,699 (0.9)	
White	437,674 (69.8)	345,284 (67.8)		2,407,051 (63.6)	1,937,413 (61.8)	
Ethnicity, n (%)			0.021			0.036
Not Hispanic or Latino	574,833 (91.7)	463,393 (91.2)		3,395,850 (89.8)	2,783,474 (88.7)	
VA priority group, n (%)			0.073			0.09
1 and 4: high disability	289,712 (46.2)	242,313 (47.6)		1,855,833 (49.1)	1,637,210 (52.2)	
2, 3, and 6: low/ moderate disability	107,612 (17.2)	89,556 (17.6)		713,188 (18.9)	571,864 (18.2)	

Percentages in table may not add to 100% due to missing values.
[a]Pre-COVID-19 periods: March 2018–February 2020; during-COVID-19 periods: March 2020 –February 2022.
[b]SMD ≤0.2 indicates variable balance between populations.
[c]VA enrollment priority group is calculated using military service history, service-connected disability, income, Medicaid qualification, and other VA benefits, and determines the amount of co-payment required.
ECSC, emergency care-sensitive condition; *ED,* Emergency Department; *SMD,* standardized mean difference; *VA,* Veterans Affairs.

Table. Continued.

	ECSC visits (n=1,136,248)			Non-ECSC visits (n=6,920,763)		
	Pre-COVID-19[a] (n= 626,801)	During COVID-19[a] (n= 509,447)	Standardized mean difference for ECSC visits[b]	Pre-COVID-19[a] (n=3,783,322)	During COVID-19[a] (n=3,137,441)	Standardized mean difference for non-ECSC visits[b]
5: Low income	169,001 (27.0)	122,410 (24.0)		852,578 (22.5)	602,678 (19.2)	
7-8: non-disabled; copayment required	60,445 (9.6)	55,164 (10.8)		361,540 (9.6)	325,638 (10.4)	
VA ED driving distance miles, n (%)			0.068			0.06
0-10 miles	209,599 (33.5)	142,526 (35.5)		1,240,286 (32.8)	843,541 (34.3)	
10-20 miles	148,020 (23.6)	96,521 (24.0)		935,931 (24.8)	620,026 (25.2)	
20-30 miles	80,262 (12.8)	51,833 (12.9)		512,430 (13.6)	340,367 (13.8)	
30-40 miles	51,555 (8.2)	33,063 (8.2)		315,869 (8.4)	206,196 (8.4)	
40-50 miles	33,665 (5.4)	20,097 (5.0)		190,582 (5.0)	117,478 (4.8)	
50-60 miles	24,704 (3.9)	14,798 (3.7)		137,017 (3.6)	81,496 (3.3)	
>60 miles	78,074 (12.5)	42,727 (10.6)		444,804 (11.8)	250,040 (10.2)	
Residential location, n (%)			0.051			0.046
Urban	458,149 (73.1)	381,260 (74.8)		2,920,960 (77.2)	2,471,039 (78.8)	
Rural	154,794 (24.7)	115,813 (22.7)		796,698 (21.1)	607,019 (19.3)	
Highly rural	13,240 (2.1)	12,103 (2.4)		61,807 (1.6)	57,281 (1.8)	
Unhoused, n (%)	72,501 (11.6)	56,116 (11.0)	0.017	520,066 (13.7)	398,953 (12.7)	0.03
Marital status, n (%)			0.021			0.03
Married	270,820 (43.2)	221,374 (43.5)		1,552,476 (41.0)	1,281,284 (40.8)	
Not married	353,368 (56.4)	285,172 (56.0)		2,212,396 (58.5)	1,833,501 (58.4)	
Elixhauser Comorbidity Index score, mean (SD)	6.33 (3.42)	6.23 (3.34)	0.028	3.97 (3.18)	3.76 (3.00)	0.066
Elixhauser Comorbidity Index score, n (%)			0.02			0.039
0	8,830 (1.4)	8,319 (1.6)		384,238 (10.2)	339,031 (10.8)	
1	27,379 (4.4)	22,204 (4.4)		509,529 (13.5)	444,595 (14.2)	
2	44,142 (7.0)	36,932 (7.2)		570,993 (15.1)	489,461 (15.6)	
≥3	546,450 (87.2)	441,992 (86.8)		2,318,562 (61.3)	1,864,354 (59.4)	

Percentages in table may not add to 100% due to missing values.
[a]Pre-COVID-19 periods: March 2018–February 2020; during-COVID-19 periods: March 2020 –February 2022.
[b]SMD ≤0.2 indicates variable balance between populations.
[c]VA enrollment priority group is calculated using military service history, service-connected disability, income, Medicaid qualification, and other VA benefits, and determines the amount of co-payment required.
ECSC, emergency care-sensitive Condition; *ED,* Emergency Department; *SMD,* standardized mean difference; *VA,* Veterans Affairs.

Both ECSC and non-ECSC visits counts decreased throughout all eight quarters during COVID-19 compared to their pre-COVID-19 equivalent quarters (Figure); total visit count trends are presented in the Supplemental Materials. Of note, there was a steady increase in the total number of VA ED visits in the four years preceding the COVID-19 pandemic,

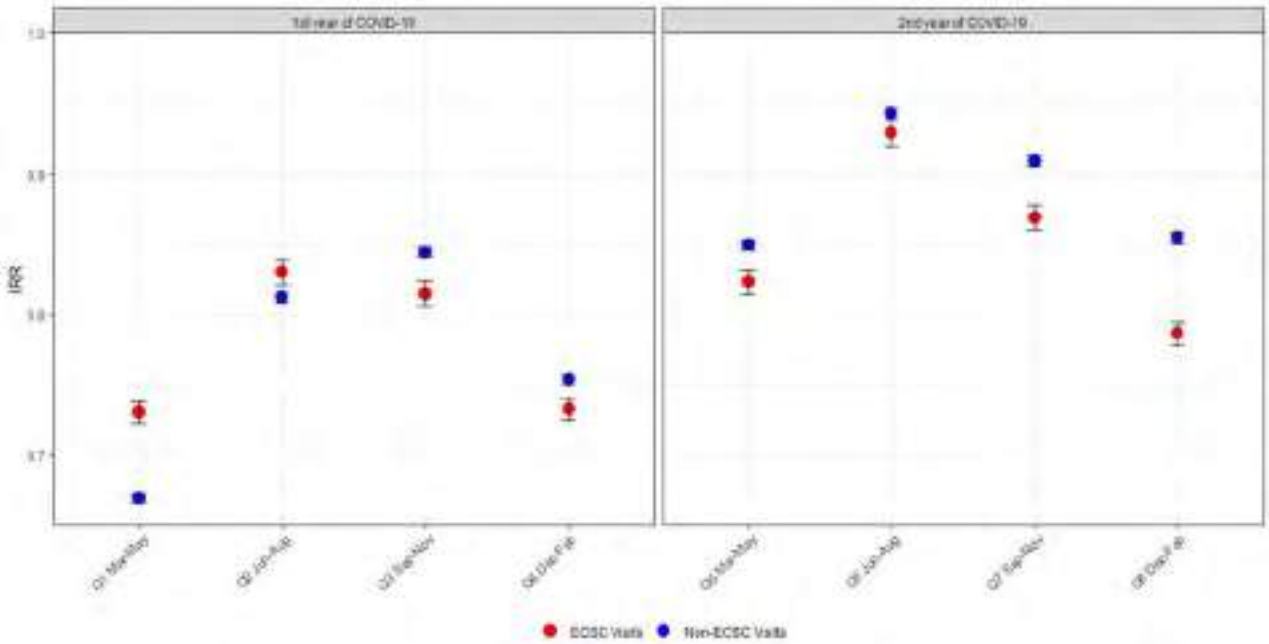

Figure. Incident rate ratios and 95% confidence intervals of emergency department visits during COVID-19 compared to pre-pandemic years by quarter.
Ratio rates <1.0 indicate fewer ED visits in the COVID-19 quarter.
ECSC, emergency care-sensitive condition; *IRR,* incident rate ratio.

with counts as follows: FY 2016–2,105,766; FY 2017–2,137,716; FY 2018– 2,209,497; and FY 2019– 2,215,048. This trend further underscores the subsequent changes in ED visit counts during the COVID-19 pandemic period.

In the first quarter of the pandemic, non-ECSC visits had a greater decrease than ECSC visits. When comparing March-May 2020 (Quarter 1) to the pre-pandemic baseline quarters of March-May 2018 and 2019, non-ECSCs were 33.0% lower (IRR 0.67, 95% CI 0.67-0.67) and ECSCs were 26.9% lower (IRR 0.73, 95% CI 0.72-0.74). This gap narrowed in June-August 2020 (Q2); non-ECSCs were 18.8% lower (IRR 0.81, 95% CI 0.81-0.82), and ECSCs were 17% lower (IRR 0.83, 95% CI 0.82-0.84) when compared to their pre-pandemic baseline visit counts in June-August 2018 and 2019. After that, ECSC visits had a greater relative decrease than non-ECSC visits in each of the six following quarters (covering September 2020–February 2022) when compared to their pre-pandemic baseline.

As expected, the greatest decreases in both ECSC and non-ECSC visits were from March-May 2020 (Q1), although ECSC visits had a similar decrease of -26.7% (IRR 0.73, 95% CI 0.73-0.74) between December 2020-Feb 2021 (Q4). Both ECSC and non-ECSC visits returned closest to their pre-pandemic baseline in June-August 2021 (Q6), with a -7% change in ECSC visits (IRR 0.93, 95% CI 0.92-0.94) and a -5.7% change in non-ECSC visits (IRR 0.94, 95% CI 0.94-0.95). Both ECSCs and non-ECSCs again then declined further from their pre-pandemic baselines in the subsequent two quarters from September 2021–February 2022 (Q7-Q8).

DISCUSSION

Examining two years of ED visits during the COVID-19 pandemic in the VHA, we demonstrate that as of 2022, neither emergent nor non-emergent ED visits returned to their pre-pandemic baselines. Beyond the initial six months of the pandemic, emergent visit rates were still lower compared to non-emergent visits. Our results are consistent with a previous study through August 2022, demonstrating that ED visits did not fully recover in the second year of the pandemic compared to pre-pandemic years (while ED crowding increased), and similarly show fluctuations with peak decreases in visits during winter seasons.[18] However, our results suggest different trends in emergent ED visits in the second year of the pandemic.

Oskvarek et al examined trends in illness severity based on Emergency Severity Index (ESI) level and critical care billing, but they did this at a yearly level, demonstrating an overall increased proportion of ED visits for ESI levels 1 and 2 in 2022 (18.9%) vs 2019 (17.9%). In our study, we characterized severity based on emergency care sensitive diagnoses and conversely demonstrated that emergent visit rates have decreased even more than non-emergent visits. This difference in results may be due to the approach to characterizing emergent vs non-emergent visits. An approach based on final ED visit discharge diagnoses may better capture the broader continuum of emergent ED services compared to an initial triage-based assessment. Additionally, we elected to exclude ED visits specifically for COVID-19 in our analysis to better understand how COVID-19-

driven changes in outpatient care impacted routine "non-COVID-19" ED care, which may have accounted for more "high-acuity" visits in their study.

Overall, these findings demonstrating even greater sustained decreases in emergent over non-emergent ED visits are notable. Considering the impact of increased use of telehealth for outpatient care,[3] we might have expected a relatively greater decrease in non-emergent ED visits, as these may be more amenable to virtual care. However, veterans' access to and acceptability of telehealth varies,[19] and more work is needed to understand whether both ECSC and non-ECSC visits have similarly shifted to telehealth or are being forgone altogether, as well as subsequent clinical impact. Additionally, while increased use of community care EDs would also have contributed to the general decrease in ED visits, the specific impact of this shift on these emergent and non-emergent categories is unknown, and an important direction for future work.[20] Understanding these trends is vital for assessing the potential implications on health system capacity and use of alternative sites of care.

LIMITATIONS

We recognize that this study has several limitations. First, it is focused on a population of US military veterans, which may limit generalizability to other systems. This study did not include non-VA-delivered ED visits made by veterans and paid for by Medicare or other insurance, which may have affected the observed changes observed during COVID-19 and limit generalizability to veterans who sought ED care outside the VA system. Additionally, use of ECSCs as a method to define emergent ED visits is based on administrative data and, thus, is limited in its ability to fully capture clinical severity. The use of ICD-10 codes to define excluded COVID-19 visits also poses a risk of including visits for viral illnesses that were in fact COVID-19, potentially leading to an undercount of ED visits not directly attributed to COVID-19. However, we selected this approach to ensure that we did not exclude other viral respiratory conditions. Finally, as this was an administrative study, we were limited in our ability to suggest causal reasons for declines in either emergent or non-emergent ED visits. Nevertheless, this work provides valuable insights and can suggest directions for further investigation.

CONCLUSION

While COVID-19 is no longer deemed a public health emergency, it remains imperative to assess whether the recurring pattern of reduced ED visits observed during the second year of the pandemic persists. These changes in care-seeking behavior may be due to subsequent infection waves, as well as more persistent changes in healthcare delivery and health systems outside the ED setting.

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Relationship of Tijuana River Flow and Ocean Bacteria Counts and Emergency Department Diarrhea Cases

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Introduction: The Tijuana River, which affects southern San Diego Beaches, is severely contaminated with untreated sewage. Exposure to pathogens can lead to various health problems, commonly gastrointestinal (GI) illnesses. We aimed to look for any relationship between Tijuana River flow rates and ocean pollution levels and levels of diarrhea at a nearby Emergency Department (ED).

Methods: In this retrospective study that spanned the 2023 dry season and included Hurricane Hillary, we compared Tijuana River flow rates and fecal bacterial counts on the southern San Diego County coastline to the number of visits to a nearby ED, specifically a 225-patient sample size, with the chief complaint of diarrhea, a potential waterborne illness.

Results: In late August of 2023, after Hurricane Hillary made landfall as a tropical storm in Baja California, Mexico, there was a large increase in the Tijuana River flow rate and a correspondingly significant increase in diarrhea cases at 3.25 times the mean, from a mean of 4.25 cases per week to 14 cases the week of Hurricane Hillary.

Conclusion: We found a significant correlation between Tijuana River transboundary flow rates and Emergency Department case levels of diarrhea, a known waterborne illness, in the summer of 2023. [West J Emerg Med. 2025;26(4)876–879.]

INTRODUCTION

Imperial Beach, a coastal community in southern San Diego County, CA, is five miles north of the Mexican border. Imperial Beach has had its coastal waters closed to the public for more than 1,000 consecutive days since 2022 related to high levels of cross-border sewage contamination. Inadequate sewage treatment facilities with aging infrastructure to support the growing population in the city of Tijuana, Mexico, have allowed sewage, agricultural, and urban runoff to pollute the Tijuana River Valley, These contaminants ultimately discharge into the Pacific Ocean and are carried toward Imperial Beach and as far north as Coronado, nine miles from Imperial Beach. The San Diego Department of Environmental Health and Quality tests the ocean water off Imperial Beach daily and publishes the results on www.waterboards.ca.gov. The water is tested for fecal indicator bacteria (FIB) such as *Escherichia coli* and *Enterococcus*.

The Tijuana River is contaminated with sewage, industrial waste, and urban runoff. It is has been identified as an impaired water body, per the US Clean Water Act, and a public health threat with health implications.[1,2,3,4,5,6] The presence of FIB and, correspondingly, its concentration is indicative of more virulent bacteria and viruses being present in both the seawater and sea spray aerosol.[7,8,9] Exposure to these pathogens can lead to various health problems, commonly gastrointestinal illness including enterovirus and norovirus, as well as respiratory, eye, ear and skin problems, that prompt medical visits.[10,11,12] It is estimated that 7.15 million waterborne illnesses occur

annually in the United States.[13] Even sand from contaminated beaches may be a route of exposure.[14] In this study we aimed to investigate Tijuana River flow rates and FIB levels in the ocean off southern San Diego County and any correlation with the frequency of potential waterborne-related healthcare visits to the emergency department (ED), specifically for diarrheal illnesses.

METHODS

We looked for a correlation between Tijuana River flow rates and FIB levels on the Imperial Beach coastline by obtaining the river flow rates and FIB levels from waterdata.ibwc.gov and waterboards.ca.gov. We also obtained visit data on the number of patients seen for a chief complaint of diarrhea in US ZIP codes 92118, 91932 ,and 92154 (Coronado, San Ysidro, and Imperial Beach) using Epic Slicer Dicer, a data analysis tool in the electronic health record system (Epic Systems Corporation, Verona, WI). We looked for a temporal correlation between visit numbers and Tijuana River flow-rate volume and FIB levels at Imperial Beach in 2023. This was a retrospective population study, and all data analyzed is free of any patient identifiers.

RESULTS

In 2023 we correlated residential ZIP codes 92118, 91932, and 92154 with patient healthcare visits to an ED in the neighboring city of Chula Vista. We found 225 patients who were seen for chief complaints of diarrhea over 52 weeks. The mean was 4.3 patients per week. There was a spike in diarrhea cases seen from August 20–26, 2023 to 14 cases, 3.25 times the mean. This was the week that Hurricane Hilary made landfall as a tropical storm in Baja California bringing torrential rain and causing much higher volumes of Tijuana River flow at 354.8 million gallons average daily transboundary flow. (The yearly weekly average for 2023 was 118 million gallons; summer season 36.5 million gallons).

Data is limited with regard to FIB levels as the county does not tend to test on days that they know the counts will be higher based on rainfall levels. For example, two days after Tropical Storm Hilary, Silver Strand State Beach total coliforms reached >16,000 copies/100 milliliters (mL). Imperial Beach did not have any levels reported that week, but the beach remained closed. Coronado Beach 8.9 miles to the north went from 916 copies/100mL to 32,094 copies from August 16 to August 24. The highest flow rate days between were not tested.

We focused our analysis on the summer months when ocean activity is higher and the risk of exposure to waterborne illnesses increases. Specifically, we examined the drier period from June 4–November 18, 2023. By correlating the daily average transboundary flow of the Tijuana River with patient encounters reporting diarrhea as the chief complaint, we identified a strong correlation, with a Pearson coefficient of .75. (See Figures 1A and 1B).

Population Health Research Capsule

What do we already know about this issue?
The Tijuana River and nearby ocean is contaminated with sewage; exposure to sewage pathogens can lead to health problems, commonly gastrointestinal illnesses.

What was the research question?
Is there a correlation between Tijuana River flow/ocean pollution levels and cases of diarrhea in the local population?

What was the major finding of the study?
We found a Pearson correlation coefficient of .75 between transboundary Tijuana River flow and diarrhea cases at a local ED in the summer of 2023.

How does this improve population health?
Increased awareness of the risks of polluted ocean water would help protect residents in coastal southern San Diego County communities.

DISCUSSION

Looking at both FIB and Tijuana River flow rates, the data on FIB levels provided on waterboard.ca.gov is incomplete. Although we did not evaluate for a definitive correlation between transboundary flow rate and FIB levels, there is an obvious trend when looking at the data. The Tijuana River flow rate is more useful as a daily indicator of possible water contamination levels, as it is reported every day. Looking at summer dates in 2023, we noted a spike in the number of ED visits with a chief complaint of diarrhea in patients with residential South Bay ZIP codes the week of August 20, 2023, which corresponded with a dramatic spike in the transboundary river flow. The Pearson correlation coefficient of .75 is strong. Diarrhea cases increased by 325% from mean summer levels. We hope increased awareness of the dangers of polluted ocean water will help protect residents in the coastal southern San Diego County communities.

LIMITATIONS

Limitations of this study include the fact that many people who get ill from the water do not seek medical attention. Another limitation is that winter dates with high flow rate and more frequent rains do not correlate with levels of waterborne illness and diarrhea, as most people do not go into the water in colder months. We found no correlation between flow rates, FIB levels and diarrhea in winter

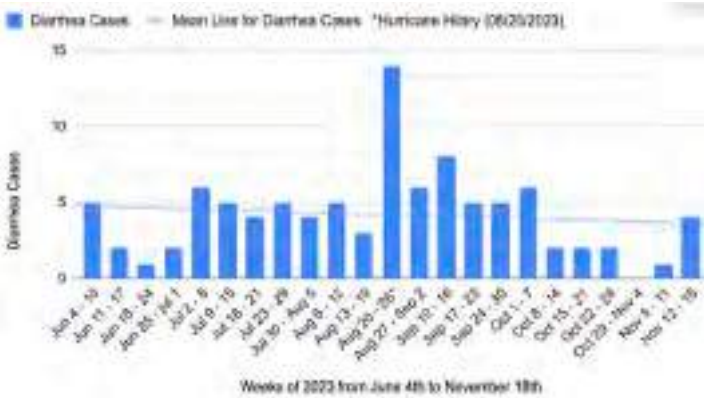

Figure 1A. Emergency department cases for chief complaint of diarrhea from June 4–November 18, 2023.

months, or when looking at 2021 and 2022. Our finding may be a unique event in August 2023 coinciding with a tropical storm. Another limitation is we do not know whether the patients had ocean exposure.

Future studies could include a prospective survey following an ocean-user population, to track levels of illness and compare against transboundary flow rates and/or FIB. Again, we found FIB levels to be a less reliable indicator, as it is not updated or checked every day. It tends to not be measured on days when the levels are predicted to be high, possibly to ensure the safety of testers. However, on those days we did find that the beaches were closed without levels checked. A final limitation to this study is that the patient data abstractor was not blinded to our hypothesis.

CONCLUSION

We found a correlation between Tijuana River transboundary flow rates and an increased number of visits to the ED with a chief complaint of diarrhea, a known waterborne illness, in southern San Diego County in the summer of 2023, with a peak number of cases reported the week that Tropical Storm Hilary made landfall in the Mexican state of Baja California.

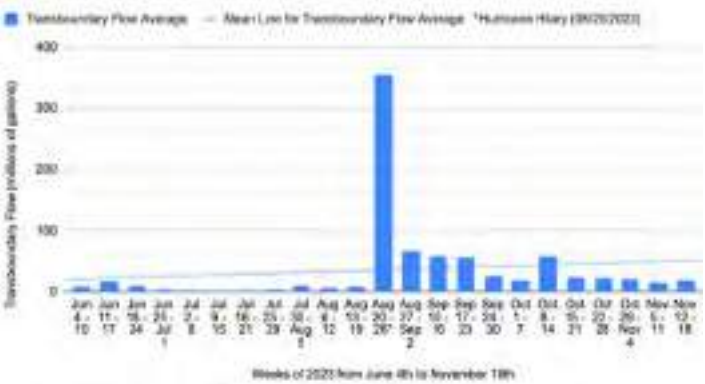

Figure 1B. Tijuana River flow average at US-Mexico border in millions of gallons of water per day from June 4–November 18, 2023.

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Sepsis Presentation, Interventions, and Outcome Differences Among Men and Women in the Emergency Department

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Objectives: Sepsis is a common presentation to the emergency department (ED) and represents a life-threatening syndrome with high mortality rates. The existing literature has conflicting findings regarding outcomes between sexes. Our goal in this study was to investigate the clinical presentation, interventions, and outcomes based on sex for sepsis in the ED.

Methods: We conducted a retrospective cohort study to identify patients presenting with sepsis to the ED. We employed the Global Collaborative Network from 119 international healthcare organizations in the TriNetX Research Network. Sepsis was defined according to *International Classification of Diseases*, *10th Rev*, codes. To evaluate sex differences in sepsis presentation, we collected data on age, comorbidities, sex, vital signs, laboratory values, medications, intensive care unit (ICU) admission, mechanical ventilation, and mortality at 30 days, 90 days, and one year. We used a 1:1 propensity score matching by age, race, comorbidities, and infection source to identify and balance potential risk factors across the study groups to investigate mortality, interventions, and intensive care unit admission trends. Data abstraction and analysis were conducted in the TriNetX platform.

Results: In total, 920,160 patients were included in this study. The most common infection source for both females and males was respiratory, accounting for 40% and 46.2% of sepsis cases, respectively. After adjusting for urinary tract infection as an infection source, females were less likely to receive piperacillin-tazobactam (21% vs 23.6%; odds ratio [OR] 0.76; 95% confidence interval [CI] 0.75 - 0.77), vancomycin (32.9% vs 36%; OR, 0.87; 95% CI 0.86 - 0.88), and vasopressors (16.5% vs 17.6%; OR, 0.92; 95% CI 0.91 - 0.93). Females had a lower all-cause mortality at 30 days (12.1% vs 13%; OR 0.91; 95% CI 0.90 - 0.92), 90 days (17.1% vs 18.7%; OR 0.91; 95% CI 0.90 - 0.92), and one year (21.5% vs 23.3%; OR 0.90; 95% CI 0.89 - 0.91).

Conclusion: Females demonstrated 10% lower odds of mortality from sepsis at 30 days, 90 days, and one year (absolute difference: 0.9%, 1.6%, 1.8%, respectively). Females were less likely to receive vasopressors, vancomycin, or piperacillin-tazobactam, even after accounting for urinary tract infection as the sepsis source. [West J Emerg Med. 2025;26(4)880–887.]

INTRODUCTION

Sepsis is a common presentation to the emergency department (ED) that if not promptly recognized and treated can lead to severe end-organ damage, coma, and death. Despite decades of research efforts, mortality from sepsis remains high, with one meta-analysis on European, North American, and Australian patients reporting an average 30-day mortality of 24.4%.[1] Although the causes of sepsis are multifactorial, one proposed area of research for furthering understanding and treatment of sepsis is differences related to sex. Worldwide, there has been a growing understanding of the necessity for research—from basic science to clinical studies—to collect, stratify, and analyze data based on sex. This is an essential area of research, as females have been historically under-represented

in clinical trials, and sex-dependent differences affecting disease pathogenesis, outcomes, and response to treatment have been consistently reported.[2]

Men and women have been reported to have different immune responses to infections, likely due to genetic, hormonal, epigenetic, and environmental factors.[3] The exact mechanism by which sex differences affect the initial clinical presentation and outcomes of sepsis in the ED has yet to be fully elucidated. There are conflicting reports in the literature, with some studies finding no difference[4,5] and others showing higher mortality in women,[6] while yet others found higher mortality in men.[7] A meta-analysis of >25,000 pooled patients found females had a slightly higher mortality than males, although two of the largest cohorts included in the analysis reported opposing findings, rendering the overall meta-analysis inconclusive.[8–10] A large retrospective study in Australia reported that among older adults, males had significantly higher sepsis mortality, intensive care unit (ICU) admission, and hospital readmission.[11,12] Most of these studies have been limited to patients in the ICU, with fewer studies looking at the role of sex in the initial presentation to the ED.[13,14]

Several studies have demonstrated that female patients experience delays in receiving antibiotics, a critical component of sepsis management. Retrospective cohort analyses found that women presenting with sepsis or septic shock had significantly longer median time-to-antibiotics compared to men, even after adjusting for confounding factors such as infection source and severity scores.[15,16] These delays likely contribute to clinical deterioration, potentially negating any physiological advantages associated with female immune responses. Furthermore, treatment disparities extend beyond antibiotic administration. For instance, systematic reviews and observational studies highlight that females are less likely to receive aggressive resuscitation with fluids, timely vasopressor therapy, or organ support despite similar or worse sepsis severity.[17,18]

Beyond treatment delays, differences in clinical presentation between sexes may contribute to diagnostic challenges. Studies have identified that female sepsis patients often exhibit atypical symptoms such as fatigue or altered mental status rather than classic indicators such as fever and tachycardia, more commonly seen in males.[17,19] This variation in symptomatology may lead to under-recognition, delays in triage prioritization, and altered clinical decision-making. Early detection and initiation of treatment for sepsis is critical for improving patient outcomes and decreasing mortality.

Given these discrepancies, we recognized a need to further investigate sex differences among the initial patient presentation to the ED of the septic patient. In this study we aimed to address these gaps in the literature through a retrospective cohort study using a multicenter research network investigating the association between patient sex and clinical presentation with clinical outcomes.

Population Health Research Capsule

What do we already know about this issue?
Sepsis is a frequently encountered condition in the ED with high mortality. Existing literature presents conflicting evidence regarding outcome differences between sexes.

What was the research question?
Are there differences based on sex on the clinical presentation, interventions, and outcomes of sepsis in the ED?

What was the major finding of the study?
Females had lower mortality at 30- (12.1% vs 13%; OR 0.91; 95% CI 0.90-0.92), and 90 days (17.1% vs 18.7%; OR 0.91; 95% CI 0.90-0.92), and at one year (21.5% vs 23.3%; OR 0.90; 95% CI 0.89-0.91).

How does this improve population health?
Recognizing sex-based differences in sepsis interventions and outcomes may guide more equitable treatment strategies and improve survival rates across populations.

METHODS

Study Design and Data Source

We conducted a large, retrospective, cohort study to identify patients presenting with sepsis to the ED. We employed the Global Collaborative Network from 119 healthcare organizations (HCO) in the TriNetX Research Network. TriNetX is a federated research network encompassing over 100 HCOs across the world. It facilitates real-time access to healthcare records, featuring de-identified data from more than 250 million patients across various HCOs. The data is sourced directly from the electronic health record management systems (EHR) of participating organizations, which range from large academic centers providing tertiary care to satellite outpatient office locations.

Clinical variables are derived from clinical documents using a built-in natural language processing system, ensuring that robust quality assurance procedures are implemented prior to inclusion in the database. TriNetX safeguards patient privacy by offering only aggregate counts and statistical summaries, maintaining de-identification of data throughout the retrieval and dissemination processes.

Study Definitions, Variables, and Outcomes

The available data included information about the demographics, diagnoses (based on the *International Classification of Diseases, 10th Rev, Clinical Modification*, [ICD-10-CM] codes and procedures coded in the ICD-10

Procedure Coding System or Current Procedural Terminology); medications coded in the Veterans Affairs National Formulary; laboratory tests coded in Logical Observation Identifiers Names and Codes and healthcare utilization. Sepsis was defined according to the ICD-10-CM diagnosis code. Any adult (18 years of age) who presented to and was diagnosed with sepsis in the ED in the Global Collaborative Network from the HCOs within the TriNetX system were included. We excluded minors and pregnant patients from the study.

To evaluate sex differences in the sepsis presentation, we collected the following variables: age; sex; vital signs; white blood count; lactate; hemoglobin; platelets; ICU admission; antibiotics use; intravenous fluids, mechanical ventilation; infection source; and 30-day, 90-day, and one-year mortality. Intervention data, such as the administered medication, was collected if the medication was given within 24 hours of the patient's presentation to the ED.

Statistical Analysis

The TriNetX platform uses input matrices containing user-identified covariates and employs logistic regression analysis to derive propensity scores for individual subjects. Subsequently, 1:1 matching is conducted based on these propensity scores, using greedy nearest neighbor algorithms with a caliper width of 0.1 pooled standard deviations. To mitigate bias resulting from these algorithms, TriNetX randomizes the order of rows. Through this process, individuals with similar propensities, and hence similar comorbidity profiles, were matched, minimizing potential confounding effects and allowing for a more balanced comparison between male and female cohorts in terms of their comorbidities and other potential confounders. This study method has been previously validated.[12,20–22] Missing data in the TriNetX network was addressed using median imputation, where the median value of the specific variable was used to replace missing entries.

This study followed several elements of an optimal retrospective chart review, as detailed by Worster and Bledsoe.[23] We designed the study methodology to ensure rigor and consistency. Data collection was conducted using the TriNetX platform, which automates extraction from EHRs through natural language processing. Consequently, we did not use manual abstractors, eliminating the need for abstractor training, data abstraction forms, performance monitoring, or interobserver reliability testing. Inclusion and exclusion criteria for sepsis cases were clearly defined based on ICD-10-CM codes, and key variables, such as demographics, vital signs, laboratory values, interventions, and outcomes, were precisely described. The TriNetX platform employs robust data quality-assurance procedures, ensuring consistent and reliable data across all participating HCOs. Because the dataset was de-identified and retrospective, the risk of abstractor bias was inherently mitigated. We included in the analysis all patients meeting the inclusion criteria, ensuring comprehensive sampling. Missing data were managed using median imputation for the specific variables, maintaining dataset integrity.

RESULTS

Study Population

In total, 1,003,928 patients were included in this study: 47.4% females, and 52.6% males (Table 1). Most patients in both cohorts were White. Males and females who presented to the ED with sepsis had similar rates of diabetes, cerebrovascular disease, liver disease, peptic ulcer disease, chronic obstructive pulmonary disease, heart failure, peripheral vascular disease, cerebrovascular disease, and neoplasms. A significantly greater proportion of males presented with a history of ischemic cardiac disease compared to their female counterparts (26.6% vs 20.9%; $P < .0001$). Males also presented with a significantly greater proportion of chronic kidney disease compared to females (20.1% vs 18.2%; $P < .0001$). In both cohorts, a history of neoplasms and diabetes were the two most common comorbidities.

Clinical Presentation

All the covariates used for matching in the two groups were similar after propensity score matching (mean standard difference <0.1) (Table 1). Males and females with sepsis presented to the ED with similar initial vital signs (Table 2). While there was a statistically significant difference between systolic blood pressure, diastolic blood pressure, respiratory rate, and heart rate, these differences were probably not clinically remarkable. Notably, a significantly greater proportion of males (39.1% vs 36.4%) presented with a fever >100°F compared to females ($P < .0001$). Males and females had a similar degree of leukocytosis, with females presenting with significantly greater platelet count than men ($P < .0001$). Females also demonstrated significantly lower lactate levels compared to men ($P < .0001$).

Clinical Interventions

Among both males and females, penicillin was the most commonly administered antibiotic within 24 hours of presentation to the ED (Table 2). Females were less likely to receive vasopressors (OR 0.87; 95% CI 0.86 - 0.89), beta-lactamase inhibitors (OR 0.84; 95% CI, 0.83 - 0.85), first-generation cephalosporins (OR 0.84; 95% CI, 0.83 - 0.86), fourth-generation cephalosporins (OR 0.95; 95% CI, 0.94 - 0.96), clindamycin (OR 0.91; 95% CI, 0.89 - 0.93), macrolides (OR 0.92; 95% CI 0.91 - 0.93), sulfonamides (OR 0.92; 95% CI 0.91 - 0.94), and vancomycin (OR 0.85; 95% CI 0.84 - 0.86). Females were more likely to receive second-generation cephalosporins (OR 1.29; 95% CI 1.24 - 1.34), third-generation cephalosporins (OR 1.06; 95% CI 1.05 - 1.07), quinolones (OR 1.17; 95% CI 1.16 - 1.19), metronidazole (OR 1.12; 95% CI 1.10 - 1.14), and carbapenems (OR 1.14; 95% CI 1.11-1.16).

Table 1. Characteristics of men and women who present to the emergency department with sepsis.

	Before matching			After matching		
	Females–n (%) n = 475,812	Males–n(%) n = 528,116	SD	Females–n (%) n = 460,080	Males–n(%) n = 460,080	SD
Demographics						
Age at Index (years)	60.5± 21.3	60.4 ± 19.7	0.004	60.1± 21.4	60.3 ± 20.7	0.011
Race						
White	301,623 (63.7)	340,824 (64.9)	0.024	282,524 (63.5)	291,401 (65.1)	0.032
Black	71,731 (15.2)	73,032 (13.9)	0.036	68,133 (15.2)	60,248 (13.5)	0.05
Other	52,988 (11.2)	57,497 (10.9)	0.008	50,856 (11.4)	50,204 (11.2)	0.005
Comorbidities						
Neoplasms	151,338 (32.2)	161,917 (30.8)	0.02	137,654 (30.7)	141,705 (31.6)	0.02
Diabetes	136,938 (28.0)	155,305 (28.7)	0.015	126,293 (27.3)	128,126 (27.1)	0.009
Ischemic cardiac disease	101,981 (20.9)	144,009 (26.6)	0.14	92,760 (20.1)	111,001 (24.0)	0.09
Chronic kidney disease	89,083 (18.2)	108,854 (20.1)	0.048	82,027 (17.7)	83,769 (18.1)	0.010
Heart failure	86,413 (17.7)	98,893 (18.3)	0.015	75,066 (16.2)	75,331 (16.3)	0.002
Peripheral vascular disease	36,014 (7.4)	45,498 (8.4)	0.04	31,720 (6.9)	31,390 (6.8)	0.0003
Cerebrovascular disease	33,741 (6.9)	37,124 (6.9)	0.0018	30,242 (6.5)	30,453 (6.6)	0.0018
Liver disease	15,301 (3.1)	17,908 (3.3)	0.01	13,830 (3.0)	14,210 (3.1)	0.0005
Peptic ulcer disease	8,116 (1.7)	7,878 (1.5)	0.017	6,714 (1.5)	6,765 (1.5)	0.0001
Chronic obstructive pulmonary disease	71,177 (14.6)	76,037 (14.0)	0.015	62,540 (13.5)	63,550 (13.7)	0.006

Categorical variables are given in total number of patients and valid percentages (%). Continuous variables are depicted as mean ± SD.

Ceftriaxone and piperacillin-tazobactam are two commonly prescribed antibiotics used in the sepsis treatment pathway. Females were less likely to receive piperacillin-tazobactam (OR 0.85; 95% CI 0.84 - 0.86) than males who presented to the ED. However, females were more likely to receive ceftriaxone (OR 1.23; 95% CI 1.22 - 1.24) than males.

Clinical Outcomes

We used propensity score matching to establish comparable cohorts with respect to morbidities between male and females. The most common infection source for both females and males was respiratory, accounting for 40% and 46.2% of sepsis cases, respectively (Table 3). A urinary infection source was found in 29.7% of females and 18.7% of males. A urinary infection source was more common in females (OR [odds ratio] 1.73; 95% confidence interval [CI] 1.71 - 1.75), whereas respiratory, abdominal, and skin and soft tissue infection sources were more common in males (Table 3). Approximately two-thirds of both cohorts were admitted to the hospital. Septic shock occurred in 15.2% of females and 15.6% of males. The all-cause mortality rate at 90 days was 17.1% for females and 18.7% for males (Figure). Females had a lower all-cause mortality rate at 30 days (OR 0.91; 95% CI 0.90 - 0.92); 90 days (OR 0.91; 95% CI 0.90 - 0.92); and one year (OR 0.90; 95% CI 0.89 - 0.91). Females were also less likely to require ICU admission within 30 days (OR 0.85; 95% CI 0.84 - 0.86) or mechanical ventilation (OR 0.76; 95% CI 0.75 - 0.77).

We found that urinary infection sources were more common in females than males, and previous studies have shown urinary tract infections (UTI) have better clinical outcomes and reduced mortality compared to other infection sources.[24] We performed a secondary analysis in which UTIs were included in the 1:1 propensity score matching to account for this potential confounder (Supplemental Table 1). Females were still less likely to receive piperacillin-tazobactam (OR 0.76; 95% CI 0.75 - 0.77), vancomycin (OR 0.87; 95% CI 0.86 - 0.88), and vasopressors (OR 0.92; 95% CI 0.91 - 0.93). Females also had a lower all-cause mortality at 30 days (OR 0.94; 95% CI 0.93 - 0.95); 90 days (OR, 0.95; 95% CI 0.94 - 0.96); and one year (OR 0.93; 95% CI 0.92 - 0.94).

DISCUSSION

This multicenter, retrospective, cohort study is one of the largest studies investigating the ED clinical presentation and outcomes of sepsis based on sex. We report several differences in initial presentation and outcome of sepsis between the sexes. Males were more likely to have chronic kidney disease or ischemic heart disease than their female counterparts, but otherwise the two cohorts had similar rates of comorbidities. Males also had a higher frequency of fever, similar to what was reported in other published studies.[14] While the differences between the presenting heart rate, systolic blood pressure, diastolic blood pressure, and respiratory rates were statistically significantly between the sexes, the differences were not clinically remarkable. Females tended to have a greater platelet

Table 2. Clinical presentation and interventions performed in the emergency department stratified by sex.

Characteristic	Females–n (%) N = 460,080	Males–n(%) N = 460,080	OR	95% CI	*P*-value
ED Presentation					
Fever > 100°F	183,959 (36.4)	218,089 (39.1)	—	—	<.0001
SBP (mmHg)	106.6 ± 23.9	108.2 ± 23.9	—	—	<.0001
DBP (mmHg)	59.0 ± 13.7	61.7 ± 13.8	—	—	<.0001
HR (bpm)	86 ± 18.8	84.3 ± 19.2	—	—	<.0001
RR (breathes/min)	18.2 ± 3.82	18.4 ± 3.91	—	—	<.0001
Altered Mental Status	54,749(11.9)	54,289(11.8)	—	—	<.0001
Laboratory findings					
WBC / uL	17.1 ± 7.7	17.4 ± 7.9	—	—	<.0001
Platelets / uL	260 ± 116	236 ± 115	—	—	<.0001
Hemoglobin (g/dL)	11.6 ± 2.13	12.2 ± 2.5	—	—	<.0001
Lactate (mmol/L)	1.91 ± 1.81	1.99 ± 1.79	—	—	<.0001
IV fluids	369,190 (80.2)	370,071 (80.4)	0.99	0.98-1.01	.07
Vasopressors	75,000 (16.3)	84,019 (18.2)	0.87	0.86–0.89	<.0001
Antibiotics					
Penicillins	301,593 (65.5)	300,504 (65.3)	1.01	1.0–1.02	.0208
Beta-lactamase inhibitors	101,905 (22.1)	116,260 (25.2)	0.84	0.83–0.85	<.0001
Piperacillin-tazobactam	94,998 (20.6)	107,398 (23.3)	0.85	0.84–0.86	<.0001
Cephalosporins					
1st generation	22,491 (4.9)	26,414 (5.7)	0.84	0.83–0.86	<.0001
2nd generation	5,268 (1.1)	4,105 (0.9)	1.29	1.24–1.34	<.0001
3rd generation	216,323 (47.0)	460,080 (45.6)	1.06	1.05–1.07	<.0001
Ceftriaxone	140,267 (30.5)	121,087 (26.3)	1.23	1.22–1.24	<.0001
4th generation	80,110 (17.4)	83,303 (18.1)	0.95	0.94–0.96	<.0001
Quinolones	52,865 (11.5)	45,901 (9.9)	1.17	1.16–1.19	<.0001
Clindamycin	17,275 (3.8)	18,926 (4.1)	0.91	0.89–0.93	<.0001
Macrolides	57,174 (12.5)	61,462 (13.4)	0.92	0.91–0.93	<.0001
Sulfonamides	9,178 (2.0)	9,781 (2.2)	0.94	0.91–0.94	<.0001
Vancomycin	149,574 (32.5)	165,948 (36.1)	0.85	0.84–0.86	<.0001
Metronidazole	51,211 (11.1)	46,031 (10.0)	1.12	1.10–1.14	<.0001
Tetracycline	20,544 (4.5)	20,772 (4.5)	1.0	0.99–1.01	0.25
Carbapenem	23,776 (5.1)	20,997 (4.6)	1.14	1.11–1.16	<.0001

Medication administration data were collected within 24 hours of initial presentation to the ED. Propensity score matching was employed to ensure comparable distributions of comorbidities between the male and female cohorts. Categorical variables given in total number of patients and valid percentages (%). Continuous variables are depicted as mean ±SD.
OR, odds ratio; *CI,* confidence interval; *ED,* emergency department; *DBP,* diastolic blood pressure; *mmHg, millimeters of mercury* ; *HR,* heart rate; *bpm,* beats per minute; *RR,* respiration rate; SBP, systolic blood pressure; *WBC,* white blood cell count; *IV,* intravenous.

count and lower serum lactate than males, in line with the published literature.[14] Platelets play a dual role, not only participating in coagulation activation but also contributing to the acute phase response in infectious diseases and enhancing innate immune cell responses.[25] Thrombocytopenia frequently occurs in sepsis and correlates with organ failure, a reduced immune function, and a poor prognosis.[26] Females were also more likely to present with a UTI compared to males, a finding that has been reported in other studies.[4,27] Males were more likely to have a respiratory, abdominal, skin and soft tissue infection, or unknown cause as the source of their infection.

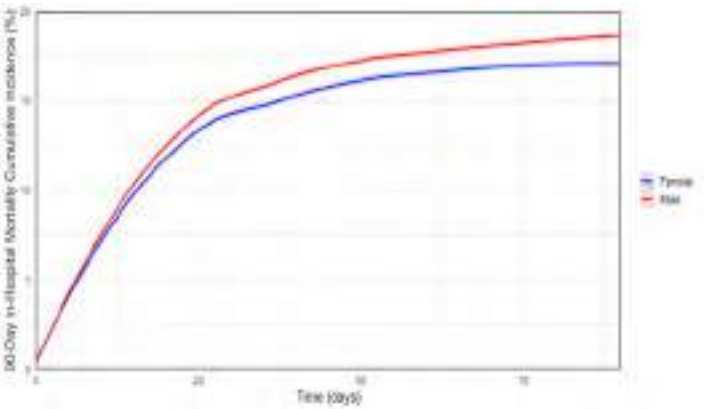
This is one of the first studies to report on medication treatment patterns in the ED for sepsis based on sex. We report that females were more likely to receive second- and third-generation cephalosporins, quinolones, metronidazole, and carbapenems compared to males. Females were less likely to receive vasopressors, beta-lactamase inhibitors, first- and fourth-generation cephalosporins, clindamycin, macrolides,

Table 3. Outcomes of sepsis patients stratified by sex.

Outcome	Females–n (%) N = 460,080	Males–n (%) N = 460,080	OR	95% CI	P-value
Mechanical ventilation	47,848 (10.4)	67,172 (14.6)	0.76	0.75 – 0.77	<.0001
ICU admission within 30 days	135,263 (29.4)	167,929 (36.5)	0.85	0.84 – 0.86	<.0001
Infection source					
Respiratory	184,032 (40.0)	212,557 (46.2)	0.86	0.85 – 0.87	<.0001
Urinary	136,643 (29.7)	86,034 (18.7)	1.73	1.71 – 1.75	<.0001
Abdominal	17,022 (3.7)	14,722 (3.2)	1.15	1.12 – 1.17	<.0001
Skin and soft tissue	47,388 (10.3)	63,491 (13.8)	0.72	0.71 – 0.73	<.0001
Unknown origin	74,993 (16.3)	83,274 (18.1)	0.74	0.73 – 0.75	<.0001
Septic shock	69,932 (15.2)	71,772 (15.6)	0.97	0.96 – 0.98	<.0001
Hospital Admission	308,253 (67.2)	311,014 (67.6)	0.98	0.97 – 0.99	<.0001
In-hospital mortality					
30-day mortality	55,670 (12.1)	59,810 (13.0)	0.91	0.90 – 0.92	<.0001
90-day mortality	78,673 (17.1)	86,034 (18.7)	0.91	0.90 – 0.92	<.0001
1-year mortality	98,917 (21.5)	107,199 (23.3)	0.90	0.89 – 0.91	<.0001

Propensity score matching was employed to ensure comparable distributions of comorbidities between the male and female cohorts. *OR,* odds ratio; *CI,* confidence interval; ICU, intensive care unit.

sulfonamides, and vancomycin. Ceftriaxone and piperacillin-tazobactam are two broad-spectrum antibiotics that are commonly prescribed to any patient suspected of sepsis. We found that females were less likely to receive piperacillin-tazobactam, but they were more likely to receive ceftriaxone. This difference likely reflects that UTIs were more commonly the infection source in females compared to males. To account for this difference, we performed a secondary analysis in which UTI was included in the propensity score matching criteria to create two balanced cohorts with approximately equal numbers of patients with UTIs. After adjusting for this potential confounder, females were still less likely to receive vasopressors, vancomycin, or piperacillin-tazobactam. Females also had a lower rate of in-hospital mortality.



score matching was used to ensure comparable distributions of comorbidities between the male and female cohorts. Ribbons depict 95% confidence interval.

We report that females had 10% lower odds of mortality at 30 days, 90 days, and one year. There are conflicting reports in the literature regarding mortality differences between males and females for sepsis. Some studies have reported that males have increased mortality,[7,28] whereas others have found that females have increased mortality,[29,30] and yet others have found no difference.[14,31] Some of these studies had smaller sample sizes and may have been underpowered to detect a mortality difference.[14] We employed propensity score matching to demonstrate that females exhibit diminished odds of ICU admission, requirement for mechanical ventilation, and mortality, thereby revealing sex-based differences in critical care outcomes.

The difference in mortality between males and females may be due to differences in sex steroid levels. Estrogens are known to influence immune functions, although the precise mechanisms remain incompletely understood. They primarily regulate innate immune function by suppressing the activation of monocyte-macrophage cells and reducing the production of inflammatory cytokines.[32] Additionally, estrogens impact neutrophil behavior, enhance dendritic cell maturation, and increase TH1 and TH17 activity.[32] Estrogens are suggested to confer a protective influence in sepsis by modulating the release of inflammatory cytokines and inhibiting tissue neutrophil infiltration, thereby mitigating organ damage.[33] Additionally, estrogen shields against sepsis-induced liver injury by modulating mitochondrial function and activating inflammatory-mediated pyroptosis signaling pathways.[34]

The strengths of this study are its multicenter design that captured a large patient sample across 119 HCOs from around the world. The large sample size powered the study to detect differences in clinical presentations and outcomes of sepsis

between the sexes. Given the global distribution of the participating HCOs in the TriNetX database, this study has good generalizability. However, there are several limitations.

LIMITATIONS

Because we used a large international database that lacked line-level data, we were unable to determine sepsis severity as determined through quick Sequential Organ Failure Assessment or severe inflammatory response syndrome criteria at the patient level. This could potentially have introduced confounding and should be further investigated in future studies. Furthermore, patient outcomes and practice patterns may differ based on location and year. Due to the lack of line-level data provided in the TriNetX network, we were unable to control for these potential confounders. Another limitation of our study was the reliance on ICD-10 codes to define sepsis, which may have potentially missed some cases due to coding inaccuracies or variations in coding practices across different healthcare settings and regions. Reliance on a sepsis diagnosis based on ICD-10 code upon discharge from the ED may have missed patients who were diagnosed with sepsis later upon their admission to the hospital. Despite these potential shortcomings, this study was among the largest to investigate clinical presentation, interventions, and outcome differences in sepsis based on sex.

CONCLUSION

In this large retrospective cohort study, we found that females with sepsis had lower mortality rates at 30 days, 90 days, and one year compared to males, despite receiving fewer vasopressors or certain broad-spectrum antibiotics like vancomycin or piperacillin-tazobactam. While these findings suggest potential sex-based differences in sepsis management and outcomes, the underlying mechanisms remain unclear. Further research is needed to explore biological, clinical, and systemic factors that may contribute to these differences and to assess how treatment disparities impact patient outcomes.

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Extended-release Injectable Buprenorphine Initiation in the Emergency Department

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Introduction: Extended-release buprenorphine (XR-BUP) is a long-acting injectable medication used for the treatment of opioid use disorder (OUD). It is currently approved for use in patients who have been administered at least seven days of sublingual buprenorphine (SL-BUP). For patients with OUD who are unstable (ie, not at treatment goal, with active opioid use) or not yet on medication for OUD (MOUD) such as SL-BUP, the emergency department (ED) setting is an essential location for access to treatment. There is, as yet, no research on the utility of on-demand XR-BUP administration in the ED.

Methods: We performed a retrospective cohort study of individuals with OUD who received XR-BUP in the ED through our novel reallocation pathway. We reviewed charts from an addiction medicine specialty outpatient clinic to determine retention in treatment, continuation on XR-BUP, and reported quantitative analysis. Our primary outcome was retention in treatment, measured by subsequent XR-BUP injection after initial ED XR-BUP administration. The secondary outcome was the reason for ED administration of XR-BUP (as opposed to administration in the clinic setting).

Results: Our study population included 69 patients (68.2% male). Our primary outcome showed that 51 (73.9%) patients who had their first injection in the ED received a second XR-BUP injection and 40 (58%) received their third XR-BUP injection. Our secondary outcome showed that 7.2% had barriers with access to treatment; however, most of the patients received the injection due to instability of the treatment of the OUD (69.6%). These patients were either unable to adhere to MOUD, reported issues with the prescription, or were still using substances while on MOUD. For 52 (75%) patients, the index ED injection was their first ever XR-BUP injection. Logistical regression analyses demonstrated that clinical and demographic factors did not lead to increased attrition, while patients with other co-occurring substance use disorders were more likely to present for follow-up treatment.

Conclusion: In our retrospective study, patients who received ED-initiated extended-release buprenorphine had a strong retention rate compared to previous studies evaluating ED-initiated sublingual BUP (retention rates ranging from 16.7-60%). The ED provided a convenient healthcare access point for XR-BUP initiation. The XR-BUP is a helpful tool for achieving induction after failed SL-BUP initiation and may have further implications in minimizing treatment gaps after discharge and improving OUD treatment retention. [West J Emerg Med. 2025;26(4)888–896.]

INTRODUCTION

Opioid use disorder (OUD) is highly prevalent in the United States, with considerable associated morbidity and mortality.[1] Buprenorphine, a high-affinity partial μ-opioid agonist, is an effective medication for OUD (MOUD) that treats opioid cravings and withdrawal. There is abundant data demonstrating buprenorphine's efficacy in reducing mortality for patients with OUD.[2-4] Extended-release buprenorphine (XR-BUP) is an injectable formulation with a duration of action of four weeks. It is currently approved by the US Food and Drug Administration as an alternative treatment option for OUD in patients who have been stable on sublingual buprenorphine (SL-BUP) for at least seven days.[5-7]

The XR-BUP is an appealing formulation for patients who desire the convenience of once-monthly administration over sublingual medications, which require 15-20 minutes of administration of a dissolvable tablet or film taken 1-4 times per day.[8] Along with the convenience of XR-BUP, like most extended-release injectable medications, it is postulated to contribute to greater medication efficacy due to increased adherence. The XR-BUP provides a more continuous, steady-state level of buprenorphine[8]; thus, it confers relative protection from overdose for a critical one-month period. The XR-BUP has been associated with improved treatment retention rates in patients in other settings.[9-12]

Despite the benefits of XR-BUP, patients who desire this medication can face multiple barriers to receiving it, including insurance coverage, cost, and access to a clinician who administers it. Compared to SL-BUP, XR-BUP is less widely available to patients, substantially more expensive, and less likely to be covered by insurance.[13] Initiating XR-BUP is often a 1-6 week process during which the medication must be ordered from a specialty pharmacy, delivered to a clinic, and then administered at a subsequent encounter.[14] This process generally precludes same-day or on-demand administration of XR-BUP; however, through a collaboration with our addiction medicine division, the emergency department (ED), our institution's inpatient pharmacy, and a New Jersey Medicaid managed care organization, we created a novel alternate pathway to make XR-BUP available for patients in our ED.[15] This reallocation process transferred unused XR-BUP from our outpatient addiction medicine clinic to the institution's inpatient pharmacy. Patients in the ED were candidates if they had a specific NJ Medicaid managed care organization.[15] Emergency clinicians were informed of this process and used the addiction medicine consult service to counsel patients and administer the medication.

Given the long duration of action of XR-BUP, this MOUD formulation is of particular value for treatment retention.[16] Several demographic, psychosocial, and comorbidity factors impact retention in OUD treatment, including age,[17] sex,[18] race,[19] housing stability,[17,19,20] insurance,[21] and use of other substances,[17] as well as comorbid psychiatric or medical issues.[20,22,23] Notably, these studies typically assessed retention in MOUD treatment with SL-BUP, but none specifically examined patients administered XR-BUP in the ED. It is critical to determine whether treatment retention on XR-BUP is related to sociodemographic and medical variables to identify and coordinate care for potentially vulnerable patients.

Population Health Research Capsule

What do we already know about this issue?
Extended-release buprenorphine (XR-BUP) is a long-acting injectable medication used for the treatment of opioid use disorder (OUD).

What was the research question?
Does use of ED-initiated XR-BUP increase retention in treatment of OUD?

What was the major finding of the study?
Retention in treatment at 60 and at 90 days was 73.9% and 57.9%, respectively.

How does this improve population health?
Administering XR-BUP in the emergency department is a possible strategy for improving outcomes for treatment of OUD.

Our aim in this retrospective cohort study was to characterize patients who received XR-BUP in the ED and identify predictors of treatment retention. Our primary outcome for measuring retention was subsequent XR-BUP injections after initial ED XR-BUP administration. Reason for ED-administration of XR-BUP was also of interest as an exploratory descriptive variable. To our knowledge, there have been no previously published studies evaluating outcomes for patients administered on-demand XR-BUP in an ED setting. We hypothesized that most patients received XR-BUP in the ED due to lack of access and/or instability of OUD. We hypothesized that once initiating XR-BUP, most patients would receive follow-up injections of XR-BUP. We further hypothesized that medical, psychiatric, and co-substance use-related comorbidities at baseline would influence likelihood of treatment retention.

METHODS

Setting

Cooper University Hospital (CUH) is a Level I trauma center and academic, tertiary referral hospital located in Camden, NJ, with 635 inpatient beds. The ED, which has over 64 beds and an annual volume of over 80,000 visits, serves as a training site for an emergency medicine residency program. The hospital has an inpatient addiction medicine consult

team and low-barrier addiction medicine outpatient specialty clinics. This study was approved by the CUH Institutional Review Board (IRB protocol #22-271).

Study Population

A total of 69 patients (68.2% male; mean age 40.16 years (SD +/- 9.66)) who received XR-BUP in the ED were included in the study. Patients were identified by an ED pharmacist as anyone who received an EX-BUP injection in the ED. Patients were included if they were ≥18 years of age, had a documented diagnosis of OUD, and received their index XR-BUP injection in the CUH ED between December 2018–December 2022. We included patients who were on buprenorphine maintenance therapy and those not on MOUD prior to index injection. There was no standard protocol for patient selection (given this was a retrospective review); however, the most common process was as follows: an emergency clinician identified a consentable patient with OUD with active use who was interested in XR-BUP (all 300 milligram (mg) doses). The emergency clinician consulted an addiction medicine specialist who, in collaboration with the ED team, counseled the patient on the risks (most often risk of precipitated withdrawal) and benefits of the medication. If the patient agreed, they received the medication. Monitoring in the ED was not required after injection. There were few instances where emergency clinicians administered the XR-BUP without consult with addiction medicine. Exclusion criteria included incarceration, pregnancy, and intoxication. After injection, patients were directed to make a follow-up appointment with the outpatient addiction clinic of their choice. If the patient desired to follow up with our addiction clinic, a message was sent to a transitional navigator to reach out to the patient to schedule the appointment.

Data Collection

The elements of optimal retrospective chart review are included in this section.[24]

Using addiction medicine specialist feedback, we created a data collection tool and abstraction manual using Research Electronic Data Capture (REDCap) tools hosted at CUH. Incomplete data was mitigated by performing a pilot test on the abstraction form. Authors BC and AE pilot-tested the collection tool and manual by first abstracting 10 records, which were then adjusted according to the findings of the pilot test. Three research assistants (RA) assisted with data abstraction. The RAs were not blinded to the hypothesis. They were trained using the abstraction manual and then assigned five records to abstract from the electronic health record (EHR). (Both the ED and the clinic used the institutional EHR system [Epic Systems Corporation, Verona, WI]). If, after record review, zero discrepancies were found, the RA continued abstracting. If any discrepancies were found, the RA was retrained and assigned five more records to abstract. This process continued until the RA had zero discrepancies. They were randomly assigned a section of the dataset (with overlap for double abstraction review).

We did not formally test inter-rater reliability; however, a research coordinator (who was not involved in data abstraction) reviewed the first 10 double-abstracted data from each RA to ensure the abstracted data were congruent. The data were congruent.

Analysis

We derived all data via retrospective chart inquiry and analyzed it using RedCap; the data was de-identified prior to statistical analysis. Analyses were conducted in SPSS v29 (SPSS Statistics, IBM Corp, Armonk, NY). We conducted descriptive analyses to characterize the patient population in terms of demographic variables, social determinants of health, medical and psychiatric comorbidities, and treatment outcome variables. No patients were excluded in the descriptive analyses. We used logistic regression to determine the relationship of variables to treatment retention vs attrition as measured by receipt of follow-up XR-BUP injections. We also calculated confidence intervals (CI) at 95%. Analysis of variance (ANOVA) was used to compare demographic groups on medical, psychiatric, and treatment outcome data.

We used logistic regression models to analyze the relationship of descriptive variables (sex, race, ethnicity, insurance type, housing stability), clinical variables (number of prior XR-BUP injections, number of ED visits in the prior six months), and medical variables (presence of medical, psychiatric, or substance use disorder comorbidities) while controlling for age, with whether the patient was still in treatment at one- and three-month follow-ups.

Three patients were excluded as outliers for the number of ED visits in the prior six months, two for number of prior XR-BUP injections (only logistic regression model). Race, ethnicity, and insurance type had incomplete information, with too few patients in some categories. Race was converted to a dichotomous variable (White vs non-White) to create more parity in group size, while we excluded ethnicity and insurance type from the final model given that group size was still too uneven for valid analyses. Sex, dichotomized race, housing, and comorbidity variables were each examined in univariate models, while clinical variables were included in one combined model.

RESULTS

Descriptive Analyses

Demographics

The 69 patients (68.2% male; mean age 40.16 years [SD +/- 9.66]) who received XR-BUP in the ED were included in the study demographic and medical outcome data for the current analyses. Scores for variables >3 SD from the mean for each group were excluded from analyses and are noted below. Demographic variables are described in Table 1; however, it should be noted that 87% of the patients had

Table 1. Study participant demographics in a study of extended release buprenorphine initiation in the emergency department.

Mean age	40.16	
Sex		
Male		68.2%
Female		31.8%
Race		
Asian	1	1.4%
Black	20	29%
White	41	41.6%
Hispanic	5	7.2%
Unknown	2	2.9%
Ethnicity		
Hispanic	10	14.5%
Non-Hispanic	59	85.5%
Insurance		
Medicaid	60	87%
Medicare	6	8.7%
Private	0	0
None	3	4.3%
Housing		
Stable	41	59.4%
Unstable	25	36.2%
Not documented	3	4.3%

Table 2. Study participant comorbidities in a study of extended release buprenorphine initiation in the emergency department.

Comorbidities		
Medical		
Congestive heart failure	4	5.7%
CVA without hemiplegia	1	1.4%
Ulcer disease	6	8.7%
Mild liver disease	2	2.9%
Diabetes without complications	3	4.3%
Connective tissue disease	3	4.3%
Chronic obstructive pulmonary disease	21	30.4%
Moderate or severe renal disease	3	4.3%
Psychiatric		
Depression	40	57.9%
Anxiety	41	59%
Bipolar disorder	29	42%
Schizophrenia	4	5.7%
ADHD	9	13%
Suicidal ideations	15	21.7%
Insomnia	20	29%
PTSD	18	26%
Borderline personality disorder	3	4.3%
Other	3	4.3%

CVA, cerebrovascular accident; *ADHD,* attention deficit hyperactivity disorder; *PTSD,* post-traumatic stress disorder.

Medicaid insurance, and almost 5% had no insurance. More than a third of the patients (36.2%) had unstable housing.

The vast majority (84%) of the patients had a comorbid psychiatric diagnosis, anxiety being the most frequent diagnosis reported (59%), followed by depression and bipolar disorder (57.9% and 42%, respectively). A total of 88% of patients had a comorbid substance use at the time of the index injection, of which cocaine was the most preferred (76%). See full list of comorbidities in Table 2.

Substance Use Patterns

The most commonly reported substance use method at the time of index injection was intranasal by 31 patients 44.9%), followed by intravenous (29, 42.0%), oral (1, 1.4%) and smoking (1, 1.4%). The majority of patients reported primary substance use of heroin/fentanyl (66, 95.7%), rather than prescription opioids (3, 4.3%). Sixty-one patients (88.4%) were noted to have comorbid substance use at the time of index injection, while eight (11.6%) did not. These other substances included the following: alcohol (9, 14.5%); amphetamines (1, 1.6%); benzodiazepines (24, 38.7%); crack cocaine/cocaine (53, 85.5%); marijuana (cannabis, THC) (19, 30.6%); methamphetamine (11, 17.7%); and PCP (4, 6.5%). Of note, tobacco was not included in comorbid substance use.

Treatment Outcomes

For our primary outcome, retention in treatment at 60 and 90 days was 73.9% and 57.9%, respectively. This includes patients who received follow-up injections in the outpatient clinic in addition to those who returned to the ED for their subsequent doses. Of those patients following up at 30 days, 53% received their second XR-BUP injection in the outpatient setting; at 60 days, 47.8% of the patients received their third XR-BUP injection in the outpatient setting. The most frequent reasons for ED-initiated XR-BUP administration were as follows: instability of treatment of OUD, such as frequently missed visits, medication non-adherence, or continued illicit opioid use (69.6%); patient preference (15%); access challenges (incarceration, entering residential treatment that did not allow MOUD, could not get appointment) (7.2%); prescription issues (4.3%); unknown (1.4%); and other (1.4%).

For most patients (75%), the ED index injection was their first ever XR-BUP injection. Those who had received prior injections had a mean of four XR-BUP administrations prior

to the ED index injection (range 1-20). Most patients (97.1%) had not undergone buprenorphine micro-induction (a process of starting low doses of buprenorphine and increasing daily to therapeutic maintenance dosing of buprenorphine while simultaneously given opioid agonists) prior to the index XR-BUP injection.

Mean time from first addiction medicine clinic contact to index injection (counted as patient's first addiction medicine visit) was 67.77 weeks (SD 0-208 weeks). From chart inquiry, 11.6% of patients reported adverse reactions to XR-BUP injection. Of this 11.6%, adverse injection reactions included pain, swelling, itching, rash, redness, or infection (37.5% of 11.6%); withdrawal symptoms (37.5%); and other (25%). Sixty-one patients (88.4%) received a supplemental script for SL-BUP, and eight (11.6%) did not. The daily dose of SL-BUP patients continued taking following their index injection ranged from 8-24 mg total daily dose (mean 19.28 mg, SD 5.73).

Logistic Regression Analysis

Predictors of treatment retention

Demographic variables: Univariate logistic regression models predicting receipt of the second dose of XR-BUP (with age as a covariate) based on housing status or dichotomized race were not statistically significant. The model that regressed second dose on sex, controlling for age, was significant ($\chi 2$ (2)= 7.5, P = .02), but main effect of patient's sex had only a trend-level relationship with odds of retention at one month (B = 1.1, P =.07, Exp(B) = 2.9, 95% CI 0.9-9.3). None of the demographic variable models significantly predicted odds of retention at three months.

Clinical variables: The logistic regression model for receipt of the second dose of XR-BUP regressed on the number of prior XR-BUP injections and the number of ED visits in the prior six months while controlling for age was not statistically significant. The model predicting odds of retention at three months was also not significant.

Comorbid diagnoses: Univariate logistic regression models predicting receipt of the second dose of XR-BUP (controlling for age) based on medical comorbidity was not significant. The psychiatric comorbidity model was statistically significant ($\chi 2$ (2)= 7.1, P = .03) but the main effect of psychiatric comorbidity had only a trend-level relationship with odds of one-month retention (B = 1.3, P = .08, Exp(B) = 3.6, 95% CI 0.8-15.0). In contrast, the model for additional substance use disorder comorbidity was significant ($\chi 2$ (2)= 12.2, P < .001), and it was found that the odds of retention after one month were significantly increased for patients who had a diagnosis of an additional comorbid substance use disorder or dependence (B = 2.0, P < .001, Exp(B) = 7.5, 95% CI 1.8-31.8). At three-month follow-up, odds of retention in treatment remained higher for patients with additional substance use comorbidities, with the model and main effect significant ($\chi 2$ (2) = 6.1, P = .05; B = 1.6, P = .02, Exp(B) = 4.8, 95% CI 1.2-19.1). Models predicting retention based on medical comorbidity and psychiatric comorbidity were both non-significant.

DISCUSSION

To our knowledge, this study is the first to evaluate on-demand XR-BUP administration in the ED setting and identify predictors of retention. The ED can serve as a critical access point for MOUD initiation, especially in unstable patients who are actively using illicit substances and having trouble with BUP initiation. Although XR-BUP is currently approved only for use with patients stable on SL-BUP for at least seven days, almost all the patients in this study received their index XR-BUP injection in the context of instability of OUD (ie, difficulty with outpatient SL-BUP initiation). This suggests that on-demand, ED-initiated XR-BUP may be a safe and effective alternative treatment strategy for patients with unstable OUD. The ED is commonly used for stabilization of acute illness in other diseases where patients are not linked with continuity of care (ie, psychiatric illness); our findings suggest this utility can be extended to SUD.

Notably, the retention rate demonstrated in this study was considerably higher than that found in similar studies looking at 30-day follow-up after ED-initiated SL-BUP (43.1-54.1%).[25,26] This outcome is especially striking when taking into account that our studied patient population had appreciable housing insecurity, co-substance use, and medical comorbidities. We suspect this increased treatment retention may be attributed to the long-acting, extended-release nature of the medication, which maintains steady-state blood levels of buprenorphine for several weeks, thus, reducing burden on patients.

Ad hoc analyses of predictors of retention at one and three months suggest that demographic variables, social determinants of health such as housing stability, and comorbid medical conditions may not increase risk of dropout from treatment in this population, which further encourages flexibility in prescribing. Of particular note, those who had a co-occurring substance use disorder were more than seven times as likely to present for their second shot compared to those who had no comorbid substance use disorder, and more than four times to still be in treatment at three months. It is possible that this population of patients with multiple substance use disorders may be particularly responsive to XR-BUP, may have less severe OUD, or may benefit more markedly from the added stability of injectable MOUD. Future research exploring neurobiological or metabolic correlates of XR-BUP in those with multiple SUD diagnoses would be useful to determine the potentially unique benefit to these patients.

Future research is necessary to fully describe the role of ED-initiated XR-BUP in improving long-term outcomes. Larger and prospective studies are needed to evaluate the effectiveness of ED-initiated XR-BUP in improving treatment retention, adherence, and abstinence. Next steps should also examine the effect of ED-initiated XR-BUP on

Table 3. Predictors of treatment retention at one month and three months in a study of sublocade initiation in the emergency department.

Retention at 1 month		Chi-square	df	P		B	SE	P	Exp (B)	Exp(B) 95% CI for Exp (B) Lower	Upper
					Age	0.1	0.0	.10	1.1	1.0	1.1
	Housing Status	5.705	2	.06	Housing status (stable/ unstable)	0.8	0.7	.23	2.2	0.6	7.9
					Constant	-2.2	1.4	.13	0.1		
Demographic variables					Age	0.1	0.0	.05	1.1	1.0	1.1
	Race	4.318	2	.12	Race (White/non-White)	-0.2	0.6	.70	0.8	0.2	2.6
					Constant	-1.2	1.4	.38	0.3		
					Age	0.1	0.0	.06	1.1	1.0	1.1
	Sex	7.516	2	.02	Sex (M/F)	1.1	0.6	.07	2.9	0.9	9.3
					Constant	-3.2	1.7	.06	0.0		
					Age	0.1	0.0	.03	1.1	1.0	1.2
					ED visits 6 months prior to index injection	-0.1	0.1	.13	0.9	0.8	1.0
Clinical variables		7.517	3	.06	How many sublocade injections has the patient received before the index case? (not including the index injection)	0.2	0.2	.23	1.3	0.9	1.8
					Constant	-1.8	1.4	.19	0.2		
					Age	0.1	0.0	.06	1.1	1.0	1.1
	Medical	4.217	2	0.12	Medical comorbidity (y/n)	-0.1	0.6	.83	0.9	0.3	2.7
					Constant	-1.4	1.3	.28	0.2		
					Age	0.1	0.0	.04	1.1	1.0	1.1
Comorbid diagnoses	Psychiatric	7.12	2	0.03	Psychiatric comorbidity (y/n)	1.3	0.7	.08	3.6	0.8	15.0
					Constant	-2.7	1.6	.08	0.1		
					Age	0.1	0.0	.07	1.1	1.0	1.1
	SUD				SUD comorbidity (y/n)	2.0	0.7	< .001	7.5	1.8	31.8
					Constant	-3.1	1.6	.05	0.0		
Retention at 3 months											
					Age	0.0	0.0	.35	1.0	1.0	1.1
	Housing Status	1.1	2	.59	Housing status (stable vs unstable)	-0.3	0.5	.57	0.7	0.3	2.1
					Constant	0.1	1.2	.93	1.1	1.0	1.1
					Age	0.0	0.0	.37	1.0	0.3	2.5
Demographic variables	Race	0.8	2	.66	Race (White/non-White)	-0.2	0.6	.76	0.8		
					Constant	0.0	1.2	.98	1.0		
					Age	0.0	0.0	.41	1.0	1.0	1.1
	Sex	1.0	2	.61	Sex (M vs F)	0.3	0.5	.62	1.3	0.4	3.9
					Constant	-0.6	1.4	.67	0.5		

CI, confidence interval; df, degree of freedom ; *ED,* emergency department; *SE,* standard error; *SUD,* substance use disorder comorbidity.

Table 3. Continued.

									Exp(B) 95% CI for Exp (B)	
		Chi-square	df	P		B	SE	P	Exp (B)	Lower	Upper
Clinical variables		6.4	3	.09	Age	0.0	0.0	.19	1.0	1.0	1.1
					ED visits 6 months prior to index injection	-0.1	0.1	.12	0.9	0.8	1.0
					How many sublocade injections has the patient received before the index case? (not including the index injection)	0.4	0.2	.10	1.5	0.9	2.3
					Constant	-0.8	1.3	.51	0.4		
Comorbid diagnoses	Medical	2.5	2	.29	Age	0.0	0.0	.35	1.0	1.0	1.1
					Medical comorbidity (y/n)	-0.7	0.5	.19	0.5	0.2	1.4
					Constant		0.0	1.0	1.0	1.0	
	Psychiatric	1.9	2	.38	Age	0.0	0.0	.36	1.0	1.0	1.1
					Psychiatric comorbidity (y/n)	0.8	0.7	.27	2.1	0.6	8.0
					Constant	-0.9	1.3	.50	0.4		
	SUD	6.1	2	.05	Age	0.0	0.0	.50	1.0	1.0	1.1
					SUD comorbidity (y/n)	1.6	0.7	.02	4.9	1.2	19.1
					Constant	-1.3	1.3	.30	0.3		

CI, confidence interval; *df*, degree of freedom; *ED*, emergency department; *SE*, standard error; *SUD*, substance use disorder comorbidity.

ED utilization, rates of opioid overdose, and mortality rates. Further investigations may focus on the cost-effectiveness of ED-initiated XR-BUP. While it is an expensive medication, we suspect that over time its use could offset significant healthcare costs related to continued opioid use. The intent of this reallocation program was to reduce costs by repurposing an expensive medication that would otherwise go to waste; a cost-benefit analysis could favor the addition of XR-BUP to hospital formularies in the future. Finally, qualitative studies may also be helpful in assessing the patient perspective and relationship of XR-BUP in facilitating more prolonged recovery.

LIMITATIONS

While use of XR-BUP in this study was technically off-label, more rapid initiation of XR-BUP has become increasingly common in practice, and small studies have characterized patients receiving the medication in this manner.[27,28] Generally, the primary concern with premature initiation of XR-BUP is precipitated opioid withdrawal syndrome; in the event that a partial μ-opioid agonist (BUP) is administered while a patient has high blood levels of full μ-opioid agonist (such as fentanyl), the partial μ-opioid agonist will displace the full μ-opioid agonist, quickly inducing a severe opioid withdrawal syndrome.[29] Of this studied population, many were "unstable" and possibly willing to accept the risk of short-term precipitated withdrawal for the anticipated benefit of long-term future stability on a maintenance medication. Although precipitated withdrawal is a feared side effect for patients, it is not inherently lethal, and must be weighed with the generally greater risk of morbidity and mortality in this population that is associated with continued use of illicit opioids.[2] Patients were prescribed SL-BUP supplemental scripts to compensate for anticipated opioid tolerance (as it often takes multiple injections to reach steady state) as well as mitigate any possible post-injection precipitated withdrawal symptoms.

Another limitation is that this study did not have a standard protocol for the emergency clinician's patient selection; however, aside from a few instances overnight, most patients were counseled by a specialist from the addiction consult team. Many emergency clinicians are not acquainted with the process by which patients could be candidates for XR-BUP. We did not use an objective marker for stability of OUD, such as buprenorphine/norbuprenorphine urine toxicology levels, nor did we disclose a subjective marker

of current opioid withdrawal. With this in mind, it would be advantageous to have additional training for emergency physicians with regard to candidate selection and patient counseling if a program akin to that described in our study were to be implemented elsewhere. The ED-addiction consultant collaboration we describe in this study may further limit generalizability to the wider OUD population.

The analysis was limited to a small sample size of patients in a single ED, with one payor and that followed up in a single specialty addiction clinic. Thus, our patient population characteristics may limit the generalizability of our findings to other settings. The cohort of patients receiving XR-BUP were candidates due to the reallocation program with a managed care organization; XR-BUP was not available to other patients in our ED due to insurance restrictions.

An additional limitation to the generalizability of this study is the pre-existing reallocation program for administration of XR-BUP in the ED, which is relatively unique. There are significant logistical barriers involved with ordering XR-BUP in the outpatient setting; thus, it is too expensive to be kept on formulary in most inpatient pharmacies. In the setting for this study, we already had an extensive outpatient XR-BUP program that provided excess unused product that could be allocated for ED or inpatient use. Given the success of retaining patients in treatment using this approach, our findings support the utility of this reallocation program.[8]

Finally, this study was retrospective in nature, and we did not compare treatment retention rates for XR-BUP to patients in this population with other ED-initiated MOUD (such as SL-BUP).

CONCLUSION

This retrospective cohort study highlights the feasibility of administering extended-release buprenorphine in an ED setting and demonstrates its potential implications for access and cost barriers. Our findings showed that ED-initiated XR-BUP was associated with improved retention rates, increased from rates pertaining to ED-initiated sublingual buprenorphine.[9] Furthermore, clinical and demographic variables did not lead to increased attrition, supporting the use of XR-BUP in patients with complex presentations. The ED provided an important and convenient healthcare access point for XR-BUP initiation. The XR-BUP may be a helpful tool for achieving induction after failed SL-BUP initiation and can minimize treatment gaps after discharge and improve retention.

Future research will focus on evaluation of the impact of XR-BUP on ED utilization, patient-centered outcomes, and morbidity and mortality related to opioid use disorder. Clinical goals will support training our emergency clinicians for counseling and administration of this medication. Despite the many barriers to this medication, XR-BUP is an effective alternative treatment strategy for patients with unstable opioid use disorder. The ED is an essential setting for initiation of medication for OUD and a critical access point for unstable patients.

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Retention Challenges in Opioid Use Disorder Treatment: The Role of Comorbid Psychological Conditions

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Introduction: Comorbid psychological conditions have an impact on opioid use disorder (OUD). We measured multiple psychological tests in OUD patients who entered an emergency department (ED)-based medication for opioid use disorder (MOUD) program to determine whether any test correlated with six-month retention in the MOUD treatment program.

Methods: Patients with OUD who were enrolled in an ED-based MOUD program over a 12-month period were eligible to participate. We surveyed enrollees using nine validated tools to assess depression, anxiety, and traumatic stress within 24 hours of their ED presentation and then at one and six months. The primary outcome was program retention rates at one and six months. Secondary outcomes were levels of clinical symptoms, substance use, and quality of life.

Results: Of 143 patients enrolled in the MOUD program, 64 (44.8%) participated during the 12-month study. The mean age was 33 years, with 65% male and 35% female. Baseline surveys indicated moderate symptom severity for depression and anxiety. The Post-Traumatic Stress Disorder Checklist (PCL-5) scores showed significant traumatic stress. Retention rates were 47% at one month and 25% at six months. General well-being improved from 40% at baseline to 56% at six months. Average income correlated (0.51) with six-month retention, suggesting that those with financial means were more likely to remain in treatment. The Life Events Checklist (LEC-5) correlated (0.41) with six-month retention. This indicates that the more trauma an individual experienced, the less likely the person would remain in treatment.

Conclusion: Higher income and lower post-traumatic stress disorder scores had higher retention rates in a medication-based opioid use disorder program. Psychological surveys of patients entering a MOUD program may help predict treatment retention. There will likely be challenges in keeping patients with extensive trauma histories retained in treatment. [West J Emerg Med. 2025;26(4)897–904.]

INTRODUCTION

Patients with opioid use disorder (OUD) often have significant comorbid psychological health concerns, including depression, anxiety, and post-traumatic stress disorder (PTSD).[1-4] The extent to which these psychological comorbidities affect participation in a medication for opioid

use disorder (MOUD) treatment program is unknown.[5] Longitudinal evaluation of mental health and well-being in patients receiving MOUDs alone, without counseling, is lacking in the scientific literature.[6] Two studies have shown that patients taking buprenorphine experience decreases in psychiatric symptoms (depression and anxiety) in the first three months of treatment.[5,7] Another study with longer follow-up found that mental health (as measured by the Short Form Health Survey-36) significantly improved from baseline to 12 months in patients enrolled in a study of extended-release buprenorphine injections.[8] All these studies demonstrated that the most significant improvement in mental health symptoms occurred in the first month of treatment. More research is needed to understand changes in mental health and well-being in patients receiving MOUD in a primary care setting.

We measured multiple validated and reliable psychological surveys, including the Personal Health Questionnaire (PHQ-8) measuring depression symptoms,[9] Generalized Anxiety Disorder 7-item scale (GAD-7) to measure anxiety symptoms,[10] the PTSD checklist (PCL-5) to measure PTSD symptoms,[11] World Health Organization well-being index (WHO-5) to measure well-being,[12] Brief Addiction Monitor (BAM-R) to measure addiction symptoms,[13] Adverse Childhood Experiences Survey (ACE) to measure adverse childhood trauma,[14] life events checklist (LEC-5) to measure post-tramatic stress,[15] and the Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences scale (PRAPARE) to measure social determinants of health[16] in patients entering an ED-based MOUD program to ascertain predictors of treatment retention. These surveys measure a cumulative score that correlates with symptoms and can be followed over time. The primary outcome was retention rates in the program at one and six months. Secondary outcomes were levels of various clinical symptoms (eg, depression, anxiety), substance use, and quality of life. We correlated individual survey findings with retention in a MOUD program measured as seeing an addiction medicine clinician at one and six months.

Population Health Research Capsule

What do we already know about this issue?
Use of baseline psychological tests in patients with opioid use disorder (OUD) to predict retention in an ED-based treatment program has never been studied.

What was the research question?
Does baseline psychological testing in patients in an ED-based medication for OUD (MOUD) program correlate with six-month retention?

What was the major finding of the study?
Patients with higher income and lower PTSD scores had higher retention rates in a MOUD treatment program at six months ($P < .05$).

How does this improve population health?
Opioid use disorder is a significant health concern. Trauma-informed surveys may help predict who will remain in MOUD treatment.

METHODS

Participants

All patients who enrolled in any of our four ED-based MOUD programs during the 12-month study period were eligible to participate in this study. The vast majority of these patients presented to the ED asking for treatment for their OUD. The remainder were enrolled into the MOUD program through our screening, brief intervention, and referral to treatment (SBIRT)[17] questioning required in our nurse triage process. Patients electing inpatient OUD treatment were not eligible. The patients enrolled were followed up at one and six months; therefore, the study was conducted over 18 months.

Our MOUD program comprises one urban hospital-based ED, one community hospital-based ED, and two suburban freestanding EDs We sought to compare the following outcomes for our MOUD enrollees:

- Program retention, defined as attendance at follow-up appointments (in-person or telehealth) or patient contact via telephone at one and six months after the initial ED MOUD encounter; this was measured through chart review.
- Well-being and quality of life.[18] These were assessed at baseline, and at one and six months post initial MOUD encounter.

We used previously validated and reliable measures such as the PHQ-8, GAD-7, PCL-5, WHO-5, Difficulties in Emotion Regulation Scale (DERS), BAM-R, ACE, LEC-5, and PRAPARE. This allowed us to track participant outcomes efficiently, compare with other systems, and to replicate our program at different sites. Surveys monitored and evaluated depression, anxiety, PTSD symptoms, quality of life, substance use and risk, and social determinants of health, including lifetime trauma and adversity.

The addiction care coordinator (ACC) assisted all patients in completing the surveys, in person or remotely, at the applicable time points, and aggregated all relevant data for analysis. If a patient entered the MOUD program at night, the ACC would follow up with the patient the next day, enroll the patient in the study, and complete surveys by phone. Surveys

could also be completed through an online survey program (Neuroflow [NeuroFlow, Inc, Philadelphia, PA] or RedCap [Research Electronic Data Capture hosted at Northeast Ohio Medical University. The results provided information to assess changes over time, evaluate differences between patients served at different sites, and improve our program, leading to better patient outcomes, program sustainability, and a healthier community. The chart abstractors for collecting survey data and retention rates were blinded to the study hypothesis.

Program Description and Evaluation Focus

Measures

We administered the mobile health (mHealth) app usability questionnaire (MAUQ),[19] which has versions for patients and healthcare professionals. The MAUQ provides information about three domains: ease of use; usefulness, interface; and satisfaction. We used two platforms (NeuroFlow and REDCap) to assess telehealth's efficacy in a MOUD program.

Emotion Dysregulation

Given that substance use is one way that people cope with emotional distress, emotion (dys)regulation is an essential psychological process to measure for assessing the risk of substance use/relapse and identifying potential targets of intervention that ultimately may help improve engagement in substance use treatment and outcomes. The DERS[20] assesses various aspects of emotion dysregulation, including non-acceptance of emotional responses, difficulties engaging in goal-directed behavior, impulse control difficulties, lack of emotional awareness, limited access to emotion regulation strategies, and lack of emotional clarity. This tool can be especially useful in helping patients identify areas for growth in how they respond to their emotions, especially those with borderline personality disorder, generalized anxiety disorder, or substance use disorder.

Trauma/Adversity and Social Determinants of Health

The US Centers for Disease Control and Prevention define social determinants of health as the conditions in which people live, learn, work, and play that affect various health risks and outcomes.[21,22] They include demographic and psychosocial factors such as race, ethnicity, education, employment, income, language barriers, food insecurity, housing stability, neighborhood/environmental factors, and more.[23] The PRAPARE is a standardized patient social risk assessment tool.[16] Social determinants of health are correlated with substance use and accessing treatment services. Exposure to traumatic events or other types of adversity is also known to be associated with increased risk of substance use as well as to the likelihood of treatment seeking, engagement, and outcomes. The LEC-5[15] assesses 17 categories of traumatic events (eg, physical assault, natural disasters, combat) and whether someone, in adulthood or childhood, has ever experienced, witnessed, or learned about these events happening to a loved one. Adverse trauma events were not weighted for severity when using the LEC-5.

The ACE[14] questionnaire includes some of these trauma types as well as other types of adversity and social determinants of health, such as neglect and family dysfunction, which are also associated with substance use and other health risks and outcomes. Together, the PRAPARE, ACE, and LEC-5 provide a thorough understanding of psychosocial factors and experiences across the lifespan that are associated with substance use, treatment, and outcomes.

Mental Health Symptoms and Quality of Life

We included several clinical symptom-severity measures in the data collection plan. The PHQ-8, GAD-7, and PCL-5 assess symptoms of depression (excluding suicidality), anxiety, and traumatic stress, respectively. It is well established that these symptom types highly co-occur with substance use. Thus, these measures serve as predictors of treatment engagement/retention and secondary outcomes of their own. In addition, because it is vital to assess broader outcomes than just clinical symptoms, we administered the WHO-5 to evaluate quality of life.

Substance Use, Mental Health Symptoms, and Quality of Life

The BAM-R is designed to measure progress in patients who are in treatment for substance use disorder. It assesses alcohol and drug use, as well as risk and protective factors associated with use or sobriety, within the prior 30 days. Several clinical symptom-severity measures are also included in the data collection plan. The PHQ-8, GAD-7, and PCL-5 assess symptoms of depression (excluding suicidality), anxiety, and traumatic stress, respectively. It is well established that these symptom types highly co-occur with substance use

ANALYSIS AND INTERPRETATION

The primary outcome was retention in the program at one and six months post-initial ED MOUD encounter. Secondary outcomes were severity levels of various clinical symptoms (eg, depression, anxiety). We obtained descriptive statistics for all demographic, clinical, and other variables (predictors and outcomes) in the measurement plan. A correlation table was generated to examine associations among the variables. We conducted chi-square tests for categorical variables (count and percent variables), and we performed *t*-tests and analysis of variance for continuous variables, with $P < .05$ considered statistically significant. We used regression analyses to identify significant predictors of retention. This analysis included covariates/control variables (eg, social determinants of health) associated with the outcome variable. We assessed clinical symptom-severity changes within groups over time with paired *t*-tests using baseline and final endpoint

measurements. Since this was part of a QI project, the Summa Health System Institutional Review Board deemed it to be patients' assets, risks, and experiences scale (PRAPARE) exempt from review.

RESULTS

During the one-year study period (September 2021–August 2022), our EDs saw 148,251 patients, with a total of 2,875 OUD-confirmed patients. Of confirmed OUD patients, 143 enrolled in our ED-based MOUD programs. The vast majority (96%) of those enrolled presented to the ED for treatment for their OUD. The rest (4%) were identified with an OUD and offered MOUD through the triage-nurse SBIRT process. All patients enrolled had cell phone access to the internet to complete surveys. Of the enrolled patients, 64 (45%) completed a baseline assessment. The patient's mean age was 33 years (SD 8), ranging from 20-62 years. Demographics were as follows: 67% male; 70% single; 17% married; and 13% divorced/separated/widowed. The racial profile noted 81% White, 9% Black, 3% American Indian/Alaskan, and 7% identified as Hispanic or Latino. Regarding their living situation, 30% reported living alone, and 75% reported having housing; however, 41% reported concerns about losing their housing. In total, 86% of patients had a high school diploma, and 60% were unemployed. The average income was $25,000 annually, and 71% of the population had Medicaid health insurance.

For the primary outcome measure, surveyed patients had a retention rate in the MOUD program of 47% (95% confidence interval [CI] 46.0-48.0; 30 patients) at one month and 25% (95% CI 24.1-25.9; 16 patients) at six months. The Consolidated Standards of Reporting Trials flow diagram is noted in the Figure.

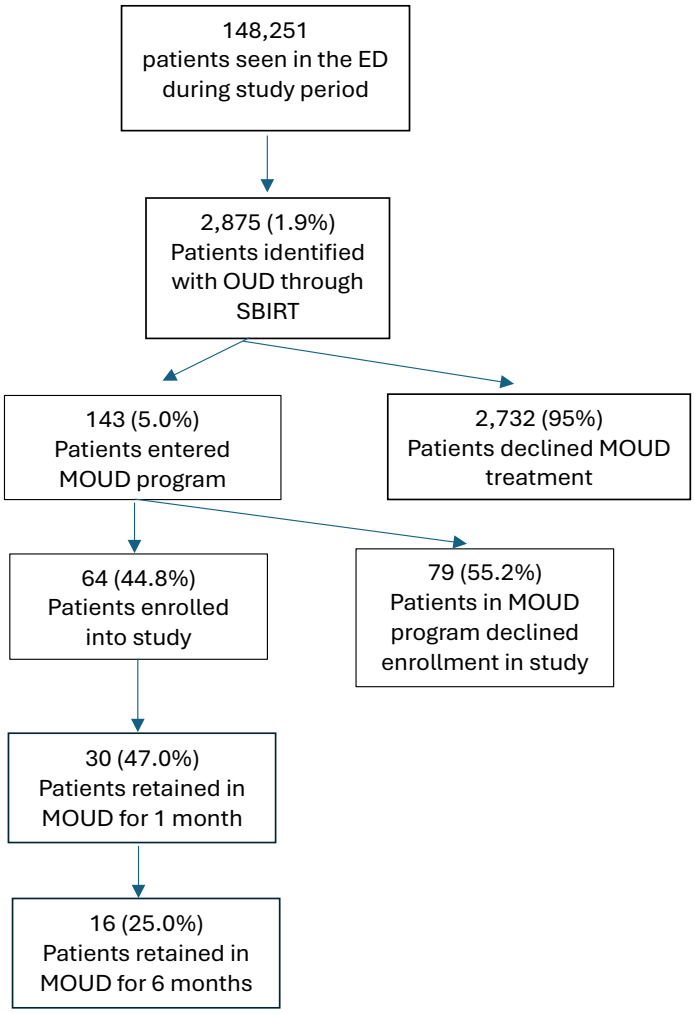

Figure. Consolidated Standards of Reporting Trials (CONSORT) flowchart for patient enrollment.
ED, Emergency Department; *OUD,* Opioid use disorder; *MOUD,* Medication for opioid use disorder; *SBIRT,* Screening, brief intervention

Baseline Clinical Symptom Levels

Patients reported scores that indicated moderate symptom severity for both depressive symptoms (PHQ-8) and anxiety (GAD-7). The PCL-5 scores showed significant traumatic stress levels that approached the cutoff of 33 for indicating probable PTSD. The WHO-5 scores were <13, indicating poor general well-being. Scale scoring for the BAM-R, considered very preliminary regarding its psychometric properties, includes use, risk factor, and protective factor scores. All three scales exceeded cutoffs that warranted further examination or clinical attention (Table 1).

Follow-Up Clinical Symptom Levels

We documented several areas of improvement at the six-month follow-up. Both depressive and anxiety symptoms improved at the six-month follow-up to <10 and <8, respectively, indicating an improvement from moderate to mild symptoms ($P<.05$). General well-being improved from 40% at baseline, a score of 9.91, to a score of 14.11, or 56%, at the six-month follow-up, which exceeds the suggested cutoff of at least a 10% improvement in percentage score to indicate improved well-being. The BAM-use score decreased below the clinical cutoff of one at one month and was above one at six months. Furthermore, the average BAM-risk factor score decreased below the clinical cutoff 12 at one and six months. The average BAM-protective score was correct at the clinical cutoff at one and six months. Another way to interpret the BAM is to compare the BAM-risk and BAM-protective scores to see which is higher. While the risk score was somewhat higher than the protective score at baseline (as expected), the protective score was slightly higher than the risk score at one and six months, which suggests the patients were somewhat less at risk of using opioids.

Exposure to Trauma and Adversity

The data indicate this patient population has experienced significant amounts of trauma and adversity. The ACE questionnaire assesses 10 different types of adverse childhood

Table 1. Baseline clinical symptom levels.

Construct and measure	Baseline (n=30) Average score (SD)	6 months (n=16) Average score	Baseline symptom severity
Depressive Symptoms (PHQ-8)	13.80 (6.78)	9.66 (4.78)*	Moderate > 10 = Major > 20 Severe
General Anxiety (GAD-7)	10.88 (6.52)	7.78 (4.33)*	Moderate 10-14 = Moderate > 15 = Severe
Traumatic Stress (PCL-5)	28.77 (19.29)	19.86 (13.22)*	Significant/High > 30 = Severe
PTSD (LEC-5)	5.88 (2.52)	2.33 (1.63)*	Significant PTSD > 5 = Severe
General Well-being (WHO-5)	9.91 (6.35)	14.11 (5.89)*	Poor well-being < 10 = Poor
Addiction (Use BAM-R)	3.10 (2.33)	1.81 (1.72)	Cutoff of 1+ correlates with high addiction
Childhood Trauma (ACE)	4.15 (3.15)	3.92 (2.89)	Moderate > 4 = Significant
Emotional Dysregulation (DERS)	81.91 (13.84)	79.77 (13.66)	High > 82 = Severe

*p < .05.
PHQ-8, Personal Health Questionnaire; *GAD-7*, General Anxiety Disorder; *PCL-5*, Post-Traumatic Stress Disorder Checklist; *PTSD*, post-traumatic stress disorder; *LEC-5*, Life Events Checklist; *WHO-5*, World Health Organization well-being index; *BAM-R*, Brief Addiction Monitor; *ACE*, Adverse Childhood Experiences survey; *DERS*, Difficulties in Emotional Regulation Scale.

experiences in the areas of abuse, neglect, and family dysfunction. It returns a score from 0-10, indicating the number of types (not frequency) of experiences witnessed, learned of, or experienced by 18 years of age. Patients averaged four types of adverse childhood experiences. The ACE score was not statistically different at baseline for patients retained at six months compared to those not retained at six months.

The LEC-5 assesses 17 types of traumatic experiences in childhood and/or adulthood. For the patients who completed this questionnaire, trauma was highly prevalent. Patients, on average, reported directly experiencing four different types of traumas, witnessing two types of traumas, and learning about two types of traumas happening to loved ones. (As with the ACE, the LEC does not assess the number of experiences of these different types.) The LEC-5 was lower for the patients who were retained in the program at six months, 5.88 vs 2.33, noting clinical and statistical significance ($P < .05$). The LEC-Happened (number of types of trauma directly experienced by the person) correlated -0.41 (95% CI 0.39, -0.43) with six-month retention. This suggests that the more types of trauma experienced throughout life, the less likely the person is to remain in treatment at six months.

One other statistical and clinical correlation was noted in the survey. The PRAPARE14 (average annual income) correlated 0.51 (95% CI 0.49 - 0.53) with six-month retention, suggesting that people with relatively more financial means were more likely to remain in treatment at six months.

Emotion Regulation

The DERS measures emotion regulation problems. Baseline data for patients showed an average score of 81.91 (95% CI 71.9 - 91.9), which was not significantly different from the six-month score of 79.77 (95% CI 76.4 - 83.1, $P > .05$). This was similar to the scores in a published sample of adults who presented at a general outpatient clinic and were diagnosed with one or more disorders in the *Diagnostic and Statistical Manual of Mental Disorders, 5th Ed*.[24] The sample size was again low, but here are the findings:

- The DERS score at baseline was statistically and clinically correlated with the baseline BAM score (0.75 (95% CI 0.71 - 0.79)).
- The DERS score at baseline was statistically and clinically correlated with baseline GAD-7 score, (0.62 (95% CI 0.58 - 0.66)).
- The DERS score at baseline was statistically and clinically correlated with the baseline WHO-5 score (-0.73 (95% CI -0.69 , -0.77).

Thus, more difficulties in emotion regulation at baseline are associated with more risk of use/relapse, more generalized anxiety, and lower general well-being. This underscores that emotion regulation may be a significant factor to consider in

MOUD treatment and that bolstering emotion regulation skills may be an important focus of treatment.

Table 2 lists additional factors from the social determinants of health. Almost half of the sample reported seeing or talking to people they cared about and felt close to no more than twice a week. Additionally, 80% reported feeling quite a bit or very much "stressed," and 31% had spent more than two consecutive nights in jail/prison/detention/juvenile correction in the prior year. A total of 5% identified as refugees. Surprisingly, 95% reported feeling physically and emotionally safe where they lived. However, 15% reported being afraid of a partner or ex-partner sometime in the previous year. We assessed the patient satisfaction level of 39 individuals at the end of the first visit (95% CI 93.9 - 96.1) who reported being "satisfied" or "very satisfied" with their care experience in the MOUD program.

DISCUSSION

This project examined using previously validated well-being and psychosocial surveys on MOUD program retention rates. The surveys were administered by the ACCs during the first MOUD visit and subsequently by use of the NeuroFlow remote patient monitoring platform. The results of our surveys indicate several significant trends and correlations. First, the LEC-5 (lifetime trauma exposure) scores significantly correlated with MOUD program retention. Specifically, the LEC-happened (number of types of trauma directly experienced by the person) correlated -0.41 with six-month retention. This suggests that the more types of trauma someone experiences throughout their life, the less likely the person would remain in treatment at six months. An epidemiological study with nationally representative samples reported that 50-60% of the population will experience at least one traumatic event in their lives, and a third will experience three or more instances of trauma.[25] Survey participants who were not retained in the MOUD program at six months averaged 5.88 on the LEC-5 at baseline, and people who were maintained at six months averaged 2.33 on the LEC-5. These are significantly different (P = .02). This further underscores that the more types of trauma (not specific to childhood) someone experiences is an essential factor in whether they remain in MOUD treatment at six months. Thus, if MOUD treatment is not trauma-informed, there likely will be more difficulty keeping patients with extensive trauma histories retained in treatment.

Table 2. Social determinants of health in the previous year.

Social Determinants of Health Factor	Percentage of sample n = 64
Patients or family members had been unable to get food when needed	30%
Patients or family members had been unable to get clothing when needed	30%
Patients or family members had failed to get utilities when needed	32%
Patients or family members had been unable to get childcare when needed	6%
Patients or family members had failed to get health care when needed	23%
Patients or family members had failed to get a phone when needed	21%
Lack of transportation kept them from medical appointments or medication	43%
Lack of transportation kept them from other appointments, work, or getting things they needed	9%

The literature shows that higher ACE scores are associated with a higher risk of numerous adverse health, academic/occupational, interpersonal, and behavioral outcomes, including substance use.[26] Scores of ≥4 are consistently associated with high rates of these adverse outcomes. Half of the respondents had scores of ≥4, consistent with a study reporting that with each additional point on the ACE questionnaire, there is a 17% increase in the risk of relapse during MOUD treatment, usually after the first visit.[27] The high ACE scores in our patients highlight the significant relapse risk related to childhood trauma history. Fortunately, in that study,[26] each treatment visit was associated with a 2% reduction in the risk of relapse. This highlights the importance of engaging patients and retaining them in treatment.

The DERS score correlated with the BAM-R risk score, GAD-7 score, and WHO-5 score in our survey patients. Thus, more difficulties in emotion regulation at baseline are associated with more risk of use/relapse at baseline, more generalized anxiety at baseline, and lower general well-being at baseline. This underscores that emotion regulation may be a significant factor to consider in MOUD treatment and that bolstering emotion regulation skills may be an important focus of treatment. PRAPARE14 (average annual income) was correlated 0.51 with six-month retention. This suggests that people with relatively more financial means were more likely to remain in treatment for six months.

Although the sample size was small and the findings must be considered preliminary, there is evidence that patients showed improvement in depression, anxiety, PTSD symptoms, and general well-being during the initial months of MOUD treatment. This demonstrates our MOUD program's positive effect in improving physical and mental health in patients with OUD. Overall, 95% of our patients were satisfied or very satisfied with what they received at their initial visit.

Finally, the surveys gave us a better understanding of the social determinants of health that our OUD patients experience. We believe that measuring the survey results over time, specifically using the PRAPARE survey, allowed us to examine and understand the social dieterminants of health that our OUD patients experienced over time. Understanding this is important to meeting the social needs of this population as

outlined in the Health Opportunity and Equity Initiative and State Health Improvement Plan. Not only is the stigma surrounding OUD a barrier to effective treatment, but psychosocial issues of transportation, food, housing, and finances all affect patients' ability to remain in a coordinated program such as a MOUD.

LIMITATIONS

The small sample size limited this study. This was directly related to the number of surveys performed and the difficulty in getting this patient population to work with traditional medicine. We used the Neuroflow program to administer surveys online, but the response rate was low. The use of mhealth apps could considerably assist both individuals and healthcare professionals in the prevention and management of chronic diseases, in a person-centered manner. However, there is a lack of both standardized methods to measure the clinical outcomes of mHealth apps and techniques to encourage user engagement and behavior changes in the long term. Current research is exploring ways to overcome these barriers[28]

We attempted to improve the response rate by providing gift cards for continued participation, but this did not increase the response rate. We also educated our follow-up behavioral health professionals on the importance of this study, and to assist us in procuring survey responses. There was a decrease in the number of patients entering our MOUD program compared to previous years, which may have contributed to the small sample size. The reasons for this are unclear, but several factors could be involved. First, the primary opioid used in our area is fentanyl, and some have postulated that MOUD may be less effective due to the increased potency of fentanyl. Additionally, fentanyl may lead to worsening withdrawal symptoms, making MOUD treatment less palatable and leading to an increase in inpatient admission for OUD. Because we have an extensive inpatient detox program, many people opted for inpatient therapy. The expansion of MOUD programs at other sites in our community may have reduced the number of patients in our MOUD program. Lastly, there is debate regarding the effectiveness of behavior counseling on retention in MOUD patients. Of the three studies that examined this question, only one found that behavioral counseling improved retention rates.[29-31]

CONCLUSION

Psychological surveys of patients with opioid use disorder entering a medication for OUD program may help predict treatment retention. Our study found patients with higher income and lower PTSD scores had higher MOUD retention rates at six months. If MOUD treatment is not trauma-informed, there will likely be challenges in keeping patients with extensive trauma histories retained in treatment. Emergency department staff may need to examine the potential for PTSD and whether it affects retention in MOUD programs.

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Association of Mental Health Disorders and Social Determinants of Health with Frequent Emergency Department Use

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Introduction: Patients who frequently use the emergency department (ED) make up 8% of ED patients annually but account for up to 28% of all ED visits. Frequent ED utilization has been associated with mental health disorders. However, the association between social determinants of health (SDoH) and frequent ED use is not as well understood. Our objective was to identify associations between frequent ED use and mental health disorders and SDoH among patients visiting 19 Upper Midwest EDs in an integrated health system.

Methods: We conducted a cross-sectional analysis of adult patients presenting to the 19 EDs from July 1, 2020–June 30, 2021. Using odds ratios (OR) and 95% confidence intervals obtained from multivariable logistic regression models, we characterized associations between mental health disorders (based on ICD-10 groupings) and 10 SDoH with frequent ED utilization (defined as ≥6 ED visits per year).

Results: A total of 228,814 visits among 134,452 patients were eligible for inclusion. After accounting for clinical features and mental health risk factors, the following had the strongest association with frequent ED use: unmet transportation needs (OR 1.73); high risk for financial resources (OR 1.52); food insecurity (OR 1.58); smoking tobacco (OR 1.31); and physical inactivity (OR 1.23). The top mental health risk factors for frequent ED utilization were adult personality and behavioral disorders (OR 4.0) and anxiety, stress and non-psychotic disorders (OR 3.35).

Conclusion: We found strong associations between mental illness and SDoH and frequent ED use. The strongest SDoH risk factors included unmet transportation needs, financial resource risk, and food insecurity. The top two mental health risk factors were adult personality and behavioral disorders as well as anxiety and stress disorders, with differences that persisted when analyzed independently as well as when adjusting for other mental health risk factors. By understanding the interaction between social determinants of health and mental health disorders researchers can better address root causes and improve health outcomes among this vulnerable population. [West J Emerg Med. 2025;26(4)905–917.]

INTRODUCTION

Patients who frequently use the emergency department (ED) comprise up to 8% of all individuals visiting the ED, but they account for up to 28% of visits.[1-4] These patients tend to suffer from high rates of psychiatric illness,[5-7] are more likely to be undomiciled,[4,8-11] have public insurance or lack of insurance,[12,13] suffer from substance use disorders,[1,2,4,5,7,14-17] and have higher risk of mortality and hospital admission.[18] Addressing community social determinants of health (SDoH) is increasingly being recognized as a key factor in healthcare utilization, with patients who live in under-resourced neighborhoods having 55% more encounters in the health

system as compared to those who are in well-resourced neighborhoods.[19] In this study we aimed to identify the specific mental health and social needs factors that contribute to ED use.

Knowledge Gaps

Although prior studies have demonstrated increased rates of psychiatric illness among patients who frequently use healthcare resources,[1,5-8,13-15] these studies lack a standardized approach using diagnostic code groupings to better understand which categories of psychiatry illness carry the most risk. Furthermore, although SDoH are increasingly recognized as predictors of healthcare disparities, reflecting the economic, political, social, and physical environments that impact access to healthcare and disproportionality in disease burden, there is a paucity of research on the impact of SDoH in combination with psychiatric illness on frequent ED use.[20,21]

Study Objectives

We hypothesized an association between SDoH, psychiatric illness, and frequent ED use that can provide insight into how best to meet the underlying needs of this vulnerable population. Our objective in this study was to assess for associations of each of these risk factors with frequent ED use defined as ≥ 6 visits in a calendar year. We sought to assess the interactions between psychiatric illness and SDoH to highlight additional risk factors for frequent ED utilization beyond the previously studied psychiatric illness risk factors.

Population Health Research Capsule

What do we already know about this issue?
Associations between social determinants of health (SDOH) and mental health disorders for patients who frequently use the Emergency Department (ED) is not well understood.

What was the research question?
Identify associations between frequent ED use and mental health disorders and SDOH and frequent ED utilization.

What was the major finding of the study?
Top risk factors: transport (OR 1.7), finances (OR 1.5), food insecurity (OR 1.6), personality disorders (OR 4.0), anxiety (OR 3.4), p<0.001.

How does this improve population health?
By understanding the interactions between social determinants of health and mental health disorders researchers can address root causes and improve health outcomes for this population.

METHODS

Study Design and Setting

We conducted a multicenter, cross-sectional analysis of 19 EDs within an integrated health system in the Upper Midwest. The ED visits were identified from 19 Mayo Clinic EDs in Minnesota and Wisconsin from July 1, 2020 – June 30, 2021. These EDs encompass a regional health system with practice locations ranging from small, rural hospitals in southern Minnesota and western Wisconsin to an academic, quaternary-care hospital in Rochester, MN. The population selection included all ED encounters during this time frame.

Visits were excluded if the patient did not provide research authorization or was <18 years of age. Our primary outcome of interest was ED use calculated as the number of visits by the same patient in the previous 12 months. Thresholds for utilization were determined as ≥ 3 visits, ≥ 6 visits, or ≥ 18 visits in the prior year. Frequent ED use is defined in different ways in the literature; however, the most commonly reported threshold is six visits, which we chose for our primary analysis. The study adheres to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) and RECORD (Reporting of Studies Conducted Using Observational Routinely-collected Data) reporting guidelines and was exempted from review by the Mayo Clinic Institutional Review Board.[22,23]

Variables

Primary variables of interest were patient responses to SDoH surveys and active mental health diagnoses. The SDoH survey responses were collected using an institutional survey methodology administered annually on an outpatient basis for patients at ambulatory clinic appointments. Active mental health diagnoses were provided by primary care and mental healthcare teams for which the patients were enrolled. Only a portion of ED patients had data from SDoH surveys due to survey methodology, as well as gaps in enrollment with ambulatory care teams. Components of the SDoH survey were collected via social history across healthcare encounters by registration staff, nurses, or clinicians. To address response bias we evaluated the SDoH risk factors individually rather than excluding patient visits with partial data availability, and the responses to SDoH items were grouped for analysis.

Active mental health diagnoses were identified through the patient "active problems" list. Mental health diagnoses were categorized based on the *International Classification of Diseases, Rev 10* (ICD-10) codes recorded as active problems at the time of ED visit and flagged as present or not-present regardless of the number of distinct diagnoses

from a single category. Other variables of interest included patient demographics, age- and disease severity-weighted Charlson Comorbidity Index (CCI) score, and insurance type. Only comorbid diagnoses occurring within three years of the ED visit were included in the CCI score. Insurance was classified as Medicare, Medicaid, private, self-pay, or other. We also assessed patient primary language, means of arrival, arrival day of the week and time of day, chief concern, triage Emergency Severity Index (ESI) score, modified early warning score with a 24-hour window (MEWS24), primary ED diagnosis, and ED disposition.[24,25] Categorization of patient chief concerns and ED have been previously described.[26]

Statistical Methods

We summarized patient demographics and visit characteristics across ED use groups using means with standard deviations and medians with interquartile ranges for continuous features, or frequency counts and percentages for categorical measures. Associations between patient risk factors and high ED utilization were assessed using population-averaged logistic generalized estimating equations (GEE). The benefit to using GEEs over standard logistic regression is that GEEs account for multiple ED visits from a single patient during the study period, which cannot be assumed to be independent from one another. Moreover, by analyzing across all ED visits we allowed individual patients to change ED use status and update their SDoH survey results during the study period. For these analyses, we assumed that visits from individual patients had constant correlation; we calculated covariance using the Eicker-Huber-White estimator.

We constructed three sets of GEE models for this analysis. First, the association between frequent ED utilization and each SDoH or mental health risk factor was evaluated individually, adjusting for patient age, sex, race, ethnicity, primary language, means of arrival, arrival day of the week and time of day, chief complaint, triage ESI, MEWS24 score, age- and severity-weighted CCI score, insurance class, primary diagnosis, and ED disposition. Second, we assessed the mental health risk factors after adjusting for the presence of all other mental health risk factors along with the patient and visit characteristics. Third, the SDoH risk factors were assessed after adjusting for all mental health risk factors as well as patient and visit characteristics. Model results were reported as odds ratios (OR) with 95% confidence intervals (CI). We conducted all analyses using R v4.1.2 (R Foundation for Statistical Computing, Vienna, Austria).

Data Source, Access and Cleaning

We retrieved all data from the electronic health record (Epic Systems Corporation, Verona, WI) used at each participating site. We extracted ED data from structured ED record sets, while SDoH survey data were obtained from ambulatory encounters in the same health system. We performed data extraction using Structured Query Language-based tools, linking the unique medical record numbers with the ED data and SDoH survey responses at the individual patient level. The process was automated and carried out by the biostatistician. No manual chart review was conducted.

Missing Data

Visits with missing data from the SDoH survey were excluded from any analysis specific to the missing SDOH risk factors; visits with partial SDoH data were included for analysis on the available SDoH risk factors. Patients missing the ICD-10 codes flagged for mental health risk factors were considered to not have these risk factors present at the index visit. In all cases of missing data, the total number of patient visits included for analysis is provided.

RESULTS

Participant Enrollment

Participant enrollment in number of visits and unique patients is shown in Figure 1. We included patients ≥ 18 years of age who provided research authorization. Of the 228,814 visits included for analysis, 143,704 visits (79,597 distinct patients) (62.8%) had a response to at least one SDoH item, and 24,802 visits (13,691 distinct patients) (10.8%) had responses to all SDoH items. The reasons for non-participation pertained to institutional annual survey practices at primary

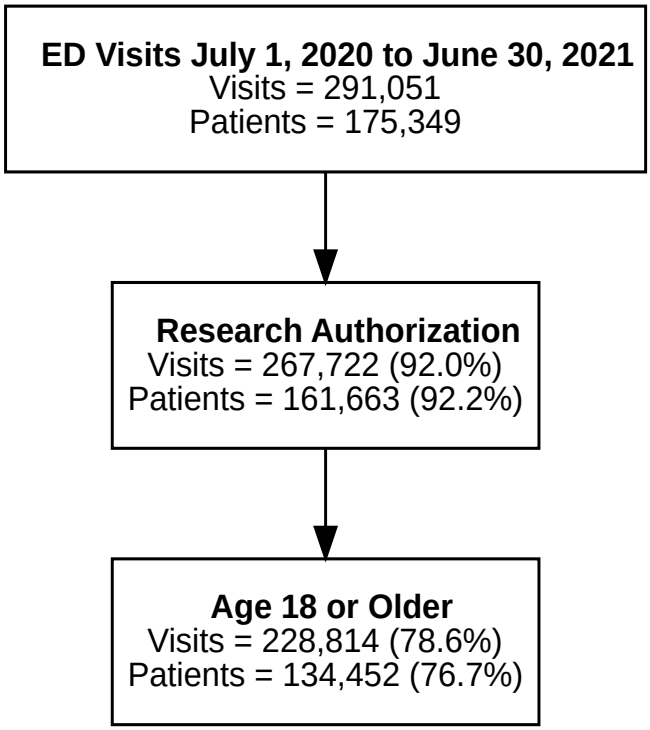

Figure 1. Participant enrollment in social determinants of health survey by number of visits and unique patients.
ED, emergency department.

care visits and access to primary care, as well as patient factors and choice in answering the survey questions.

Patient Characteristics

The overall mean age for ED visits during the study period was 52.1 years, with 53.5% visits from females, 11.1% non-White, and 96.7% English-speaking. Insurance, means of arrival, CCI score, acuity level, and dispositions are included in Table 1. Primary mental health diagnoses included 1.2% for an alcohol-related diagnosis, 0.3% for a substance-related diagnosis, and 2.0% for a psychiatric-related diagnosis (Table 1). As compared with patients with ≤5 ED visits in the prior year, patients in the frequent-user cohort were more likely to be younger, female, and Black. They were also more likely to have Medicaid insurance, arrive by emergency medical services (EMS), have a higher CCI score, have higher proportions of digestive and psychiatric chief complaints, and ethanol-related visits. Patients with frequent ED use had death rates that were lower at seven days but higher at 90 days and 180 days (Table 1). All comparisons were significant, $P < .001$.

Table 1. Summary of patient demographics, visit characteristics, and outcomes

	All ED Visits (N = 228,814)	0-5 ED Visits in the Prior Year (N = 208,285)	6+ ED Visits in the prior year (N = 20,529)
Age, years			
Mean (SD)	52.1 (21.4)	52.4 (21.5)	49.5 (19.7)
Median (Q1, Q3)	52 (33, 70)	52 (33, 70)	48 (32, 64)
Sex, n (%)			
Female	122,415 (53.5%)	110,664 (53.1%)	11,751 (57.2%)
Male	106,392 (46.5%)	97,614 (46.9%)	8,778 (42.8%)
Unknown/did not disclose	7 (0.0%)	7 (0.0%)	0 (0%)
Race, n (%)			
American Indian/Alaskan Native	998 (0.4%)	853 (0.4%)	145 (0.7%)
Asian	2,771 (1.2%)	2,630 (1.3%)	141 (0.7%)
Black/African American	10,886 (4.8%)	9,442 (4.5%)	1,444 (7.0%)
Native Hawaiian/Pacific Islander	412 (0.2%)	373 (0.2%)	39 (0.2%)
White	203,339 (88.9%)	185,430 (89.0%)	17,909 (87.2%)
Mixed race	1,519 (0.7%)	1,216 (0.6%)	303 (1.5%)
Unknown/did not disclose	8,889 (3.9%)	8,341 (4.0%)	548 (2.7%)
Ethnicity, n (%)			
Not Hispanic or Latino	213,018 (93.1%)	193,642 (93.0%)	19,376 (94.4%)
Hispanic or Latino	11,476 (5.0%)	10,443 (5.0%)	1,033 (5.0%)
Unknown/did not disclose	4,320 (1.9%)	4,200 (2.0%)	120 (0.6%)
Primary language, n (%)			
English	221,226 (96.7%)	201,175 (96.6%)	20,051 (97.7%)
Spanish	2,948 (1.3%)	2,823 (1.4%)	125 (0.6%)
Somali	1,445 (0.6%)	1,314 (0.6%)	131 (0.6%)
Arabic	672 (0.3%)	597 (0.3%)	75 (0.4%)
Hmong	316 (0.1%)	278 (0.1%)	38 (0.2%)
Other language	1,648 (0.7%)	1,550 (0.7%)	98 (0.5%)
Unknown/did not disclose	559 (0.2%)	548 (0.3%)	11 (0.1%)
Language interpreter, n (%)			
No	147,930 (64.7%)	145,026 (69.6%)	2,904 (14.1%)
Yes	3,856 (1.7%)	3,810 (1.8%)	46 (0.2%)
Unknown/not recorded	77,028 (33.7%)	59,449 (28.5%)	17579 (85.6%)
Insurance type, n (%)			
Medicaid	51,544 (22.5%)	43,153 (20.7%)	8,391 (40.9%)
Medicare	85,769 (37.5%)	77,169 (37.0%)	8,600 (41.9%)
Other	10,658 (4.7%)	10,289 (4.9%)	369 (1.8%)

ED, emergency department; *SD,* standard deviation; *Q,* quartile.

Table 1. Continued.

	All ED visits (N = 228,814)	0-5 ED visits in the prior year (N = 208,285)	6+ ED visits in the prior year (N = 20,529)
Private insurance	70,715 (30.9%)	67,981 (32.6%)	2,734 (13.3%)
Self-pay	10,124 (4.4%)	9,690 (4.7%)	434 (2.1%)
Unknown	4 (0.0%)	3 (0.0%)	1 (0.0%)
ED Region, n (%)			
MCHS Northwest Wisconsin	57,118 (25.0%)	51,849 (24.9%)	5,269 (25.7%)
MCHS Southeast Minnesota	51,105 (22.3%)	46,026 (22.1%)	5,079 (24.7%)
MCHS Southwest Minnesota	41,588 (18.2%)	37,665 (18.1%)	3,923 (19.1%)
MCHS Southwest Wisconsin	24,094 (10.5%)	22,001 (10.6%)	2,093 (10.2%)
Rochester	54,909 (24.0%)	50,744 (24.4%)	4,165 (20.3%)
Means of arrival, n (%)			
Non-EMS arrival	186,128 (81.3%)	170,838 (82.0%)	15,290 (74.5%)
EMS arrival	40,441 (17.7%)	35,391 (17.0%)	5,050 (24.6%)
Unknown	2,245 (1.0%)	2,056 (1.0%)	189 (0.9%)
Arrival Day of the Week, n (%)			
Sunday	30,756 (13.4%)	27,939 (13.4%)	2,817 (13.7%)
Monday	36,081 (15.8%)	32,874 (15.8%)	3,207 (15.6%)
Tuesday	33,353 (14.6%)	30,393 (14.6%)	2,960 (14.4%)
Wednesday	33,560 (14.7%)	30,595 (14.7%)	2,965 (14.4%)
Thursday	32,045 (14.0%)	29,090 (14.0%)	2,955 (14.4%)
Friday	32,502 (14.2%)	29,552 (14.2%)	2,950 (14.4%)
Saturday	30,517 (13.3%)	27,842 (13.4%)	2,675 (13.0%)
Arrival time of the day, n (%)			
Midnight to 6AM	20,819 (9.1%)	18,473 (8.9%)	2,346 (11.4%)
6am to Noon	64,659 (28.3%)	59,599 (28.6%)	5,060 (24.6%)
Noon to 6PM	86,914 (38.0%)	79,506 (38.2%)	7,408 (36.1%)
6PM to Midnight	56,422 (24.7%)	50,707 (24.3%)	5,715 (27.8%)
Triage ESI, n (%)			
Level 1	1,709 (0.7%)	1,575 (0.8%)	134 (0.7%)
Level 2	32,533 (14.2%)	29,113 (14.0%)	3,420 (16.7%)
Level 3	130,813 (57.2%)	119,064 (57.2%)	11,749 (57.2%)
Level 4	45,075 (19.7%)	41,605 (20.0%)	3,470 (16.9%)
Level 5	4,972 (2.2%)	4,499 (2.2%)	473 (2.3%)
Unknown	13,712 (6.0%)	12,429 (6.0%)	1,283 (6.2%)
MEW score, 0 - 14			
Mean (SD)	3.7 (1.0)	3.6 (1.0)	3.8 (1.0)
Median (Q1, Q3)	3 (3, 4)	3 (3, 4)	3 (3, 4)
Adjusted Charlson Comorbidity Index, 0 - 37			
Mean (SD)	4.0 (4.5)	3.8 (4.4)	5.8 (5.2)
Median (Q1, Q3)	2 (0, 7)	2 (0, 6)	4 (1, 10)
ED disposition, n (%)			
Discharge	168,043 (73.4%)	153,376 (73.6%)	14,667 (71.4%)
Admit	30,258 (13.2%)	27,685 (13.3%)	2,573 (12.5%)
Hospital observation	14,534 (6.4%)	13,117 (6.3%)	1,417 (6.9%)
Transfer – external	10,955 (4.8%)	9,790 (4.7%)	1,165 (5.7%)
Irregular departure	4,300 (1.9%)	3,656 (1.8%)	644 (3.1%)

ED, emergency department; *MCHS,* Mayo Clinic Health System; *EMS,* emergency medical services; *ESI,* Emergency Severity Index; *MEW,* modified early warning score; *SD,* standard deviation; *Q,* quartile.

Table 1. Continued.

	All ED visits (N = 228,814)	0-5 ED visits in the prior year (N = 208,285)	6+ ED visits in the prior year (N = 20,529)
Transfer – internal	151 (0.1%)	131 (0.1%)	20 (0.1%)
ED Observation	276 (0.1%)	251 (0.1%)	25 (0.1%)
Expired	195 (0.1%)	186 (0.1%)	9 (0.0%)
Unknown	102 (0.0%)	93 (0.0%)	9 (0.0%)
Chief complaint, n (%)			
Musculoskeletal	39,102 (17.1%)	36,122 (17.3%)	2,980 (14.5%)
Digestive	35,870 (15.7%)	32,101 (15.4%)	3,769 (18.4%)
General	33,857 (14.8%)	31,275 (15.0%)	2,582 (12.6%)
Respiratory	26,094 (11.4%)	23,679 (11.4%)	2,415 (11.8%)
Neurological	25,250 (11.0%)	22,910 (11.0%)	2,340 (11.4%)
Cardiovascular	21,414 (9.4%)	19,532 (9.4%)	1,882 (9.2%)
Skin	16,189 (7.1%)	15,285 (7.3%)	904 (4.4%)
Mental health	11,530 (5.0%)	9,661 (4.6%)	1,869 (9.1%)
Urological	6,101 (2.7%)	5,382 (2.6%)	719 (3.5%)
Eye	3,536 (1.5%)	3,386 (1.6%)	150 (0.7%)
Genital	2,127 (0.9%)	1,970 (0.9%)	157 (0.8%)
Ear	1887 (0.8%)	1,775 (0.9%)	112 (0.5%)
Pregnancy	1,087 (0.5%)	1,003 (0.5%)	84 (0.4%)
Endocrine	713 (0.3%)	614 (0.3%)	99 (0.5%)
Process	711 (0.3%)	585 (0.3%)	126 (0.6%)
Social problem	641 (0.3%)	584 (0.3%)	57 (0.3%)
Unknown	2,705 (1.2%)	2,421 (1.2%)	284 (1.4%)
Chief complaint – pain, n (%)			
Non-pain complaint	156,492 (68.4%)	142,826 (68.6%)	13,666 (66.6%)
Pain complaint	69,617 (30.4%)	63,038 (30.3%)	6,579 (32.0%)
Unknown	2,705 (1.2%)	2421 (1.2%)	284 (1.4%)
Primary mental health diagnosis, n (%)			
ETOH related	2,801 (1.2%)	2,188 (1.1%)	613 (3.0%)
Substance related	776 (0.3%)	649 (0.3%)	127 (0.6%)
Other psych diagnosis	4,504 (2.0%)	3,789 (1.8%)	715 (3.5%)
Other diagnosis	220,733 (96.5%)	20,1659 (96.8%)	19,074 (92.9%)
ED utilization in prior year, n (%)			
0 - 2 visits	176,515 (77.1%)	176,515 (84.7%)	0 (0.0%)
3 - 5 visits	31,770 (13.9%)	31,770 (15.3%)	0 (0.0%)
6 - 17 visits	17,977 (7.9%)	0 (0.0%)	17,977 (87.6%)
18 or more visits	2,552 (1.1%)	0 (0.0%)	2,552 (12.4%)
Patient mortality, n (%)			
Death within 7 days	1,697 (0.7%)	1,569 (0.8%)	128 (0.6%)
Death within 90 days	8,151 (3.6%)	7,079 (3.4%)	1,072 (5.2%)
Death within 180 days	11,787 (5.2%)	10,186 (4.9%)	1,601 (7.8%)

ED, emergency department; *ETOH,* ethanol.

Outcome Data

Overall, visits among patients with ≥3 previous ED visits accounted for 22.9% (52,299 / 228,814) of the total ED utilization, and visits among patients with ≥6 ED visits accounted for 9.0% (20,529/228,814) of total ED utilization (Table 2).

Mental Health Disorder Associations with Frequent Emergency Department Use

The most common ICD-10 mental health diagnosis codes were mood and affective disorders (32.0%), anxiety and other non-psychotic disorders (30.1%), and psychoactive substance

Table 2. Frequency of active mental health problems by ED utilization, n (%)

		ED utilization in the year prior to index visit				
All patients	ICD-10 Codes	All visits (N = 22,8814)	0 – 2 visits (N = 176,515)	3 – 5 visits (N = 31,770)	6 – 17 visits (N = 17,977)	18+ visits (N = 2,552)
Disorders due to physiological conditions	F01 – F10	10,643 (4.7%)	6,088 (3.4%)	2,425 (7.6%)	1,829 (10.2%)	301 (11.8%)
Psychoactive substance use	F11 – F19	41,060 (17.9%)	23,297 (13.2%)	8,875 (27.9%)	7,508 (41.8%)	1,380 (54.1%)
Non-mood psychotic disorders	F20 – F29	6,532 (2.9%)	3,119 (1.8%)	1,477 (4.6%)	1480 (8.2%)	456 (17.9%)
Mood/affective disorders	F30 – F39	73,168 (32.0%)	45,150 (25.6%)	14,916 (46.9%)	11128 (61.9%)	1,974 (77.4%)
Anxiety, stress and non-psychotic disorders	F40 – F49	68,873 (30.1%)	42,119 (23.9%)	14,079 (44.3%)	10,658 (59.3%)	2,017 (79.0%)
Behavioral syndromes due to physical factors	F50 – F59	5,809 (2.5%)	3,254 (1.8%)	1,267 (4.0%)	1,097 (6.1%)	191 (7.5%)
Adult personality and behavioral dsorders	F60 – F69	10,172 (4.4%)	4,282 (2.4%)	2,373 (7.5%)	2,821 (15.7%)	696 (27.3%)
Intellectual disabilities	F70 – F79	1,088 (0.5%)	532 (0.3%)	237 (0.7%)	242 (1.3%)	77 (3.0%)
Pervasive developmental disorders	F80 – F89	2,510 (1.1%)	1320 (0.7%)	576 (1.8%)	458 (2.5%)	156 (6.1%)
Childhood behavioral disorders	F90 – F98	14,482 (6.3%)	8,732 (4.9%)	2,966 (9.3%)	2,374 (13.2%)	410 (16.1%)

ED, emergency department.

use (17.9%). The patients with 6-17 visits had the same most common disorders but higher proportions of each (61.9%, 59.3%, and 41.8%, respectively) (Table 2). Mental health risk factors increased with frequency of ED utilization for all categories (Figure 2).

Mental Health Risk Factors and Emergency Department Use

In a multivariable model adjusting for clinical features, all mental health diagnostic categories were significantly associated with frequent ED utilization as defined by having ≥6 annual ED visits, with the greatest odds of association with adult personality disorders (OR 4.00, 95% CI 3.79 - 4.23, $P < .001$), anxiety and other non-psychotic disorders (OR 3.35, 95% CI 3.23 - 3.47, $P < .001$), and mood/affective disorders (OR 3.23, 95% CI 3.11 - 3.34, $P < .001$). In the multivariable model adjusting for both clinical features as well as the presence of diagnoses in other mental health diagnostic categories, all categories of mental health diagnoses continued to be significantly associated with frequent ED utilization; however, the odds of association were attenuated. The diagnostic categories with the greatest associations were anxiety stress and other non-psychotic disorders (OR 1.95, 95% CI 1.87 - 2.03, $P < .001$), adult personality and behavior disorders (OR 1.91, 95% CI 1.80 - 2.02, $P < .001$), and non-mood psychotic disorders (OR 1.79, 95% CI 1.66 - 1.93, $P < .001$) (Table 3).

SDoH and Mental Health Diagnoses Associations with Frequent Emergency Department Use

The most common SDoH risk factors among the entire cohort included social isolation (56.5%), physical inactivity (28.3%), daily stress (24.3% high risk), and high-risk tobacco smoking (23.9%). For patients with 6 - 17 visits the most common SDoH risk factors were social isolation (70.0%), high-risk daily stress (39.3%), food insecurity (37.3%), and tobacco smoking (35.1% high risk). Patients with ≥ 18 ED visits had the highest proportions of depression risk (54.8%), food insecurity (55.1%), inadequate financial resources risk (26.3%), and unmet transportation needs (45.8%), but the lowest proportion of heavy alcohol use (10.9%) (Table 4). Item response rates ranged from 18.1 - 49.7% for the SDoH factors (Table 5). The SDoH risk factors increased with frequency of ED use for most categories with the exceptions of alcohol use and interpersonal violence, with tapering at the extremely high categories for daily stress, physical inactivity, social isolation, and tobacco use (Figure 3).

Social Determinants of Health Risk Factors and Emergency Department Use

In a multivariable model adjusting for clinical features, most SDoH risk factors were significantly associated with frequent ED use (≥ 6 annual visits). Heavy alcohol use was

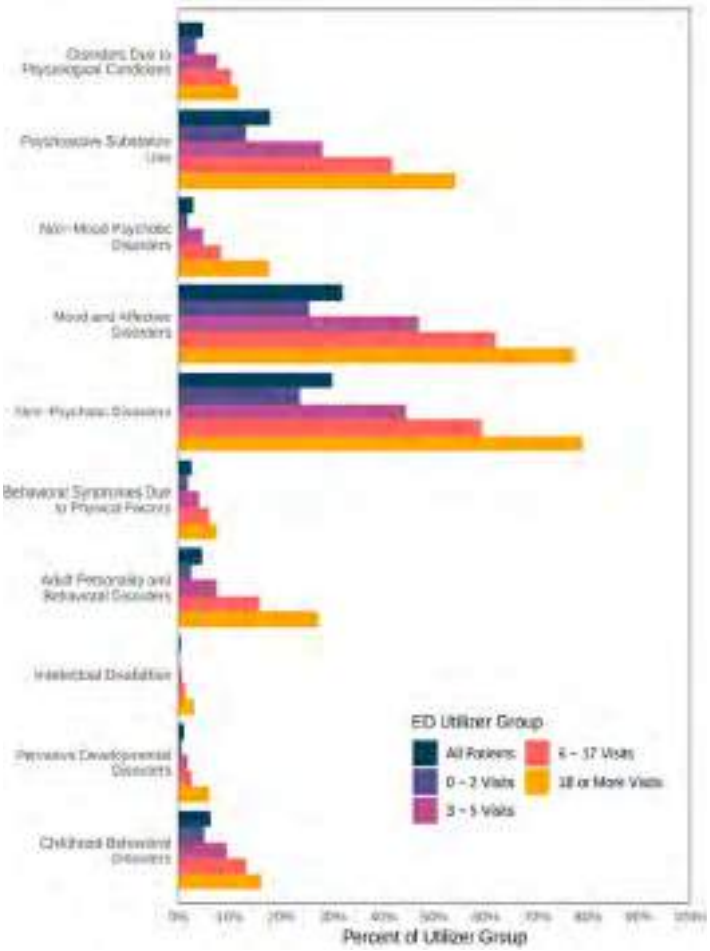

Figure 2. Mental health risk factors associated with emergency department use.
ED, emergency department.

associated with a decreased odds of high ED use (OR 0.72, 95% CI 0.66 - 0.79, $P < .001$) while the others were associated with an increased odds of frequent ED use. The greatest associations were for unmet transportation needs (OR 2.28, 95% CI 2.10 - 2.46, $P < .001$), inadequate financial resources risk (OR 2.04, 95% CI 1.88 - 2.20, $P < 0.001$), food insecurity (OR 2.00, 95% CI 1.88 - 2.14, $P < .001$), depression risk (OR 1.74, 95% CI 1.65 - 1.83, $P < .001$), and high risk of daily stress (OR 1.60, 95% CI 1.47 - 1.73, $P < .001$).

When adjusting for both clinical features and mental health diagnoses, the magnitude of most SDoH associations were attenuated and interpersonal violence, low risk for daily stress, and social isolation were not significantly associated with frequent ED use. The top three risk factors associated with the greatest odds of frequent ED use continued to be unmet transportation needs (OR 1.73, 95% CI 1.59-1.88, $P < .001$), food insecurity (OR 1.58, 95% CI 1.48-1.70, $P < .001$), and high risk for inadequate financial resources (OR 1.52, 95% CI 1.40-1.65, $P < .001$) (Table 5).

DISCUSSION

This large multicenter study involving 228,814 patients across EDs in the Upper Midwest found significant associations between mental illness and SDoH with frequent ED use. This is in line with prior studies that demonstrate associations between increased healthcare utilization and mental health illness[1,5,6,7,8,13-15] and SDOH risk factors such as homelessness.[1,10,14,15] Our study encompasses a diverse range of settings, including academic, community, and critical access hospitals across

Table 3: Association between active mental health diagnoses and frequent ED utilization

	Univariable[1] 6+ ED visits		Multivariable[1] 6+ ED visits	
Mental health risk factor	OR[2] (95% CI)	P-value	OR[2] (95% CI)	P-value
Disorders Due to Physiological Conditions	2.02 (1.91, 2.15)	< 0.001	1.31 (1.22, 1.39)	< .001
Psychoactive Substance Use	2.87 (2.76, 2.98)	< 0.001	1.72 (1.65, 1.79)	< .001
Non-Mood Psychotic Disorders	3.18 (2.97, 3.42)	< 0.001	1.79 (1.66, 1.93)	< .001
Mood/Affective Disorders	3.23 (3.11, 3.34)	< 0.001	1.73 (1.66, 1.81)	< .001
Anxiety, Stress and Non-Psychotic Disorders	3.35 (3.23, 3.47)	< 0.001	1.95 (1.87, 2.03)	< .001
Behavioral Syndromes Due to Physical Factors	2.32 (2.15, 2.50)	< 0.001	1.31 (1.21, 1.41)	< .001
Adult Personality and Behavior Disorders	4.00 (3.79, 4.23)	< 0.001	1.91 (1.80, 2.02)	< .001
Intellectual Disabilities	2.84 (2.42, 3.34)	< 0.001	1.56 (1.32, 1.85)	< .001
Pervasive Developmental Disorders	1.93 (1.73, 2.16)	< 0.001	1.23 (1.09, 1.39)	.001
Childhood Behavioral Disorders	1.88 (1.78, 1.99)	< 0.001	1.09 (1.03, 1.16)	< .01

[1]Univariable models assess each mental health risk factor individually, multivariable models adjust for all other psych risk factors
[2]Odds ratios were adjusted for patient age, sex, race, ethnicity, primary language, insurance, means of arrival, arrival day of the week and time of the day, ESI, MEW score, Charlson comorbidity, chief complaint, primary diagnosis, and ED disposition.
ESI, Emergency Severity Index; *MEW,* modified early warning score; *ED,* emergency department; *OR,* odds ratio.

Table 4: Frequency of SDOH risk factors by ED utilization, n (%)

			ED utilization in the year prior to index visit			
Social determinant of health	Risk level	All visits	0 – 2 visits	3 – 5 visits	6 – 17 visits	18+ visits
Alcohol use	Total responses	65,060	48,040	10,203	5,984	833
	Not at risk	53,743 (82.6)	39,128 (81.4)	8,704 (85.3)	5,169 (86.4)	742 (89.1)
	Heavy drinker	11,317 (17.4)	8,912 (18.6)	1,499 (14.7)	8,15 (13.6)	91 (10.9)
Daily stress	Total responses	74,373	55,007	11,666	6,779	921
	No risk	19,571 (26.3)	15,549 (28.3)	2,553 (21.9)	1,337 (19.7)	132 (14.3)
	Low risk	36,741 (49.4)	27,974 (50.9)	5,526 (47.4)	2,781 (41.0)	460 (49.9)
	High risk	18,061 (24.3)	11,484 (20.9)	3,587 (30.7)	2,661 (39.3)	329 (35.7)
Depression	Total responses	113,643	82,973	18,408	10,776	1,486
	Not at risk	93,499 (82.3)	71,057 (85.6)	14,098 (76.6)	7,673 (71.2)	671 (45.2)
	At risk	20,144 (17.7)	11,916 (14.4)	4,310 (23.4)	3,103 (28.8)	815 (54.8)
Financial resources	Total responses	68,919	50,630	10,925	6,505	859
	Low risk	49,709 (72.1)	39,038 (77.1)	6,823 (62.5)	3,557 (54.7)	291 (33.9)
	Medium risk	12,347 (17.9)	7,827 (15.5)	2,526 (23.1)	1,652 (25.4)	342 (39.8)
	High risk	6,863 (10.0)	3,765 (7.4)	1,576 (14.4)	1,296 (19.9)	226 (26.3)
Food insecurity	Total responses	62,972	45,939	10,077	6,089	867
	No insecurity	50,081 (79.5)	38,798 (84.5)	7,093 (70.4)	3,801 (62.4)	389 (44.9)
	Insecurity present	12,891 (20.5)	7,141 (15.5)	2,984 (29.6)	2,288 (37.6)	478 (55.1)
Inter-personal violence	Total responses	41,306	31,134	6,185	3,634	353
	Not at risk	37,988 (92.0)	29,081 (93.4)	5,486 (88.7)	3,098 (85.3)	323 (91.5)
	At risk	3,318 (8.0)	2,053 (6.6)	699 (11.3)	536 (14.7)	30 (8.5)
Physical inactivity	Total responses	68,084	50,614	10,594	6,198	678
	Sufficiently active	19,261 (28.3)	15,191 (30.0)	2,530 (23.9)	1,423 (23.0)	117 (17.3)
	Insufficiently active	29,756 (43.7)	22,356 (44.2)	4,414 (41.7)	2,615 (42.2)	371 (54.7)
	Inactive	19,067 (28.0)	13,067 (25.8)	3,650 (34.5)	2,160 (34.8)	190 (28.0)
Social isolation	Total responses	53,874	39,729	8,441	5,048	656
	Socially integrated	23,434 (43.5)	18,641 (46.9)	2,915 (34.5)	1,515 (30.0)	363 (55.3)
	Socially isolated	30,440 (56.5)	21,088 (53.1)	5,526 (65.5)	3,533 (70.0)	293 (44.7)
Smoking tobacco	Total responses	142,403	105,714	22,261	12,695	1,733
	Low risk	60,186 (42.3)	48,068 (45.5)	7,890 (35.4)	3,823 (30.1)	405 (23.4)
	Medium risk	48,170 (33.8)	35,109 (33.2)	7,872 (35.4)	4,420 (34.8)	769 (44.4)
	High risk	34,047 (23.9)	22,537 (21.3)	6,499 (29.2)	4,452 (35.1)	559 (32.3)
Transportation needs	Total responses	64,240	47,350	10,110	5,975	805
	Needs met	57,931 (90.2)	44,153 (93.2)	8,663 (85.7)	4,679 (78.3)	436 (54.2)
	Needs not met	6,309 (9.8)	3,197 (6.8)	1,447 (14.3)	1,296 (21.7)	369 (45.8)

SDOH, social determinants of health; *ED,* emergency department.

two Midwestern states, broadening the perspective on frequent ED use.

We found that even after accounting for clinical and visit features and mental health risk factors, unmet transportation needs, high risk for financial resources, and food insecurity had the strongest associations with frequent ED utilization (Table 7). This adds to prior studies that focus on homelessness as a key risk factor,[1,8,11] which may be highly correlated with financial strain, food insecurity, and transportation challenges. These findings are particularly pertinent to the population included in this study, which includes rural, geographically isolated EDs where patients may not have access to robust public transportation resources or strong social programs to address food insecurity and financial strain. The two mental health diagnostic categories most associated with frequent ED use were adult personality and behavioral disorders and anxiety, stress, and non-psychotic disorders. This is similar to prior research that

Table 5. Association between social determinants of health and frequent ED utilization

Social Determinant of Health		Adjusted for clinical features		Adjusted for clinical features and mental health risk factors	
		6+ ED Visits OR (95% CI)	P-value	6+ ED visits OR (95% CI)	P-Value
Alcohol use (N = 65,060)	Not at risk	-Reference-	---	-Reference-	---
	Heavy drinker	0.72 (0.66, 0.79)	< .001	0.78 (0.71, 0.85)	< 0.001
Daily stress (N = 74,373)	No risk	-Reference-	---	-Reference-	---
	Low risk	1.11 (1.03, 1.19)	.01	1.00 (0.91, 1.09)	.94
	High risk	1.60 (1.47, 1.73)	< .001	1.11 (1.03, 1.20)	.0
Depression (N = 113,643)	Not at risk	-Reference-	---	-Reference-	---
	At risk	1.74 (1.65, 1.83)	< .001	1.14 (1.08, 1.20)	< .001
Financial resources (N = 68,919)	Low risk	-Reference-	---	-Reference-	---
	Medium risk	1.61 (1.51, 1.73)	< .001	1.40 (1.30, 1.50)	< .001
	High risk	2.04 (1.88, 2.20)	< .001	1.52 (1.40, 1.65)	< .001
Food insecurity (N = 62,972)	No insecurity	-Reference-	---	-Reference-	---
	Insecurity present	2.00 (1.88, 2.14)	< .001	1.58 (1.48, 1.70)	< .001
Inter-personal violence (N = 41,306)	Not at risk	-Reference-	---	-Reference-	---
	At risk	1.44 (1.28, 1.62)	< .001	1.06 (0.94, 1.20)	.36
Physical inactivity (N = 68,084)	Sufficiently active	-Reference-	---	-Reference-	---
	Insufficiently active	1.19 (1.10, 1.28)	< .001	1.09 (1.01, 1.18)	.03
	Inactive	1.38 (1.27, 1.51)	< .001	1.23 (1.13, 1.34)	< .001
Social isolation (N = 53,874)	Socially integrated	-Reference-	---	-Reference-	---
	Socially isolated	1.06 (0.99, 1.14)	.09	0.98 (0.91, 1.05)	.55
Smoking tobacco (N = 142,403)	Low risk	-Reference-	---	-Reference-	---
	Medium risk	1.34 (1.27, 1.41)	< .001	1.24 (1.18, 1.31)	< .001
	High risk	1.58 (1.49, 1.66)	< .001	1.31 (1.24, 1.39)	< .001
Transportation needs (N = 64,240)	Needs met	-Reference-	---	-Reference-	---
	Needs not met	2.28 (2.10, 2.46)	< .001	1.73 (1.59, 1.88)	< .001

[1]Clinical features include patient age, sex, race, ethnicity, primary language, insurance, means of arrival, arrival day of the week and time of the day, ESI, MEW score, Charlson comorbidity, chief complaint, primary diagnosis, and ED disposition.
ED, emergency department; *OR,* odds ratio; *CI,* confidence interval; *ESI,* Emergency Severity Index; *MEW,* modified early warning score.

demonstrated increased risk in conditions of depression, anxiety, personality disorders, and overall severe chronic mental health illness.[7] After adjusting for all other mental health diagnostic categories there remained an almost doubling of the odds of frequent ED use for both (Table 7). The high prevalence of anxiety, stress, and non-psychotic disorders (30.1% of all visits, 61.7% 6+ visits) among frequent users is significant.

We observed a near doubling of the odds of anxiety and stressor personality and behavior disorders and an

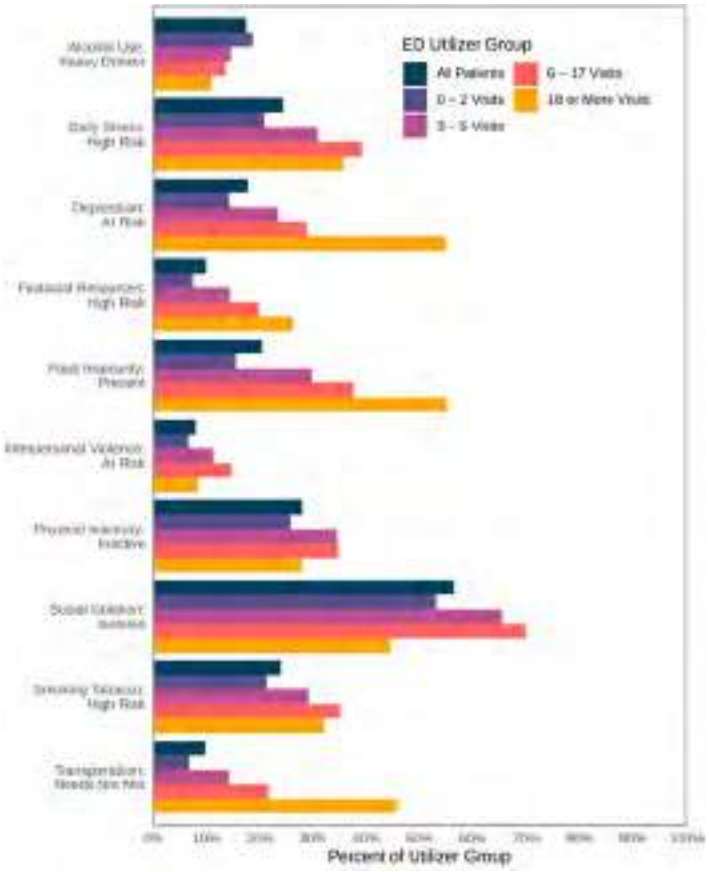

Figure 3. Social determinants of health risk factors associated with emergency department use.
ED, emergency department.

Table 6: Odds of death for frequent utilizers relative to non-frequent utilizers

Odds of death	OR (95% CI)	P-Value
7 Days After ED Encounter	0.83, 95% CI: 0.69-0.99	p = .04
90 Days After ED Encounter	1.57, 95% CI: 1.47-1.68	p < 0.001
180 Days After ED Encounter	1.64, 95% CI: 1.56-1.74	p < 0.001

ED, emergency department; OR, odds ratio; CI, confidence interval.

approximately 75% increased odds of psychotic disorders and mood disorders. The associations continue to be positive but attenuate after adjusting for clinical factors and other mental health diagnoses. We found that after accounting for clinical and visit characteristics and mental health risk factors, heavy alcohol use was associated with a 22% decreased odds of frequent ED use (Table 7). This is a novel finding not previously reported per our literature review and deserves further study. Prior studies show an association of alcohol and substance use with frequent ED use.[1, 3, 5,10,14,15] Our findings could be driven by survey response biases in under-reporting alcohol consumption.

Similar to the findings of prior studies we found that ED frequent users are more likely to be younger, female, on Medicaid, arrive via EMS, have high comorbidity, and have digestive and psychiatric chief complaints.[27] In a prior study of frequent ED use, mortality rates among frequent ED users ranged from no different to three times higher compared to non-frequent ED users.[18] In our study we found that the odds of patient mortality were 17% lower, at seven days, and nearly 60% higher at 90 days and 180 days in the frequent-user group (≥6 ED annual visits compared to <6 visits in prior year) in line with the increased risk identified across other studies.

LIMITATIONS

Our study has several limitations, the most significant being the methodology used to collect SDoH data. This information is gathered during outpatient visits within our organization, resulting in ≈60% of ED visits with at least one SDoH question completed, potentially affecting the generalizability to the broader ED cohort. For example, missing SDoH responses to sensitive or personal questions—potentially due to perceived stigma—may induce a sample bias leading to the under-representation of certain SDoH risk factors. However, with over 65,000 patients providing SDoH data, this still represents a substantial proportion of the total cohort, offering valuable insights that warrant further investigation. We hypothesize that SDoH factors will show even stronger associations when data is available for the entire ED patient population, although additional studies are needed to confirm this. In addition, our population is primarily White and speaks English as a primary language, which limits generalizability to more diverse populations outside Midwest rural populations. There may be unmeasured variables such as homelessness, which could result in confounding of results.

CONCLUSION

We found strong associations between mental illness and social determinants of health and frequent ED utilization. The strongest SDoH risk factors include unmet transportation needs, financial resource risk, and food insecurity. These risks persist after adjusting for clinical features and mental health risk factors. Additionally, the top two mental health risk factors are adult personality and behavioral disorders as well as anxiety and stress, differences that persist when analyzed independently as well as when adjusting for other mental health risk factors.

Further understanding of the interaction between SDoH, mental health disorders, and frequent ED utilization, including in rural geographically isolated areas with limited access to public transportation and strong social programs, will empower care teams to address root causes and improve health outcomes among this vulnerable population. Further studies of rural healthcare systems could be compared to

studies conducted in large metropolitan areas to better understand how interventions can be customized based on the needs of the population.

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Emergency Medical Services Calls for Service at Adult Detention Centers: A Descriptive Study

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Introduction: Incarcerated individuals represent a vulnerable sector of society, with a disproportionate burden of substance use, mental health problems, and chronic illness. The purpe of this study was to perform a descriptive analysis of emergency medical services (EMS) response to detention facilities.

Methods: We conducted a retrospective review of Mayo Clinic Ambulance Service ground EMS emergency (9-1-1) calls for service to nine detention centers within the service area occurring between January 1, 2002–December 31,2021. We excluded calls to a 10th detention center, the Federal Medical Center – Rochester, due to the unique nature of this facility. Additional exclusion criteria included non-emergency calls and lack of patient care narratives within the patient care report. We analyzed data using descriptive statistics, chi-square, and the Student *t*-test. This study was reviewed and approved by the Mayo Clinic Institutional Review Board.

Results: During the study period, 3,114/1,231,853 (0.25%) service requests to detention facilities occurred. After accounting for exclusion criteria, the final sample size consisted of 2,034 patients. Average patient age was 40.2 ± 13.3 years of age, compared with 54.0 ± 25.9 years of age for non-detention center calls ($P < 0.001$). The majority (80.8%) of patients were male. Mean scene time was 14:13 ± 7:49 minutes, compared with 12:04 ± 12:27 minutes ($P < 0.01$) for non-detention center calls. The most common complaints were medical, behavioral emergencies, cardiac, and trauma. Obstetrics requests accounted for 5.8% of calls for female patients. Most calls (91.3%) to detention centers involved incarcerated individuals, with the remainder representing facility staff (1.5%), visitors (0.5%), and undetermined (6.7%). Nearly 4% of patients refused treatment; 48.9% of these patients were still transported. Consent for treatment/transport by the patient was documented in 6.1% of charts.

Conclusion: Recognizing the retrospective, single-agency nature of this study, we found that calls to detention facilities within our 9-1-1 service area predominantly involved incarcerated individuals. Consent for treatment/transport was not documented in most EMS encounters. Further study is needed to better understand the healthcare needs of these patients, including ability to consent. [West J Emerg Med. 2025;26(4)918–923.]

INTRODUCTION

The United States (US) has the highest reported prison population in the world, and the highest incarceration rate in the western world.[1] In 2008, 1 in every 100 US adults was behind bars.[2] Incarceration rates among minority populations were even more stark; 1 in 36 Hispanic males ≥18 years of age was incarcerated, as was 1 in 15 Black males. Incarcerated individuals represent a vulnerable sector of society, and incarceration itself forms a social determinant of health.[3,4] Studies suggest that up to 76% of incarcerated adult males have substance use and/or mental health disorders.[5-7] These individuals also have a disproportionate burden of chronic

illness compared with the general public, including heart disease, cancer, and HIV.[8]

Deaths in detention facilities are increasing.[9] Suicide is the single leading cause of death, accounting for approximately 30% of all prisoner deaths.[10] However, 46% of deaths are due to illness, including heart disease, liver disease, and cancer. The number of deaths due to substance intoxication quadrupled between 2000 and 2018.[9] COVID-19 incidence and standardized mortality were higher in prisons than in the general US population.[11]

Incarcerated and recently released individuals are frequent users of emergency departments.[12-15] Despite this, little is known about the emergency medical services (EMS) response to detention facilities.[16-18] A recent news report highlighted the issue of delayed EMS access to incarcerated patients resulting in death.[19] One EMS article suggested a deceptive agenda for EMS use by incarcerated individuals, using the pejorative term "incarceritis" to suggest malingering and inappropriate transport.[17]

Purpose

Given this identified knowledge gap surrounding a vulnerable patient population, our goal in this study was to perform a descriptive analysis of EMS response to detention centers to better understand the nature of patients (eg, incarcerated individual, facility staff, visitor) and associated complaints and, therefore, the operational needs and training requirements for our EMS agency, as well as to identify the unique patient care needs of this population.

Population Health Research Capsule

What do we already know about this issue?
Although incarcerated individuals represent a vulnerable population, very little is known about their medical needs requiring EMS 911 assessment.

What was the research question?
To perform a descriptive analysis of a single EMS agency's response to detention centers

What was the major finding of the study?
Most patients (91.3%) were incarcerated. Consent for treatment/transport was documented in only 6.1% of charts.

How does this improve population health?
Behavioral health emergencies are most common in jails, providing an opportunity for collaborative interventions. Further study is needed to better understand barriers to consent.

METHODS

We conducted a retrospective review of all EMS calls for service to detention facilities served by a single EMS agency between January 1, 2002–December 31, 2021. The study was reviewed and approved by the Mayo Clinic Institutional Review Board.

Study Setting

Mayo Clinic Ambulance Service (MCAS) is a comprehensive prehospital care system, including ground EMS and helicopter EMS assets. MCAS is the sole Advanced Life Support ground transport service for the served areas, with 18 ambulance bases covering 6,894 square miles responsible for providing both 9-1-1 response and interfacility transportation. The service also provides emergency intercept for regional Basic Life Support services. Within the service area are 10 detention facilities: seven county jails; one state prison; and two federal prisons, one of which is the Federal Medical Center (FMC) - Rochester. Jails and prisons differ in terms of populations and resources. Jails are short-term municipal facilities, used for those newly in custody, those awaiting trial or sentencing, and those sentenced to serve custodial sentences <1 year. In contrast, prisons are state or federal institutions in which convicted offenders serve sentences >1 year.

Study Design

We electronically abstracted all MCAS emergency (9-1-1) calls for service to an adult detention facility based upon service address/name from stored electronic patient care reports (ePCR) into a de novo, deidentified Microsoft Excel for Mac 2023, v16.77.1 (Microsoft Corporation, Redmond, WA) data collection instrument. Data points included facility name, time call originated, at-scene time, transport time, age, sex, transport priority, chief complaint, vital signs, interventions performed, transport outcome, and patient narrative record. Although the study was primarily a descriptive analysis, we abstracted the data and reported it in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist, using best practices for retrospective chart reviews.[20-22]

Exclusion criteria included non-emergency calls and calls for service at the FMC - Rochester, as these calls represent interfacility transfers rather than primary emergency responses. Although data points other than the narrative record were analyzed, we excluded from review calls with no narrative recorded from the final dataset as lack of narrative precluded assessment of consent and transport outcomes. Individual EMS patient care reports were reviewed to ensure that the final cohort of cases met inclusion and exclusion criteria.

Data Analysis

Using Microsoft Excel, we summarized numeric data with means and standard deviations; categorical data were summarized

with frequency counts and percentages. Data were analyzed using descriptive statistics. We compared patient characteristics using a two-sided Fisher exact test and unpaired two-sample *t*-tests. *P*-values less than 0.05 were considered significant.

RESULTS

During the study period, EMS responded to 1,231,853 emergency (9-1-1) response calls for service, of which 3,114 (0.25%) were calls to detention facilities. Of these, 138 did not involve EMS patient contact, and 942 had no associated patient narrative, resulting in a final cohort of 2,034 patients. Patient demographics are provided in Table 1. Mean scene time for detention center calls was 14:13 ± 7:49 minutes, compared with 12:04 ± 12:27 minutes ($P < .01$) for all other non-detention center 9-1-1 calls. Forty-nine calls explicitly documented extended delays accessing the patient due to the nature of the facility. Facility medical personnel were present prior to EMS arrival in 383 (18.8%) cases. State and federal prisons were more likely to have facility medical personnel (43.2%) than county jails (11.8%, $P < .01$). The most common chief complaints are listed in Table 1 and Table 2. Obstetrics (OB) requests accounted for 5.8% of calls for female patients. Behavioral emergencies and overdoses were more common in individuals incarcerated in county jails (370 and 50, respectively, vs 36 and 5) while cardiac issues were more common in state and federal prisons (122 vs 171). Differences in chief complaints were noted between inmates, facility staff, and visitors (Table 2). In 2% of cases, EMS personnel were called and asked to provide medical clearance. Within the ePCR narratives, documentation of consent for treatment and patients' wishes was infrequent (Table 3). Despite treatment refusal by 4.6% of patients, 42.5% of these patients were transported, all of whom were incarcerated. Treatment was specifically requested by 2.7% of patients; this was denied in 0.5% of patients. Compared with staff and visitors, inmates were more likely to be refused transport ($P = .21$) or transported against their explicit wishes ($P < .001$; Table 3). Sample narratives surrounding consent are provided in Table 4.

Table 1. Patient characteristics based upon level of incarceration in a study of emergency medical services calls to adult detention centers.

	All	Jail	State prison	Federal prison
Total Patients (n)	2,034	1,480	341	213
Age (Y)	40.1 ± 13.1	38.4 ± 12.0	39.1 ± 12.8	53.0 ± 13.4
Male (%)	79.9	73.5	95.6	98.2
Chief complaint (%)				
Behavioral	20.6	26.0	9.8	1.4
Cardiac	14.9	12.0	20.1	26.2
Medical	43.5	41.9	45.1	52.3
Obstetrics	1.5	2.0	0.0	0.5
Poisoning/ overdose	3.0	3.5	1.5	0.0
Respiratory	5.2	3.4	10.7	8.6
Trauma	11.3	11.2	12.8	11.0
Patient type (%)				
Inmate	91.3	93.1	88.0	80.3
Staff	1.5	1.2	3.5	0.5
Visitor	0.5	0.0	1.5	0.9
Undetermined	6.7	5.7	7.0	18.3
Transport Mode (%)				
Ground	100	100	100	100
Air	0	0	0	0
Transport Priority (%)				
Priority 1 (L+S)	2.6	1.6	11.8	1.9
Priority 2 (No L+S)	97.4	98.4	88.2	98.1

L+S, lights and sirens.

Table 2. Selected patient complaints based upon patient status in a study of emergency medical services calls to adult detention centers.

	All	Inmate	Staff	Visitor
Total Patients (n)	1,833	1,779	26	28
Behavioral	21.7%	21.8%	0.0%	17.9%
Cardiac	14.2%	14.2%	23.1%	14.3%
Medical	43.8%	43.6%	53.8%	57.1%
Obstetrics	1.3%	1.3%	0.0%	0.0%
Poisoning/overdose	2.9%	3.0%	0.0%	0.0%
Respiratory	4.9%	5.0%	3.8%	0.0%
Trauma	11.2%	11.1%	19.3%	10.7%

DISCUSSION

In the current study, most patient encounters involved inmates (91.3%, Table 1, Table 2). Incarcerated populations frequently over-represent minorities, have higher rates of substance use disorder and mental illness than the general population, and a limited ability to access the emergency medical care system.[2-7] Incarceration itself may, therefore, be viewed as a social determinant of health.[4] Literature regarding EMS management of incarcerated patients is sparse and often explicitly biased against this group.[17,24] Based upon ePCR narratives, EMS personnel in the current study occasionally demonstrated both explicit bias and confusion regarding an inmate's ability to both access and refuse treatment (Table 4). Most US case law in this area involves violations of the Eighth Amendment of the US Constitution, which forbids cruel or unusual punishment. Two specific cases, Estelle v Gamble and Farmer v Brennan, are frequently cited but are focused on deprivation rather than the refusal of care.[25,26] Neither ruling addresses medical decision-making by prisoners. Two decisions, Quinlan and Cruzan v Director, Missouri Department of Health, provide everyone, including competent prisoners, with the right to self-determination,

Table 3. Patient incarceration status and transport outcomes in a study of emergency medical services calls to adult detention centers.

	Inmate	Staff	Visitor
Patient Mental Status as Documented in the ePCR			
Altered mental status	309 (18.6%)	0 (0%)	3 (20%)
Not noted	1,257 (75.8%)	22 (100%)	12 (80.0%)
Uncooperative	92 (5.6%)	0 (0%)	0 (0%)
Patient Transport Request and Subsequent Disposition			
Request + transport	35 (29.4%)	1 (16.7%)	6 (46.2%)
Request + no transport	9 (7.6%)	0 (0%)	0 (0%)
Refuse + transport	37 (31.1%)	0 (0%)	0 (0%)
Refuse + no transport	38 (31.9%)	5 (83.3%)	7 (53.8%)

ePCR, electronic patient care report.

including the right to refuse treatment.[27,28,29] Despite this, consent was rarely documented in the patient care report. Although occurring infrequently, inmates were both refused transport and transported against their explicit wishes.

In contrast to the general population, restrictions placed upon access to inmates may serve to delay EMS response. The ePCR narratives specifically identified delays in patient access in 49 cases; therefore, EMS agencies should be aware of the logistical constraints in responding to calls for service at custodial facilities. Most patients in this study were detained in local jails. This may result in differences both in patient populations and medical complaints (Table 1). In contrast to prisons, which often have medical facilities on site, jails are less likely to have these resources. EMS agencies serving communities with detention facilities should plan accordingly. Differences in patient complaints were also noted based upon the nature of the patient (inmate, staff, visitor) (Table 2).

Table 4. Selected patient care report narratives in a study of emergency medical services calls to adult detention centers.

The pt argued for a while that he did not want to go to the hospital but eventually gave into her wishes.
Patient was in custody and treated and transported under the authority of the [Redacted] Correctional Facility
COULD NOT OBTAIN SIGNATURE BECAUSE PATIENT WAS PRETENDING TO HAVE AN ALTERED LEVEL OF CONSCIOUSNESS.
Patient was refusing care, but [Redacted] County policy states that patient must be checked out at emergency department. Patient refused signature
Did not want to go to the hospital. Patient finally decided to cooperate, as deputies advised that he was going to have to go regardless of the situation, due to him being in custody
Did not wish to be transported, however she was not able to decide because she was in custody
We came to a conclusion that the pt. had no head injury or need for further medical treatment.
PT stated that she did not want to go to the hospital. Jail personnel advised the PT that she did not have a choice in the matter and that she would be transported for evaluation.

pt, patient.

Due to their short-term nature, jail populations tend to be younger than those in prisons. In the current study, jail populations had an age of 38.43 ± 12.03 years, state prison populations had an age of 39.12 ± 12.75 years, and federal prison populations 52.96 ± 13.44 years. As previously noted, overdose and behavioral complaints were more common in jails.[6,30] This may reflect the fact that jail populations, being younger and often incarcerated for short periods of time, have difficulty adjusting to custodial sentences. Jail tends to be more unpredictable than prison, resulting in increased perceived stress.[31] Alternatively, jail detainees may still be suffering from the acute effects of substance exposure; thus, this population may be more likely to include patients with underlying behavioral health conditions resulting in their incarceration, which in turn may be less likely to result in felony conviction and prison sentences. Regardless, the prevalence of behavioral health calls to jails may provide an opportunity both for facility-based and EMS-based behavioral health crisis intervention teams.

Females represented 20.1% of the population in this study. The majority were encountered in jail settings compared with state or federal prisons. Only four calls for service in federal prisons involved female patients. One hundred and thirty-six calls for service at jails involved OB-related complaints.

Emercency medical services were requested to respond to custodial facilities to perform medical screening evaluations in 2% of cases. Although an uncommon occurrence, these are high-risk patient encounters. EMS agencies should consider policies and protocols for these requests, as well as perform quality assurance on all these calls.

LIMITATIONS

This study was subject to several limitations. As with any retrospective analysis, it was prone to biases, including selection bias and misclassification bias. Initial patient stratification was based upon dispatch to detention facilities. Many jails, however, are part of larger municipal complexes. We excluded 942 from the final study cohort due to lack of patient care report narratives, representing 30.3% of the initial dataset and potentially biasing the analysis. Only a single EMS system was evaluated. Each EMS system is unique and should be viewed as such. The geography and patient complaints noted in our study may not be generalizable to other systems.

A large federal prison located within the study area was excluded from this analysis. FMC - Rochester is one of seven federal Bureau of Prisons medical referral centers that provide specialized medical care and function as a medical prison.[32] However, the advanced medical care available at FMC - Rochester means that it is fundamentally different from other custodial facilities, serving as a healthcare facility for the

federal prison population. Patients are only transferred when in need of advanced diagnostic workups, specialist assessment, or higher levels of care.

Consent for treatment and transport was rarely noted in the patient narrative. It may be that crews obtained consent but simply did not document this. The rate of consent documentation in other patient populations within this EMS system is unknown. Consent may also be implied by the fact that an inmate specifically requested medical evaluation. Based upon the medical narrative, it was not always clear who initiated the request for EMS response. Due to the retrospective nature of the study, it is also unclear why consent was explicitly documented in 7.0% of cases.

CONCLUSION

Within our 9-1-1 service area, calls to detention facilities occur at a low frequency. Behavioral health emergencies are most common in county jails, providing an opportunity for collaborative interventions. Consent for treatment/transport was not documented in most EMS encounters. Although infrequent, inmates are both more likely to be transported despite refusal and to be refused transport despite requesting emergency department evaluation when compared with staff and visitors. Further study is needed to better understand the health care needs of these patients, including ability to consent.

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Mixed-Methods Investigation of Rural Emergency Medical Services ST-Elevation Myocardial Infarction Time to Percutaneous Coronary Intervention: High- vs Low-Performing Agencies

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Background: Patients with ST-elevation myocardial infarction (STEMI) cared for by rural emergency medical services (EMS) agencies commonly do not have first medical contact-to-percutaneous coronary intervention (PCI) time within the recommended goal of 90 minutes. In this study we identify factors associated with performance variation among rural EMS agencies in first medical contact-to-PCI time.

Methods: In this explanatory, sequential, mixed-methods study, we ranked eight rural county EMS agencies by continuous first medical contact-to-PCI time, accounting for loaded mileage, using data from a regional STEMI registry (2016–2019). A qualitative researcher conducted 28, one-hour, semi-structured interviews from January– March 2021 with the EMS director, training officer, medical director, and four paramedics at the top two high- and bottom two low-performing rural EMS agencies. Key informants were blinded to agency STEMI performance. Interviews were structured to identify positive deviance by exploring agencies' clinical approach to patients with chest pain, their organizational culture, structure, and quality improvement (QI) activities regarding STEMI care, and recommendations for improving STEMI performance. Interviews were digitally recorded and transcribed verbatim by a professional transcription service. We established a codebook and performed a thematic analysis using an inductive approach. We summarized and compared data across agencies to identify commonalities and differences between high- and low-performing agencies. Findings were reviewed and validated by an expert panel.

Results: The top two highest-performing EMS agencies had a median first medical contact-to-PCI time of 79 minutes (interquartile range [IQR] 65-91) minutes vs 98 minutes (IQR 82-120) among the bottom two lowest-performing agencies, $P<.001$. Both high- and low-performing agencies identified issues with electrocardiogram (ECG) transmitting technology and cumbersome hospital activation communications. However, top-performing agencies shared a culture that encourages early EMS activation of the cardiac catheterization lab after STEMI recognition. Top-performing agencies also placed a higher value on QI and training. These agencies prioritized mission and chain of command over staff relationships/interpersonal bonds; have stable, strong leadership; provide opportunities for career advancement; and collaborate with community leaders.

Conclusion: Top-performing rural EMS agencies for STEMI care promote early activation, have a strong chain of command, are mission focused, and have a greater focus on quality improvement and training. [West J Emerg Med. 2025;26(4)924–935.]

INTRODUCTION

ST-elevation myocardial infarction (STEMI) is a life-threatening condition in which rapid treatment is the key determinant of improved outcomes.[1,2-4] The time between first medical contact and percutaneous coronary intervention (PCI) is linearly associated with mortality.[5-8] The American College of Cardiology/American Heart Association (ACC/AHA) guidelines recommend a first medical contact-to-device time of ≤90 minutes.[2] Rural emergency medical services (EMS) agencies have variable success in achieving the recommended 90-minute PCI time goal. Rural Americans are less likely to receive timely PCI than urban Americans.[9-13] The disparity in timely PCI drives excess morbidity and mortality among rural patients with STEMI.[13,14] The US Centers for Disease Control and Prevention, Department of Health and Human Services Healthy People 2020, and the Centers for Medicare & Medicaid Services have identified health equity and improving cardiovascular health for rural Americans as urgent goals.[15,16] Further, a goal of EMS Agenda 2050 is the delivery of equitable care regardless of rurality.[17] Strategies to leverage rural EMS systems to reduce total ischemic time are needed.[18-22]

Achieving PCI time goals is multifactorial, including emergency medical services (EMS) agency structure and organizational culture among broader, systems-based factors such as in-hospital process performance and culture.[23] Organizational culture—defined as a set of shared values, beliefs, and assumptions within an organization that influences how people within that organization behave—has been associated with both cardiovascular mortality and disease-specific outcomes.[24-29] The performance of an EMS system is a key determinant in first medical contact to PCI and improving patient outcomes; however, the impact of agency structure and organizational culture related to STEMI care is unclear.[9,10,30-37]

To address this key evidence gap, we sought to identify the key organizational and behavioral attributes associated with high performance. In this study we quantitatively identified high and low performers based on first medical contact-to-PCI time and then investigated practices that drive differences in performance using qualitative methods.[38] We hypothesized that organizational culture (eg, teamwork, communication), structure (eg, leadership, training), and practices (eg, meeting benchmarks, interventions) for care of patients with STEMI impact the timeliness of PCI.

Population Health Research Capsule

What do we already know about this issue?
Rural patients with ST-elevation myocardial infarction (STEMI) under emergency medical services (EMS) care often do not achieve timely reperfusion, exposing them to increased morbidity and mortality.

What was the research question?
What organizational and behavioral factors distinguish high- vs low-performing rural EMS agencies in STEMI timeliness?

What was the major finding of the study?
High vs low-performing EMS agencies had median first medical contact to percutaneous coronary intervention time of 79 vs. 98 minutes (-20 min, 95% CI -31 to -10, P<.001).

How does this improve population health?
Findings highlight actionable EMS practices to improve STEMI care in rural settings.

METHODS

Study Design

We conducted an explanatory, sequential, mixed-methods study of rural STEMI patients with previously published methods.[39] We used regional STEMI registry data (2016–2019) to quantitatively identify the top two- and bottom two- performing EMS agencies based on continuous first medical contact-to-PCI time. Key informant interviews were conducted at these EMS agencies to investigate organization culture, structure, and practices under the positive deviance framework. Positive deviance is a behavioral research approach based on the concept that groups of organizations performing a similar task have certain members who are high performers relative to their peers, based on specific attributes that allow them to perform more effectively despite having similar resources as other group members.[40] This study was approved by the Wake Forest University Institutional Review Board. We obtained waivers of informed consent for individual patients included in the registry. This study was registered at ClinicalTrials.gov (NCT04381260).

Study Setting

Patients were accrued from eight rural EMS agencies in the Piedmont region of North Carolina transporting patients to one of three PCI centers. Agencies continually operated at the paramedic level and received medical direction from a board-certified emergency physician. Ambulance crew configuration was variable but always included at least one paramedic. All agencies had the authority to activate the catheterization (cath) lab, but this activation could be canceled by either the emergency physician or the cardiologist upon review of the transmitted

electrocardiogram (ECG). Of note, all EMS agencies had the ability to transmit ECGs. The EMS agencies were selected for participation based on their location in a rural county as defined by the 2014 US Census Bureau American Community Survey.[41] Descriptive information (number of annual patient transports, staffing and staffed ambulances in a 24-hour period) of the eight rural county EMS agencies[23] is provided in Supplemental Table 1. The PCI centers were Atrium Health Wake Forest Baptist in Winston-Salem, NC, with 821 licensed beds and full specialty/subspecialty availability; High Point Medical Center in High Point, NC, with 351 licensed beds and extensive specialty/subspecialty availability; and Moses H. Cone Memorial Hospital in Greensboro, NC, with 517 licensed beds and extensive specialty/subspecialty availability. The EMS agencies transport patients with STEMI to the nearest PCI center. The STEMI protocol used by the EMS agencies is provided in Supplemental Figure 1.

Population

We included patients who were ≥ 18 years, transported to one of the three participating PCI centers by one of eight rural-county EMS agencies, and received primary PCI for STEMI. We excluded interfacility transports and patients with prehospital cardiac arrest.

Agency Performance

The 2016–2019 regional STEMI data registry defined EMS first medical contact-to-PCI time as patient initial contact time (recorded by EMS personnel after arrival on scene) to first device activation time (recorded in the National Cardiovascular Data Registry) in minutes. First medical contact-to-PCI time was the key quantitative outcome. Several secondary process outcomes were also defined: dispatch time, the period from when the 9-1-1 call was received to when EMS was dispatched; response time, the period from when EMS was dispatched to arrival on scene; scene time, the period from EMS arrival on scene to EMS departure from scene; ECG time, the period from EMS arrival to first 12-lead ECG being performed; activation time, the period from first 12-lead ECG to when the PCI center team was activated (PCI activation based on EMS pre-activation at the discretion of the destination hospital); transport time, the period from EMS departure from scene to arrival at destination. Total EMS time was the time from EMS arrival on scene to arrival at the hospital, while door-to-balloon time was defined as the time of EMS arrival at destination to PCI time. Loaded mileage was defined as the

Table 1. Time intervals among the two highest- and two lowest-performing emergency medical services (EMS) agencies for time from first medical contact to percutaneous coronary intervention among patients with ST-elevation myocardial infarction.

	Highest two ranked agencies (N=194) Median (IQR)	Lowest two ranked agencies (N=24) Median (IQR)	Difference in location[1] (95% CI)	P-value[2]
FMC to PCI, minutes (PCI Time – At Patient)	78.5 (65.25-91)	97.5 (82.25-119.75)	-20.0 (-31.0, -10.0)	<.001
Dispatch Time, minutes (Dispatch – Call Received)	1 (0-2)	1 (1-2)	-1.0 (-1.0, 0.0)	.05
Response Time, minutes (On Scene – Dispatch)	9 (7-13)	11.5 (9.75-13.25)	-2.0 (-4.0, 0.0)	.04
Time to First ECG, minutes (12-Lead ECG – At Patient)	4 (2.75-5)	5 (2-9.5)	-0.0 (-2.0, 1.0)	.49
Activation Time, minutes (Cath lab activation – 12-lead ECG)	12.5 (7-21)	21 (15-44)	-10.0 (-17.0, -4.0)	< .01
Scene Time, minutes (Depart Scene – On Scene)	14 (11.25-16)	18 (12.75-21.25)	-3.0 (-6.0, -1.0)	.01
Transport Time, minutes (At Destination – Depart Scene)	24 (19-27)	38 (28-42)	-14.0 (-18.0, -10.0)	<.001
Total EMS Time, minutes (At Destination – On Scene)	37 (32.25-42)	52 (45.75-59)	-16.0 (-20.0, -12.0)	<.001
Door-to-balloon Time, minutes (PCI Time – At Destination)	41 (33-54)	37.5 (32-66.25)	-1.0 (-9.0, 6.0)	.85

[1]Hodges-Lehmann estimator for the shift in location of the distribution of times for patients in the highest two ranked agencies compared to the lowest two ranked agencies,
[2]Wilcoxon rank-sum test.
IQR, interquartile range; *CI*, confidence interval; *FMC,* first medical contact; *PCI,* percutaneous coronary intervention; *ECG,* electrocardiogram; *STEMI,* ST-segment elevation myocardial infarction.

distance from the incident scene to hospital destination.

Quantitative Analysis

Among the eight included rural EMS agencies, we ranked their performance on a scale from 1-8 as measured by continuous first medical contact-to-PCI time. Robust regression was used to generate the rankings while adjusting for loaded mileage. We used this technique instead of ordinary least squares regression as it is less sensitive to outliers; thus, no outliers were removed from the analysis.[42] The two top- and bottom-performing agencies were identified to participate in the qualitative portion of this study. All agencies were staffed by paid EMS professionals, without volunteer members. (Additional first-responder care was provided by local fire and rescue teams that are supplemented with volunteers.) We summarized time metrics using median and interquartile range (IQR) and used Wilcoxon rank-sum tests to compare between the top- and bottom-performing agencies. Hodges–Lehmann estimators were also calculated for the shift in location of the distribution of times for patients in the highest two ranked agencies compared to the lowest two ranked agencies. We used Kruskal-Wallis tests to compare time metrics across all four agencies.

Qualitative Data Collection

Based on the quantitative analysis, the two top-performing and two bottom-performing EMS agencies were selected for qualitative inquiry. A trained qualitative researcher conducted a total of 28 interviews with EMS agency leadership and staff at four rural EMS agencies in North Carolina. At each of the four sites, seven interviews were conducted. Each interview participant was practicing during the time of the quantitative data collection (2016–2019) used for ranking. Key informants included the director, training officer, medical director or assistant medical director, and four paramedics. Key informants were blinded to their agency's STEMI performance-ranking and the reason for their agency's inclusion in the study. Interviews were structured to explore participants' clinical approach to patients with chest pain, the agency's organizational culture, structure, and quality improvement (QI) activities regarding STEMI care, as well as recommendations for improving STEMI performance. The interview guide was pilot tested with four EMS clinicians from a local urban EMS agency and iteratively revised prior to data collection. Please see supplemental documents 1-4 for the complete interview guides. The interviews, which were conducted via videoconferencing software or telephone, ranged from 45-68 minutes, with an average length of 58 minutes. Interviews were digitally recorded and transcribed verbatim by a professional transcription service. A member of the research team reviewed all transcripts against the audio recordings for quality.

Qualitative Analysis

We used Atlas.ti v9.0 (Lumivero, LLC, Denver, CO) to manage data.[43] Thematic analysis was performed using an inductive approach.[44] Two members of the research team systematically reviewed interview transcripts and identified relevant concepts and codes. Once an initial codebook was established, two researchers (AES and JPS) independently coded each transcript; they met regularly to discuss and resolve coding discrepancies and to revise the codebook, as needed. Data were then summarized within and across codes, compared across agencies to identify commonalities and differences between top- and bottom-performing agencies, and organized into themes that reflect the characteristics of high- and low-performing agencies' clinical practices, organization culture, and QI activities. Themes were reviewed and validated by an expert panel composed of an EMS compliance officer, an emergency physician board-certified in EMS, and a hospital cardiovascular EMS liaison.

RESULTS

We identified 365 patients for analysis whose demographics are available in Supplemental Table 1. Across the eight EMS agencies, the median number of STEMI cases per agency during the study period was 16 (IQR 11-40). The top two EMS agencies cared for 186 and 8 patients, respectively, with STEMI, while the bottom two EMS agencies cared for 11 and 13 patients with STEMI. The two high-performing EMS agencies had a median first medical contact-to-PCI time of 79 minutes (IQR 65-91) minutes vs 98 minutes (IQR 82-120) among the two low-performing agencies, $P<.001$. Compared to the bottom two agencies, the top two agencies were significantly faster in the following time intervals: ECG transmission to catheterization lab activation time (12.5 minutes [IQR 7-21] vs 21.0 [IQR 15-44], $P=.002$), on-scene time (14.0 minutes [IQR 11-16] vs 18 minutes [IQR 13-21)], $P=.010$], transport time (24.0 minutes [IQR 19-27] vs 38.0 minutes [IQR 28-42], $P<.001$), and total EMS time (37.0 minutes [IQR 32-42] vs 52.0 minutes [IQR 46-59], $P<.001$. Interestingly, door-to-PCI times were similar across agencies. See Table 1 for all time interval comparisons of top- and bottom-performing agencies. Supplemental Table 1 describes county- and agency-level factors for each EMS agency. Supplemental Table 2 describes patient- and incident-level factors stratified by whether PCI was achieved within the time goal. Fifty-five codes were identified from the key informant interviews and narrowed to five key themes. Key themes and representative quotes are shown in Table 2.

Theme 1: Top agencies recognize the need for early STEMI activation.

Paramedics and administrators in both high- and low-performing agencies commonly cited the importance of early activation of the cath lab following STEMI recognition. Top

Table 2. Themes and representative quotes from qualitative interviews of agencies leaders and paramedics.

Theme	Representative quotes
1. Top agencies recognize the need for early STEMI activation and are supportive of occasional false activation.	*We encourage them to err on the side of—be aggressive in STEMI alerts ... That's one instance where time really matters with downstream outcomes. – A*dministrator, top agency *…to be honest with you, I don't care what they [hospitals] see on the other end. I have enough feeling in my conscience to say, "This is a STEMI." We're going to run it as a STEMI. They can cancel it when we get there.* – Paramedic, top agency *This was an instance at [hospital], actually, where my 12-lead wouldn't transmit. I called and talked to a doc, and I'm like, "Doc, I can't get this 12-lead to transmit through, but this is what I'm lookin'—" and I explain to him a textbook inferior wall MI. From there, he said, "Well, hey, you're my eyes and ears. You just identified one very well. I'm gonna go ahead and activate the cath lab," and that went well.* – Paramedic, top agency *I can't jump straight on the phone and start callin'. Sometimes, it may be 5, 10 minutes before I can get caught up just to make that phone call. I know sometimes that phone call's requested immediately, but sometimes that can't happen in the back of the truck in reality.* – Training officer, bottom agency *…this is a topic that paramedics feel just a little bit uncomfortable with 'cause we're being asked to ask for the cath lab to be activated and "is that really our decision" is what goes through our mind.* – Paramedic bottom agency *We preach to them that you don't need to transmit the ECG but we all know it works better if you do. [Laughter] That's just the way it is. We tell them that they [hospitals] should actively just based on your interpretation, but we all know they don't.* – Administrator, bottom agency
2. Top agencies value quality improvement officers, training, and coordination with local hospitals.	*Good medics really love to know what they found when they got to the cath lab. [Hospitals are] good to share that information. It keeps our medics involved and want to do good.* – Administrator, top agency *Usually it's like a shift meeting. We'll talk about if it was extended scene times or—we're always looking at ways to improve it. It's not a punitive thing whenever we discuss somethin'. It's more a learning opportunity, 'Okay, this happened. How can we improve this?* – Paramedic, top agency *Communication is probably the top thing between EMS and the STEMI facilities because you've gotta have that connection, or it's gonna fail…it started out bumpy. Anytime you implement somethin' new, you're gonna pick up some bumps. It took us a little while to get there, but I think now, especially in the last two or three years, we've had those representatives here. They were physically coming to our peer-review meetings and havin' open, candid conversations about all the processes and havin' the ability just to call 'em up and say, "Hey, what happened with this call, or what happened with this?" Either way, whether it's us callin' them, or them callin' us. I think it's improved.* – Administrator, top agency *We have a quality improvement officer…he reviews this type of stuff, and he don't micromanage it in my opinion. ... If you're on scene for a long time, all you have to do is justify it in your paperwork. If it's justifiable, which it should be, then you're fine to go.* –Paramedic, bottom agency *…that's why I like that [hospital name] email because we can just forward that email, and honestly, they've already done the work. They've got EMS scene times on there. They've got the first 12-lead, the transmission time. It's all there, so it makes it easy for us to be able to just share that with the employee and say, 'Look, here's your outcome on this call,' and discuss those metrics as they happen, not every three months.* – Training officer, bottom agency *No one looks forward to being told, "Hey, you can do this a little better," but they're not as opposed or shamed about it because it's an open way we do it. It's the way we do business. They know that I'm not gonna jump up and down and scream and shout at 'em and take their pay for a day or suspend 'em.* – Administrator, bottom agency

EMS, emergency medical services; *ECG*, electrocardiogram; *STEMI*, ST-segment elevation myocardial infarction; *ED*, emergency department; *PAPR*, powered air-purifying respirator.

Table 2. Continued.

Theme	Representative quotes
3. Top agencies prioritize mission and chain of command over staff relationships and interpersonal bonds.	*I think that our beliefs are patient oriented and service oriented—or at least that's what I'm trying to instill in the organization. They're told, when they're hired, that the S in EMS stands for service, and that's what we're here to do and provide a service for the citizens.* – Administrator, top agency *[X] County is a little more regimented in its culture, not necessarily in a negative way. The leadership … has a military background. There's a lot more emphasis on chain of command, on following proper procedure, not oppressively so, but it's the way they do things there."* – Training officer, top agency *You're told from the moment you're hired in [X] County: We are a county service. We're not privately owned, and we are the only advanced service available in [X] County, as far as there's no hospital. We've got a smattering of doctor's offices, and there are two…urgent care clinics. That's it, so our director wants everyone to understand … there's no one else you can call. There's nowhere that you can take people within [X] Count y… these people rely very heavily on us.* – Paramedic, top agency *The culture, we still try to keep it as close-knit, extended, and family-type culture…we have open-door policies and things where if you need somebody to talk … just because we are the administration doesn't mean you can't come talk to us…* –- Administrator, bottom agency *We've had little instances pop up here and there, and we email back and forth—or, mostly, just up to them[45]—with no real feedback or response. At the end of the day, very few things end up getting accomplished that we ask for improvement from.* – Paramedic, bottom agency *Many of 'em are really close, so that's important for our service to have that camaraderie among the service and especially among the shifts. That's important for us, and that's always been here at [county] since I've worked here is bein' really tight. Everybody gets along really well. It's not just a number. You don't feel like you're a number when you work here. We're a small enough service that thankfully, everything's personal here" …* – Paramedic, bottom agency
4. Top agencies have focused leadership and opportunities for career advancement.	*…what [county] has done is they've put in a career ladder to find opportunities for advancement within the agency to get rid of this idea, well it's a good old boy network … it's as objective as it can possibly be.* – Administrator, top agency *… when the COVID money started disbursing out to the county …our director and operations manager went immediately and bought the PAPR units. … We had 'em quick. Working in another county, I realized quickly how nice it was to have bosses that were doing everything they could to keep me safe …* –- Paramedic, top agency *There's definitely a lot of room to be able to move up in the county. I think a lot of people try and stay for the most part 'cause it is a good county to work with.* – Paramedic, top agency *My four years as training officer, I've worked under three different directors.* – Administrator, bottom agency *We're a small service, so we have a lotta roles. Between me and the training officer, we have a lot on our plate.* – Administrator, bottom agency *It's physically taxing. It's mentally taxing. Sometimes, the body just can't hold up with it, or there's some people and they just have had a lot of crummy calls that just weigh on 'em. They decide this isn't really something I want to do anymore. I want to go do something that's a little less taxing, and so they might find a different job*. – Paramedic, bottom agency

Table 2. Continued.

Theme	Representative quotes
5. Communication with the hospital and emergency department delays are a challenge for all agencies.	*What really usually creates a large problem is whatever charge nurse is on duty at that facility acts a little frustrated that, 'You're bothering me. What do you want?' We have to go through that couple of minute delay…* –- Paramedic, top agency *…it depends on the cardiologist. Some of 'em really care about what we have to say. Some of them hear what we've done and then they just wanna talk with the patient* – Paramedic, top agency *I think the best thing to do is figure out a way that we could go directly to a cardiologist, review—you don't have to be on the phone with that doctor, but it would be nice to be able to cut out the charge nurses or the ED because they are very busy already.* – Paramedic, top agency *First thing we do is have to sit there and wait for registration to get the patient registered. Even if we provide the patient information over the phone to the charge nurse, a lot of the times, they don't have 'em registered when we get there, even though they have access to all that information* – Paramedic, bottom agency *…we really appreciate whenever we call and ask to go to the cath lab that they take us directly there* – Paramedic, bottom agency *It can be frustrating sometimes. It's an active STEMI, but maybe—I don't know all the situations, but maybe the cath lab's already busy, things like that, and we take him to a room. That can sometimes be a little bit frustrating 'cause they're like—now, they're just sitting down in the ED when we know we need to go to the cath lab, so that can be a little bit frustrating. I don't know all the details behind why there's that delay.* – Paramedic, bottom agency

EMS, emergency medical services; *ECG*, electrocardiogram; *STEMI*, ST-segment elevation myocardial infarction; *ED*, emergency department; *PAPR*, powered air-purifying respirator.

agencies emphasized the importance of paramedics expressing confidence when activating a STEMI and accepting that the physicians at the PCI center may disagree. Bottom agencies felt that emergency physicians were reluctant to notify the cath lab based on a paramedic's interpretation of an ECG. Several paramedics in the low-performing agencies described lacking confidence in activating the cath lab themselves and a desire to defer to the judgment of a physician.

> *We encourage them to err on the side of—be aggressive in STEMI alerts ... That's one instance where time really matters with downstream outcomes. – A*dministrator, top agency

Theme 2: Top agencies value quality improvement and collaboration with local hospitals.

Both high- and low-performing agencies identified hospital involvement as valuable in QI, such as providing outcome data, sending pictures of patient's vessel occlusions, and STEMI coordinators attending EMS peer-review meetings. Top agencies tended to consistently provide feedback to their paramedics who viewed feedback as a positive learning opportunity. In one of the low-performing agencies, paramedics stated they only received feedback if they asked for it. Others noted weeks- and months-long delays on receiving feedback. Top agencies tended to strive for consistent QI, whereas low-performing agencies tended to excuse missed metrics if an explanation was given in the patient care narrative. Top agencies recognized that good outcomes are a system responsibility and focus on systems issues, whereas the low-performing agencies focused on individual responsibility and clinician issues.

> *Good medics really love to know what they found when they got to the cath lab. [Hospitals are] good to share that information. It keeps our medics involved and want to do good.* – Administrator, top agency

Theme 3: Top agencies prioritize mission and chain of command over staff relationships and interpersonal bonds.

Most participants from all agencies spoke positively about their agency culture. Top-performing agencies tended to describe an emphasis on high-quality patient care, staff wellness, following a chain of command, adherence to protocol, and service. Low-performing agencies had less emphasis on chain of command and protocols and seemed more focused on interpersonal relationships. For example, the low-performing agencies tended to reference a tightknit and family-like culture, pride in their agency, and open-door

policies with administration.

> *I think that our beliefs are patient oriented and service oriented—or at least that's what I'm trying to instill in the organization. They're told, when they're hired, that the S in EMS stands for service, and that's what we're here to do and provide a service for the citizens.* – Administrator, top agency

Theme 4: Top agencies have focused leadership and opportunities for career advancement.

The high-performing agencies identified leadership that closely communicated with each other. Even when leaders were stretched thin, they prioritized crew needs. One top agency had a defined pathway for career advancement based on performance. The low-performing agencies identified difficulty with frequent leadership changes.

> *…what [our county] has done is they've put in a career ladder to find opportunities for advancement within the agency to get rid of this idea, well it's a good old boy network … it's as objective as it can possibly be.* – Administrator, top agency

Theme 5: Communication with the hospital and emergency department delays are a challenge for all agencies.

Paramedics from both high- and low-performing agencies identified challenges communicating with hospitals. One EMS clinician from a top agency reported encountering incivility in encounters with ED staff and delays when attempting to consult with emergency physicians. Some paramedics preferred to bypass the ED and proceed directly to the cath lab. Paramedics from top agencies believed patients' arrival to the cath lab were delayed by hospital staff not listening to them and performing unnecessary tasks, such as changing defibrillator pads. Paramedics from the low-performing agencies cited delays related to registration and frustration when patients were not taken directly to the cath lab. Technological difficulties, such as with transmitting ECGs, affected both the high- and low-performing agencies.

> *What really usually creates a large problem is whatever charge nurse is on duty at that facility acts a little frustrated that, 'You're bothering me. What do you want?' We have to go through that couple of minute delay…* – EMS Clinician, top agency

DISCUSSION

This mixed-methods study identified potential drivers of performance differences for patients with STEMI observed between high- and low-performing rural EMS agencies. The top two and bottom two agencies differed significantly in first medical contact-to-PCI time after adjustment for distance from the PCI center. Most patients with a STEMI who were cared for the low-performing agencies did not meet the guideline-recommended first medical contact-to-PCI goal of <90 minutes, exposing them to increased risk of morbidity and mortality.[2,13,14] Top-performing agencies shared a culture of early EMS activation of the cardiac cath lab, placed a high value on QI and training, prioritized mission and chain of command, and had stable leadership. Several key findings are detailed below.

First, we found differences in practice regarding STEMI recognition and cath lab activation. The median cath lab activation time among the top two agencies in this study was significantly faster than the bottom two agencies. Prehospital cath lab activation is an essential component of optimizing timely care for STEMI patients, and activation time is associated with door-to-PCI time.[34,46-48] Top agency administrators and paramedics identified early recognition of STEMI and early cath lab activation as important. They tended to be aggressive in activation, accepting that false activations will occur and are acceptable. Conversely, the need for review of an ECG by a physician prior to cath lab activation was common among the low-performing agencies in this study. While the AHA Mission Lifeline PreAct algorithm recommends physician review of ECGs prior to cath lab activation, this practice may be detrimental.[49] Lastly, paramedics from the low-performing agencies in our study discussed lack of confidence in diagnosing STEMI. Systems of STEMI care should continue to support prehospital cath lab activation without imposing additional barriers.[34,46-48]

Our second key finding relates to communication. First responders from all EMS agencies mentioned frustration with hospital communication and processes, with concerns ranging from delays in registering patients to incivility from nurses and physicians. Paramedics from both high- and low-performing agencies described technological barriers to communication, such as difficulty transmitting ECGs. Some paramedics strongly preferred proceeding directly to the cath lab rather than going through the ED. The safety and efficacy of the direct-to-cath lab strategy has been described repeatedly in the literature and is recommended by the AHA.[50-53,54] Protocolization of care and improved communication may improve the intersection of EMS and in-hospital care.

Third, top agencies value designated and empowered QI officers who provide prompt performance feedback and training. As many as one in four US EMS agencies do not have dedicated QI personnel.[55,56] Moreover, rural agencies are less likely to follow quality metrics than non-rural agencies.[56] Top agencies in this study held a mature view of QI by recognizing that good outcomes are a responsibility of the system. Meanwhile, low-performing agencies focused on individual performance. Agencies should incorporate an evidenced-based, comprehensive continuous QI policy with sufficient resources to affect positive change. Key components of an effective QI program

include clear aims, a non-punitive culture, focused education, and a teams-based approach.[55]

The impact of leadership was our fourth key finding. Strong leadership in healthcare organizations is associated with high quality care.[57,58] The top agencies in our study described their leadership as focused, whereas the low-performing agencies described difficulty with leadership turnover. Nationally, turnover of EMS agency leaders is high, with a near 20% annual turnover rate nationally.[59] It may be difficult for EMS agencies to adhere to a strong organizational culture of continuous improvement with frequent leadership turnover. Conversely, a mission-driven, outcome-oriented leadership culture has been associated with higher rates of job dissatisfaction among paramedics.[60] Therefore, to improve patient care outcomes, leaders must be mindful of practices that may worsen job absenteeism and turnover.

Our prior article that reports the quantitative data used in this study describes a number of systems factors that contribute to delayed reperfusion.[23] In descending order of strength of association, those factors associated with a lower odds of meeting first medical contact-to-PCI included female sex, cath lab activation outside normal business hours (ie, 5 PM -6 AM), lack of exertional chest pain, longer distance transport, older age, and higher body mass index. The results of this study add key qualitative data that provide a framework of organizational structure, culture, and processes associated with better first medical contact-to-PCI performance among rural EMS agencies in North Carolina.

These data suggest that governmental and organizational leaders should support EMS agencies in developing focused, mission-oriented leaders and encourage collaboration between EMS agencies and hospitals. The EMS agency leaders should establish a clear chain of command, promote a mission-driven vision for their agency, and develop a collaborative and non-punitive QI and continuing education program. Paramedics should follow defined protocols for care of patients with chest pain and STEMI, including being comfortable activating the cardiac cath lab early in a patient's care. Our data suggest that hospital-based healthcare professionals should collaborate with EMS agencies on QI and take action to improve interactions with paramedics that enhance collegiality and respect and build greater understanding of the limitations inherent to prehospital care. As process improvement is an iterative process, this study represents the first step in identifying opportunities to improve care. Future study will include hypothesis testing among a larger sample and subsequently working with stakeholders to disseminate results.[38]

LIMITATIONS

This study ranked agencies using a database of patients from EMS systems that use a single electronic health record and have agreed to share their de-identified data for the purposes of research and benchmarking. These methods may have created participation bias as successful agencies may have been more likely to agree to participate in a data-reporting study than lower performing EMS agencies. Patients in this study were suspected of STEMI by their EMS clinician and not confirmed STEMI patients. Likewise, our analyses were limited to available data. Other confounding variables such as EMS staffing and experience and accuracy of documentation could not be assessed. Information in key-informant interviews may be susceptible to social desirability bias. However, an independent interviewer was used, and agencies were blinded to their rank.

The small number of employees for each agency completing an interview may limit generalization. Despite this, purposive sampling was used to include a diverse selection of employees. Included EMS agencies are in the southern US and may not be generalizable to STEMI patients in all EMS systems. Finally, the top-performing agency in our study cared for nearly half of the included patients while the lowest-performing agency cared for the fewest patients with STEMI per capita. Given that the association of hospital and procedural patient volume with improved outcomes has been extensively described,[61-64] these agencies' performance could be primarily driven by STEMI volume.

CONCLUSION

Several key themes distinguished top-performing agencies, including understanding the need for early STEMI activation, recognizing the value of a strong quality improvement program, coordination with local hospitals, and mission-driven leadership. The EMS agencies may focus on a clear chain of command and promote a mission-driven vision for their agency supported by a collaborative QI program. Policymakers can support leadership development in EMS agencies. Paramedics should follow defined protocols for care and likely should be comfortable activating the cardiac catheterization lab early. Hospital-based healthcare professionals may work on improving interactions with paramedics when receiving patients with a suspected STEMI and should collaborate with EMS agencies on QI. Given the limitations of this article, future study is needed to evaluate these findings among a larger sample of rural EMS agencies.

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Utility of Emergent Spine MRI in the Emergency Department

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Introduction: Prolonged emergency department (ED) waiting times for STAT spine magnetic resonance imaging (MRI) in the ED can expose patients to hospital-acquired infections and increase the workload in the ED, further impacting healthcare quality. In this study we aimed to characterize emergent spine MRI frequency and positivity in the ED, and its impact on ED length of stay (LOS), admission rates, and the necessity for surgical interventions.

Methods: We performed a retrospective chart review of a consecutive group of patients who had emergent spine MRI (cervical, thoracic, lumbar) ordered from the EDs at four hospitals from January 1, 2017-December 31,2022 were included for traumatic and atraumatic patients. We recorded patient demographics, time metrics, discharge status, and surgical interventions within seven days (for those who were hospitalized during the ED encounter). Spine MRI reports were reviewed and categorized, with positive cases defined as severe spinal canal stenosis regardless of cause and/or fracture. We used descriptive statistics to assess the positivity rate for emergent spine MRIs as well as the LOS, rate of surgery, and rate of admission for patients getting emergent spine MRIs.

Results: A total of 689 spine MRI of 889,527 ED visits (0.1%) were included. Patients' mean age was 51.3 ±17.1 years, and 59.5% were female. Discharge rate was 93.9%, 3.3% were admitted, 1.7% left against medical advice, and 1.0% were transferred to other facilities. The overall spine MRI positivity rate was 18.9% (130). Moreover, the median (IQR) time from imaging order placement to imaging completion was 2.6 (1.8 - 3.7) hours, while the time from imaging completion to final report availability was 1.5 (0.4 - 13.9) hours. The median ED LOS was 7.4 (5.7 - 9.5) hours. Of 23 hospitalized patients, 17 (73.9%) required surgical intervention. Positive cases had significantly higher ED LOS compared to negative cases (8.1 vs 7.2, respectively; $P < .001$).

Conclusion: The positivity rate for ED spine MRI in this study was 18.9%. Of the positive cases, 17.7% underwent hospitalization, with 13.1% requiring emergent surgery. Considering high costs in both time and resource utilization, further research is needed to optimize the triage process for patients requiring emergent spine MRI. [West J Emerg Med. 2025;26(4)936–942.]

INTRODUCTION

Diagnostic imaging plays a pivotal role in the evaluation of patients presenting with acute spine pathologies in the emergency department (ED). Magnetic resonance imaging (MRI) offers unparalleled visualization of soft-tissue structures, thus allowing for optimal identification of pathologic changes to bone marrow, ligaments, spinal cord, and neural structures.[1-7] Timely and accurate diagnosis of emergent spinal pathologies in

the ED is of paramount importance. In trauma, MRI allows for accurate identification and characterization of injury and directs management to improve patient outcomes, which is especially important given the high morbidity and mortality of traumatic spinal cord injuries.[8,9]

However, other chronic pathologies, such as degenerative spondylosis, are not considered "emergent" and may not require MRI in the ED setting. For instance, according to the American College of Radiology appropriateness criteria, cervical spine MRI is usually appropriate in the setting of trauma; however, thoracolumbar spine MRI is only appropriate when there are neurologic findings with imaging-confirmed thoracolumbar spine injury.[10,11] In addition, the benefits of MRI must be weighed against its costly and time-intensive nature, particularly in the time-conscious ED setting.[12] Therefore, while spinal MRI is absolutely appropriate in some cases, the optimal setting—emergent, urgent, or outpatient—for acquiring these images is yet to be determined. Implementation of diagnostic and triage algorithms can decrease unnecessary advanced imaging usage, reduce referrals to spine surgeons, lower healthcare costs, decrease the average time from imaging to diagnosis, and optimize the triage process.[13-19]

While some studies have assessed the MRI positivity in trauma patients,[20] there is limited literature specifically addressing the impact of emergent spine MRI on physician decisions regarding hospitalization or surgery.[21] Furthermore, additional research is necessary to identify potential areas for improvement in patient triage for emergent spine MRI and to establish a system to meet patients' need in the ED. In this study we aimed to determine the prevalence of positive spine MRI results overall and across different spinal segments in four urban EDs and to assess the associated admission rates, the number of resulting surgical interventions, and the impact of these MRIs on the length of stay (LOS) in the ED.

Population Health Research Capsule

What do we already know about this issue?
The necessity of STAT spine magnetic resonance imaging (MRI) remains a topic of debate; however, it is well-accepted that emergent spine MRIs may not always be warranted.

What was the research question?
What was the positivity rate of STAT spine MRI at our institution, and what are the clinical outcomes of patients following the MRI?

What was the major finding of the study?
The positivity rate of STAT spine MRI was 18.9%, with 3.3% admitted. Positive cases had longer ED waits (8.1 vs 7.2 hours; $P < .001$).

How does this improve population health?
STAT spine MRI had a high negative rate, and most positive cases were discharged for non-emergent care. A better triage system may improve efficiency in the ED.

METHODS

Study Design and Setting

We performed a retrospective chart review of patients from four hospitals in the southeastern United States who had an MRI of the spine ordered in the ED. In this multi-hospital study we analyzed data from EDs at four different hospitals, which collectively received approximately 150,000 annual ED visits. All the hospitals were within one university healthcare system (none of which were trauma centers), and all EDs within these hospitals were run by emergency medicine residents and attendings. This study was approved by the institutional review board.

Data Collection

We obtained the data from a comprehensive data warehouse. All the optimal elements of retrospective chart review were considered, based on previous studies where applicable.[22] The inclusion criteria for this study encompassed consecutive emergent cervical, thoracic, and lumbar spine MRIs ordered between January 1, 201–December 31, 2022. The spine MRI reports were reviewed by trained personnel consisting of a medical student and research associates to classify the findings into positive, negative, or indeterminate for pathology based on the report findings and impression. Subsequently, a neuroradiologist reviewed the reports and MRI for indeterminate cases and classified these cases accordingly. The imaging findings were classified into categories based on the severity of canal stenosis or fracture: mild, moderate, severe, or no evidence of such conditions. Subsequently, positive cases were defined as those exhibiting severe stenosis and/or fracture.

We extracted a wide range of information from the data, including patient demographics, discharge status, any surgical interventions performed within seven days of MRI acquisition, and various time metrics such as arrival time, imaging order time, time of imaging completion, time that reports became available, and ED discharge time. Furthermore, ED chief complaint and MRI indications were recorded from reviewing the ED notes and MRI reports, respectively.

Outcomes

We used the time points to determine time intervals: ED LOS, which was defined as the time interval between ED

arrival and ED discharge; image acquisition time, which was defined as the time from image order placement to imaging completion; and image interpretation time, which was defined as the time between imaging completion and the time final report became available.

Statistical Analysis

In addition to descriptive statistics for frequency and median with interquartile range (IQR) for time intervals, we employed Mann-Whitney U tests to compare time intervals. Chi-square test was used to compare sex differences between positive and negative spine MRI groups. Pearson correlation analysis was applied to determine the association between age and spinal MRI positivity. The significance level was set at 0.05. We conducted all statistical analyses using SPSS v29.0 (IBM Corp, Armonk, NY) and created graphs with SPSS and Prism v10.02 (GraphPad, Inc, San Diego, CA).

RESULTS

Of the 889,527 ED encounters in the four EDs, a total of 689 spine MRIs were identified in the study period, which represented 0.1% of the total encounters. Of these, 112 (6.3%) were trauma cases including those due to falling and motor vehicle/bicycle collisions. Among the spine MRIs, 426 (61.8%) were lumbar, 234/(34.0%) were cervical, and 29 (4.2%) were thoracic MRIs. The mean age of the patients was 51.3 ±17.1 years, with females accounting for 59.5% (410/689) of the cases. Of the total, 414 were White (60.0%), 212 (30.8 %) were Black, and 9.1% (63/689) were from other racial groups.

Regarding mode of arrival, 85.0% (586/689) of patients arrived at the ED by private vehicle, 13.5% (93/689) by emergency medical services, and 1.4% (10/689) by other means. Of the total 689 patients, both trauma and non-trauma, 93.9% (647) were discharged home, 3.3% (23) were admitted for hospitalization, 1.7% (12) left against medical advice, and 1.0% (7) were discharged to other facilities. Of 23 hospitalized patients, 73.9% (17/23) underwent a surgical procedure while 26.1% (6/23) received medical management alone. Similarly, of 577 non-trauma patients, 3.5% (20) were hospitalized, and among those hospitalized, 70% (14) underwent surgery.

Indications for STAT Magnetic Resonance imaging

The indications for STAT spine MRI, as shown in Table 1, encompassed a range of critical signs and symptoms. A majority of patients (57.5%) presented with a complaint of "back pain," which led to hospitalization in only 3.5% of cases and necessitated surgery in 2.8% of cases. Moreover, upper extremity weakness was observed in 8.1% of patients, while lower extremity weakness was observed in 16.4% of patients. This myelopathy led to surgical intervention for 1.8% and 3.5% of these patients, respectively. Other notable indications, not presented in the table, included various concerns such as a spinal metastasis with history of malignancy, follow-up

Table 1. Indications for STAT magnetic resonance imaging in the Emergency Department.

MRI Indication as ordered	Presentation	Hospitalization	Surgery
Back pain/injury	57.5% (396/689)	3.5% (14/396)	2.8% (11/396)
Lower extremity pain	25.7% (177/689)	2.2% (4/177)	1.1% (2/177)
Numbness	20.7% (143/689)	2.8% (4/143)	1.4% (2/143)
Neck pain/injury	16.4% (113/689)	0.9% (1/113)	0.9% (1/113)
Fall	9.7% (67/689)	3.0% (2/67)	3.0% (2/67)
Motor vehicle / bicycle accident	6.5% (45/689)	2.2% (1/45)	2.2% (1/45)
Upper extremity pain	5.9% (41/689)	2.4% (1/41)	0%
Headache / head injury	3.3% (23/689)	0%	0%
Post-surgery/spinal injection complications	16.0% (110/689)	5.4% (6/110)	2.7% (3/110)
Fecal incontinence	5.7% (39/689)	5.1% (2/39)	5.1% (2/39)
Constipation	2.2% (15/689)	6.7% (1/15)	6.7% (1/15)
Urinary incontinence	10.3% (71/689)	2.8% (2/71)	1.4% (1/71)
Urinary retention	4.9% (34/689)	2.9% (1/34)	2.9% (1/34)
Upper extremity weakness	8.1% (56/689)	3.6% (2/56)	1.8% (1/56)
Lower extremity weakness	16.4% (113/689)	6.2% (7/113)	3.5% (4/113)
Saddle anesthesia	3.9% (27/689)	3.7% (1/27)	3.7% (1/27)
Hyperreflexia / spasm	0.6% (4/689)	0%	0%
Paresthesia	20.3% (140/689)	1.4% (2/140)	1.4% (2/140)
Total	100% (689/689)	3.3% (23/689)	2.0% (14/689)

*Some patients experienced more than one indication for hospitalization and surgery.
MRI, magnetic resonance imaging.

examinations guided by computed tomography (CT)/radiography findings, infectious workup in cases involving fever, patients with a history of demyelinating disease, routine annual MRI follow-ups, and instances necessitating a repeat of a previously suboptimal outpatient MRI.

Findings on Magnetic Resonance Imaging

The overall positivity rate for spine MRIs was 18.9% (130/689), wherein 77.7% (101) of them had pure severe spinal canal stenosis, 18.5% (24) had acute vertebral fracture without spinal canal stenosis, and 3.8% (5) had acute vertebral fracture with severe spinal canal stenosis. Positivity rates varied across different regions of the spine, with thoracic MRIs showing the highest rate at 34.5% (10/29), followed by lumbar MRIs at 19.2% (82/426), and cervical MRIs at 16.2% (38/234). The positivity rate was significantly higher in the thoracic region compared to the lumbar (P = .04) and cervical spine (P = .01). Furthermore, atraumatic cases had an 18.0% (104) positivity rate, 81.7% of which (85) had pure severe spinal canal stenosis, 14.4% (15) showed acute vertebral fracture without spinal canal stenosis, and 3.8% (4) had acute vertebral fracture with severe spinal canal stenosis.

There was significant correlation between age and spine MRI positivity (r = 0.313, P <.001). Additionally, female gender correlated with positivity of the spinal MRI (χ^2 = 5.076, P = .02), as the odds for females to have a positive spinal MRI was 0.6 (confidence interval [CI] 0.4 - 0.9). Further analysis revealed that patients' age (after controlling for sex) significantly correlated with patient hospitalization (r = 0.08, P = .02, CI, 0.01 - 0.16).

Other findings in the spinal MRIs included spinal cord edema or hemorrhage in 1.3% (9/689) and severe subarticular zone or lateral recess stenosis in 25.4% (175/689) of the cases (Figure 1).

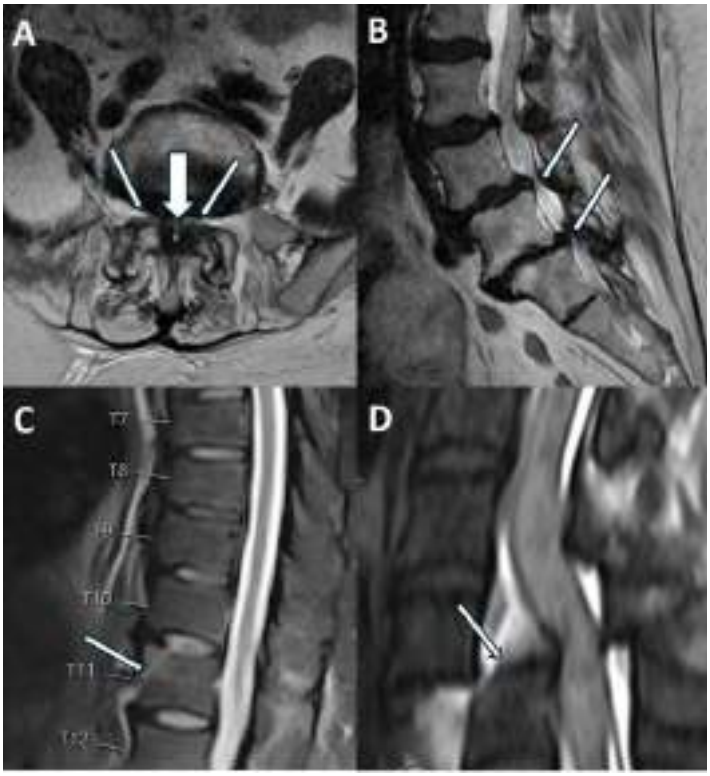

Figure 1. Representative positive findings in STAT magnetic resonance imaging of the spine. A: Severe spinal canal (thick arrow) and bilateral subarticular zone (thin arrows) stenosis. B: Severe spinal canal stenosis at L4-5 and L5-S1. C: Thoracic spine distraction fracture without canal stenosis. D: Cervical spine translation fracture with ligamentous and disc injury with cord edema and hemorrhage.

Emergency Department Wait Times

The median (IQR) image acquisition time was 2.6 (1.8 - 3.7) hours, while the median interpretation time was 1.5 (0.4 - 13.9) hours. The median LOS in the ED was 7.4 (5.7 - 9.5) hours. For non-trauma cases, median (IQR) for image acquisition, interpretation, and LOS times were 2.7 (1.8 - 3.8), 1.6 (0.5 - 14), 7.4 (5.8 - 9.5) hours, respectively. Only image acquisition time was significantly lower in trauma patients compared to non-trauma patients (P < 0.001).

Emergency Departmeent Process Variability

Distribution of patients in the four EDs were 16.3% (112), 27.6% (190), 24.2% (167), and 31.9% (220). Patient characteristics and waiting times for each ED are shown in Table 2. There was a significant difference among the four EDs image acquisition time, image interpretation time, and ED LOS. MR indications for patients in each ED are presented in Supplement 1**.**

DISCUSSION

This multi-hospital retrospective study demonstrated that STAT ED spine MRIs are rare, occurring in < 0.1% of ED encounters and with a low prevalence of positive findings (18.9%), which are defined as severe spinal canal stenosis and/or fracture. Among ED patients receiving spine MRI, one in 30 required hospitalizations, and one in 40 underwent surgery within seven days. Most (83.7%) non-trauma patients had hospitalization and surgery rates similar to those of the overall cohort. Furthermore, while positive MRI results led to longer ED stays, not all resulted in hospitalization or surgery. Stratifying patients by hospital revealed longer image acquisition, interpretation, and ED LOS in hospitals with a higher Black patient population.

While our study's overall MRI positivity rate of 18.9% aligns with the range of 6.6-52% reported in previous studies for emergent spine MRIs,[7,23-28] it is crucial to emphasize the persistent challenge of consistently low positivity rates observed across various investigations. For example, Balasubramanian et al[25] found a positivity rate of 18.8% of 80 patients for confirmed cauda equina syndrome (CES) leading to emergency surgery. Similarly, Bell et al[26] reported a 22% positive MRI rate for CES, and Domen et al[27] observed a 13% positive yield in urgent MRI performed for CES. In the study

Table 2. Differences in emergency department patient populations and wait times.

	ED 1 (n = 112)	ED 2 (n = 190)	ED 3 (n = 167)	ED 4 (n = 220)	P-value
Age mean (SD) yrs	48.6 (14.7)	48.4 (17)	50.1 (15.5)	56.3 (18.6)	<.001
Female sex (n)	54.5% (61)	61.1% (116)	59.3% (99)	60.9% (134)	.67
Race (Black [n] / White [n])	59.8 % [67] / 36.6% [41]	14.7% [27] / 71.6% [136]	43.1% [72] / 52.1% [87]	20.5% [45] / 68.2% [150]	<.001
Trauma (n)	17% (19)	20.5% (39)	11.4% (19)	15.9% (35)	.13
Hospitalization rate	2.7% (3)	5.8% (11)	3% (5)	1.8% (4)	.14
Surgery	1.8% (2)	3.7% (7)	3% (5)	1.4% (3)	.44
MRI positivity rate	20.5% (23)	16.8% (32)	18.6% (31)	20% (44)	.82
Median (IQR) image acquisition time [hours]	2.7 (1.8 - 4.3)	2.5 (1.7 - 3.4)	3.1 (2.1 - 4.1)	2.3 (1.5 - 3.1)	<.001
Median (IQR) image interpretation time	8.5 (1.2 - 16.9)	0.9 (0.4 - 6.8)	14.2 (3.5 – 18.0)	0.6 (0.3 - 1.6)	<.001
Median (IQR) ED LOS	8.6 (6.7 - 11.1)	6.5 (5.1 - 8.1)	9.0 (7.5 - 11.4)	6.6 (5.5 - 8.1)	<.001

ED, emergency department; *SD*, standard deviation; *MRI, magnetic resonance imaging*; *IQR*, interquartile range; *LOS*, length of stay.

by Sayed et al[29] focusing on ED MRI for suspected epidural abscess, only 6.6% of the MRI showed positive results of 106 cases. These findings collectively underscore the persistent challenge of low positivity rates in emergent spine MRIs and emphasize the pressing need for clinical guidelines to enhance the diagnostic efficiency for spinal canal stenosis in the ED.

Interestingly, our study revealed marked differences in positivity rates across different spinal levels. The thoracic spine presented the highest positivity rate at 34.5%, while the cervical spine had the lowest at 16.2%. This variability hints at the impact of clinical decision-making, with the thoracic spine possibly prompting clinicians to order MRI with a higher pre-test probability, resulting in elevated positivity rates. Investigating the reasons for this heterogeneity in positivity by spinal level could offer valuable insights to improve overall diagnostic yield.

Building on this exploration, our study highlights "back pain or injury" as the most common (57.5%) indication for emergency spine MRI among our patients, revealing a notably lower subsequent surgery rate for back pain (2.8%) compared to that reported in the existing literature. For instance, Hussain et al[18] found 13% (32 of 250 patients) with clinical and radiological CES underwent urgent surgery. Similarly, Kindrachuk et al[13] recommended surgery for 12.6% of their cohort (11 of 87 patients), slightly below the previously reported rate of 15%. Moreover, Webster et al[30] reported that 22.0% (156 patients) proceeded to surgery of the cases that had undergone MRI earlier in the course of back pain. Possible reasons for our reduced surgery incidence could be variations in patient populations, ordering behaviors, clinical indications, and the use of different diagnostic algorithms among physicians.

In a step forward we delved into the assessment of ED waiting times including ED LOS, image acquisition time, and image interpretation times to pave the way for future research on the cost effectiveness of emergent spine MRI, as well as potential resources consumed in this process. Although these time intervals are influenced by various factors, we found that the image acquisition, image interpretation, and ED LOS for these patients were 2.6, 1.5, and 7.4 hours, respectively.

Additionally, studies, such as that by Aaronson et al,[31] highlight increased observation admissions and longer ED LOS for patients with uncomplicated back pain undergoing MRI (4.8 vs 2.7 hours). While not implying causation, these findings suggest a correlation between imaging and extended ED LOS. Gardner et al[32] note both CT and MRI independently contribute to approximately 36 minutes additional time. Our longer ED LOS may result from variations in study design and differences in target patients and settings. Strategies to reduce ED LOS include enhancing the management of patients awaiting MRI results, potentially involving measures such as transient hospitalization during the waiting period. Current policies mandating waiting for the final MRI spine report before patient transfer could be revisited to expedite patient flow without compromising care quality.

LIMITATIONS

Limitations in our retrospective study include potential missing or inaccurate data, inherent to this study design. Classification bias may occur in categorizing indeterminate results, relying on subjective judgment. The study lacks an assessment of imaging exam quality, and variations in recording ED time metrics across sites could have introduced inconsistency. Additionally, excluding patients seeking care from hospitals outside university health system, being performed in a single university system in a specific metropolitan area, and absence of a Level I trauma center may impact the generalizability of the findings. Furthermore, our study specifically examines canal stenosis and fractures as indirect indicators for potential surgery candidates. However, we acknowledge that other emergent medical conditions, while not surgical in nature, such as transverse myelitis and osteomyelitis without epidural abscess, may have been

overlooked in our positive cases. Additionally, we did not include positive cord signal as an independent factor to identify positive MRI. Finally, our reliance on admission and surgery as clinical interventions may overlook other ED interventions.

Given the low positive findings rate and the predominance of discharged patients, future research should delve into risk stratification and alternative care pathways beyond the ED for this patient population. Additionally, a more standardized checklist to define the positivity of STAT spine MRI in the ED perhaps should be explored in future studies.

CONCLUSION

Our study revealed the incidence of positive emergent spine MRI, with a relatively small number necessitating hospitalization or surgery. This suggests a potential overuse of ED spine MRI. Selecting patients for emergency spinal MRIs presents a challenge due to the wide spectrum of diseases and non-specific clinical presentations. Our study also highlights heterogeneity in positivity rates based on the imaged spinal level, with the thoracic spine demonstrating the highest positivity. Interestingly, the implementation of diagnostic algorithms has shown potential in increasing positivity rates, and hence reducing time, healthcare expenses, and improving patient outcomes. Further research is needed to optimize the triage process for patients requiring emergent spine MRI.

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The Incidence of Stroke Mimics in the Emergency Department of a Tertiary-care Center in Lebanon

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Introduction: Stroke mimics comprise a significant proportion of cases presenting with neurological deficits and can be difficult to differentiate from true stroke cases. Our aim in this study was to assess the frequency and etiologies of stroke mimics presenting to our emergency department (ED).

Methods: We conducted a retrospective review of the charts of patients presenting to the ED of a tertiary- care center between November 2018–August 2023 and on whom the stroke code was activated. The cases were categorized into real strokes or stroke mimics based on patients' discharge diagnoses.

Results: Stroke code activation was implemented on 584 patients during the study period. These patients received full service and a final discharge diagnosis. Of these, 349 (59.8%) received a diagnosis of a true stroke, whether ischemic, hemorrhagic, or transient ischemic attack. The remaining 235 (40.2%) were classified as stroke mimics, with functional (12.8%) and medical (87.2%) etiologies. Medical stroke mimics were further categorized into non-cerebrovascular neurologic (59.5%), infection or allergic reaction (17.1%), cardiovascular (11.7%), metabolic or drug-induced (8.3%), and other (3.4%). Factors found to favor stroke mimics were history of neurological (adjusted odds ratio [aOR] 4.98; 95% confidence interval [CI] 2.89 - 8.57) or psychiatric disorders (aOR 2.88; 95% CI 1.29 - 6.41) and patients presenting with altered mental status (aOR 1.70; 95% CI 1.04 - 2.80) or generalized weakness (aOR 2.38; 95% CI1.12 - 5.03). Conversely, factors that favored true strokes (with OR <1 for mimics), were patients aged >65 years (aOR 0.61; 95% CI 0.38-0.96), history of hypertension (aOR 0.61; 95% CI 0.38 - 0.97) or atrial fibrillation (aOR 0.39; 95% CI 0.21 - 0.72), and presenting with speech disturbance (aOR 0.56; 95% CI 0.37-0.83) or extremity weakness (aOR: 0.22; 95% CI 0.15- 0.38).

Conclusion: Approximately 40% of cases presenting to our ED with stroke code activation were found to be mimics. The high ratio warrants the establishment and adoption of a more specific triaging algorithm for stroke code activation to minimize the pressure on an already overburdened healthcare sector. [West J Emerg Med. 2025;26(4)943–950.]

INTRODUCTION

In 2019, stroke was the second leading cause of death globally, accounting for 11.6% of deaths annually.[1] Given the high rate of mortality and disability, it is essential to investigate and treat any presenting stroke patient in a timely manner. This requires a host of diagnostic tests and, possibly, subsequent thrombolytic treatment. The costs add up to further stress an already burdened healthcare system. Globally, there is

one new stroke every three seconds, leading to a worldwide cost exceeding 1% of the global gross domestic product.[2] This high burden makes it crucial to distinguish a stroke from any similar mimic. Stroke mimics (SM) are defined as stroke-like symptoms and presentations that arise due to a non-cerebrovascular etiology.[3] Such mimics are estimated to make up an average of 22% of all stroke presentations, ranging from 1-64% of all suspected stroke cases.[4]

Stroke mimics have a wide range of etiologies, with seizures, migraines, and functional disorders making up more than 40% of the cases.5,6 Other causes include cerebrovascular narrowing, toxic or metabolic origins, brain trauma and subdural hematoma, infection, and cardiovascular and other neurologic disorders.5 Patients experiencing stroke mimics exhibit different characteristics from those experiencing an actual stroke. These include differences in age, gender, comorbidities, and presenting signs and symptoms.[7–14]

An improper identification of an SM can subject a patient to a myriad of diagnostic tests and imaging, and potentially to an unnecessary thrombolytic treatment. It is estimated that between 1-16% of SM patients receive thrombolysis with tissue plasminogen activator (tPA), with 0.5% of these patients developing a symptomatic intracerebral hemorrhage.[15] Such unnecessary interventions can add up, with an estimated cost of treatment of $5,400 per admission.[16] These factors necessitate the early identification of an SM patient to spare the unwarranted tests and interventions.

Stroke is also a leading cause of mortality in Lebanon, with 3.1% of total deaths in 2021 attributed to cerebrovascular incidents.17 The prevalence of stroke was estimated to be 0.5%[18], with an average cost of US $6,961 per stroke patient.19 Moreover, a survey of Lebanese people above the age of 40 indicated that 12.1% had experienced at least one stroke symptom.20 Data on the incidence of SMs in Lebanon is scarce. This study aimed to assess the incidence of stroke presentations to a local emergency department (ED) and explore the subsequent diagnoses related to SMs. We looked at patient characteristics, tests and interventions performed, and final diagnoses upon discharge.

Population Health Research Capsule

What do we already know about this issue?
A significant proportion of individuals presenting with stroke-like symptoms are ultimately diagnosed with a stroke mimic rather than true stroke.

What was the research question?
What are the frequency and etiologies of stroke mimics presenting to our tertiary-care center emergency department?

What was the major finding of the study?
Among 584 patients, 235 (40.2%) received a diagnosis of stroke mimic with functional (12.8%) or medical (87.2%) etiologies.

How does this improve population health?
The study highlights the need for a more specific screening pathway for stroke-code activation to reduce strain on an already burdened healthcare system.

METHODS

Study Design and Sample

This was a retrospective, descriptive study of adult patients presenting to the ED of a tertiary-care center in Lebanon. We reviewed the records of all adult patients aged ≥18 years on whom the stroke code was activated upon presentation to our ED between November 2018–August 2023. In our facility, the stroke code is typically activated after the initial assessment of the patient upon arrival. The activation is triggered either directly by the senior attending in the ED or after confirmation with them.

The study was approved by our institutional review board (BIO-2020-0293) and followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) statement.

Data Collection and Variables Measured

Patients were identified using the administrative data of all stroke code activations during the study period. Patients who left against medical advice or were transferred to another hospital before a diagnosis could be made were excluded from the analysis. All study data were extracted manually from the electronic health record (EHR) (Epic Systems Corporation, Verona, WI). Data abstractors, who had prior training in using the EHR for clinical purposes, were not blinded to the study hypothesis.

The data collection protocol was standardized, with variables defined prior to the analysis. Collected variables included patient demographics and characteristics, vital signs upon presentation to the ED, presenting symptoms, imaging studies performed, thrombolysis interventions given, disposition, and discharge diagnoses. We reported missing variables as "unknown."

Diagnoses

We used the *International Classification of Diseases, 10th Rev*, Clinical Modification (ICD-10-CM) coded diagnoses to classify patients into nine categories: ischemic stroke; hemorrhagic stroke; transient ischemic attack (TIA); functional

disorders; neurological disorders other than cerebrovascular accidents; infections or allergic reactions; cardiovascular; metabolic or drug-induced; and diagnoses not elsewhere classified. True strokes were defined as TIA, ischemic stroke, or hemorrhagic stroke confirmed on brain imaging. The six remaining categories were classified under SMs.

Medical Record Review Studies Criteria

This study followed recommended practices for retrospective chart reviews, as described by Worster et al.[21] Details of individual method criteria followed are described in Table 1.

Statistical Analysis

We performed statistical analysis using SPSS Statistics v28.0 (IBM Corp, Armonk, NY). Significance was set at an alpha of 0.05. We presented categorical variables as percentages and frequencies, while continuous variables were expressed as means ± standard deviation or median and interquartile range (IQR). We used chi-squared and Fisher's exact tests to compare groups of categorical variables, and the *t*-test and Mann-Whitney U tests to compare the differences in numerical variables. A multivariable logistic regression model was constructed to determine independent factors associated with SMs. Variables were included in the model if they were clinically relevant or found to be significant on bivariate analysis.

RESULTS

Over a 58-month period, 654 patients presented to our ED and had a stroke code activation. Of these, 70 (10.7%) patients either left against medical advice or were transferred to another facility after being deemed stable and having received incomplete service. Patients who did not have a definitive diagnosis were excluded from the analysis. Of the 584 patients who had a known diagnosis at discharge, 349 (59.8%) had a true stroke, 249 (71.3%) were diagnosed with ischemic stroke, 37 (10.6%) with hemorrhagic stroke, and 63 (18.1%) with TIA.

The remaining 235 (40.2%) were diagnosed with a stroke mimic. Of those, 30 (12.8%) had a functional SM (ie, a psychiatric etiology of their symptoms), while 205 (87.2%) had a medical SM (non-cerebrovascular, non-psychiatric origin of symptoms. Neurological disorders other than strokes were the most common presentation (59.5%) in the medical SM, and seizures were the most common presentation, comprising 27.0% of neurological SM and 14.0% of all SM (Figure 1).

Table 2 shows the demographics and ED visit characteristics of the identified patients. Stroke patients were significantly older than stroke-mimic patients (70.6 [±13.5] years vs 64.7 [±16.0], respectively; $P = .001$). There was no significant difference in gender, marital, or smoking status between the two groups. Stroke patients were more likely to have hypertension (72.5% vs 61.3%; $P = .004$), coronary artery disease (31.8% vs 18.7%; $P = .001$), atrial fibrillation (23.5% vs 8.5%; $P < .001$), and previous ischemic stroke (21.0% vs 10.6%; $P = .001$). On the other hand, a history of psychiatric (11.5% vs 4.3%; $P = .001$) and neurological disorders (29.8% vs 9.7%; $P < .001$) was more common in SM patients. Of the 122 patients with neurological etiology of SM, 51 (41.8%) had a known past neurological history, and of the 30 patients with psychiatric etiology, only seven (23.3%) were known to have a past psychiatric history.

The time elapsed between patient arrival at the ED and the activation of the stroke code varied significantly between the stroke and stroke-mimic groups. Stroke patients had a shorter time from arrival to activation (median of 7.5 [IQR 8.5 minutes]) compared to SM patients (median of 11 [IQR 15 minutes], $P < .001$). Almost all patients (99.3%) who presented to the ED received brain imaging during the visit.

Stroke-mimic patients were less likely to have computed tomography angiography (CTA) (42.1% vs 57%; $P < .001$) and magnetic resonance angiography (MRA) (20.4% vs 39.3%; *P*

Table 1. Adherence to recommended retrospective chart review methodology based on Worster et al criteria.

Method criterion	Details
Abstractor training	Data abstractors had prior training in using the EHR for clinical purposes.
Case selection criteria	We defined inclusion of cases as patients who had stroke code activation upon presentation to the ED. We excluded patients with incomplete service at our facility.
Variable definition	We defined and agreed on all variables before data extraction.
Abstraction forms	A standardized data extraction form was prepared as part of study conceptualization and approved by the IRB.
Medical record identified	The database used in our study was the EHR.
Sampling method	We reviewed all patients who had stroke code activation, identified by administrative record.
Missing-data management plan	Missing data is reported in the study as "unknown."
Institutional review board approval	The study was approved by the IRB.

EHR, electronic health record; *ED,* emergency department; *IRB,* institutional review board.

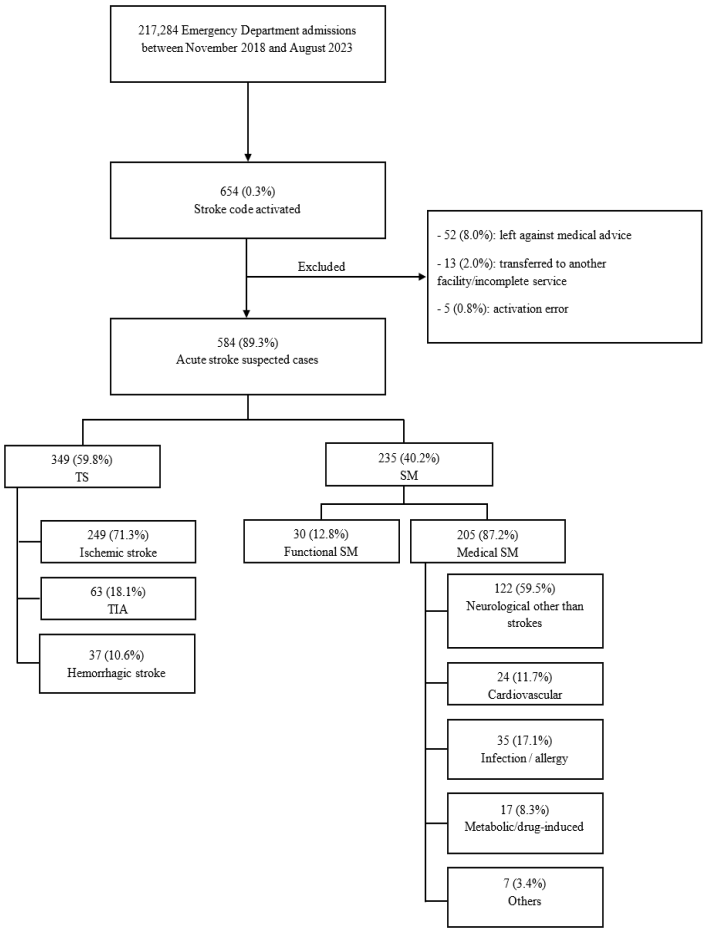

Figure 1. Flow diagram of patient selection from all stroke code activations between November 2018–August 2023: diagnostic classification into true stroke and stroke mimic.
TS, true stroke; *SM,* stroke mimic; *TIA,* transient ischemic attack.

< .001). Thirty-three patients (5.7%) received thrombolysis with recombinant tPA, one of whom had a stroke mimic (Table 2). Table 3 shows the patients' vital signs and symptoms upon ED presentation. Stroke patients presented more with speech abnormalities (64.8% vs. 49.4; *P*< .001), extremities weakness (63% vs 29.8%; *P* < .001), or facial weakness (30.7% vs. 19.1%; *P* = .002). They were also found to have significantly higher mean systolic (151.8 ± 26.3 vs 144.0 ± 27.4; *P* = .001).

DISCUSSION

To the best of our knowledge, this study is the first to describe the rate and characteristics of stroke mimics in Lebanon. Roughly half of our patients (40.2%) were found to have SM. Roughly half of our patients (40.2%) were found to have SM. This incidence of mimics is more than double the reported global average of 22%[4] and is higher than the reported figures in regional studies from Qatar (35%)[22] and Morocco (15.6%).[23] Conversely, our findings are similar to those reported in a study from Canada (43.2%).[24]With no prior data on the incidence of SMs in other local hospitals, it is difficult to pinpoint the origin of our high rate and to comment on the sensitivity of our stroke

code-activation practices. Several studies have proposed an algorithm for the early detection of a mimic[25,26]; however, in the absence of a standardized and validated mimic identification model, the activation of the stroke code must rely on the judgment of the triage team and the internal protocol set by each medical care facility. Of the 235 SM patients, 122 (51.9%) had a non-cerebrovascular neurologic origin. Seizures, as a single disease diagnosis, were the most common presentation for SMs. This mirrors globally reported trends, which state that seizures cause most SM cases.[3,6] Nevertheless, global incidence accounts for an average of 20% of said cases[5,10] as compared to 14.0% in our study. The lower number of seizure disorders presenting as a stroke to our ED could be due to an early identification of neurologic comorbidities at the triage level, prompting the treatment of the patient as a regular neurologic case rather than a potential stroke case. A patient presenting in the postictal phase could be accompanied by a chaperone who witnessed the seizure, which decreases the likelihood of a stroke diagnosis.

Our data revealed that 30 patients (12.8%) had functional SM. This incidence was similar to that found in the United Kingdom (13%)[27] and Canada (11.9%),[28] lower than that found in France (16.7%)[29] and Saudi Arabia (24.4%)7, and higher than that found in Korea (5.6%)10 and Iran (8.1%).[30] Cultural distinctions and variations in illness manifestation behaviors across countries could account for these differences. This is substantiated by data from Qatar initially showing a 17% incidence of functional SM.[31] However, when including all nationalities presenting to the same center, this incidence increased to 29.2%.[31] Interestingly, our incidence paralleled that from SM studies in other EDs (11.9%, 8.1%, 5.6%)[10,28,30] as opposed to studies conducted in stroke centers where psychiatric disorders were identified as one of the highest proportions of all causes of mimics (29.2%, 25.7%, 24.4%).[7,23,31] This discrepancy may be explained by the fact that the primary assessors in the former studies were neurologists, while those in the latter studies, including ours, were emergency physicians. The more diversified exposure to psychiatric cases during emergency medicine training may be related to the lesser percentage observed. It may also be skewed by self-selection bias, whereby functional patients, exhibiting stroke symptoms, would be more likely to present to a stroke center rather than to an ED.

Several clinical features were found to be associated with SM in our sample. Age <65 years was independently associated with SM. This is in line with the published literature on younger individuals being more likely to have SM.[10,12–14] This is also expected, considering that 75% of all strokes occur in persons ≥65 years of age.[11] Past medical history and presenting symptoms were also consistent with prior studies in terms of risk factors. A history of hypertension or atrial fibrillation, or

Table 2. Demographics and emergency department visit characteristics of patients presenting with stroke activation: stroke mimics vs, true stroke patients.

		TS (N=349)	SM (N=235)	*P*-value
Patient demographics				
Age (years, mean ± SD)		70.6 ± 13.5	64.7 ± 16.0	<.001
>65 years		234 (67.0%)	120 (51.1%)	<.001
Sex	Male	200 (57.3%)	118 (50.2%)	.09
	Female	149 (42.7%)	117 (49.8%)	
Marital status	Single	47 (13.5%)	29 (12.3%)	.80
	Married	281 (80.5%)	189 (80.4%)	
	Widowed or divorced	21 (6%)	17 (7.2%)	
Smoking status	Never	143 (41.0%)	96 (40.9%)	.38
	Current	101 (28.9%)	76 (32.3%)	
	Former	92 (26.4%)	50 (21.3%)	
	Unknown	13 (3.7%)	13 (5.5%)	
Past medical history	Hypertension	253 (72.5%)	144 (61.3%)	< .01
	Diabetes mellitus	118 (33.8%)	77 (32.8%)	.79
	Dyslipidemia	163 (46.7%)	98 (41.7%)	.23
	Coronary artery disease	111 (31.8%)	44 (18.7%)	.001
	Atrial fibrillation	82 (23.5%)	20 (8.5%)	<.001
	Carotid artery disease	4 (1.1%)	3 (1.3%)	1
	Transient ischemic attack	29 (8.3%)	17 (7.2%)	.64
	Ischemic stroke	73 (21.0%)	25 (10.6%)	.001
	Hemorrhagic stroke	6 (1.7%)	5 (2.1%)	.76
	Malignancy	42 (12.0%)	36 (15.3%)	.25
	Psychiatric disorder	15 (4.3%)	27 (11.5%)	.001
	Other neurological disorders*	34 (9.7%)	70 (29.8%)	<.001
ED visit characteristics				
Time arrival to activation (min)		7 (8.5)	11 (15)	<.001
CT with and without contrast		227 (65%)	165 (70.2%)	.19
CT angiography		199 (57%)	99 (42.1%)	<.001
MRI with and without gadolinium		136 (39.0%)	89 (37.9%)	.80
MR angiography		137 (39.3%)	48 (20.4%)	<.001
r-tPA		32 (9.2%)	1 (0.4%)	<.001
ED disposition	Home	11 (3.2%)	37 (15.7%)	
	Admit	338 (96.8%)	195 (83%)	<.001
	Dead	0 (0%)	3 (1.3%)	

*Previous history of neurological disorders other than stroke or transient ischemic attack (including seizures, migraines, Alzheimer's disease, brain lesions, etc).
TS, true stroke; *SM,* stroke mimic; *CT,* computed topography; *MRI,* magnetic resonance imaging; *r-tPA,* recombinant tissue plasminogen activator; *ED,* emergency department.

motor deficits such as extremity weakness or speech disturbances favored a TS diagnosis.[9,10,15,32,33]

In contrast, a history of psychiatric or neurological disease or an altered mental status presentation increased the odds of a SM diagnosis.[10,15] Specifically, in our dataset, a history of neurological diseases other than stroke strongly favored SM diagnoses. This can be explained by the fact that individuals with a history of seizures can present in a postictal state, mimicking strokes.[15,34] Seizures are one of the most common SM presentations in both our data and in the literature.[34,35] Additionally, previously published studies have shown that migraines, especially those with aura or hemiplegic migraines, are one of the leading SM presentations, and having a history of migraines increases the likelihood of an SM diagnosis

Table 3. Symptoms and vital signs at ED presentation of stroke-mimic and true-stroke patients with stroke code activation.

	TS (N=349)	SM (N=235)	P-value
Presenting symptoms			
Speech abnormalities	226 (64.8%)	116 (49.4%)	<.001
Visual abnormalities	17 (4.9%)	13 (5.5%)	.72
Extremity weakness	220 (63%)	70 (29.8%)	<.001
Extremity numbness	57 (16.3%)	46 (19.6%)	.31
Facial weakness	107 (30.7%)	45 (19.1%)	< .01
Facial numbness	22 (6.3%)	27 (11.5%)	.03
Headache	34 (9.7%)	44 (18.7%)	< .01
Altered mental status	58 (16.6%)	71 (30.2%)	<.001
Loss of consciousness	19 (5.4%)	23 (9.8%)	.05
Generalized weakness	18 (5.2%)	28 (11.9%)	< .01
Triage Vital Signs			
Temperature (°C)	36.7 ± 0.3	36.8 ± 0.6	.15
Pulse (beats per minute)	83.0 ± 19.4	86.4 ± 18.8	.03
Systolic blood pressure (mmHg)	151.8 ± 26.3	144.0 ± 27.4	.001
Diastolic blood pressure (mmHg)	85.6 ± 19.0	82.5 ± 15.8	.03
Oxygen saturation (%)	97.6 ± 3.8	97.4 ± 4.4	.55
Respiratory rate (breaths per minute)	18.4 ± 3.5	19.2 ± 5.2	.04

ED, emergency department; *TS,* true stroke; *SM,* stroke mimic; *mmHg*, millimeters of mercury.

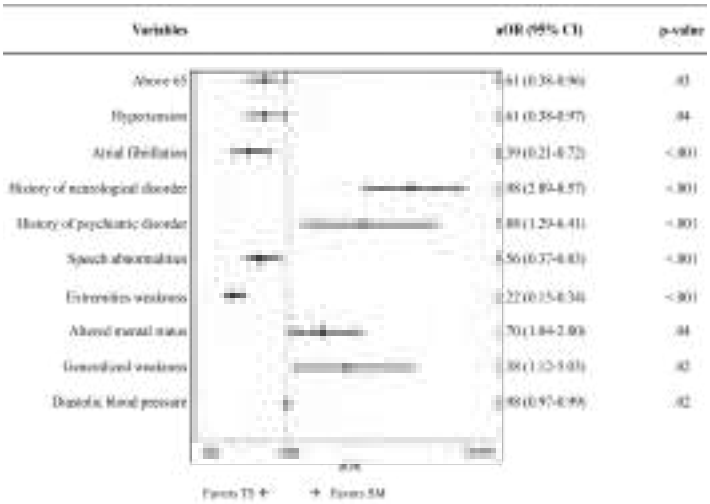

Figure 2. Multivariate logistic regression analysis identifying factors associated with stroke mimic vs. true stroke among patients with stroke code activation.
aOR, adjusted odds ratio; *CI,* confidence interval; *TS,* true stroke; *SM,* stoke mimic.

compared to a TS. Furthermore, due to increased intracranial pressure or mass effect, patients with brain lesions can present with neurological deficits like those seen in strokes, despite the absence of any vascular event.[5,36]

The results obtained in our study suggest the need for a more specific algorithm for activating a stroke code. This could include the involvement of more physicians and personnel with exposure to neurologic and psychiatric training in the triage of suspected stroke cases and the subsequent activation of the stroke code. Our data also highlight the need for more studies on the incidence of SMs in various medical care facilities across Lebanon. A local average stroke-mimic rate would allow for a better evaluation of the specificity and efficiency of the stroke code system in hospitals nationwide.

LIMITATIONS

The study is limited to patients presenting to the ED of a single, tertiary-care center in Lebanon. This limits the generalizability of the results we reported and may not reflect the true rate of SMs in the country. The lack of data from other local hospitals makes it difficult to compare our results to other care centers, thus diminishing the ability to accurately describe the incidence of SMs as well as the sensitivity of our stroke code-activation system. In addition, the total number of patients treated with r-tPA was low, making it difficult to truly evaluate the negative outcomes of misidentifying and wrongly treating SM cases.

Moreover, this study has methodological limitations common to retrospective reviews. The data were examined retrospectively, and the diagnoses at discharge were extracted as ICD-10-CM codes from the charts of identified patients. The diagnoses may have been classified and labeled incorrectly, making some etiologies over- or under-represented. Also, not all Worster et al criteria for retrospective chart reviews were followed.[21] Specifically, the performance of data abstractors was not formally monitored, they were not blinded to the study objectives, and data extraction was conducted once; thus, interobserver reliability was not formally tested or reported, which may have introduced bias. However, to reduce this risk, we used a structured data abstraction form with predefined variables to ensure consistency. Additionally, all data abstractors were medically trained and had extensive prior experience with the database, which contributed to the consistency and accuracy of data entry.

CONCLUSION

Given that stroke is a time-dependent medical emergency, it is imperative that emergency physicians rule out acute stroke first. However, given that nearly half of the presenting cases received a diagnosis of stroke mimic, it is imperative to devise a more specific screening pathway for stroke code activation. In low- and middle-income countries, specifically Lebanon, unwarranted code activations overburden the fragile healthcare

system, which already suffers from limited capacities characterized by insufficient staff, equipment, and medications. Thus, a step forward toward developing a psychometrically robust and culturally adapted assessment for stroke mimics may help physicians in triaging suspected patients and considering alternative diagnoses.

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Emergency Department Utilization by Race, Ethnicity, Language, and Medicaid Status

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Introduction: Emergency department (ED) use varies by age, sex, race, ethnicity, language preference, and payor type. Most studies comparing ED use by patients with English vs non-English preference (ELP/NELP) have used racially aggregated data, potentially masking differences across population subgroups. In this study we aimed to disaggregate the associations of race, ethnicity, language preference, and Medicaid coverage with ED utilization.

Methods: We used cross-sectional study electronic health record data for 2,047,105 Kaiser Permanente Northern California members who were 25 - 85 years of age in January 2019 and had been continuous health plan members during 2018 - 2019. We tabulated the percentages of adults in seven racial and ethnic groups (White, Black, Hispanic, Chinese, Filipino, Vietnamese, South Asian) within three age groups (25 - 44, 45 - 64, 65 - 85) who had ≥1 ED visit in 2019. Modified log-Poisson regression was used to examine racial, ethnic, and language preference differences after adjusting for demographic and Medicaid status covariates.

Results: The study population was 51.8% White, 53.2% female, 9.6% NELP, and 6.2% Medicaid-insured. Overall, 18% had ≥ 1 ED visit. Compared with White adults, Black and Hispanic adults were more likely and Chinese, Vietnamese, and South Asian adults were less likely to have ≥ 1 ED visit. After adjusting for all covariates, NELP adults 25 - 64 years of age were 10% less likely to have had an ED visit. However, while NELP was associated with a 10-20% lower ED visit prevalence among Hispanic, Filipino, Chinese, and Vietnamese adults 25 - 64, the prevalence was 10% higher among White and South Asian adults 45 - 64 and Filipino and South Asian adults aged 65 - 85. Adults with Medicaid coverage aged 25 - 64 were twice as likely and adults aged 65 - 85 were 50% more likely to have had ≥ 1 ED visit.

Conclusion: This study of a US adult health-plan membership found several significant differences in ED use across racial, ethnic, and language subgroups and a higher prevalence of ED use by Medicaid-covered adults ≤ 65 years of age in most racial and ethnic groups. Our findings highlight the importance of using disaggregated data, particularly for Asian ethnic groups, when comparing ED use in different populations. Further research is needed to identify similarities and differences in social, personal, and policy factors driving ED use in diverse adult populations to better inform population-specific health interventions. [West J Emerg Med. 2025;26(4)951–959.]

Population Health Research Capsule

What do we already know about this issue?
Emergency department (ED) use has been shown to vary by age, sex, race, ethnicity, language preference, and health insurance type.

What was the research question?
What demographic factors predict ED use in an insured adult population receiving care within an integrated care delivery system?

What was the major finding of the study?
Large differences in utilization were seen across race/ethnicity, particularly between different Asian ethnic groups, but not by language preference within ethnic groups.

How does this improve population health?
Our study highlights the importance of using disaggregated data, particularly for Asian ethnic groups, when exploring sociodemographic factors associated with ED use.

INTRODUCTION

Background

In recent years, the rising use of emergency departments (ED) nationwide has highlighted challenges within the healthcare system. The increase in the number of ED visits has been contemporaneous with a national decline in access to primary care services.[1-2]

Previous research has identified sociodemographic and healthcare access factors associated with ED visits including age, sex, race and ethnicity, language barriers, payor and coverage status, and access to a regular primary care physician.[3,4,5-6] However, many of these studies are now over a decade old and included adults who lacked health insurance and/or a usual source of primary care, factors that have been shown to increase likelihood of ED use. Additionally, most studies examining differences in ED use by adults with limited English proficiency (LEP) have compared Hispanic adults with and without LEP or compared racially aggregated populations with non-English language preference (NELP) vs English language preference (ELP), which may mask differences between and within racial and ethnic groups.[7-9] Researchers have begun to advocate for using racially/ethnically disaggregated data for such comparisons to disentangle the effects of race and ethnicity from those of English or non-English language preference (as a proxy for English proficiency), as this could lead to better understanding of drivers of healthcare utilization within different demographic subgroups. In turn, this could improve efforts to develop and monitor system-level interventions aimed at reducing suboptimal healthcare utilization in higher risk segments of the population.[10,11]

In this study we aimed to disaggregate the associations of race and ethnicity, language preference, and Medicaid coverage with the prevalence of ED visits among younger, middle-aged, and older adults in a contemporary study population of adult, Northern California health plan members who received healthcare from the same integrated healthcare delivery system.

METHODS

Study Design

In this cross-sectional retrospective study we analyzed data from an existing electronic health record (EHR)-derived research dataset to compare the percentages of adults in seven racial and ethnic groups who in 2019 made ≥ 1 ED visit to a Kaiser Permanente Northern California (KPNC) medical center. This study was conducted under the scope of a broader study of racial and ethnic health and healthcare disparities that was approved by the KPNC Institutional Review Board with a waiver of informed consent and HIPAA authorization.

Setting and Study Population

Kaiser Permanente Northern California is an integrated healthcare delivery system that provides primary and specialty outpatient and hospital care along with pharmacy and laboratory services, a 24/7 telephone Advice Call Center, a patient portal, and interpreter services to a sociodemographically diverse health plan membership that includes >3.4 million adults who mostly reside in the Greater San Francisco Bay Area, Sacramento, the Silicon Valley, and Central Valley. The KPNC adult membership includes a very low percentage of adults covered by California's Medicaid program and is similar to the non-Medicaid insured adult population of Northern California with regard to social, demographic, and health characteristics.[12] Upon enrollment in the health plan, all members are assigned a primary care physician within the healthcare system and are encouraged to use primary care services and to obtain clinical advice using the Appointment and Advice Call Center and the patient portal.

We used secondary data from an existing EHR-derived research dataset that included demographic variables, Medicaid coverage status, and selected healthcare utilization data for 2.52 million adults 25 - 89 years of age who were continuous KPNC members during calendar year 2019.[13] The study population was comprised of a subset of 2,047,105 adults 25-85 in January 2019, who had been continuous health plan members during 2018-2019. It included

1,061,066 White (0.5% NELP), 153,817 Black (0.4% NELP), 431,031 Hispanic (29.2% NELP), 133,733 Chinese (30.0% NELP), 132,247 Filipino (4.0% NELP), 97,549 South Asian (6.8% NELP), and 37,662 Vietnamese (31.9% NELP) men and women.

Study Variables

Sociodemographic Characteristics

Age, sex at birth, and race and ethnicity were available for all adults from the source cohort. Detailed information about how adults were assigned to a racial/ethnic group can be found in the article describing the source dataset.[13] Spoken language preference and Medicaid coverage status during 2019 were available for nearly all individuals in the study cohort. Language preference was collapsed into non-English language preference (NELP) vs. English language preference (ELP).

ED Visits

The source dataset included a variable for total number of ED visits during 2019. The *International Classification of Diseases* code indicating primary diagnosis for each ED visit was not available in the dataset. In this study, our outcome of interest was ≥1 ED visit during 2019.

Statistical Analysis

All analyses were conducted in 2024 using SAS v9.4 (SAS Institute, Inc, Cary, NC). We calculated the unadjusted prevalence of ≥ 1 ED visit by race and ethnic group for adults in three age groups (25 - 44, 45 - 64, and 65 - 85 years of age) and used chi-square tests to identify statistically significant differences (at $P < .05$) between White and non-White racial/ethnic groups within each age group. White patients were chosen as the reference group because they comprised the largest proportion of the sample. Because the very large racial and ethnic subgroups resulted in significant *P*-values for very small differences in prevalence, we made an a priori decision that to be considered *meaningfully* significant, differences between groups needed to be ≥ 1 percentage point and have a chi-square *P*-value < .05. Unless otherwise noted, subgroup differences mentioned in the text met the criteria for meaningful difference.

We used modified log-Poisson regression models to estimate adjusted prevalence ratios (aPR) with 95% confidence intervals (CI) that compare the prevalence of ≥ 1 ED visit among Black, Hispanic, Chinese, Filipino, South Asian (adults with ethnic origins in India, Pakistan, Afghanistan, Bangladesh, Sri Lanka, Nepal, or Bhutan, or who were Fijian Indian), and Vietnamese adults to the prevalence among White adults within each age group after controlling for sex, age as a five-year interval variable, NELP/ELP status, and Medicaid coverage.[14] Medicaid coverage served as a proxy for very low income, but additionally, Medicaid-covered members did not have a copay for ED visits, whereas ED visits for commercially and Medicare-covered adults had a substantial co-pay. Black adults were excluded from analyses comparing NELP vs. ELP status within racial/ethnic groups due to small subgroup sizes. Adults with missing data were only excluded from bivariate and multivariate analyses that included that variable. Finally, our statistical analyses did not adjust for multiple comparisons, but we report the results of all statistical tests.[15]

RESULTS

Demographic Characteristics of the Study Population

The overall study population of 2,047,105 was 53.2% female, 9.6% NELP, and 6.2% Medicaid-insured, with a mean age of 52.3 years of age (standard deviation 15.2 years). Descriptive data for the overall study population and the seven racial and ethnic groups by age group, are found in the Table.

Percentages of the Study Population with ≥ 1 ED Visit in 2019

During the 2019 study period, 18.0% of the 2,047,105 patients had ≥ 1 ED visit, with adults 65 - 85 years of age more likely than adults 25 - 44 and 45 - 64 to have had an ED visit (24.9% vs 16.2% and 16.4%, respectively).

Racial and Ethnic Group Differences in ED Use

In all three age groups, Black and Hispanic adults were more likely and Chinese and Vietnamese adults less likely than White adults to have had an ED visit (Figure 1). South Asian adults were less likely than White adults to have had an ED visit in the 25 - 44 and 45 - 64 age groups, while Filipino adults did not meaningfully differ from White adults in any age group. The racial and ethnic group differences for ED visits remained significant after adjusting for sex, age, NELP status, and Medicaid coverage (Figure 2). Although the percentages of patients with only one ED visit were similar across racial/ethnic groups (≤ 0.5% for 25 - 44 years of age, ≤ 0.7% for 45 - 64, ≤ 1.3% for 65-85), the percentages of patients who had ≥ 5 ED visits varied widely, ranging from 4.3% for Chinese patients 25 - 44 years of age to 17.8% for Black patients. This pattern was consistent within all age groups, but the 65 - 85 years age group had higher numbers of ED visits overall. (Supplemental File 1).

Sociodemographic and Medicaid Coverage Factors Associated with Having ≥ 1 ED Visit

Sex

In the full study population, after controlling for other covariates, males in the 25 - 44 and 45 - 64 age groups were less likely than similarly aged females to have had ≥ 1 ED visit (aPR = 0.86 [0.85 - 0.87] and aPR = 0.94 [0.93-0.95], respectively). However, no significant sex difference was seen for prevalence of ≥ 1 ED visit in the 65 - 85 age group (Figure 3). Within racial and ethnic groups, Black, Hispanic,

Table. Characteristics of the study population, overall and by racial and ethnic group.

Study subgroup	N	Percentage of total population	Mean age (Years)	Female sex	Non-English language preference	Covered by Medicaid
25-44 years of age						
Overall population	401,113	100.0%	35.4	53.0%	8.0%	4.7%
White	304,441	43.1%	35.3	51.2%	0.4%	3.9%
Black	50,715	7.2%	35.3	58.2%	0.5%	13.3%
Hispanic/Latino	191,949	27.2%	35.2	51.6%	22.0%	4.9%
Chinese	43,444	6.2%	35.7	57.5%	16.8%	3.0%
Filipino	43,943	6.2%	36	59.5%	1.7%	3.2%
South Asian	55,875	7.9%	35.3	52.1%	3.4%	2.9%
Vietnamese	15,187	2.2%	36.3	60.8%	18.1%	4.5%
45-64 years of age						
Overall population	410,724	100.0%	54.6	52.2%	11.9%	2.9%
White	433,903	51.4%	55.2	51.5%	0.6%	2.3%
Black	67,823	8.0%	54.6	55.8%	0.4%	6.0%
Hispanic/Latino	177,334	21.0%	53.5	50.9%	37.1%	3.2%
Chinese	57,459	6.8%	54.5	55.9%	34.3%	2.9%
Filipino	58,582	6.9%	54.3	57.6%	4.4%	1.7%
South Asian	32,256	3.8%	53	46.8%	9.8%	4.2%
Vietnamese	17,270	2.0%	53.2	49.8%	37.6%	5.2%
65-85 years of age						
Overall population	496,924	100.0%	72.5	55.2%	7.8%	1.8%
White	322,722	64.9%	72.6	54.8%	0.5%	0.7%
Black	35,279	7.1%	72.3	59.1%	0.3%	2.8%
Hispanic/Latino	61,748	12.4%	72.5	55.3%	28.8%	3.1%
Chinese	32,830	6.6%	72.3	53.4%	39.8%	4.4%
Filipino	29,722	6.0%	72.2	59.0%	6.6%	3.1%
South Asian	9,418	1.3%	71.8	46.1%	17.5%	10.1%
Vietnamese	5,205	1.0%	71.6	51.3%	53.7%	12.0%

and Filipino males in all age groups, White, Chinese, South Asian, and Vietnamese males in the 25 - 44 age group, and South Asian males in the 45 - 64 age group were less likely than females in the same age group to have had an ED visit (Supplemental File 2).

Non-English vs English Language Preference

In the full study population, after controlling for other covariates, NELP adults in the 25 - 44 and 45 - 64 age groups were approximately 10% less likely than their ELP counterparts to have had an ED visit (aPR = 0.91 [0.89 - 0.93] and aPR = 0.92 [0.91 - 0.94], respectively), but no association with NELP status was seen in the 65-85 group (Figure 3).

Comparisons of the prevalence of ≥ 1 ED visit within racial and ethnic groups and prevalence of ≥ 1 ED visit by NELP vs ELP status within racial and ethnic groups are shown in Figure 4. Adjusted prevalence ratios comparing NELP to ELP subgroups within racial and ethnic groups are found in Supplemental File 2. Hispanic, Filipino, Chinese, and Vietnamese adults with NELP in the 25 - 44 and 45 - 64 age groups were 10 - 20% less likely to have had an ED visit than their ELP counterparts (aPR range: 0.80 - 0.91). However, White and South Asian adults with NELP in the 45 - 64 group and Filipino and South Asian adults with NELP in the 65 - 85 group were at least 10% more likely to have had an ED visit.

Medicaid Coverage

In the full study population, after controlling for sociodemographic covariates, adults with Medicaid coverage were twice as likely as those not covered by Medicaid to have ≥ 1 ED visit in the 25 - 44 and 45 - 64 age groups (aPR = 2.09 [2.05 - 2.12] and aPR = 2.07 [2.03 - 2.10], respectively) and 50% more likely in the 65-85 age group (aPR = 1.54 [1.50 - 1.59]). Having Medicaid coverage approximately doubled the likelihood of having an ED visit in all racial and ethnic groups in the 25 - 44 and 4 5- 64 age groups (aPR range: 1.84 - 2.55), with a slightly lesser

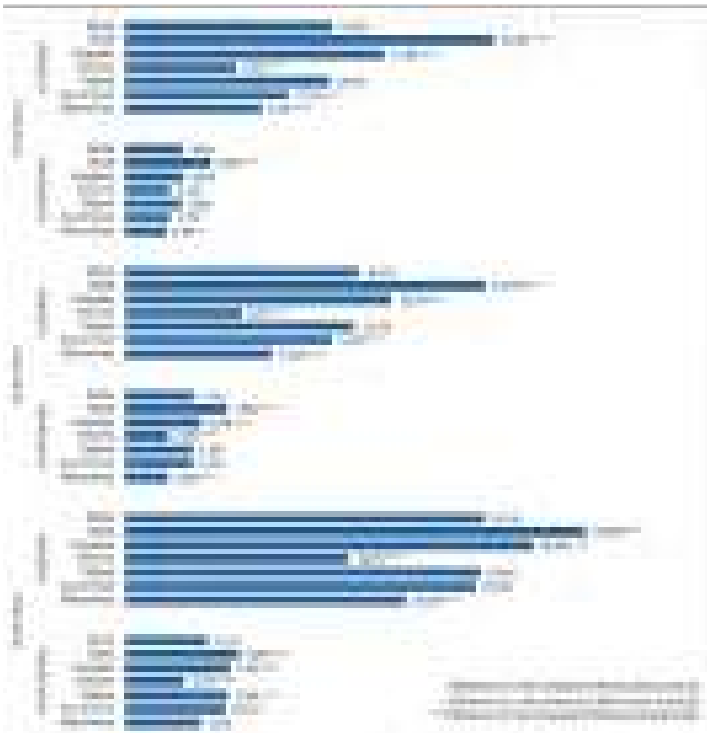

Figure 1. Percentages of adults with ≥ 1 emergency department visit in 2019 by race, ethnicity, and age group.
*Racial/ethnic group significantly differs from White adults at $P < .05$.

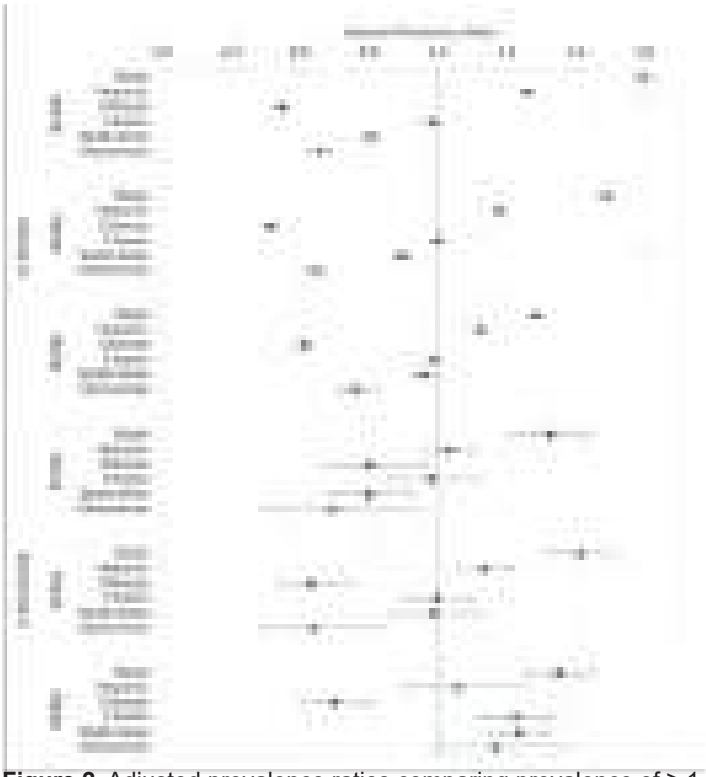

Figure 2. Adjusted prevalence ratios comparing prevalence of ≥ 1 emergency department visit among adults in six non-White racial and ethnic groups to White adults, by age group.
Adjusted prevalence ratios with 95% confidence intervals compare prevalence of ≥ 1 emergency department visit among each non-White racial/ethnic group to prevalence among White adults in the same age group after adjusting for age as a 5-year interval variable, sex, non-English vs. English language preference, and Medicaid coverage status.

association in the 65-85 age group (aPR range: 1.23 - 1.89, but no significant difference among Vietnamese adults).

Outpatient Clinic Visit

In this health plan, an effort is made to connect all patients with a primary care doctor upon enrollment. Over 70% of adults 25 - 64 years of age and over 90% of adults 65 - 85 years of age had at least one outpatient clinic visit during 2019, with little variation across racial, ethnic, and language subgroups. However, clinic visits could not be temporally associated with ED visit use.

DISCUSSION

Our aim in this study was to disaggregate the associations of race and ethnicity, language preference, and Medicaid coverage with the likelihood of having ≥ 1 ED in an insured adult population that was covered by the same health plan and received healthcare within the same integrated healthcare delivery system. We found that in this health plan population, Black and Hispanic adults were more likely than similarly aged White adults to have had ≥ 1 ED visit during 2019. These findings are consistent with previous population-based studies that included adults without health insurance and a regular source of primary care, which found that Black adults were more likely than White and Hispanic adults to have an ED visit,[16-18] and that Black and Hispanic adults were more likely than White adults to make multiple ED visits and to use the ED for non-urgent care.[19,20]

We believe this is the first US study to examine ED use by different Asian ethnic subgroups, documenting a lower prevalence of ED use among Chinese, Vietnamese, and South Asian adults and similar prevalence among Filipino adults compared to White adults. A growing body of research points to the importance of using disaggregated data for Asian ethnic groups when studying health outcomes and healthcare utilization to improve health equity. For example, significant differences across US Asian ethnic groups have been documented in the prevalence of smoking, obesity, diabetes, hypertension, and coronary artery disease[13,21] and in mortality from ischemic heart disease, heart failure, and stroke.[22]

With respect to language preference, adults 25 - 64 years of age with NELP were approximately 10% less likely than those with ELP to have had an ED visit. This is consistent with previous studies that found NELP status had little or no impact on likelihood of having an ED visit.[23-25] However, we further showed that the impact of NELP status on ED use

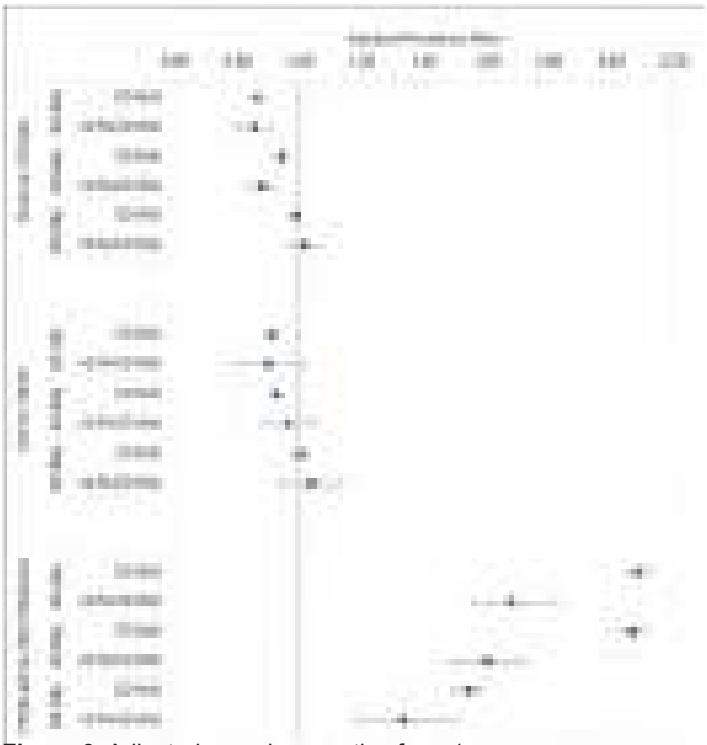

Figure 3. Adjusted prevalence ratios for ≥ 1 emergency department visit by sex, language preference, and Medicaid coverage status within three age groups.
Adjusted prevalence ratios (with 95% confidence intervals) for ≥ 1 ED visit comparing males to females after adjusting for age as a 5-year interval variable, racial/ethnic group, language preference, and Medicaid status; non-English vs. English language preference after adjusting for age, sex, racial/ethnic group, and Medicaid status; and Medicaid to non-Medicaid covered adults after adjusting for age, sex, racial/ethnic group, and language preference.
ELP, English language preference; *NELP,* non-English language preference.

varied by racial and ethnic group within the three age strata, slightly lowering likelihood of ED use among Hispanic, Filipino, Chinese, and Vietnamese adults in the 25 - 44 and 45 - 64 age groups and slightly increasing likelihood among White and South Asian adults in the 45 - 64 age group and Filipino and South Asian adults in the 65 - 85 age group.

Several previous studies have reported substantially higher ED usage among adults covered by Medicaid as compared to private insurance.[26-29] In our study, we also found that Medicaid coverage was associated with an approximately twofold higher prevalence of ED use among adults 25 - 64 years of age and a 50% higher likelihood among adults 65 - 85 across all racial/ethnic groups. This occurred even though all members of the study population had a usual source of primary and specialty care with access to limited evening and weekend outpatient care and a 24/7 advice nurse line, an assigned primary care physician and, for selected chronic health conditions, a care manager. We were unable to examine whether the higher ED usage among Medicaid-covered members was associated with a higher disease burden or social factors such as work- or childcare-related barriers. However, we do know Medicaid-covered members had no financial disincentive for ED use (ie, no copay), while non-Medicaid covered members, including those covered by Medicare, had a substantially higher co-pay for ED visits that did not result in a hospitalization. Higher ED visit copays have been shown to decrease likelihood of ED use for non-urgent reasons.[29-31]

LIMITATIONS

This study had several limitations. The study data were for insured adults who all received care from the same integrated healthcare delivery system and thus may not be generalizable to populations that include uninsured adults, adults with more fragmented sources of healthcare, and adults without a primary care physician. Additionally, because this was a secondary analysis of an existing dataset, we lacked data to control for health burden and education, income, and other social determinants of health when comparing ED use by race and ethnicity, language preference, and Medicaid coverage status. Our dataset only captured ED visits within KPNC; so patients who presented to outside EDs would not have been captured. While KPNC covers out-of-plan ED visits for Medicaid and non-Medicaid covered members at the same copay level as the member would have for an in-plan ED visits, our study lacked data to evaluate whether out-of-plan ED use differed by Medicaid coverage status or other demographic factors. The dataset also lacked detailed information about the reason for the ED visit (eg, whether it was considered a true emergency), whether the individual was told to go to the ED by health plan staff, and whether the visit occurred outside regular outpatient clinic hours.

Furthermore, EHR data for race and ethnicity and language preference may contain some inaccuracies. Specifically, some adults with Asian race in the EHR but not Asian ethnicity were assigned to an Asian ethnic group based on surname, and some individuals who reported themselves as White but had first and last names and/or a spoken or written language preference that indicated they were likely South Asian, Hispanic/Latino, or Middle Eastern were re-assigned to a different racial/ethnic group. Additionally, at the time the source dataset was created, the health plan's EHR only captured one racial/ethnic value for each member based on the US Office of Management and Budget's six category combined race and ethnicity question. This, plus the use of a study-created algorithm to assign individuals to one racial/ethnic group when data for that individual from multiple sources indicated potential mixed race or ethnicity, may have led to misclassification or confounding due to mixed race/ethnicity in some instances.[13]

Further, although the source dataset allowed us to disaggregate Asian ethnic subgroups, we lacked the ability to do the same for the Black, White, and Hispanic groups. Finally, EHR-documented spoken language preference may

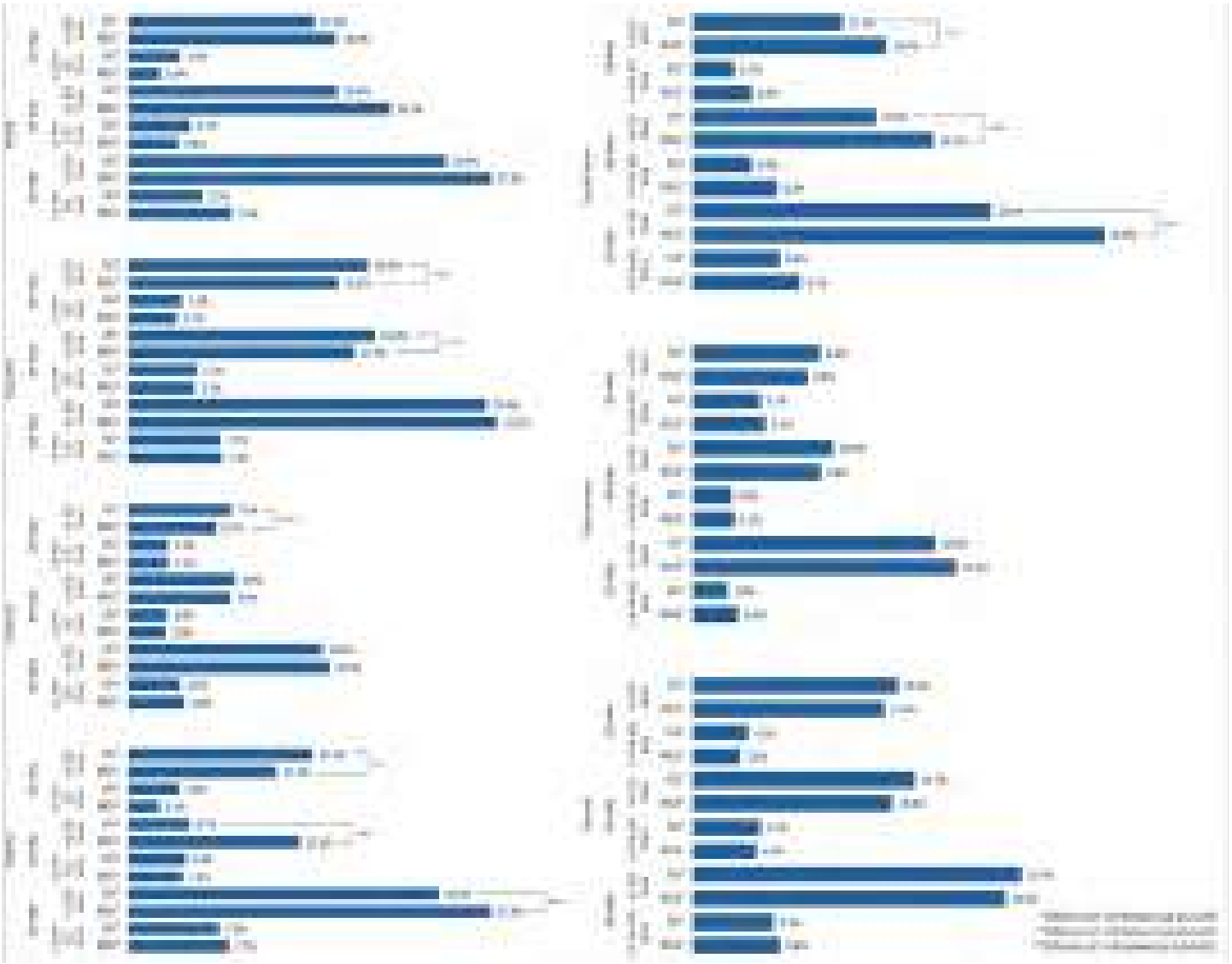

Figure 4. Prevalence of ≥ 1 emergency department visit by language preference, overall and within racial and ethnic groups.
* NELP subgroup significantly differs from ELP subgroup $P < .05$.
NELP, non-English language preference; *ELP,* English language preference.

not reflect a patient's ability to communicate in English. For example, some individuals with a non-English language preference may have had limited English proficiency but some ability to communicate in English, and some with an English preference may not have communicated very well in English.

CONCLUSION

In an adult health plan population that received care from the same integrated healthcare delivery system, we found substantial variation in prevalence of ED use by race and ethnicity, minimal difference by language preference, and substantially higher prevalence among adults with Medicaid coverage. Our study showed that differences between population subgroups can be masked when factors such as race, language status, and type of insurance coverage are simply controlled for in statistical models rather than examined using disaggregated data. Future studies should control for comorbidities associated with ED use, as well as social determinants of health such as educational attainment, access to food and housing, and environmental risks when comparing ED use across racial and ethnic groups as well as by language preference and Medicaid coverage status. To improve monitoring and to develop interventions to reduce ED visits, further research is needed to better understand the cultural and societal factors that drive ED usage in different segments of the population.

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Impact of COVID-19 on Patients with a Preferred Language Other than English in the Emergency Department

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Background: The COVID-19 pandemic had a disproportionate impact on minority communities, including patients who identify as having a preferred language other than English (PLOE). Our primary goal in this study was to evaluate the effect of the COVID-19 pandemic on patients with a PLOE in the emergency department (ED), and the use of interpreter services. Secondary outcomes evaluated were measures of patient care, including length of stay, number of studies performed, and unplanned return visits to the ED.

Methods: We performed an interrupted time series study of prospectively collected electronic health record (EHR) adult ED and language services data from an urban, safety-net hospital.

Results: The total number of patients presenting to the ED went down in the early peak of the pandemic; however, the percentage of patients with a PLOE went up compared with previous years (19% vs 16%) and, despite making up only 19% of total patients, comprised 44% of total COVID-19 positive patients. In-person interpreter use decreased (prevalence ratio 0.49, 95% confidence Interval [CI] 0.43-0.56) while telephonic and video interpretation increased (prevalence ratio 3.97, 95% CI 3.56-4.43). Baseline testing was unchanged. All groups experienced a decrease in median LOS in 2020, but this was only found to be significant for patients who speak a language other than English or Spanish (P<0.001). None of the patient groups experienced a significant increase in unscheduled returns in 2020.

Conclusion: Our data confirms that COVID-19 disproportionately affected patients with a PLOE, with patients with a PLOE 2.9 times more likely to test positive for COVID-19 than their English-speaking counterparts. Efforts should be made to mitigate this effect via language-concordant care, professional interpreters, and culturally appropriate interaction and information dissemination, not only as it relates to planning for public health crises, but in the day-to-day function of the healthcare system at large. Continued research into the factors driving these inequities and ways to mitigate them is warranted. [West J Emerg Med. 2025;26(4)960–969.]

INTRODUCTION

The COVID-19 pandemic emerged worldwide as a major health concern. Its impact on minority communities highlighted healthcare disparities at many levels.[1] In particular, its impact on patients who have a preferred language other than English (PLOE) has been significant.[2-7] The United States is home to a large number of people who speak a language other than English at home, including 21.5

million people who identify as having a PLOE.[8] Patients who identify their preferred language as something other than English are more likely to contract COVID-19, have lower testing rates, and are more likely to be hospitalized with COVID-19.[9-13]

While a study in a pediatric emergency department (ED) demonstrated increased interpreter utilization during the pandemic,[13] to our knowledge there are no published studies looking at the effects of COVID-19 on PLOE patients, the use of interpreter services, and the effects of these factors on patient care in an adult ED setting. Multiple lay sources have reported decreased availability of in-person interpreters, difficulty in coordinating phone and video interpreters in a short time frame, and limitations in the use of all forms of interpreters in the setting of ubiquitous mask and other personal protective equipment (PPE) use.[2-6] The current body of evidence clearly demonstrates that use of professional interpreters and/or language-concordant care result in fewer communication errors, improved patient comprehension, improved clinical outcomes, and equalization of healthcare and clinical services utilization.[14,15] Unfortunately, the setting of COVID-19 complicated the use of professional interpreters, as described in the lay press.

Our primary goal in this study was to evaluate the association between COVID-19 and adult ED patients with a PLOE. Secondary goals were to evaluate the utilization of interpreter services and the associated measures of patient care, including length of stay (LOS), number of diagnostic studies performed, and unplanned return visits to the ED, during the first peak of the pandemic.

Population Health Research Capsule

What do we already know about this issue?
The COVID-19 pandemic had a global health impact, disproportionately affecting minority communities.

What was the research question?
What is the association between COVID-19 and emergency department (ED) patients who prefer a language other than English, as well as patterns of interpreter use?

What was the major finding of the study?
Patients who preferred a language other than English were more likely to have COVID-19 than their English-speaking counterparts, OR 2.9 (95% CI 2.1-4.1).

How does this improve population health?
We found an association of COVID-19 with language itself, not just race or ethnicity, which should inform efforts toward language equity in the ED and from a public health standpoint.

METHODS

Study Design and Setting

We performed an interrupted time series study of prospectively collected electronic health record (EHR) (Epic Systems, Inc, Verona, WI) ED and language services data from Denver Health Medical Center in Denver, Colorado. Denver Health Medical Center is an integrated health system and anchor institution for the County of Denver that includes an acute care hospital, Denver Health Medical Center, with a high-volume adult and pediatric ED, a Level I trauma center, and multiple community-based clinics. Denver Health Medical Center serves large numbers of patients from minority, underinsured, homeless, and immigrant communities. This study was approved by our institutional review board as being exempt from informed consent and is reported in accordance with STROBE guidelines for electronic data extraction.[16]

Population

We included all adult (≥18 years of age) patients who presented to the ED from April 1-April 30 from 2017–2020. The month of April was chosen as it included the initial peak of the COVID-19 pandemic in the US in 2020 and allowed comparison to prior non-pandemic years. At the time of this analysis, subsequent months had significantly lower COVID-19 volumes; for this reason we analyzed this initial peak.

Data Collection

Variables extracted from the EHR included demographics (age, gender, race, ethnicity, address, and primary preferred language); payer status; chief complaint; top five discharge diagnosis codes (per the *International Classification of Diseases 10thRevision [ICD-10]*); laboratory studies performed; radiology studies performed; LOS; and return visit to the ED within 48 hours.

Interpreter services data were obtained from the hospital's Department of Language Services. Language services at Denver Health Medical Center are comprised of in-house interpreters who can interpret in person or via telephone, as well as contracted services from an external vendor that provides interpretation via telephone or video. We queried the in-house log for in-person interpreters for the specified time frame; the contracting entity that provided external telephone and video interpretation also provided logs for these services over the specified time period.

Outcomes

The primary outcome was diagnosis of COVID-19, defined as the presence of the ICD-10 code for COVID-19

(U07.1). We summarized interpreter service data into two service categories: 1) the use of language line services when ED staff would call into a vendor providing interpreter services over the phone or via video; or 2) in-person interpreter services when dedicated hospital language services staff were consulted to provide face-to-face interpretation between medical staff and the patient. Emergency department LOS was defined as the number of minutes between time of ED arrival and time of ED departure. We stratified ED visit characteristics (LOS; number of lab or radiology studies; return visits within 48 hours by the primary preferred language of the patient (categorized as English, Spanish and other) and reported across the four years of the study period.

Data Management and Statistical Analyses

We extracted visit-level data using structured query language (SQL Server Management Studio, Microsoft Corporation, Redmond, WA) and transferred into an Excel spreadsheet (Microsoft Corporation, Redmond, WA). We performed data management and analyses using SAS Enterprise Guide v 8.3 (SAS Institute, Inc, Cary, NC). Descriptive statistics for continuous data are reported as means with standard deviations for normally distributed data and medians with interquartile ranges (IQR) for non-normally distributed data, and categorical data are reported as counts, proportions, or percentages with 95% confidence intervals (CI). Bivariate statistical tests (eg, Wilcoxon rank-sum test, chi-square) were used to compare variables and absolute differences with 95% CIs reported between groups. For the primary analysis, we used a multivariable logistic regression model to assess the association between PLOE and COVID-19 diagnoses and included the following covariates as potential confounders: age; sex; race; ethnicity; and Area Deprivation Index (ADI), which was used to adjust for socioeconomic context. The ADI is a validated, composite measure of US area-based deprivation based on 17 variables on poverty, education, housing, and employment.

We matched the geographic locations of patient-reported address for each visit to census tracts (CT). The ADI was calculated for each populated tract in Denver County from the 2015-2019 American Community Survey five5-year estimates (US Census.gov). We assigned each Denver CT an ADI by weighting the 17 variables by the factor score coefficients. The index was standardized with a mean of 100 and a SD of 20 and divided into quintiles as the ADI, consistent with other studies that included ADI, and because it has not been validated as a continuous predictor.[17] Higher ADI index values were indicative of higher deprivation. Patients who were homeless did not have an address to geocode and were assigned an ADI value of "most deprived." We assessed effect modification between Hispanic ethnicity and PLOE by including an interaction term into the logistic model. The primary explanatory variable was a PLOE, defined as a patient-reported preferred language as something other than English. The primary unit of analysis was the visits. Given that this was an observational study with no explicit testable hypothesis, no a priori sample size calculation was performed.

The data provided for interpreter services included information about each encounter, and there may have been multiple interpreter-service encounters for the same patient. The provided data did not include a patient identifier to allow for linkage of each interpreter-service encounter with a specific patient visit. Thus, results are presented as total number of interpreter-service contacts (language line or in person) per year (numerator) and number of ED visits (denominator). We calculated prevalence ratios of interpreter-service contacts and ED visits with April 2017 serving as the reference.

RESULTS

The total number of ED visits for the month of April ranged from 3,557 (in 2020) to 4,952 (in 2019). Patient demographics are shown in Table 1. The median percentage of patient visits with a PLOE in April 2017-2019 was 16% (2,275/14,646), whereas in April 2020 these patients represented 19% of all visits (683/3,557). The proportion of visits in April 2020 with a COVID-19 diagnosis was 7% (261/3,557). Demographics of patients based on their COVID-19 diagnosis are shown in Table 2. Of the 261 patient visits with COVID-19 diagnosis, 114 (44%) had a PLOE. Of patients who identified their primary language as English, 5% (95% CI 4-6%) (147/2,875) had a final diagnosis of COVID-19. Among those patients who identified as PLOE, 18% (95% CI 15-21%) (102/559) of patients who preferred Spanish and 10% (95% CI 5-10%) (12/121) of patients who preferred other languages had a final diagnosis of COVID-19.

A significant association was identified between patients with a PLOE and a COVID-19 diagnosis (Table 3). Interaction between Hispanic ethnicity and a PLOE was not significant ($P = 0.3$) and, thus, was not included in the final model. The number of contacts with interpreter services as they relate to total ED visits are displayed in Figure 1.

The prevalence ratio of total interpretation encounters per patient was significantly higher in April 2020 compared to April 2017 (Figure 2 and Table 4). The prevalence ratio of remote (video and telephonic) interpreter encounters went up in April 2020, while the prevalence ratio of in-person interpreter encounters went down (Figure 2).

The other outcomes measured, including median number of lab studies, median number of radiology studies, median ED LOS, and unplanned return visits within 48 hours are shown in Table 5, with *P*-values in Table 6. The median number of radiology studies performed per ED visit was 1, and there was no significant difference among the groups. The median number of lab studies ordered per ED visit was four for Spanish-speaking patients, and three for patients who spoke English or other languages. This difference was only significant for Spanish-speaking patients in 2017-

Table 1. Demographics of adult emergency department visits in April of each year, 2017–2020.

	2017 N (%)	2018 N (%)	2019 N (%)	2020 N (%)
Total number of visits	4,884	4,812	4,950	3,555
Median Age, years (IQR)	44 (31 – 57)	45 (32 – 58)	45 (31-58)	45 (33-58)
Gender				
Female	2,101 (43)	2,019 (42)	2,087 (42)	1,329 (37)
Male	2,783 (57)	2,793 (58)	2,863 (58)	2,226 (63)
Ethnicity				
Hispanic/Latinx	1,788 (37)	1,707 (35)	1,850 (37)	1,402 (39)
Not Hispanic/Latinx	3,043 (62)	3,046 (63)	3,061 (62)	2,098 (59)
Unknown / Missing	53 (1)	59 (1)	39 (1)	55 (2)
Race				
Asian	64 (1)	84 (2)	85 (2)	63 (2)
Black	784 (16)	695 (14)	725 (15)	492 (14)
Native American	78 (2)	94 (2)	81 (2)	91 (3)
Other Pacific Islander	3 (0)	17 (0)	8 (0)	12 (0)
White	3,613 (74)	3,489 (73)	3,601 (73)	2,474 (70)
Other	298 (6)	387 (8)	411 (8)	373 (10)
Unknown / Missing	44 (1)	46 (1)	39 (1)	50 (1)
Primary Preferred Language				
English	4,156 (85)	4,073	4,142 (84)	2,875 (81)
Spanish	589 (12)	607 (13)	675 (14)	559 (16)
Other	139 (3)	132 (3)	133 (3)	121 (3)
Interpreter Services Encounters	1,142	1,538	1,457	1,346

IQR, intraquartile range.

Table 2. Patient characteristics of emergency department patient visits by COVID-19 diagnosis in April 2020.

	COVID-19 Diagnosis			
	Yes (n = 261)		No (n = 3,296)	
	n	(%)	n	(%)
Median Age, years (IQR)	51	(39 – 61)	44	(33 – 57)
Gender				
Female	164	(63)	1,232	(37)
Male	97	(37)	2,064	(63)
Ethnicity				
Hispanic/Latinx	149	(57)	1,254	(38)
Not Hispanic/Latinx	109	(1)	1,987	(60)
Unknown / Missing	3	(42)	55	(2)
Race				
Asian	8	(2)	54	(2)
Black	30	(11)	464	(14)
Native American	3	(1)	88	(3)
Other Pacific Islander	1	(0)	12	(0)

IQR, interquartile range.

Table 2. Continued.

	COVID-19 Diagnosis			
	Yes (n = 261)		No (n = 3,296)	
	n	(%)	n	(%)
White	166	(64)	2,297	(70)
Other	50	(20)	330	(10)
Unknown / Missing	3	(1)	51	(2)
Primary Preferred Language				
English	147	(56)	2,727	(83)
Spanish	102	(39)	459	(14)
Other	12	(5)	3	(0)
Area Deprivation Index				
Quintile 1 (least deprived)	17	(7)	359	(11)
Quintile 2	33	(13)	540	(16)
Quintile 3	35	(13)	403	(12)
Quintile 4	80	(31)	829	(25)
Quintile 5 (most deprived)	84	(32)	982	(30)
Missing	12	(5)	183	(6)

2019 (P<0.001). These testing rates were unchanged across the years of the study. All groups experienced a decrease in LOS in 2020, but this was only found to be significant for patients who speak a language other than English or Spanish (P<0.001). None of the patient groups experienced a significant increase in unscheduled returns in 2020 compared to previous years; however, patients who prefer English had significantly more unscheduled returns (7%, 95% CI 6-8%) than patients who preferred Spanish (4%, 95% CI 3-6%) or other languages (2%, 95% CI 0-4%) in 2020 and over the course of the study (Table 5).

DISCUSSION

This study demonstrates that after adjusting for sex, age, race and ethnicity, there is a strong association between PLOE and COVID-19 diagnoses, where patients with a PLOE had nearly three times the odds of a COVID-19 diagnosis than their English-speaking counterparts. While the overall ED census was lower than normal, the proportion of patients with a PLOE increased, consistent with this association. Use of interpreters, as reflected by the ratio of interpreter contacts per patient with a PLOE, went up during COVID-19, driven largely by the use of video and telephonic interpreters.

Our findings are consistent with other studies that demonstrate the significant impact of COVID-19 on minority communities and PLOE patients,[12,18] and reinforces the specific impact on patients who have a PLOE in the ED population. Various existing studies attempt to account for this strong association. A number of social and systemic factors are likely contributors.[12] In addition to language differences, members of immigrant communities are more likely to live in larger households and work in industries that do not accommodate remote work.[19] It has been shown that patients with a PLOE and people who live in large households are more likely to report difficulty in obtaining supplies to safely quarantine.[20]

At a community level, larger household size and percentage of foreign-born persons or non-citizens have been predictive of increased case rates and deaths.[21] Of note, increased use of public transit has also been found to predict increased death rates in communities.[21] In addition, patients and families with a PLOE have poorer understanding of public health directives on mask-wearing and shelter-in-place orders and, in contrast to our findings, have significant difficulty accessing interpreters once they have come into contact with the healthcare system.[22] Given all these factors, the strong association of COVID-19 with language is not surprising.

While the lay press described significant difficulties with accessing interpreters, our overall interpreter usage on a per-patient basis did increase vs previous years, consistent with the findings of Hartford and colleagues.[2-6,13] While the use of in-person interpreters decreased substantially, the use of telephone and video interpreters increased, as the hospital made an effort to minimize interpreters' exposure and decrease use of additional PPE. We hypothesize that the increase in overall interpreter usage is related to the decrease in ED census, allowing clinicians more time to use interpreters appropriately, although further study is warranted. While the overall increased use of interpreters is an encouraging finding, the increased reliance on video

Table 3. Multivariable logistic regression model to evaluate the association between limited English proficiency and COVID-19 diagnosis among emergency department patients.

Variable	OR	(95% CI)
Limited English proficiency* (unadjusted)	3.7	(2.9 – 4.9)
Limited English proficiency (adjusted)	2.9	(2.1 – 4.1)
Age	1.0	(1.0 – 1.0)
Female	0.9	(0.7 – 1.2)
Hispanic	1.4	(1.0 – 2.1)
Race		
Black	1.3	(0.8 – 2.0)
Asian	1.7	(0.8 – 3.8)
Other†	1.3	(0.9 – 1.8)
Area Deprivation Index		
Quintile 2	1.2	(0.6 – 2.2)
Quintile 3	1.3	(0.7 – 2.4)
Quintile 4	1.2	(0.7 – 2.2)
Quintile 5 (most deprived)	1.7	(1.0 – 2.9)

References: English primary preferred language; ethnicity: non-Hispanic; race: White; Area Deprivation Index: Quintile 1 (least deprived).
*Defined as preferring any other language besides English, as reported by the patient.
†Defined as Native American, Alaska Native, Native Hawaiian or other Pacific Islander, or other patient-reported race.
OR, odds ratio; *CI,* confidence interval.

and telephonic interpreters and shift away from in-person interpreters, and how this impacted both patients and clinicians, merits further study.

While we did demonstrate that there is a strong association between COVID-19 and patients with a PLOE, other typical measures associated with language such as number of studies performed, LOS, and unplanned return visits yielded more variable results. Testing rates were unchanged over the years of the study, with no significant difference in the number of radiology studies ordered across groups. Patients who preferred Spanish had significantly higher laboratory testing rates in 2017–2019 than patients who preferred English or other languages; however, a median of 4 vs 3 is of unclear clinical significance. All groups experienced a decrease in LOS in 2020; however, this was only found to be significant for patients who spoke a language other than English or Spanish. While unscheduled returns to the ED in 48 hours did not significantly change for each group in April 2020, we were surprised to find that contrary to other studies, unscheduled returns to the ED were higher in English-speaking patients than patients with a PLOE in our ED across all years of the study. We hypothesize that various social, cultural, and access-to-care factors were driving this. Further investigation into the factors contributing to these divergences from national trends over a larger time frame is warranted.

Patients with a PLOE face a host of difficulties in their interactions with the healthcare system, including increased LOS, increased readmission rates, less-robust informed consent, and increased adverse medical events.[24] Interestingly, similar to unscheduled returns, our baseline relative LOS

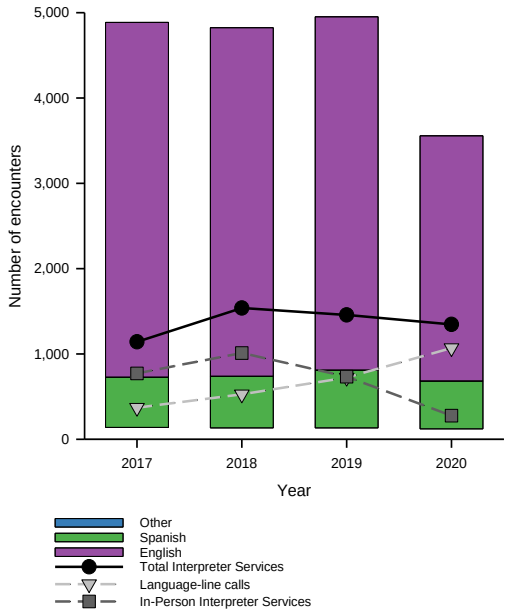

Figure 1. Number of emergency department visits and interpreter service encounters during the month of April between 2017-2020. The number of interpreter service encounters includes situations in which there may have been more than one interpreter encounter per patient.

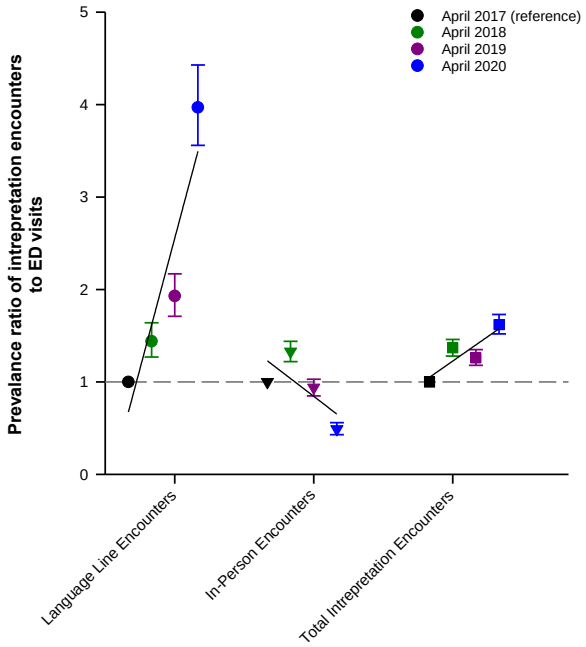

Figure 2. Prevalence ratio of interpreter encounters to ED visits.

Table 4. Prevalence ratio of interpretation encounters to ED visits during the month of April 2017–2020.

	Language-line encounters		In-person encounters		Total interpretation encounters	
	Prevalence ratio	(95% CI)	Prevalence ratio	(95% CI)	Prevalence ratio	(95% CI)
2017	Reference		Reference		Reference	
2018	1.44	(1.27–1.64)	1.33	(1.22–1.44)	1.37	(1.28–1.46)
2019	1.93	(1.71–2.17)	0.94	(0.85–1.03)	1.26	(1.18–1.35)
2020	3.97	(3.56–4.43)	0.49	(0.43–0.56)	1.62	(1.52–1.73)

CI, confidence interval.

data did not reflect the discrepancies typical for patients with a PLOE. These were extremely provocative findings; further investigation into these baseline numbers over multiple months and years will be needed to fully understand these relationships and what elements contribute to them.

Considering the data presented here, it is clear that the COVID-19 pandemic disproportionately affected patients with a PLOE in our ED. The overall impact on this community on a broader scale will have significant ramifications beyond what was measured here and should be addressed. To improve or even maintain the care of patients with a PLOE following the COVID-19 pandemic and during future health crises, it behooves emergency clinicians and hospital systems to provide language-appropriate services to patients, and researchers to prioritize inclusion of these patients in clinical trials. In some cases, patients with a PLOE were specifically excluded from some COVID-19 clinical trials.[23] Moving forward, special attention to language inclusivity, as has been established for sex, race and ethnicity, is essential in clinical trials and research overall.

While our goal was to assess the association of COVID-19 with patients with PLOE during the initial peak of the pandemic, additional longer. term studies are necessary to further understand the impact on this community and the healthcare system at large. Further evaluation of the impact on this community over the course of the entire pandemic, including hospitalization rates and mortality, as well as the effect on clinicians and interpreters can help us to further understand these impacts.

It has been well established that providing care in a patient's language will improve care via improved communication and comprehension, improved outcomes, and clinical services utilization.[14,15] The inequity that has emerged for patients with a PLOE in the COVID-19 pandemic must be addressed with linguistically and culturally appropriate patient communication, across the spectrum of healthcare. This should include collecting language data from patients and clinicians, providing linguistically and culturally appropriate communication, both at the patient bedside with interpreters or language-concordant care, and in print, media and public health communications from healthcare systems and policymakers.[7,25] Use of the National Culturally and Linguistically Appropriate Standards, both in day-to-day care and in planning for future pandemics and public health crises, is essential.[25,26]

LIMITATIONS

This study has several limitations. First, it is retrospective in nature, and the data was collected for the purpose of patient care rather than this specific analysis. This data is a snapshot in time from a single month during the initial peak of the pandemic; therefore, additional analyses of preceding and subsequent months, over varying levels of COVID-19 prevalence, may yield different results. We chose the month of April as it did represent an early peak in the pandemic, but the choice of this month could have introduced bias. While we did find that the overall proportion of patients with a PLOE presenting to the ED increased, we cannot determine whether it was specifically COVID-19 that drove this increase or rather an increase in this population in the community as a whole. While we did find that patients with a PLOE have nearly three times the odds of a COVID-19 diagnosis than their English-speaking counterparts, we cannot definitively account for all factors that may have contributed to this. We did adjust for sex, age, race and ethnicity, but it is unclear whether this was a reflection of English-speaking patients seeking care preferentially outside the ED.

In addition, patients in our healthcare system self-report their preferred language on their initial presentation, and we cannot be sure of the accuracy of this reporting, given the known difficulties in communication with patients with a PLOE. Neither could we specifically trace when patients inappropriately identified as English-speaking and the clinician did not access language services of any kind.

Additionally, our data on interpreter usage came from two different sources: the in-house, in-person interpreter log; and that of the commercial vendor providing telephone and video language services. There may be discrepancies in their reporting practices that we cannot account for. While we were able to evaluate the total number of encounters with interpreter services, at the time of this study, interpreter encounters were not directly linked to individual patient

Table 5. Secondary outcomes.

	2017		2018		2019		2020	
	Median	(IQR)	Median	(IQR)	Median	(IQR)	Median	(IQR)
Median number of laboratory studies								
English	3	(0 – 5)	3	(0 – 5)	3	(0 – 5)	3	(0 – 6)
Spanish	4	(1 – 5)	4	(2 – 5)	4	(1 – 5)	4	(1 – 5)
Other	3	(0 – 6)	3	(0 – 5)	3	(0 – 5)	3	(0 – 6)
Median number of radiology studies								
English	1	(0 – 1)	1	(0 – 1)	1	(0 – 1)	1	(0 – 2)
Spanish	1	(0 – 1)	1	(0 – 2)	1	(0 – 2)	1	(0 – 2)
Other	1	(0 – 1)	1	(0 – 2)	1	(0 – 1)	1	(0 – 2)
Median ED length of stay (minutes)								
English	296	(188 – 453)	296	(190 – 453)	272	(171 – 413)	258	(160 – 410)
Spanish	279	(191 – 407)	281	(186 – 388)	265	(179 – 403)	235	(159 – 331)
Other	285	(172 – 414)	249	(155 – 361)	263	(140 – 360)	215	(88 – 307)
Patients with return visit within 48 hours	n	(%, 95% CI)	n	(%, 95% CI)	n	(%, 95% CI)	n	(%, 95% CI)
English	281	(7, 6 – 7)	210	(5, 4 – 6)	268	(6, 6 – 7)	193	(7, 6 – 8)
Spanish	13	(2, 1 – 3)	16	(3, 1 – 4)	25	(4, 2 – 5)	24	(4, 3 – 6)
Other	1	(1, 0 – 2)	3	(2, 0 – 5)	3	(2, 0 – 5)	2	(2, 0 – 4)

IQR, interquartile ratio; *ED,* emergency department.

Table 6. P-values for the comparison of median number of studies and LOS between English vs. PLOE patients in each year. (Companion to Table 5)

	p-value*	p-value*
Median number of laboratory studies	Spanish	Other
2017	<0.001	0.22
2018	<0.001	0.43
2019	<0.001	0.47
2020	0.08	0.77
Median number of radiology studies	Spanish	Other
2017	0.2822	0.28
2018	0.01	0.92
2019	0.01	0.42
2020	0.12	0.80
Median ED length of stay (minutes)	Spanish	Other
2017	0.02	0.20
2018	0.004	0.0004
2019	0.63	0.03
2020	0.001	<0.001

*Reference=English language
LOS, length of stay; *PLOE,* preferred language other than English; *ED,* emergency department.

encounters by our language services department. Therefore, we cannot trace these back to each individual patient, and we cannot assess whether some patients had zero encounters with interpreter services while others had multiple encounters and how this may have affected their care. We anticipate future research studies in which we will be able to link interpreter encounters to specific patient encounters to provide a more robust analysis.

Finally, the COVID-19 pandemic has had a multitude of impacts on our healthcare system, and it would be impossible to account for all of these in our analysis. Patients with a PLOE have many other characteristics that may have impacted their care, including socioeconomic status, education, the amount of time they have lived in the United States, and previous interactions with our healthcare system, to name a few. Because our data was evaluated retrospectively, we cannot analyze for these types of confounders or modifiers.

CONCLUSION

Our data confirms that COVID-19 disproportionately affected patients who had a preferred language other than English, with patients with a PLOE 2.9 times more likely to test positive for COVID-19 than their English-speaking counterparts. Efforts should be made to mitigate this effect

via language-concordant care, professional interpreters. and culturally appropriate interaction and information dissemination, not only as it relates to planning for public health crises, but in the day-to-day function of the healthcare system at large. Continued research into the factors driving these inequities and ways to mitigate them is warranted.

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Fears Related to Blood-Injection-Injury Inhibit Bystanders from Giving First Aid

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Introduction: Prehospital emergency care is vital for saving lives, and increasing bystander involvement can improve survival and recovery. One potential barrier to providing first aid is blood-injury injection (BII) phobia, which affects up to 20% of people, with 3-5% experiencing severe fear. Identifying such barriers may help tailor interventions to encourage willingness to provide first aid.

Methods: We developed and validated the Probability of Giving First-aid Scale (PGFAS), a six-item questionnaire, using the polytomous Rasch Model to assess reliability and validity. The PGFAS was then used to examine how anxiety and disgust-sensitivity related to BII phobia impact the likelihood of providing medical assistance.

Results: Fear of injections and blood draws (β = -0.0987), blood (β = -0.0897) and mutilation (β = -0.1205) significantly reduced the likelihood of giving first aid. However, fear of sharp objects, medical examinations, symptoms of illness, disgust sensitivity, and contamination fear did not have a significant effect.

Conclusion: The Probability of Giving First-aid Scale may serve as a screening tool to identify individuals less likely to provide first aid and could be useful in assessing first-aid training effectiveness. Our findings highlight the importance of preparing first-aid responders and incorporating activities that reinforce helper identity into training programs. [West J Emerg Med. 2025;26(4)970–977.]

INTRODUCTION

A short and psychometrically sound questionnaire is needed to assess the willingness of lay people to provide first aid. However, to our knowledge no previous study has proposed a measure that 1) is designed to assess the likelihood of giving first aid in a general sample, rather than of, for example, children[1,3] or nursing students[2] as in previous studies, and 2) has been systematically tested using psychometric procedures. A questionnaire assessing the self-rated likelihood of providing first-aid could assess the appropriateness of first-aid training in a wide variety of settings (eg, school, workplace). It could also be used to screen specific target populations (eg, caregivers, teachers), to assess how people would react in different situations, such as road accidents or natural disasters, and to identify other factors (eg, personality, emotional response) that might be barriers to intervention.

A key factor in increasing the willingness of people to provide first aid is to identify the barriers that may prevent them from doing so. While helping to educate people about first aid and improving their skills alongside practical application are high priority objectives for organizations like the US Red Cross and American Heart Association, they tend to focus on technical knowledge and not on preparing the individual psychologically to give first aid.[4,5] An earlier study[6] showed that as little as two hours of technical training, together with activities to support helper identity, can reduce fears for up to two months and consequently increase the likelihood of providing first aid. Similarly, a recent study[1] emphasized the need to provide first aid and teach first-aid skills to a wider range of people (starting from childhood) and

to consider personality-related factors. However, there are few studies investigating the role of underlying— often unconscious—emotional factors, such as fear and disgust, which may act as barriers and prevent people from helping, even if they consciously know they should help and know what to do.[7–9]

Both fear and disgust can trigger avoidance behavior, which is an involuntary defensive response initiated upon encountering a potentially harmful object.[9–11] The response is mostly triggered by the perception of a feature or characteristic that is strongly associated with the presence of harm.[12,13] On the one hand, this is a core feature of the defensive survival circuit,[17,18] which is responsible for detecting potential threats, initiating defensive behaviors to avoid them, and making physiological adjustments. The fear response is triggered in parallel with the automatic detection system.[19] On the other hand, the importance of disgust has also been underscored by the disease-avoidance model,[20] and also as part of the behavioral immune system.[21,22] Indeed, both fear and disgust have been shown to contribute to the development of distressing contamination-related obsessive thoughts (ie, contamination fear).[23] From an evolutionary perspective, this is an adaptive response in that it helps to avoid infection, disease, and other pathogens. Avoidance strategies often function to prevent contact with potential contaminants and are associated with fear, disgust, and contamination fear.[26,27] Consequently, both fear and disgust can prevent people from giving first aid; therefore, in the present study we sought to assess their prominence in the willingness to help others.

The purpose of our study was twofold. First, we sought to develop a brief yet reliable and valid measure that could predict the probability of intervening in a potential emergency. Second, we investigated the relationship between blood-injection-injury phobia-related fears, disgust sensitivity, and likelihood of rendering first aid in a non-clinical sample. There are conflicting emotions involved in giving first aid. Seeing someone in need of help activates the approach system as people are generally willing to help others, and they are often driven by curiosity as to what has happened to that individual. In contrast, signs of blood, injury, or disease will also trigger the avoidance system to keep out of harm's way (due to the possibility of becoming infected or of encountering the same threat that resulted in the injury of the individual in need of first aid). We sought to test whether fear or disgust is a stronger predictor of avoidance in these situations.

Population Health Research Capsule

What do we already know about this issue?
Immediate bystander first aid reduces injury severity and mortality, but many people feel unprepared or unwilling to provide first aid.

What was the research question?
How do psychological factors, particularly fear of blood and injuries, relate to behavior and willingness to give first aid?

What was the major finding of the study?
Fear of blood and injury (β=-0.12, CI -0.21,-0.13, P =.01) predicts less willingness to provide first aid.

How does this improve population health?
Identifying fear as a barrier to first aid can help tailor interventions to increase bystander assistance and improve emergency outcomes.

METHODS

Participants

We targeted the lay population, rather than healthcare professionals, as our goal was to determine what may hold back the average person from intervening in an emergency situation. We recruited participants by posting on social media (Facebook, Twitter, and Instagram), mailing lists, and various discussion forums (Reddit, Lemmy). Respondents completed an anonymous and confidential online survey. We used convenience sampling. We did not record the answers of those who failed to complete the survey.

A total of 906 participants 18-68 years of age (mean 24.83, SD 7.87) volunteered to take part in the study. Table 1 shows the detailed descriptive statistics for the sample. For the psychometric analysis of the Probability of Giving First-Aid Scale (PGFAS), our goal was to recruit as large a sample as possible. The a priori power analysis[28] for the general linear model used here indicated a minimum required sample size of 791 assuming a small effect size (Cohen $f^2 = .02$), power ($1-\beta$) = .80, and nine predictors. To ensure the robustness of our analyses and to have a sufficiently large sample for descriptive purposes, we aimed to reach as many participants as possible. Data collection was organized in weekly periods, and recruitment was stopped at the end of the week when the minimum required sample size had been reached.

The dataset used in this study was previously analyzed for a different purpose in one of our earlier studies.[7] That study focused on behavioral harm avoidance in a healthcare setting, and first aid was not included. The research was approved by the Hungarian United Ethical Review Committee for Research in Psychology and was carried out by the Code of Ethics of the World Medical Association (Declaration of Helsinki). Informed consent was obtained from all participants.

Questionnaires

Sociodemographic questions included age and (biological) sex. We asked respondents about their previous

Table 1. Descriptive statistics of the sample including demographic variables.

Variable	Group	Percentage
Sex	Female	73.1%
	Male	25.7%
	Not responded	1.2%
Studies	Humanities	30.9%
	Natural sciences	10.8%
	Law	3.5%
	Healthcare-studies	22%
	Engineering	14.9%
	Other	17.9%
Care for relative	% Yes	22.4%
Learned first aid	% Yes	83.3%
Healthcare-related studies	% Yes	22%
Healthcare-related qualification	% Yes	6.7%
Healthcare-related job	% Yes	16%
	Median	IQR
Age	22	20-26
SES	12	10-13

Note: Participants self-reported their socioeconomic status. Scores could range from 3-15. Percentages for groups labeled with "Yes" indicate the proportion of participants who answered "Yes" to each question.
IQR, interquartile range; *SES*, socioeconomic status.

healthcare-related experiences, education, or practice regarding first aid. These questions assessed whether they had learned first aid; had any healthcare-related education (eg, physician, nurse, paramedic); held a degree in a healthcare-related field; have had healthcare-related jobs; and whether they had to care for a relative for at least one month. These questions were answered on a dichotomous scale (yes or no). Subjective socioeconomic status was measured by calculating the sum score of the questions about 1) the financial status of the family in childhood; 2) support received by parents as a child; and 3) an overall evaluation of their childhood. Questions were rated on 5-point Likert type scales from "1 – lack of funds/no support/very negative" to "5 – plenty of funds/very supportive/very positive."

The *willingness to perform first-aid* was measured by the PGFAS that we developed for the current study with the help of healthcare professionals. Our goal was to develop a concise yet reliable tool that allows participants to assess the likelihood (ranging from 0-100%) of them performing a specific first-aid action. Items were created based on first-aid guidelines and reviewed for face validity by experts in psychology, first-aid education, and survey design. Minor revisions were made based on expert feedback. Of the questionnaire's six items, all refer to a step of first-aid behavior considered important by educators and professionals (ie, approach the person, address the person, touch or shake the person, call for help, bandage a wound if necessary, start cardiopulmonary resuscitation). See Table 2 for the questionnaire with instructions. Reliability and internal consistency are detailed in the Results section.

We measured *blood-injection-injury phobia-related fears* using the short, 25-item version of the Medical Fear Survey (MFS).[29,30] The MFS measures an individual's fear of medical procedures and contexts, including fears related to injections and blood draws, sharp objects, blood and injury, mutilation, and interactions with healthcare professionals. The MFS has five subscales measuring different facets of the concept: injections and blood draws; sharp objects; blood; mutilation; and examinations and symptoms. All items were rated on 4-point Likert-type scales with higher scores indicating higher levels of fear. The internal consistency of the scale was satisfactory (McDonald's omegas ranged between .79 - .88).

Participants' *disgust sensitivity* was measured by the revised, 25-item version of the Disgust Scale-Revised (DSR) questionnaire.[31] The DSR measures disgust sensitivity across three dimensions: core; animal reminder; and contamination-based. Core disgust is primarily concerned with food-rejection response focused on the potential oral ingestion of aversive stimuli (eg, rotting food). Animal-reminder disgust refers to any stimulus or behavior that reminds humans of their animal nature and origin (eg, bodily injury, blood). The contamination disgust factor depicts situations or objects that represent the possibility of coming into contact with a disease. There are 13 true/false items and 12 rated on 3-point Likert-type scales. Higher scores indicate higher levels of disgust sensitivity. (The internal consistency of the scale ranged between .6 - .63). While our mega value for the DSR is below the conventional threshold of 0.7, research indicates that shorter scales or those assessing multifaceted constructs may naturally yield lower reliability coefficients, and previous studies have also found the questionnaire to have low reliability values.[32] We could have opted to inspect composite reliability (rho), similarly to a study by Olatunji and colleagues,[33] but as this questionnaire was not the primary instrument under investigation, we opted to report the ω values, as was done with the other questionnaires used.

We assessed *contamination obsessions* and washing compulsions with the Contamination Fear subscale (CF) of the Padua Inventory.[34] The subscale measures an individual's fear and avoidance of contamination, typically reflecting obsessive-compulsive concerns about cleanliness, germs, and potential contamination. The CFS is a 10-item, one-factor questionnaire. Each item is rated on a 5-point Likert-type scale. Higher scores indicate more contamination fear. In the present sample, the CFS had satisfactory internal consistency (McDonald's ω = .85).

Statistical Analysis Method

First, we tested whether the PGFAS has sound psychometric properties. The unidimensionality (meaning that all six items measure the same underlying construct—

Table 2. The Probability of Giving First Aid Scale questionnaire with six items in total. Participants rated how likely they were to perform the given activity on a 10-point Likert-type scale from 0-10% to 91-100%. There were no reverse-keyed items. Score equals the sum of all answers, and higher scores indicate a higher likelihood of giving first aid.

	0-10%	11-20%	21-30%	31-40%	41-50%	51-60%	61-70%	71-80%	81-90%	91-100%
You would approach the person if you were alone.	1	2	3	4	5	6	7	8	9	10
You would address the person.	1	2	3	4	5	6	7	8	9	10
You would touch/shake the person to get more information about their condition.	1	2	3	4	5	6	7	8	9	10
You would call for help by phone.	1	2	3	4	5	6	7	8	9	10
You would bandage a bleeding wound if you had the proper tools.	1	2	3	4	5	6	7	8	9	10
You would start CPR.	1	2	3	4	5	6	7	8	9	10

Note. Instruction: Next to each statement, please indicate THE LIKELIHOOD YOU THINK you would do that particular thing if you saw a person lying in the street who you thought might need help.
CPR, cardiopulmonary resuscitation.

the likelihood of providing first aid) was evaluated using confirmatory factor analyses with the diagonally weighted least squares estimator. We assessed the model fit based on the following: the comparative fit index (CFI) and Tucker-Lewis index (TLI), which are used to compare the specified model to the baseline model; the root mean square error of approximation (RMSEA), which evaluates model complexity by penalizing overfitting; and the standardized root mean squared residual index (SRMR) value, which measures the average discrepancy between observed and predicted correlations. The cutoffs for good model fit were CFI and TLI values of .95 or greater[35] and RMSEA and SRMR values of .08 or lower.[36] Using multiple indices ensures a balanced evaluation, as each index captures different aspects of model fit.

We also calculated the McDonald omega (conventionally accepted from .7) to check the internal consistency of the scale. We used the polytomous Rasch model to examine both how participants differ in their likelihood of giving first aid (that is, how much of the underlying trait each person has) and how difficult each item is (whether an item is easier or harder to endorse). In the Rasch model, item difficulty refers to the average level of the latent trait required for participants to answer an item in a certain way. For example, items with higher difficulty values require participants with a stronger presence of the trait to choose higher response categories. We report mean values to indicate the average level of the latent trait across the participants for each item, giving us insight into how participants generally perceive the item difficulty.

We used the Rasch model analysis to evaluate whether our questionnaire satisfies the following requirements: the goodness-of-fit (Person separation index > .7) and consistency of the items using the Wright map and infit/outfit measures.[37,38] We used a Mann-Whitney U test (as the PFGAS data are ordinal) to compare male vs female scores for previous experience and knowledge of the PGFAS. The correlation between age, socioeconomic status, and PGFAS scores was observed with the Spearman correlation. Finally, we used the general linear model to test whether the willingness of people to give first aid is more determined by fear- or disgust-related variables. The assumption of normality was not violated. The absolute values of skewness and kurtosis were less than 2 for the PGFAS scale. We performed analyses through jamovi v2.3.28.0 for Windows (https://www.jamovi.org).

RESULTS

Questionnaire Characteristics

The one-factor model showed a good fit on our data: $x^2(8)=11.99$ $P=.151$, CFI=.99, TLI=.99, RMSE=.02 (90% confidence interval [CI] .00-.05), SMRM=.04. That is, each item depends on a unique latent trait, and the scale can be considered unidimensional. The internal consistency of the test, indicated by the McDonald omega = .89 (95% CI .88-.90), was good. The average interitem correlation was .63 (95% CI .59-.66). The mean score was 46.04 with an SD of 12.58 (range: 6-60), and the median was 49 (MAD robust=11.86). The skewness was -.97 (SD .08), and the kurtosis was .24 (SD .16). Quartile scores were 39 (25^{th} percentile), 49 (50^{th} percentile), and 56 (75^{th} percentile).

Study Population Characteristics

Figure 1 presents the weighted proportions of responses for each question regarding levels of willingness to perform first aid. Participants mostly indicated that they would provide first aid. More than half of them (55.3%) would call for help by phone (M = 8.78, 95% CI 8.63 - 8.88); 39.2% reported that they would address the person (M = 8.17, 95% CI 8.03 - 8.32); 35% would bandage a wound (M = 7.50, 95% CI 7.32 - 7.68); 34.8% would approach the person (M = 7.95, 95% CI 7.80 - 8.10); 25.5% would touch/shake the person if

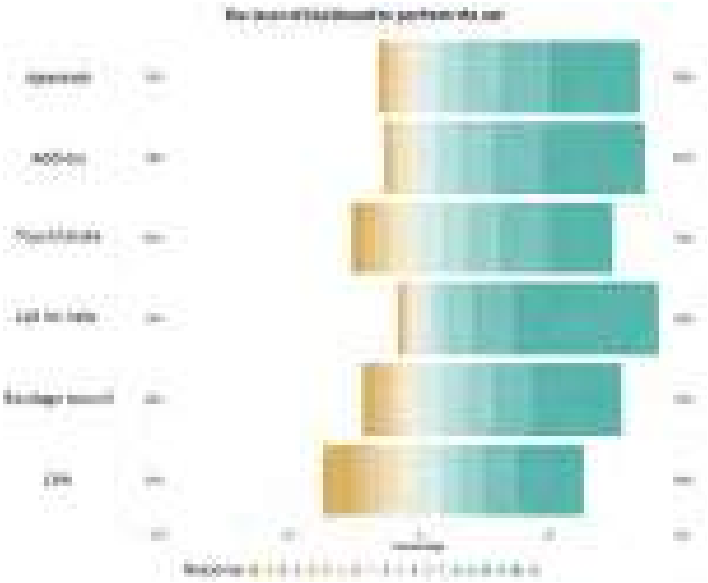

Figure 1. Levels of willingness to render various forms of first aid. *CPR,* cardiopulmonary resuscitation.

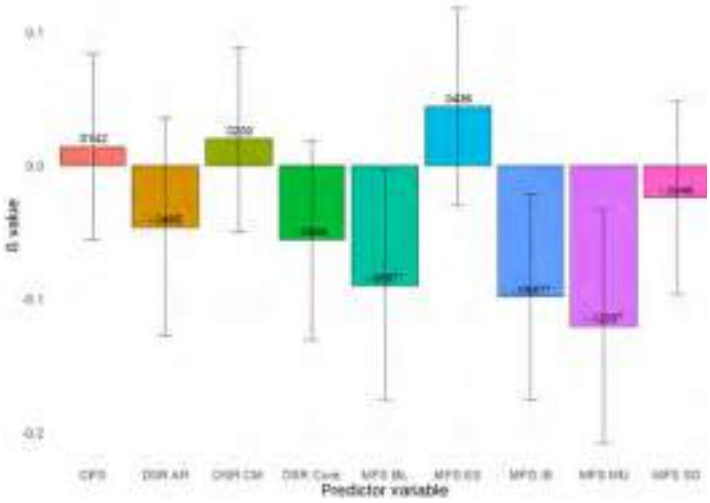

Figure 2. Results of the general linear model analyzing the effects of fear- and disgust-related scales on the Probability of Giving First-Aid Scale total score. Standardized coefficients (β) values are displayed, and error bars represent 95% confidence interval values. β=standardized estimate. Significant results are flagged (* P<.05). *CFS*,contamination fear survey; *DSR*, disgust scale-revised; *AR*, animal reminder; *CM*, contamination fear; *MFS*, medical fear survey; *BL*, blood; *ES*, examinations and symptoms; *IB*, injections and blood draws; *MU*, mutilation; *SO*, sharp objects.

unresponsive (M = 7.19, 95% CI 7.01 - 7.37); 25.2% would start CPR (M = 6.47, 95% CI 6.26 - 6.67).

Regarding the demographic variables, we found that males scored slightly higher than females (U=84553, *P*=.03, Cohen d=.096). Further, the correlation between age and PGFAS was positive and weak but significant (rho=.176, *P*<.001, 95% CI .111-.238), indicating that younger people are less likely to give first aid. The correlation between SES and PGFAS was not significant (rho=-.025, *P*=.46, 95% CI -.090-.041). See Supplementary Material 2 for a more detailed analysis of the differences in PGFAS between the grouping variables assessing previous experience.

Barriers Associated with the Probability of Giving First Aid

Regarding the predictors of how willing people are to give first aid, the model we tested was significant (F(9, 896)=9.40, *P*<.001, R^2_a=.08). This indicated that fear- and disgust-related scores were associated with the PGFAS total score. Figure 2 shows the beta values (see Supplementary Material 3 for more detailed statistical results). Our results show that MFS injection and blood draw, blood, and mutilation scores significantly decreased the probability of giving first aid. In contrast, non-relevant medical fear scales (sharp objects, examination, and symptoms) and disgust-related variables (DS-R and CFS) did not have a significant effect.

DISCUSSION

We developed a new psychometrically sound questionnaire to measure the PGFAS. The PGFAS identifies individuals who are less likely to engage in first-aid behavior and enables them to overcome the barriers that prevent them from doing so. Further, it might also indicate the appropriateness of this scale as a measure of training effectiveness. Further analysis revealed that the barriers preventing people from providing first-aid included BII-related fears (ie, seeing blood, injections, blood draws, and mutilation). This is consistent with previous studies showing that fear often leads to avoidance behavior.[7,8,39] Disgust sensitivity and contamination fear did not emerge as significant predictors in our sample, contrary to what was reported in previous studies.[27,40] Our results support those of previous studies showing the dominance of fear over other emotions[19] in influencing approach-avoidance behavior. However, it is also possible that disgust only plays a role in individuals with high levels of fear and not in the general (subclinical) population.[41–43]

It has been shown that relevant experience or exposure to an object can reduce fear (possibly leading to fear inoculation) and reduce the severity of symptoms and the degree of fear or disgust induced by the next exposure.[8,46–48] Our findings show that previous experience and knowledge are key factors in the willingness to provide first aid. Experience is a key factor in both developing[48,49] and overcoming fears.[46,51] Exposure to the object of fear in a safe environment could reduce negative emotions and decrease the likelihood of avoiding the situation or object in the future.[52] Our results are in line with previous studies emphasizing the importance of teaching first aid starting from an early age[1] and focusing on personality-related factors in addition to technical knowledge.[6] These results are important because increasing the likelihood of giving first aid may increase the

chances of both survival and full recovery.[1,2] Therefore, bystanders who call for professional help and provide first aid to people in need reduce mortality and morbidity.[45]

LIMITATIONS

Some limitations of the study are noted here. First, although we used a large sample, the sex imbalance may have confounded the results and could have made groupwise comparison problematic because sex differences are well-documented in specific phobias, including medical fears.[29,30,53] Second, the study used convenience sampling through online platforms, which may limit the generalizability of the findings. Although we aimed for a diverse sample, the lack of a representative population—particularly the over-representation of younger adults (18-30 year of age)—may affect the external validity of our results and substantially limits the applicability of our findings to older age groups. Future studies should consider using stratified or random sampling methods to enhance representativeness.

Third, our study relied on self-reported data, which is subject to social desirability bias and individual interpretation of hypothetical emergency situations. Participants' actual behaviours in real-life emergencies may differ from their self-reported willingness to intervene. Experimental or observational studies could complement self-report measures to provide a more comprehensive assessment. Accordingly, further validation is needed across different populations and settings. Future research should test the scale's reliability and predictive validity in longitudinal studies and among individuals with varying levels of first-aid training and experience. Finally, other psychological and situational factors, such as personality traits, prior exposure to emergencies, or environmental stressors, may also influence first-aid willingness, and the predictors we used in this study had only a small effect size. Future research should explore a broader range of cognitive, emotional, and contextual variables to provide a more comprehensive understanding of first-aid decision-making.

Despite these limitations, our study contributes to the field by introducing a novel measurement tool and highlighting key psychological barriers to first-aid intervention. Future research should build upon these findings to develop targeted interventions that increase first-aid willingness among the general public.

CONCLUSION

We developed a brief, self-report measure of the likelihood of providing first aid that can be used as a screening tool to identify those less likely to help someone in need of first aid and to assess the effectiveness of first-aid training. Our findings highlight blood-injection-injury-related fears as a barrier to helping, suggesting that addressing these fears in training could increase willingness to render first aid. Further research is needed to explore additional barriers (such as personal safety concerns unrelated to BII-fears) and develop effective interventions. Despite the limitations and limited prior research on first-aid behavior, these findings offer a promising new approach to studying this area.

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Biological Variation of Corrected QT and QRS Electrocardiogram Intervals: Interpreting Results of Drug-induced Prolongation

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Introduction: Toxicologists use a universal threshold to determine QRS and QTc prolongation in poisoned patients. Further understanding of the biologic variance of these intervals may allow for a more personalized approach to assessing the clinical significance of electrocardiogram (ECG) changes in these patients.

Methods: We recruited six male and six female healthy subjects. Standard 12-lead ECGs were performed in duplicate once per week for four consecutive weeks. We calculated the mean and standard deviation, the coefficient of variance (CV) for replicate readings (CV_A), and within (CV_I) and between individuals (CV_G) using analysis of variance for all subjects and separately for males and females. From these measured parameters, we determined the index of individuality (II), the reference change value (RCV), and number of readings needed to maintain a homeostatic setpoint.

Results: The median QRS interval for healthy males (103.4 milliseconds [ms]) was statistically higher than that for females (88.6 ms) in our study ($P < .05$). The CV_A and CV_I for the QRS interval for the total cohort were relatively low at 3.0 and 2.2, respectively. The CV_G for the QRS interval was relatively high at 12.9. There was no difference in the QTcorrected (QTc) interval between gender (404 vs 415 msec, respectively). The II was 0.29 for QRS and 0.74 for QTc in pooled subjects. The RCV was 10.3 and 7.1 msec, respectively, for QRS and QTc for all subjects. The number of samples needed to establish a homeostatic set point was 1 for all analyses at a closeness of 10% with a 95% probability ($P = .05$).

Conclusion: We demonstrated a significant difference in QRS duration between healthy males and females as well as a low II, particularly for the QRS interval, indicating that the CV_G is greater than the CV_I among these ECG intervals. In this study we also determined that one ECG is needed to establish a homeostatic set point for patients. If a baseline ECG is available, medical toxicologists would benefit from using the baseline tracing as an internal reference for determining QRS and QTc prolongation in the individual patient rather than a predetermined universal threshold for managing poisoned patients. [West J Emerg Med. 2025;26(4)978–983.]

INTRODUCTION

Biologic variation refers to the concept that there is variation in biological attributes between and within the individual over time and in different physiological states.[1] Within a single subject, a source of the variation comes from fluctuations around an average value. Variation may also

arise from pre-analytical factors (ie, whether an individual is standing or sitting, well hydrated or not, their fasting status). Additional sources of variation are introduced in sample collection, handling, and the analysis itself. Biologic variation becomes important when analyzing values in a medical setting, as clinicians must determine whether a given data point is deviated from the norm because of a disease state or whether this is part of normal variability for a given individual.

One outcome of analyzing the biological variation of laboratory and clinical data has been the discovery that for certain analytes there is a high degree of variation between individuals, while for others there is relative stability among individuals. As a result, certain data is best interpreted by comparing an individual to a population of patients, while others are better interpreted by comparing that individual to his/her/their self at a baseline health status. Understanding these nuances can support the goal of making medicine a more personalized and targeted.

Within the realm of laboratory medicine, the primary literature is replete with medical applications of biological variation data. Of relevance to emergency medicine practices are the calculations for high- sensitivity cardiac troponin.[2] This marker has a low index of individuality; therefore, serial measurements are more relevant than use of a population-based reference intervals.[3]

In overdose and poisoning, the electrocardiogram (ECG) is a rapid tool for interrogating the degree of ion channel blockade at the cardiac level.[4] This can aid in determining the source of the overdose, guiding treatment, and assessing the efficacy of the treatments delivered. Measured ECG intervals are calculated automatically, comparable between sequential ECGs, and are relatively straightforward to interpret. Analysis of ECG intervals in cases of suspected poisoning can identify patients likely to have serious cardiac events.[5] One study found that the QRS duration was more accurate in predicting adverse impacts such as seizures from tricyclic antidepressant overdose than serum drug concentrations.[6]

The duration of the QRS interval is determined by sodium ion influx in cardiac myocytes.[4] Many medications and toxins can cause blockade of voltage-gated sodium channels and prolongation of the QRS interval including anticholinergic medications, tricyclic antidepressants, and anti-dysrhythmics.[4] In determining the level of sodium channel dysfunction, a cutoff of QRS duration of 120 milliseconds (ms) has been used classically, although some research studies suggest cutoffs as low as 100 ms.[7]

The duration of the QT interval, which is corrected by the heart rate to give the QTcorrected (QTc), is determined by efflux through potassium channels during the depolarization phase of the cardiac cycle. Medication classes that affect the QTc are numerous and include antipsychotics, the fluoroquinolone antibiotics, and the macrolide antibiotics. A QTc duration (using the Bazett formula[8]) of greater than 450 in males and 470 in females has been proposed as a cutoff for medically significant prolongation; different cutoffs are proposed for alternative rate-correction formulas.[9]

Population Health Research Capsule

What do we already know about this issue?
The QTc and QRS intervals are provided with each 12-lead ECG. When prolonged, these values inform emergency physicians that a patient may be suffering from a toxic side effect of a drug.

What was the research question?
We determined the QT and QRS intervals in healthy subjects to determine the biological variability of these measures.

What was the major finding of the study?
Rather than using a fixed cutoff that defines prolongation of the QTc interval from an ECG, optimum use of this parameter would be to establish a within-individual cutpoint.

How does this improve population health?
A fixed cutoff is used today to determine an abnormal result for the QTc and QRS interval. Using a personalized medicine approach will improve the accuracy of drug toxicity.

From previous studies, we know that there is significant biological variation in ECG intervals. Other research groups have found that the QTc shows high intersubject variability, and additionally that the formula which best corrected the QT interval for rate differed between individuals.[10,11] Previous studies have also found substantial differences in the QRS duration between males and females.[12]

While prior studies have addressed biologic variation in ECG intervals, none to date have established an approach to apply this variation to proposing a cutoff that can guide clinical management for an individual patient. In this study we investigated the variability of the QRS interval in healthy individuals to establish the degree of inter-individual and intra-individual variability in these measurements. We argue that the high degree of inter-individual variation and low degree of intra-individual variation in these intervals necessitates a more personalized approach to ECG interpretation in the poisoned patient, and we suggest methods to accomplish this.

METHODS

Subjects

We recruited six male (mean age 39±16 y range 27-70 years) and six female healthy subjects (mean age 37±9 y

range 30-48 years, $P>0.05$ in age between genders). Due to the small numbers of subjects enrolled, we did not attempt to age match the participant's gender. Through self-disclosure, each subject denied a history of coronary artery disease, diabetes, hypertension, heart failure, or structural electrographic abnormalities. Laboratory testing was not conducted to verify the medical history. Each subject signed a written informed consent per study protocol. Standard 12-lead electrocardiograms (ECG) were performed in duplicate (Model CP150, Welch Allyn, Skaneateles Falls, NY) once per week for four consecutive weeks. For correction of the QT interval to heart rate, this instrument uses the Bazett formula, the one that is the most frequently used. The leads were removed and repositioned before each replicate ECG reading. This study was reviewed and approved by the Institutional Review Board of the University of California, San Francisco and Western Institutional Review Board.

Statistical Analysis

We used an analysis of variance (ANOVA) for calculation of the summary statistics with both sexes and separately (MedCalc, Inc., ver. 19.6.4, Ostend, Belgium). The Shapiro-Wilk test was used to determine normality. We calculated mean coefficient of variance for replicate readings (CV_A), within (CV_I) and between individuals (CV_G) using an ANOVA for all subjects and separately for males and females. We applied the Reed criterion to determine whether any outliers were statistically significant warranted rejection.[13] From these measured parameters, we determined the index of individuality (II), reference change value, and number of readings needed to maintain a homeostatic setpoint using established formulas.[2] All ECG intervals were checked manually by a physician to exclude machine computational failure.

RESULTS

The Figure shows the raw QRS and QTc results for all subjects and the Table shows the mean/median results for males, females, and combined sexes. (There were no outliers. Both the automated interpretation provided by the ECG instrument and a manual review of the tracing showed that all ECGs were without defect, including none with a bundle branch block. The QRS results for females were parametrically distributed; however, for males, they were not and, therefore, median results are reported. The QTc results were parametrically distributed for males and females and the combined group and, therefore, mean results are reported. The Table also shows the calculated values for CV_A, CV_I, CV_G, II, reference change value, and number of samples needed to establish a homeostatic setpoint.

Consistent with previous reports, the median QRS interval for healthy males was statistically higher than that for females even with a small sample size (100 and 88, respectively, $P < 0.05$).[10] The CV_A and CV_I for the combined group were low at

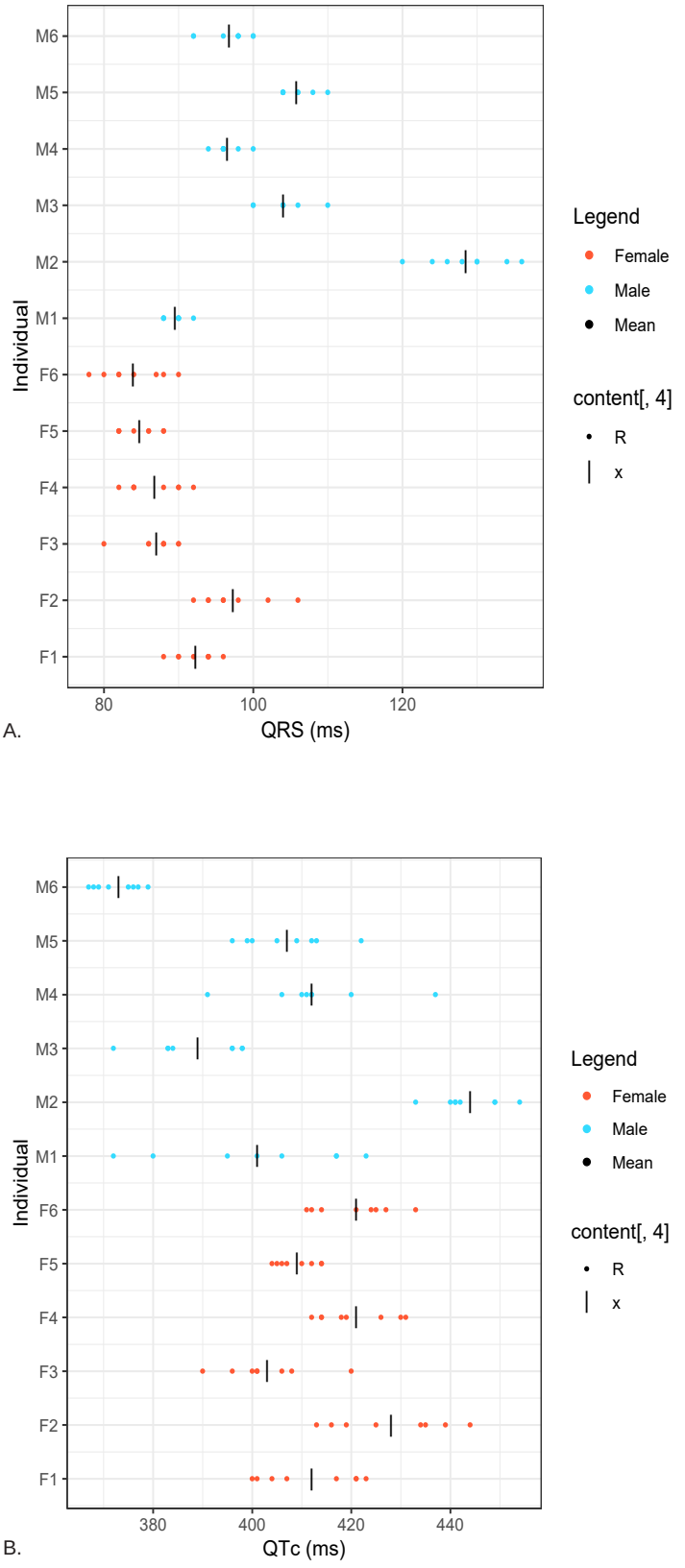

Figure. The figure shows the raw results for all subjects, and the Table summarizes the results of this study.
A. QRS interval. B. QTc interval. Red dot females, blue dots males, and the black line represents the mean of both sexes. Each dot may represent more than one reading.
ms, millisecond.

Table. Biological variation of the QTc and QRS intervals from the electrocardiogram.

	QRS			QTc		
Parameter	Males	Females[a]	Total	Males	Females[b]	Total
Mean (ms)				404.2	415.5	410
Median (ms)	100.0	88.0	94.0			
Standard deviation (ms)	10.2	5.1	14.2	4.0	9.3	13.8
CV_A	2.5	3.7	3.0	2.5	1.2	1.9
CV_I	2.2	2.0	2.2	1.1	2.0	1.6
CV_G	12.4	5.1	12.9	4.6	1.7	3.4
Index of individuality	0.27	0.83	0.29	0.60	1.39	0.74
Reference change value	9.2	11.7	10.3	7.6	6.4	7.1
Samples for homeostatic setpoint	1	1	1	1	1	1

[a]$P < 0.05$ males vs. females for median values.
[b]$P > 0.05$ males vs. females for mean values.
ms, milliseconds; CV_A, coefficient of variation between readings; CV_I, coefficient of variation within individuals; CV_G, coefficient of variation between individuals.

3.0% and 2.2%, respectively. The CV_G was higher at 12.9, resulting in an index of 0.29 (0.27 for males and 0.83 for females). An index of less than 0.6 indicates that a population-based reference interval is of no value.[1] Therefore, this test is most useful for monitoring serial change. The RCV, which takes into consideration both the imprecision and the measurement itself as well as the biological variation, was 10.3% for the combined group (9.2% for males and 11.7% for females).

There was no difference in the mean QTc interval by gender (404 milliseconds [ms] vs 415 msec, respectively). The CV_A and CV_I for the combined group were also low at 1.9% and 1.6%, respectively. The index of individuality was 0.74 when pooling all subjects (0.60 for males and 1.39 for females). The RCV was 7.1% for the combined group (7.6% for males and 6.4% for females). The number of samples needed to establish a homeostatic set point for both the QRS and QT_C was one for all analyses at a closeness of 10% ($P = .05$).

DISCUSSION

The ECG is a crucial diagnostic instrument for medical toxicologists in the work up of poisonings and overdoses. Various foreign substances, known as xenobiotics, prolong the QRS and QTc intervals, and associated ECG findings are used to predict clinically significant toxicity and help guide management in poisoned patients. This study, which included 12 healthy individuals, demonstrates a low index of individuality for these intervals, particularly for the QRS interval, indicating that inter-individual variability in QRS duration is greater than that of intra-individual variability. A statistically significant difference in QRS duration between males and females was also observed. Consequently, variability must be considered when interpreting ECG results in clinical toxicology to avoid misdiagnosis and ensure accurate assessment of cardiac toxicity in cases of poisoning and overdose.

Many xenobiotics are known to prolong the QRS and/or QT intervals, and these findings are often interpreted as objective signs of toxicity in patients with suspected overdoses. For instance, tricyclic antidepressants (TCA) are well documented as prolonging the QRS interval by blocking the fast voltage-gated sodium channels in the myocardium, leading to prolonged ventricular depolarization. In a prospective analysis of ECGs in TCA-poisoned patients, the maximal limb lead QRS duration was found to be prognostic of seizures and ventricular dysrhythmias. Specifically, the study demonstrated that the risk of seizures was 0% if the QRS duration was less than 100 ms and 30% if it was greater. Similarly, the risk of ventricular dysrhythmias was 0% if the QRS duration was less than 160 ms and 50% if it was greater. We concluded that the QRS duration is more accurate in predicting adverse outcomes than serum TCA concentrations.[6]

As a result of these findings, many medical toxicologists consider a QRS duration of 120 ms or longer, although some propose lower cutoff such as 100 ms.[4] This coupled with other ECG findings such as a prolonged terminal R wave have shown to be a reliable predictor of serious cardiovascular and neurological toxicity in TCA overdose, which may prompt earlier alkalinization such as with 1-2 milliequivalents per kilogram bolus of sodium bicarbonate, and longer periods of observation.[14]

Beyond drug-induced QRS prolongation, there are several other physiological conditions known to cause prolonged QRS intervals. For instance, patients with left ventricular hypertrophy exhibit a longer QRS duration because the greater mass of the left ventricle generates most of the heart's electrical forces. Similarly, a bundle-branch block results in a prolonged QRS interval as the ventricles depolarize sequentially rather than concurrently. While bundle-branch blocks can occur spontaneously, they may also signal toxicity, particularly due to the effects of fast

sodium-channel blocking agents.[15] These agents include amantadine, bupropion, carbamazepine, cocaine, cyclic antidepressants, diphenhydramine, lamotrigine, phenothiazines, quinidine, and other type IA and IC antidysrhythmic medications. Increased QRS complex duration is also observed in patients with hypothermia, hypermagnesemia, and hyperkalemia. Recognizing these various causes is essential for accurate diagnosis and treatment in both clinical and toxicological settings.

The QT interval, measured from the beginning of the QRS complex to the end of the T wave, exhibits normal biological diurnal variation and is influenced by factors such as autonomic tone, age, gender, the method of acquiring the ECG, and observer variability.[16,17] The QT interval also varies with heart rate, being prolonged at slower heart rates and shortened at higher heart rates. Due to this variation, multiple formulas have been developed to calculate a corrected QT interval (QTc), which estimates the QT interval corrected to a standard heart rate of 60 beats per minute (bpm). The Bazett formula is the most commonly used method and provides an accurate QTc for heart rates between 60-100 bpm.

According to the Bazett formula, the QTc is considered prolonged if it exceeds 450 ms in males and 460 ms in females.[8] However, the Bazett formula tends to overcorrect at heart rates above 100 bpm, leading to inaccurately prolonged QTc values. Some medications, such as bupropion, that are thought to prolong the QT interval may result in a "prolonged" QTc due to the increased heart rate caused by the xenobiotic.[18] To address this limitation, other formulas that more accurately calculate QTc at high heart rates have been developed, although it remains uncertain which formula is optimal.[19] A QT nomogram that plots QT interval duration against heart rate may better predict the risk for lethal dysrhythmia.[20] A QTc interval greater than 500 ms correlates weakly with an increased risk of developing ventricular dysrhythmia, and this threshold is often used by medical toxicologists to monitor and manage toxicity from medications known to prolong the QTc.[21,22] Others have suggested the half-the-reference-range rule for determining QT prolongation.[23] None of these are statistically valid approaches.

The findings from this study can be used to justify altering clinical practices within the context of medications that can prolong these intervals. Rather than use pre-established cutoffs to indicate drug toxicity, it would be best practice to first measure baseline QTc and QRS intervals prior to the initiation of treatment. Then repeat ECG measurements can be taken as part of therapeutic monitoring. An increase beyond the reference change value (RCV) of the marker would indicate a statistically significant increase. However, it is insufficient to just use the RCV values obtained from the biological variation studies conducted in health. It may be necessary to find a higher difference from baseline to indicate or predict complications due to the drug, warranting a change in therapy in terms of drug or dose. For subjects seen in the emergency department, previous ECG readings are typically available from previous visits, a routine practice that is conducted today for patients suspected of acute coronary syndromes.

LIMITATIONS

This study has several limitations. First, it only included healthy individuals, which is usually the first step in such studies.[1] However, results do not account for how biological variation might be altered in patients on a therapeutic or overdose of relevant medications. This will be the subject of our subsequent research studies. Second, this study does not address how an elevated heart rate due to xenobiotic toxicity may alter the QT interval, nor does it provide guidance on the best method to calculate the QTc in these scenarios. Overall, while the findings support the use of individualized ECG interpretation by referencing an individual's baseline intervals as reference standards for possible interval prolongation, further research is needed to understand how poisoning and elevated heart rates due to toxins affect ECG intervals and to refine the approach for calculating QTc in these situations.

This study is also limited by the small number of enrollments, as most clinical trials report on a higher number of participants. However, biological variability studies are usually conducted on recruitments of between 10-20 subjects. This is because previous studies have shown that while increasing the number of enrollments reduces the 95% confidence interval, it does not substantially alter the estimates for CV_A, CV_I, CV_G or the calculated parameters (index of individuality, reference change value and homeostatic set point, and a smaller number of samples helps reduce the pre-analytical variables.[1] To further justify the small sample size used in this study, two original landmark biological variation studies using limited enrollments were conducted on serum creatinine (n=15),[24] and high sensitivity cardiac troponin (n=12),[2] both markers demonstrating a low index of individuality. These reports led to the adoption of the estimated glomerular filtration that includes age, sex, and muscle mass to reduce inter-individual variability, and the need for serial testing for the early rule out of acute coronary syndromes, respectively.

CONCLUSION

The biological variation of ECG intervals demonstrated in this study, as evidenced by low reference change values along with known physiological conditions affecting these intervals, suggests that medical toxicologists should consider an individualized approach when determining QRS and QTc prolongation if a baseline ECG is available. Rather than relying on a universal threshold, the approach of comparison to prior individual baseline ECG intervals could allow for more accurate assessment of drug-induced cardiac effects in poisoned patients. The use of an individual's baseline ECG, as justified by the biological variation data presented in this study, may be superior to using a pre-established cutoff, or obviate the need for optimizing QTc formulas or creating nomograms.

While having a truly asymptomatic baseline ECG for which to refer is ideal, there are challenges. Today, ECGs are typically only obtained when there is medical need to do so; therefore, an abnormal tracing may invalidate this approach. Therefore, to adopt this practice, baseline ECGs would be required during health, which adds to healthcare costs and difficulties in retrieving such baseline results. We also conclude that only one ECG is necessary to establish a homeostatic set point, or reference baseline, for patients. This implies that if a baseline ECG is available, the coefficient of variance within individuals (CV_I) could be applied to the baseline QRS and QTc intervals to identify any drug-induced changes.

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Influence of Daily Meteorological Changes on Stroke Incidence Across the United States

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Introduction: Various variables of weather are hypothesized to exert a small but measurable, significant influence on the development of cerebral infarctions (strokes). Improved characterization of this relationship would enhance understanding of the impact of climate change on healthcare demand. However, current data are conflicting regarding the exact nature of the direction and magnitude of the relationship between weather variables and stroke incidence.

Methods: We conducted a retrospective analysis using patient data from 2019 across the contiguous United States obtained from the TriNetX global research data network and weather data from the National Oceanic and Atmospheric Administration database. Data from hospitalized patients who had a diagnosis of cerebral infarction, as defined from *International Classification of Diseases, 10th Rev*, diagnosis codes, were used for analysis. Negative binomial regression calculated the incidence rate ratio (IRR) between stroke and various weather variables: temperature (°C), change in temperature, pressure, change in pressure, and precipitation.

Results: Our study included 92,422 patients across 92 healthcare systems. Regression analysis revealed a small but statistically significant association between stroke and change in temperature (IRR 1.0047, confidence interval 1.0012 - 1.0083, $P = .010$). The remaining variables in our model did not have a statistically significant effect on incidence of stroke.

Conclusion: The data suggest that one aspect of weather, specifically day-to-day increases of ambient temperature, has a measurable small magnitude but statistically significant impact on local stroke patterns. [West J Emerg Med. 2025;26(4)984–989.]

INTRODUCTION

Cerebral infarctions (strokes) are a leading cause of death and disability within the United States (US) and globally,[1] and the incidence of strokes has been rising and is expected to continue to rise.[2] The occurrence of stroke has been associated with several risk factors, including hypertension, smoking, and diabetes.[3-5] The effect of weather on the incidence of stroke is less clear however.[6] Geographic trends, such as increased rates of strokes in the southeast region of the US (often referred to as the "stroke belt"), suggest a possible link with weather.[7,8] Previous studies have suggested that precipitation, temperature, and pressure effect changes in the incidence of strokes, yet their conclusions are conflicting.[9-12] The exact role of these weather variables in the development of stroke, therefore, is controversial.

Evolving patterns in weather with climate change are inevitable, and these changes may influence the occurrence of stroke.[13] Many areas of the US have experienced dramatic changes in temperature averages and precipitation in recent years; thus, a more comprehensive understanding of the relationship between weather and stroke could be an invaluable tool moving forward. This may aid in preparation and resource allocation for regions and periods at risk for increased cases of stroke. In this study, we incorporated various meteorological variables into a single statistical model to delineate how these factors may influence the incidence of stroke across the contiguous US.

Materials and Methods

In this retrospective study we used criteria as outlined in Worster and Bledsoe to optimize the quality of our investigation.[14] Specifically, we were trained on use of the databases to identify criteria for inclusion and exclusion, define variables used, define the database used, describe how datapoints were sampled/obtained, and outline management of missing data.

Data Collection

We collected the data used in this study from the TriNetX Diamond Network, which provided access to electronic health records from approximately 212 million patients from 92 healthcare organizations. The retrospective study was reviewed and accepted by Penn State University's Institutional Review Board (STUDY00022926 approved June 28, 2023) and determined to be exempt from informed consent.

Raw patient and encounter data was extracted from the TriNetX database for analysis on custom scripts in Python (Python Software Foundation, Wilmington, DE) and R (R Foundation for Statistical Computing, Vienna, Austria). (We did not use analytical tools within TriNetX). The study included hospitalized patients ≥ 18 years of age diagnosed with cerebral infarction (as defined using *International Classification of Diseases, 10th Rev.* code I63). Only the first stroke diagnosis per hospital admission was counted, and admissions within seven days were treated as the same encounter to avoid multiple counts. Cerebral infarction did not need to be the primary diagnosis. Data included only patients within the contiguous US. We excluded regions lacking weather data for specific days or entirely and regions without patient data.

We used the data from the National Oceanic and Atmospheric Administration through Google Cloud's BigQuery to obtain weather variables from weather stations across the contiguous US in 2019. US Census data from BigQuery were used to match the weather station location to the appropriate three-digit ZIP code. In three-digit ZIP code regions with multiple weather station data, we averaged data across all the stations within each region. Of note, in less populous areas of the US (particularly in the West), no ZIP code is defined, and these regions were excluded from analysis. Additionally, some three-digit ZIP code regions lacked weather data for particular days or altogether and were excluded from our analysis. Likewise, regions that lacked patient data from TriNetX were not included in the data. We created custom SQL scripts to obtain and organize weather data for the study.

Based on previous studies, we selected temperature, pressure, and amount of precipitation to use for our model. Additionally, the change in both temperature and pressure was calculated as the difference in the current weather value to the average of the previous seven days. We calculated the variance inflation factor to ensure these variables did not have significant multicollinearity, maintaining a value < 3. We filtered and merged patient and weather data using custom Python v3.11.5 scripts.

Population Health Research Capsule

What do we already know about this issue?
Weather variables are hypothesized to exert a small but measurable significant influence on the development of cerebral infarctions (strokes).

What was the research question?
At a national scale, how do weather variables influence the incidence of strokes within the United States?

What was the major finding of the study?
Increase in temperature is associated with increase in stroke incidence: IRR 1.0047, CI 1.0012 - 1.0083, P = .01.

How does this improve population health?
While these findings expand our understanding of weather and stroke relationship, they would not support varying emergency staffing given the small effect size.

Statistical Analysis

We used a negative binomial regression mixed-effects model to understand how weather variables affected the incidence of strokes per three-digit ZIP code. A mixed-effects model was used to control for the repeated measures in each three-digit ZIP code region. The incidence rate ratio (IRR) is reported for each weather variable. We scaled data before regression analysis, and regression coefficients were "unscaled" to calculate the incidence rate ratio (IRR) in relatable units. We implemented the Wald method for the calculation of 95% confidence intervals (CI). Statistical analysis was implemented using a combination of custom Python v3.11.5 and R v4.3.1 scripts.

RESULTS

Our study included 92,422 patients across 349 three-digit ZIP code regions within the US during 2019. After matching with available weather data, 85,355 occurrences of strokes were included in our analysis. Across all three-digit ZIP codes, the average daily incidence of stroke in each region was 0.69 (SD 0.95). Characteristics of the patient population are

outlined in Table 1. Summary statistics for ZIP code regions are outlined in Table 2. Negative binomial mixed-effects regression revealed notable variability in the relationship between weather variables and stroke among the different regions included in our dataset (Figure). The fixed effects from our regression analysis showed that among the weather variables we studied, only the change in temperature had a significant association with the incidence of stroke (Table 3). Specifically, our study showed that an increase in temperature (IRR 1.0047, CI 1.0012-1.0083, P = .01) was associated with a positive change in the incidence of stroke. The remaining variables did not have a significant impact on stroke incidence: temperature (IRR 1.0001, CI 0.9985-1.0017, P = .91), pressure (IRR 0.9999, CI 0.9961-1.0037, P = .94), change in pressure (IRR 1.0021, CI 0.9983-1.0059, P = .28), precipitation (IRR 0.9996, CI 0.9980-1.0012, P = .64).

DISCUSSION

This study suggests that one variable characterizing daily weather patterns has a small but statistically significant impact on the incidence of strokes across the contiguous US. Specifically, increases in daily temperature from the prior seven-day average are associated with significant small but measurable increases in the incidence of strokes. Results suggest that for every 1°C increase of temperature, the rate of stroke is increased by 1.0047 times, or 0.47%. This translates to a 4.8% increase in stroke incidence for a 10°C increase in temperature. The magnitudes of daily temperature, pressure, changes in pressure, and precipitation were not associated with statistically significant changes in stroke incidence.

Our findings add to the current and somewhat conflicting literature regarding the effect of weather on stroke. Weather has been hypothesized to influence a variety of cardiovascular diseases including strokes. A recent study in Japan found that several cardiovascular diseases are similarly influenced by daily temperature changes, specifically that the daily range in temperature increases hospitalizations related to cardiovascular disease.[15] This hypothesis extends to stroke.[6,16] A recent multicenter study across 567 cities in 27 countries showed that deaths (vs incidence in our study) related to strokes and other cardiovascular diseases were increased in days with extreme temperatures.[17] However, other studies have come to conflicting conclusions, complicating our understanding of this relationship. No consensus exists regarding the exact nature between meteorological variables and strokes.

Our data are consistent with data that suggest increased temperature and warmer seasons increase the incidence of stroke.[10,16,18,19] These studies span multiple geographic locations with specific studies located in Scotland,[10] Qatar,[18] and the US,[19] suggesting that this relationship may be generalizable across the globe and is not restricted to one specific geographic area or climate. On a cellular basis, multiple physiological mechanisms may drive this idea. One explanation is increased endothelial dysfunction with increased temperature.[20] One study used flow-mediated dilation of the brachial artery as a proxy for endothelial function and found that warmer temperatures dampened the ability of the brachial artery to dilate in the setting of ischemia. Additionally, dehydration has been proposed as a possible mechanism for increased incidence of stroke considering its increased likelihood in the setting of warmer weather, but one study in Qatar failed to show this as a contributing factor.[18] Blood pressure also changes with temperature,[21] but this is unlikely to explain our finding considering that blood pressure decreases with warmer temperatures. A decrease in blood pressure would not likely be associated with an increased incidence of strokes.

However, many studies also show that stroke incidence increases with decreases in temperature as during winter months.[9,11,12] Further, other studies suggest that both cold and hot weather can increase the occurrence of strokes with extreme temperatures in either direction being the driving force.[16,17] Considering that extreme warm temperatures are likely associated with large changes in temperatures, this is not

Table 1. Summary of patient statistics in a study of the association of weather on the incidence of stroke in the United States.

Total patients (N)	92,422
Age (median [IQR])	68 [59-77]
Sex (n [%])	
Female	46,465 [50.27 %]
Male	45,854 [49.61 %]
Unknown	4 [< 0.01 %]
Race (n)	
Black	7,080 [7.66 %]
Asian	262 [0.28 %]
White	20,372 [22.04 %]
Unknown	64,708 [70.01 %]

*The total number of patients corresponds to the incidence of strokes across hospital systems within the TriNetX database during 2019.
IQR, interquartile range.

Table 2. Summary of ZIP code region statistics in a study of the association of weather on the incidence of stroke in the United States.

Number of ZIP code regions (N)	349
Temperature (°C, mean ± SD)	13.2 ± 5.6
Pressure (hPa, mean ± SD)	1016.4 ± 1.4
Mean precipitation (mm, mean ± SD)	3.1 ± 1.2
Mean incidence of stroke (mean ± SD)	0.69 ± 0.95

* Incidence represents the mean number of strokes across all three-digit ZIP codes for hospital systems that are included in the database.
hPa, hectopascal; *mm*, millimeters.

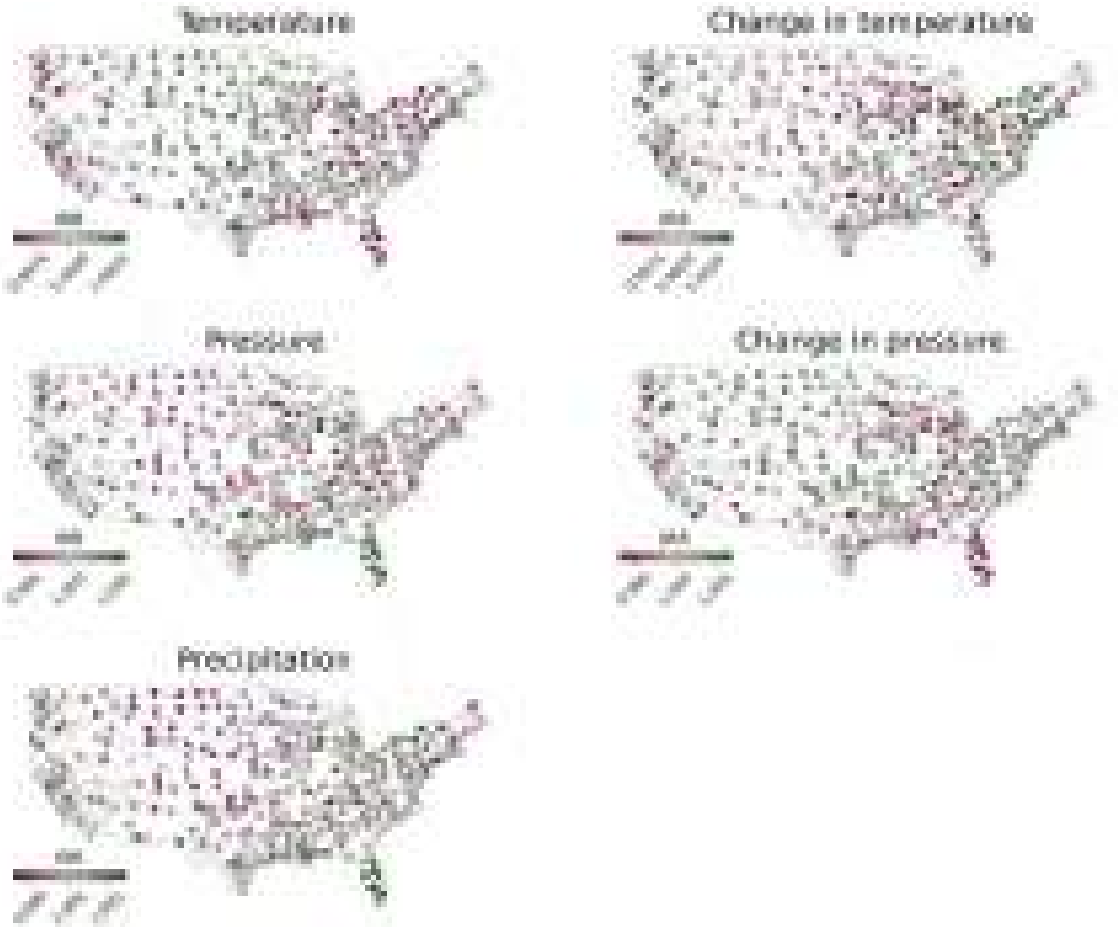

Figure. Incidence rate ratios for ZIP code regions as defined by random effects of negative binomial mixed-effects regression. Maps illustrate the relationship between weather variables and stroke. Each map depicts the IRR for each variable used in our regression model as a colored circle. Circles filled green depict a positive relationship between the variable and stroke incidence while magenta represents a negative association. Gray-filled circles have a weaker or zero association. The geography of ZIP code regions included in our analysis are outlined in gray.
IRR, incidence rate ratio.

necessarily conflicting with our results. Lastly, the effect of temperature may depend on the type of stroke with one study showing that increases in temperature increased incidence of ischemic stroke but decreased the incidence of hemorrhagic stroke.[19]

Previous investigations have also shown that atmospheric pressure is associated with the development of strokes. However, our study failed to show an influence of atmospheric pressure and strokes. One study in the United States also failed to show a significant relationship between stroke and atmospheric pressure.[22] Interestingly, this same study did show that decreases in atmospheric pressure were associated with increases in acute myocardial infarction suggesting weather may differentially affect different cardiovascular diseases. The notion that atmospheric pressure may not incur changes in stroke risk may explain the heterogeneity within the literature, with some studies showing a positive relationship[23,24] and others showing the opposite.[10,18]

Precipitation has been the focus of fewer studies compared to temperature and pressure, and studies have also had conflicting conclusions on its relationship with stroke.[25,26] In our study, precipitation did not statistically affect stroke incidence. Although precipitation does not appear to influence the incidence of strokes, one study found increased precipitation was associated with improved outcomes in patients admitted for stroke.[11]

Unfortunately, the culmination of multiple studies assessing weather and stroke has not provided a clear consensus on the exact nature of their relationship. Varying methodologies may explain the discrepancies among the many studies, including ours. For one, several limitations exist in prior studies diminishing the generalizability of their conclusions. Varying geographic regions and different timescales used between studies may explain some of the conflicting conclusions. For instance, results from studies within a single city or small geographic region may have a strong effect on local stroke incidence but are poorly

Table 3. Summary of mixed-effects negative binomial regression in a study of the association of weather on the incidence of stroke in the United States.

Variable	IRR	CI	P
Temperature (°C)	1.0001	0.9984-1.0017	.91
Change in temperature (°C)	1.0047	1.0012-1.0083	.01*
Pressure (hPa)	0.9999	0.9961-1.0037	.94
Change in pressure (hPa)	1.0021	0.9983-1.0059	.28
Precipitation (mm)	0.9988	0.9980-1.0012	.64

IRR, incidence rate ratio; *CI,* confidence interval; *°C,* Celsius; *hPa,* hectopascal; *mm,* millimeters.

generalizable. The regional variability observed in our study, with some areas showing an increase in stroke incidence and others showing a decrease (Figure), can be attributed to several factors. Geographic and climatic differences, population characteristics, and local behaviors may all play a role in modulating the impact of temperature changes on stroke incidence. For example, regions with more extreme temperature fluctuations may experience different effects compared to regions with more stable climates.

Additionally, studies that average weather variables over large timescales, such as seasons, may mask important weather dynamics that happen on the timescale of days. Further, many studies focus only on a single meteorological variable without considering complex weather dynamics. Therefore, incorporating these factors into a single framework may better delineate the relationship between stroke and weather in a more generalizable fashion. This is one of the main advantages that our study addresses. Our data cover a wide region, including diverse geographical and climate regions throughout the contiguous US. Additionally, the precision of our analysis is on the scale of days and incorporates multiple meteorological variables. Many previous studies did not have these advantage.[10,11] However, some studies go even further showing that temperature may influence strokes at the timescale of hours,[19] and this may provide a clearer picture of how weather drives the onset of stroke.

LIMITATIONS

Our study is not without limitations. One of its limitations is that isolating the effects of meteorological variables is inherently difficult. Randomized control trials are not possible, and changes in the weather will undoubtedly cause changes in other health-related variables such as increased activity on more pleasant days leading to possible confounders. Our study is also limited to data from a single year. For greater generalizability, additional data spanning multiple years would be beneficial. This may further describe how climate change specifically has influenced this relationship between stroke and weather. Additional data on patient demographics may also highlight important socioeconomic factors.

CONCLUSION

Our study suggests that increases in temperature have a positive association with stroke incidence. Our analysis benefits from multiple factors including a more precise timescale of days, more refined geographic regions at the three-digit ZIP code level, a diverse set of climate regions, and evaluation of multiple weather variables in a single model. While our study demonstrates a statistically significant association between temperature changes and stroke incidence, the effect size is small. Given that ischemic stroke patients constitute a small minority of patients seen daily in an emergency department, these findings would not support varying staffing based on temperature changes alone. The impact of temperature changes on stroke incidence, although measurable, is limited in its practical implications for emergency department operations and population health.

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Emergency Medicine at the Frontline of Climate Change: The Role of Geographic Information Systems

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INTRODUCTION

The practice of emergency medicine (EM) is becoming inseparable from public health threats like climate change. As leaders in mass casualty management and prehospital care,[1] emergency clinicians serve at the frontlines of disaster preparedness and response. With the rising incidence of natural disasters causing humanitarian emergencies,[2] it is imperative for population-based research to incorporate a spatial lens—one that extends beyond hospital departments and fosters collaboration across scientific disciplines. While several medical journals have published articles about the implications of climate change on human health,[3-9] these discussions need to be accompanied by actionable strategies to strengthen disaster preparedness.

Just as meteorologists study weather patterns, EM researchers are uniquely positioned to leverage spatial technology to anticipate disaster-related surges in patient volume and pathology. In recognition that some countries are dually burdened by high climate vulnerability and underdeveloped emergency care systems, we propose geographic information systems (GIS) as an underutilized tool in EM research to strengthen climate resilience. To emphasize the potential of GIS as a powerful supplement to EM research and disaster preparedness planning, particularly in countries with high climate vulnerability, we introduce GIS followed by a case study of Greece to demonstrate its potential.

What are geographic information systems?

Key components of disaster management include planning evacuation routes, identifying shelters and medical facilities, mapping disaster risk, developing early warning systems, and monitoring hazard progression.[10] Creating a climate-resilient disaster preparedness system inherently requires large quantities of geographic data, including elevation, land cover, meteorological observations, and population demographics. Geographic information systems can readily integrate and analyze multiple types of data to create visually informative maps of hazard risk (Figure 1). Several GIS platforms are available, some of which are open access. While they may differ in package offerings, every GIS is a fundamentally iterative system, an essential feature for preparedness systems in the face of a climate crisis with no end date.

GIS applications for disaster preparedness

As the frequency of natural disasters continues to rise annually, emergency care systems globally can leverage GIS to

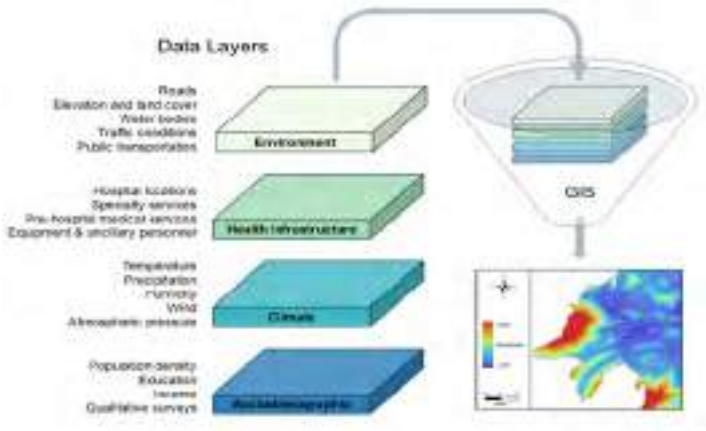

Figure 1. Various data layers can be combined in geographic information systems software to visualize climate hazard risk of a study area.

become proactive, rather than reactive, to the next climate disaster. Analysis is possible at a range of granularity, from census tracts to entire continents, making GIS highly scalable for study areas. The creation of a GIS-based prediction system is accomplished in three phases: data preparation; spatial modeling; and cross-validation.[11] Historical data from prior natural disasters can be used to test and cross-validate prediction models, enhancing their accuracy. There is a robust body of literature describing methods for prediction modeling of various climate hazards including wildfires,[12-13] landslides,[14] and floods.[15-16] In the aftermath of a severe weather event, remote-sensing and satellite imagery can be integrated with on-the-ground needs assessments to improve real-time situational awareness. A centralized GIS database also supports continuous data collection from field surveys, minimizing "false perceptions" of ground conditions that often arise during crises.[17]

Impact of climate change on emergency care systems

Severe weather events such as heatwaves, wildfires, hurricanes, floods, earthquakes, landslides, drought, and tsunamis affect high-, middle- and low-income countries alike, but their impact is felt inequitably. The World Health Organization states:

> In the short- to medium-term, the health impacts of climate change will be determined mainly by the vulnerability of populations, their resilience to the current rate of climate change and the extent and pace of adaptation.[18]

Accordingly, it is important to examine cases where natural disasters disproportionately threaten health systems to better understand regional differences in "vulnerability." Countries with fragile emergency care systems are more susceptible to the long-term impacts of severe weather events due to a lack of resources to appropriately prepare and respond. Many also face geographical constraints to service delivery in remote communities, such as underdeveloped road networks, challenging terrain, and island chains. Even during non-disaster times, the availability of specialized equipment and EM-trained staff varies across countries. Greece (Figure 2) provides an example of a country coping with challenging geography, an underdeveloped emergency care system, and high frequency of severe weather events.

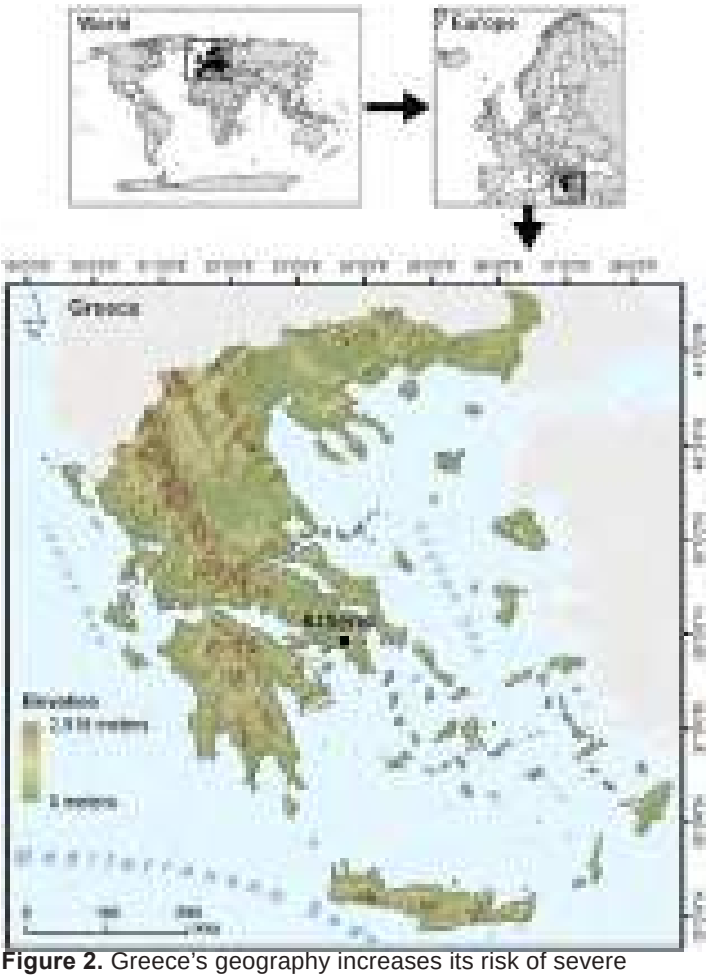

Figure 2. Greece's geography increases its risk of severe weather events.

Case study: Greece's climate vulnerabilities and emergency care challenges

We present Greece as a case study of a country with high vulnerability to climate stressors given its geography, extreme heat, and surrounding seismic activity. Its mountainous terrain creates localized weather conditions, leading to flash floods in some regions and droughts in others. Earthquakes, which have occurred as recently as February 2025,[19] are common due to Greece's location on tectonic plate boundaries and can lead to landslides and infrastructure damage. The Mediterranean climate contributes to severe wildfires every summer, while Greece's extensive coastline and islands are exposed to flooding from cyclones and hurricanes. Climate change intensifies these threats, as increasing temperatures and rising sea levels lead to more frequent heatwaves and storms, coastal erosion, ecosystems disturbance and, consequently, significant public health threats. From 1980 to 2020, Greece experienced an average of 26 floods per year. Between 2014-2018, floods and earthquakes were the most frequent natural disasters, but wildfires and heatwaves became increasingly prevalent from 2018 to 2023.[20-21] In a list of 35 European nations, Greece ranked sixth highest in the number of heat-related deaths during the summer of 2022.[22] Climate predictions for Greece have estimated that the number of days with extreme fire risk will increase by 10-15 days annually, with upwards of 15-20 heatwaves per year by 2050, along with increased flash flood events.[23-25]

As extreme weather events rise, so will the number of climate-related health conditions, injuries, and deaths. The growing health risks associated with climate change represent an imminent threat to the health of entire populations, and the emergency department (ED) plays a critical role as the first

point of contact for people seeking urgent medical care. In Greece, EM is a developing specialty, with a limited number of EM-trained physicians and persistent staffing shortages in public hospitals. The centralized oversight of the Greek Ministry of Health can lead to delayed responses to critical staffing needs, particularly during seasonal influxes of refugees and tourists. On Greece's islands, baseline challenges of understaffing, a lack of EM-trained attendings, and a fluctuating census of non-permanent residents are further complicated by the hospitals' remote locations, making them reliant on air ambulances for patient transfers to the mainland.[26]

GIS applications for disaster preparedness in Greece

In Greece, GIS has the potential to play a vital role in improving climate resilience and minimizing health threats from severe weather events. Greek researchers already use GIS to map fire-prone areas, modeling temperature, humidity, wind speed, and land cover data.[27-29] These spatial prediction models enable better resource allocation, evacuation planning, and strategic placement of firebreaks. Remote sensing and satellite data have also been incorporated for real-time monitoring, providing acute data on fire location, size, and direction to aid emergency response efforts.[30] To assess flood risk, several studies in Greece have used topographic and rainfall data to design flood protection projects.[31-33] The next step is to integrate climate research with sociodemographic and health data to create risk maps of conditions such as heat-related illnesses, pollution-related respiratory diseases, and traumatic injuries after natural disasters. Future research studies can use GIS to do the following:

- Predict the health impacts of high temperatures, wildfires, and floods on vulnerable groups of patients;
- Guide hospital administration to preemptively request additional staff and resources, enabling timely infrastructure improvements and coordinated response effort;
- Inform equitable distribution of resources to underserved or geographically vulnerable communities.

CONCLUSION

Geography is a key determinant of health, but it is often overlooked in emergency medicine research. Amid the shift-to-shift demands of emergency medicine, it can be difficult to contextualize how environmental changes are affecting the health of communities. We argue that disaster preparedness systems in climate-vulnerable countries could be more effective if specialists in medicine, climate science, geography, and epidemiology collaborated on data-driven solutions. Emergency medicine researchers can partner with geospatial experts within their hospitals or local universities to harness the potential of geographic information systems. By forecasting *"when"* and *"where"* climate-related health conditions will escalate, GIS can empower health systems to prepare for *"who"* arrives at the emergency department.

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Surgical Disease Burden, Outcomes, and Roles of Non-Physician Clinicians in Ugandan Emergency Departments

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Background: Delivery of emergency surgical care remains a challenge in much of Sub-Saharan Africa, with physician shortages in Uganda resulting in only one surgeon per 100,000 people. Emergency units in Uganda receive emergency surgical patients, but it is unknown how great of a burden these emergency surgical patients represent in terms of total number, care required, or outcomes.

Methods: We performed a retrospective review of a quality assurance database for all patients treated at two emergency units in Uganda from 2009–2019. Patients were defined as "surgical" if they were admitted directly to the operating theatre, received a surgical diagnosis, or received an emergency surgical procedure as identified by the Disease Control Priorities 3 (DCP3) group. We generated descriptive statistics.

Results: Of the 109,999 total patients seen, 24,745 (22.5%) were emergency surgical patients. Surgical patients were predominantly male (71.7%) with a mean age of 34.9 years. Most surgical patients (57.0%) were admitted to the hospital, while 38.9% were discharged, and only 1.7% were sent directly to the operating theatre. In total, 12.1% of all patients seen in the emergency unit received a surgical procedure from a non-physician clinician while in the unit. Of the surgical procedures, the most common were suturing of lacerations (51.8%), urinary catheterization (24.5%), fracture management (16.5%), and incision and drainage of abscesses (6.0%). Among surgical patients, the most common surgical diagnoses were for fractures (30.9%), lacerations (29.6%), and abscesses (8.8%). The overall three-day mortality for emergency surgical patients was 2.8%.

Conclusion: Emergency surgical patients are common in Ugandan emergency units, where emergent surgical procedures are commonly performed by non-physician clinicians. Strengthening system capacity for emergency surgical patients should also consider emergency unit resources. [West J Emerg Med. 2025;26(4)994–1001.]

INTRODUCTION

Over the last decade, inequities in global access to surgical care have gained significant attention as a public health crisis and significant contributor to high rates of preventable mortality in low- and middle-income countries (LMIC).[1-5] With numerous global initiatives underway focusing on strengthening surgical systems, we need a greater understanding of existing emergency surgical disease burden,

resources required, and short-term strategies to effectively care for patients where surgeons are lacking, including use of non-physician clinicians.[6-13] In this study we aimed to fill some of that knowledge gap by investigating the burden of emergency surgical conditions and capacity for emergency surgical care delivery in rural Uganda.

Worldwide, five billion people lack access to essential surgical care, with the overwhelming burden of surgical disease disproportionately impacting LMICs.[1,3] Although LMICs constitute 35% of the world's population, they receive only an estimated 3.5% of all surgical interventions.[4] In Uganda in particular, physician shortages result in only slightly more than one surgeon per 100,000 people vs 9.4 in LMICs overall and 71.2 in high-income countries.[14] A recent study in Uganda found that less than 25% of the population had access to a surgically capable facility within two hours.[15] Where surgical capabilities did exist, the annual surgical volume was 144.5 cases per 100,000 per year.[15] With current rates of scale-up (5.1% per year), the target of 5,000 surgical procedures per 100,000 population per year is not projected to be achieved in Uganda until 2053.[16]

As a start to addressing these disparities, 44 surgical procedures were identified in the first volume of the *Disease Control Priorities*, 3rd edition series (DCP3), titled "Essential Surgery." These procedures "address substantial needs, are cost effective, and are feasible to implement in [LMICs]. If made universally available, the provision of these 44 procedures would avert 1.5 million deaths a year and rank among the most cost effective of all health interventions."[17] Of the 44 procedures, 37 were designated as appropriate for "primary health centres" or "first-level hospitals," and of those, 28 are designated as emergency procedures (see Table 1). Essential Surgery also suggests that non-physician clinicians can play an important role in the problem of access to basic surgery, yet this has not been studied for management of emergency surgical conditions in rural Uganda.[17] To better understand the burden of emergency surgical conditions and capacity for emergency surgical care delivery in rural Uganda, we set out to describe the diagnoses, procedures, and outcomes associated with emergency surgical patients in two emergency units in Uganda from 2009–2019. This information will inform policy on prioritization of emergency surgical care in rural Uganda and development of systems at the intersection of emergency care and surgical care, including workforce utilization.

Population Health Research Capsule

What do we already know about this issue?
There is a need for emergency surgical care in resource-limited settings (RLS).

What was the research question?
What is the burden of emergency surgical disease and role of non-physician clinicians in emergency surgical care in rural Uganda?

What was the major finding of the study?
Of 109,999 patients, 22.5% were emergency surgical patients, and 12.1% received a procedure from a non-physician clinician.

How does this improve population health?
Strengthening emergency medical and surgical systems in RLS should be considered in tandem. Task sharing can be critical to improving access to emergency surgical services.

METHODS

Study Locations

We performed a retrospective review of a quality assurance database for all patients treated at two emergency units in rural southwest Uganda from November 2009–December 2019. Masaka Regional Referral Hospital is a regional referral hospital with an emergency unit patient volume of approximately 1,000 per month. Karoli Lwanga Hospital is a district-level non-governmental hospital with an emergency unit monthly patient volume of approximately 500 patients. Study sites had emergency units staffed by non-physician clinicians trained as emergency clinicians by a US and Uganda-based non-profit organization, Global Emergency Care (GEC). The non-physician clinicians were nurses who completed a two-year advanced training course in emergency care described in detail elsewhere.[18] Study sites had limited resources with variable access to plain radiographs, no computed tomography (CT), and blood banks with inconsistent supplies of blood products. A complete description of setting, resource availability, and outcomes of the training program are also described in previous publications.[19-21]

Data Collection

Beginning in 2009, GEC created a quality assurance (QA) database of emergency unit patient records to monitor and evaluate the quality of healthcare services provided at two emergency units where GEC had provided a clinical training program. Data were abstracted by trained research assistants from all consecutive emergency patients' paper charts once the treating clinician completed the patient's care and entered the information electronically into the database using Microsoft Excel from November 2009–March 2012 and Microsoft Access (Microsoft Corporation, Redmond, WA) from March–December 2019. Variables included patient demographics, vital signs, chief complaint, testing results, radiology results,

Table 1. Adapted from *Disease Control Priorities, 3rd Edition,* emergency surgical procedures.

	Platform for delivery of procedure	
	Community facility and primary health centres	First-level hospitals
Obstetric, gynaecological, and family planning	Normal delivery	Caesarean birth Vacuum extraction or forceps delivery Ectopic pregnancy Manual vacuum aspiration and dilatation and curettage Hysterectomy for uterine rupture or intractable post-partum haemorrhage
General surgical	*Drainage of superficial abscess*	Repair of perforations (perforated peptic ulcer, typhoid ileal perforation, etc) Appendectomy Bowel obstruction Colostomy Gallbladder disease (including emergency surgery for acute cholecystitis) Hernia (including incarceration) *Relief of urinary obstruction; catherisation or suprapubic cytostomy (tube into bladder through skin)*
Injury	Resuscitation with Basic Life Support measures *Suturing laceration* *Management of non-displaced fractures*	Resuscitation with Advanced Life Support measures, including surgical airway *Tube thoracostomy (chest drain)* Trauma laparotomy *Fracture reduction* Irrigation and debridement of open fractures Placement of external fixator, use of traction Escharotomy or fasciotomy (cutting of constricting tissue to relieve pressure from swelling) *Trauma-related amputations* Burr hole
Non-trauma orthopedic		Drainage of septic arthritis Debridement of osteomyelitis

Note: Italicized procedures are those included in the database for this study which included emergency unit data. Procedures performed outside the emergency unit (e.g. in the operating theatre or obstetrics unit) are not registered in the emergency unit database. Additionally, resuscitative measures were not classified in this database under "procedures" and, therefore, are not represented.

procedures completed, medications administered, diagnoses, disposition, and three-day follow-up. All data were handwritten and transcribed verbatim when entered electronically. Three-day mortality follow-up data for emergency unit visits were collected in person for admitted patients and by structured telephone interview for patients who were discharged before three days. If a patient could not be reached on the initial attempt, calls were made daily for seven consecutive days before they were labeled as lost to follow-up. Three-day follow-up was chosen both to minimize loss to follow-up in a setting where most patients do not have consistent ability to receive phone calls and because follow-up after three days was thought to be less reflective of outcomes related to acute care provided in the emergency unit.

There were three small gaps in follow-up data collection during the study period, when no RA was available. These gaps include September 24–28, 2010; January 17–February 3, 2011; and February 13–27, 2011. Data missingness was variable throughout the 10-year, real-world implementation of this QA database. Routinely collected emergency unit data was recorded at a very high rate: sex (99.8%); age (99.3%); disposition (99.7%); and diagnosis (99.1%). Rates of completeness were lower for data about three-day mortality, which relied on data collection outside the emergency unit including in-person follow-up for admitted patients (91.0%) and phone follow-up for discharged patients (54.6%).

Inclusion criteria for this study were surgical patients of all ages seen from November 2009– December 2019. There were no exclusion criteria. Patients were defined as "surgical patients" for subsequent analysis if they met any one or more of the following criteria: 1) were admitted directly to the operating theatre; 2) received a surgical diagnosis as defined below;or 3) underwent any one of 28 emergency surgical procedures identified by the DCP3 as an essential surgical procedure for first-level hospitals and primary health centres (see Table 1).[17] Surgical diagnoses were defined as conditions and diagnoses that would be considered indications for performance of the DCP3 procedures as identified by our study authors (see Appendix 1). Patients with more than one visit during the study period had each unique visit included in the analysis.

Data Analysis

Data was stored and processed on encrypted,. *Stata Statistical Software: Release 16* (StataCorp, LLC, College

Station, TX) by a single abstractor trained in applied epidemiology [BR]. Descriptive statistics were used to describe sex, age, outcomes, dispositions, diagnoses, and procedures performed. Extensive data processing using regular expressions, string recognition and other procedural and rule-based approaches was done for free-text data analysis in Stata. This coding allowed the free-text database to be restructured into a format similar to a standard electronic health record that could be queried to produce the above variables. Sample size was based on using all available records meeting the above criteria rather than an a priori power calculation. Significance testing for continuous variables used *t*-test and for categorical variables using chi-squared test. These methods comply with optimal retrospective chart review recommendations as described by Worster and Bledsoe including abstractor training, defining variables and case selection, and descriptions of the database, sampling and analysis methods.[22]

Abstractor performance was reviewed by the lead author [SC]. Interobserver reliability was not relevant given the single data abstractor, and the abstractor was aware of study objectives. There were no cases of disagreement between abstractors about case or variable definitions. Missing data for age and patient disposition is noted in the "Results" section. The development and implementation of this database received institutional review board approval from Mbarara University of Science and Technology in Mbarara, Uganda, and the Ugandan Council of Science and Technology.

RESULTS

Of the 109,999 total patients seen, all were examined for eligibility and, ultimately, we identified 24,745 (22.5%) with confirmed eligibility as emergency surgical patients as shown in the Figure.

The greatest proportion of surgical patients were included based on receiving a surgical diagnosis (44.8%), and the smallest proportion were included based on going directly to the operating theatre (1.7%). In total, 13,670 (12.4%) patients in the emergency units received an emergency surgical procedure. Of those receiving surgical procedures, 13,259 (97.0%) were performed by non-physician clinicians while in the emergency unit. Baseline characteristics of emergency surgical and non-surgical patients are compared in Table 2. Emergency surgical patients, as compared to their non-surgical counterparts, were significantly more likely to be male, less likely to be under five years of age, and more likely to be discharged from the emergency unit (all *P*-values <.001). The three-day mortality rate for surgical emergency patients was lower than mortality for non-surgical emergency patients (2.8% vs 3.6%, *P*<0.001). Limited information was maintained about patients referred to other facilities but the majority (n=204, 66.0%) were for orthopedic care after receiving fracture diagnoses in the emergency unit. The relative frequency of the emergent procedures performed by non-physician clinicians in the emergency unit is described in Table 3. Of the emergency unit surgical procedures, the majority were suturing of lacerations, with relief of urinary obstruction and management of non-displaced fractures also accounting for a large proportion. No emergency unit procedures were performed by physician surgeons. A prior study using the same database and individual patient records evaluated a subset of patients who required physician surgeon management in an operating theatre where the most common operative interventions were laparotomy, complex laceration repair, and herniorrhaphy.[21]

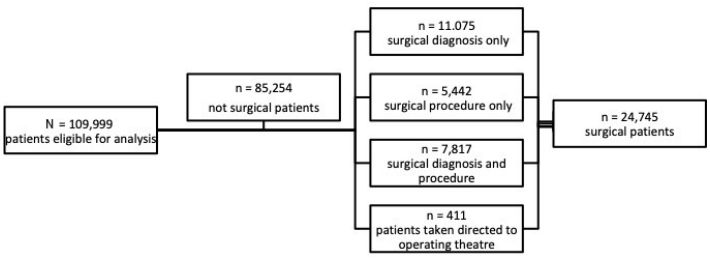

Figure. Schematic showing how emergency surgical patients were identified by category.

The frequency of surgical diagnoses are reported separately for all surgical patients and surgical patients that died within three days in Table 4. The relative frequency of some diagnoses is similar in both groups (e.g. fractures are most prevalent at approximately 30%). Some diagnoses are more prevalent among surgical patients overall than among patients who died within three days (e.g. laceration, dislocation). In contrast, some diagnoses are relatively more prevalent among patients who died than among the overall surgical population (e.g. bowel obstruction, acute abdomen, bowel perforation).

DISCUSSION

Burden of Emergency Surgical Disease

The results described above are presented to address the evidence gap that exists surrounding emergency surgical care in Uganda and in LMICs more generally. We describe a set of emergency surgical patients and procedures that represent a substantial burden but who often remain under-represented by reporting systems that look at inpatient and outpatient care but omit the emergency unit. We saw that 22.5% of all patients who arrived in two emergency units met the definition of a surgical patient, underlying the enormous burden of emergency surgical disease. Of that population, 38.9% were discharged and would not have been detected by inpatient surgical surveillance. Likewise, 12.1% of all emergency unit patients received a surgical procedure while in the emergency unit from a non-physician clinician, and these would not have been seen by studies evaluating the burden of emergency surgical disease only for patients taken to the operating theatre.[21] These findings emphasize the need for developing health systems to consider emergency unit patients as part of development aims and ensure

Table 2. Baseline characteristics of emergency surgical and non-surgical patients.

	Surgical (n= 24,745)	Non-Surgical (n=85,254)	P-value
Age, mean (SD)	34.9 (23.7)	28.1 (24.2)	<.001*
Age Group, n (%)			
Under 5 years old	1,675 (6.8%)	19,548 (22.9%)	
Age 5-17 years old	4,026 (16.2%)	13,503 (15.9%)	
18-44 years old	11,946 (48.3%)	31,455 (36.9%)	<.001
45-65 years old	3,213 (13.0%)	10,892 (12.8%)	
65+ years old	3,709 (15.0%)	9,326 (10.9%)	
Age Missing	560 (0.7%)	176 (0.7%)	
Male Sex, n (%)	17,746 (71.7%)	42,910 (50.3%)	<.001
Disposition, n (%)			
Admitted	14,095 (57.0%)	56,471 (66.5%)	
Discharged	9,629 (38.9%)	27,347 (32.2%)	
Expired in ED	196 (0.8%)	673 (0.8%)	
Left against medical advice or eloped	83 (0.3%)	221 (0.3%)	<.001
Referred	309 (1.2%)	281 (0.3%)	
Sent directly to the operating theatre	411 (1.7%)	0 (0%)	
Disposition missing	22 (0.9%)	296 (0.4%)	
Mortality (Three-day), n (%)	690 (2.8%)	3,076 (3.6%)	<.001

*T-test used for significance, all other use chi-squared tests.

emergency medicine development is paired with surgical reporting and registry efforts.

Looking at our data on a more granular level, there are additional public policy implications. Four of the top five surgical diagnoses identified (fracture, laceration, blunt trauma, and dislocation) are explicitly trauma related. Surgical patients were primarily young and male, supporting other recent findings in Uganda regarding injured patients.[23] This reinforces the need for building capacity to treat traumatic injuries, as well as for the national legislative and policy efforts targeting trauma prevention (particularly in the high-risk group of young men) and road traffic injuries, of which two-thirds are motorcycle-related in Uganda.[23]

Finally, our study found that mortality from emergency surgical patients was 2.8%. This compared favorably with mortality of non-surgical patients (3.6%); however, this still represents a substantial burden of surgical disease. In comparing diagnoses of surgical patients who survived vs died at three days, the diagnoses of bowel obstruction, acute abdomen, and bowel perforation were notably more prevalent for those who died. Trauma-related diagnoses (i.e. fractures, lacerations, blunt trauma) also contributed substantially to fatal disease burden. It is likely that patients suffering fractures and lacerations had complex poly-trauma contributing to mortality. These findings support the need for improved prehospital care measures for

Table 3. Frequency of emergency unit surgical procedures (N=14,482 total procedures).

Procedure	Frequency of Primary Level Procedure (n,% total)	Frequency of First Level Procedure (n,% total)
Suturing laceration	7,506 (51.8%)	
Relief of urinary obstruction		3,542 (24.5%)
Management of non-displaced fracture	2,147 (14.8%)	
Drainage of superficial abscess	869 (6.0%)	
Fracture reduction		250 (1.7%)
Tube thoracostomy		87 (0.6%)
Amputation		81 (0.6%)
Total	**10,522 (72.7%)**	**3,960 (27.3%)**

Table 4. Frequency of surgical diagnoses for all patients with a surgical diagnosis and all patients with a surgical diagnosis who died.

All Patients with Surgical Diagnoses (N=19,207)		Patients with Surgical Diagnoses Who Died (n=423)	
Surgical diagnoses	Freq. (n,%)	Surgical diagnoses	Freq. (n,%)
Fracture	5,937 (30.9%)	Fracture	146 (34.5%)
Laceration	5,676 (29.6%)	Bowel obstruction	75 (17.7%)
Abscess	1,682 (8.8%)	Acute abdomen	39 (9.2%)
Blunt trauma	1,235 (6.4%)	Laceration	35 (8.3%)
Dislocation	850 (4.4%)	Blunt trauma	29 (6.9%)
Hernia	832 (4.3%)	Abscess	26 (6.2%)
Bowel obstruction	804 (4.2%)	Bowel perforation	20 (4.7%)
Urinary obstruction	532 (2.8%)	Urinary obstruction	20 (4.7%)
Acute abdomen	475 (2.5%)	Hernia	11 (2.6%)
Appendicitis	400 (2.1%)	Appendicitis	6 (1.4%)
Osteomyelitis	255 (1.3%)	Dislocation	5 (1.2%)
Bowel perforation	176 (0.9%)	Ectopic pregnancy	3 (0.7%)
Ectopic pregnancy	111 (0.6%)	Pneumothorax	3 (0.7%)
Septic arthritis	70 (0.4%)	Imperforate anus	2 (0.5%)
Pneumothorax	51 (0.3%)	Osteomyelitis	2 (0.5%)
Penetrating trauma	50 (0.3%)	Penetrating arauma	1 (0.2%)
Amputation	49 (0.3%)		
Cholecystitis	15 (0.1%)		
Imperforate anus	7 (0.04%)		
Total	19,207 (100%)	Total	423 (100%)

timely hospital transport and hemorrhage control, supporting early detection and diagnostics (e.g. point-of-care ultrasound) for surgical patients, along with public health measures to address preventable trauma.

Role of Non-Physicians in Emergency Surgical Care

In regard to management and disposition of surgical patients, we found that although a significant proportion (38.9%) of emergency surgical patients were discharged from the emergency unit, most surgical patients (57.0%) were admitted to the hospital, but only a small percentage (1.7%) needed to be taken directly to the operating theatre. This high admission rate suggests that these patients do require inpatient care and resources, yet the vast majority of surgical admissions can be managed outside the operating room, and non-physician clinicians can significantly contribute to the care of these patients.

All of the five emergent procedures expected for primary health centers, as identified by DCP3, (normal delivery, drainage of superficial abscess, resuscitation with Basic Life Support, suturing laceration, management of non-displaced fractures) can be managed by trained non-physician clinicians, as can many of the procedures that are designated as first-level hospital procedures (e.g. relief of urinary obstruction, fracture reduction, irrigation and debridement of some open fractures, drainage of septic arthritis, debridement of osteomyelitis). In Sub-Saharan Africa, at least 25 countries use non-physician clinicians to perform medical and surgical procedures.[13] While long-term solutions to increasing the number of trained surgeons in the region are necessary, incorporating task-shifting or task-sharing models and setting priority targets for procedural training for the most common surgical procedures (sutures, urinary catheterization, and management of non-displaced fractures) for non-physician clinicians can help address the human-resource gap for emergency surgical care.[24] Focused training of non-physicians in triage protocols, performing trauma surveys, and identifying emergent surgical conditions may also improve outcomes with more timely diagnosis and management. Training standards, accreditation, supervision, and autonomy are all important factors that may need to be tailored to specific resource and practice environments.[9,13,20,21,24]

Role of Emergency Medicine in Surgical Care

Finally, as surgical health systems strengthening measures are considered, attention must be paid to the role of emergency clinicians not only in provision of emergency surgical procedures, but also in diagnosis and medical resuscitation of emergency surgical patients. Timely and accurate diagnosis can be critical to improving surgical outcomes by identifying the index conditions that require

emergency surgical care in the operating theatre (e.g. ectopic pregnancy, bowel perforation, appendicitis, bowel obstruction, incarcerated hernia, acute cholecystitis, traumatic intra-abdominal hemorrhage, open fractures, septic arthritis).

A previous study found that 96% of emergency surgical patients dispositioned immediately to the operating theatre had diagnostic testing (including laboratory testing and imaging) in the emergency unit.[21] This study builds upon that work identifying surgical diagnoses associated with mortality that could be identified and prioritized for surgical consultation and resuscitative measures as a bridge to definitive operative care. Using emergency clinicians can not only improve outcomes with more timely care (e.g. wound care and laceration repair that prevents infections, catheter placement to prevent acute kidney injury from urinary outlet obstruction) but also best use physician surgeon time and expertise in the operating theatre, rather than evaluating all undifferentiated patients with abdominal pain or over-burdening them with minor surgical procedures. Further investment in emergency care training for all emergency clinicians, including non-physician clinicians, is a key element to addressing the unmet need for emergency surgical care in LMICs.

LIMITATIONS

Our study has important limitations to consider. Both units evaluated in this study saw medical and surgical emergencies, with maternal emergencies typically being triaged to separate labour and delivery wards. Given that C-sections are estimated to comprise a third of surgical volume in most resource-limited settings, omission of this category likely biases the study toward an under-representation of emergency surgical burden in Uganda.

The specific training of the non-physician clinicians at the two study sites may pose another limitation to the generalizability of non-physician care for emergency surgical patients. The non-physician clinicians in these emergency units were trained in a two-year training course that notably included procedural sedation. Therefore, emergency clinicians with less training may not have the expertise to manage some surgical cases in emergency units.

This was a retrospective data analysis, which may have incomplete data and only included emergency unit data without the benefit of longitudinal data for admitted patients. Mortality data was limited to within three days of the emergency unit visit, and specific causes of death are unknown. Three-day mortality data was collected to minimize loss to follow-up given communication barriers in rural Uganda. However, overall surgical mortality may be underestimated without knowing longer term outcomes. In addition, we cannot draw direct inferences to cause of death, as our database was limited to surgical diagnoses associated with fatalities.

Finally, database limitations under-represent the DCP3 emergency surgical procedures of "resuscitation with Basic Life Support measures" and "resuscitation with Advanced Life Support measures" as these were not categorized by clinicians in our database as "procedures." Without taking these measures into account, the utility of non-physician clinicians for emergency surgical patients is likely understated.

CONCLUSION

Emergency surgical patients are common in Ugandan emergency units, comprising one fifth to one quarter of all patients seen. Many *Disease Control Priorities, 3rd ed*, emergency surgical procedures are performed by non-physician emergency clinicians. Almost 60% of emergency surgical patients require hospitalisation. Strengthening system capacity for emergency surgical patients should consider emergency unit resources, in particular human resources, to optimize quality care balanced with effective health system utilization. Non-physician clinicians and other emergency care clinicians can play a critical role in meeting the human resource gap required to improve emergency surgical care.

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Physicians in Greece's Emergency Departments: Attitudes, Readiness, and Need for Formal Training

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Introduction: Despite the recent recognition of emergency medicine (EM) as a distinct specialty in Greece, emergency departments(ED) there continue to be staffed by physicians with training in other medical specialties, although some hold EM certifications. In this study we aimed to evaluate the perceived level of competency and preparedness of physicians who work in EDs in Greece. We also sought to identify gaps in clinical EM expertise, solicit opinions on the need for EM residency training in Greece, and determine the well-being and job satisfaction of physicians practicing in Greek EDs.

Methods: This was a mixed-methods, cross-sectional, electronic, nationally representative survey of physicians working in EDs across all health districts in Greece. The survey was administered in Greek and anonymously conducted online. We used the Pearson chi-squared test to determine whether there was an association between EM certification and comfort with seeing subsets of patients. The study received institutional review board approval, and all participants signed an online consent form.

Results: The study surveyed 105 of 263 physicians working in 52 Greek EDs (39.9% response rate). We found that of the 105 physicians surveyed, 63 (60.0%) were not certified in EM. A Pearson chi-squared test revealed a significant association between comfort level in seeing pediatric, trauma, and critically ill patients, and EM certification ($X^2 = 13.37$, $P = .001$). Qualitative analysis found that physicians had a desire to engage in training opportunities, with many citing cost, time, and age as barriers. Despite these challenges, 64.1% of physicians reported satisfaction with their decision to work in the ED.

Conclusion: Most frontline emergency physicians working in Greece are uncomfortable caring for the full breadth of ED patients. This survey represents the first assessment of the attitudes, clinical preparedness, and perceived need for EM residency training among emergency physicians in Greece. Critical next steps should include enhanced training on targeted aspects of emergency care for practicing emergency physicians in the nation and continued efforts to establish formal EM residency training in Greece. [West J Emerg Med. 2025;26(4)1002–1007.]

INTRODUCTION

Greece is a high-income country located in southeastern Europe divided into seven health regions. It boasts a centralized National Health Care System, *Εθνικό Σύστημα Υγείας* (ESY), regulated by the Ministry of Health (MoH), which is responsible for medical staffing and funding of all public health facilities including 52 emergency departments (ED) across the country.[1,2,3] Since 2000, emergency medicine

(EM) has become increasingly more important in Greece as the country has experienced an increased number of climate change-related natural disasters causing mass casualty events, including wildfires, floods, earthquakes, volcanic eruptions, and tsunamis.[4]

While Greece has a long history in medicine, EM as a specialty has been slow to develop.[5] Emergency departments were created in all Greek public hospitals in 1998, using the specialty-based model (eg, cardiologists and gynecologists see their respective patients in specialty-allocated beds in the ED). In early 2000, every ED was allocated 1-3 permanent positions for physicians who had trained in one of the four major specialties: surgery, general medicine, internal medicine, or cardiology. Unfortunately, very few physicians applied, as the role was poorly defined, and EM as a specialty was largely unknown. In 2017, to strengthen emergency care capacity in Greece, an additional 465 permanent ED positions were announced. In 2019, the MoH first recognized EM as a "superspecialty," to be awarded after two years of formal training beyond residency (Figure 1). An alternative second pathway to the title of specialist in EM was through grandfathering in, which was awarded to those who had practiced in an ED for five years prior to the creation of the superspecialty.

In 2020, Greece was recovering from an austerity economic program imposed by the European Union and International Monetary Fund, whereby all public sector expenses were under tight control. Thus, very few placements for ESY physicians were made available, creating interest in the available ED positions as physicians sought a way to join ESY. However, most applicants had no direct exposure to or training in EM, thus preferring to practice within the allocated beds of their specialty within the ED.

The COVID-19 pandemic shifted the focus from developing EDs and ward-based internal medicine and intensive care units (ICU) to care for the influx of sick medical patients. Most EM development initiatives, including training and staffing, were put on pause during this time.[6] In the post-COVID-19 era, the focus in Greece has shifted back to improving emergency care capacity: more EM superspecialty training centers have been created and, more importantly, the culture of EM is growing. Emergency physicians have also been exposed to the full spectrum of EM through the efforts of the Hellenic Society for Emergency Medicine (HeSEM).[7] The HeSEM was established in 2002 with the goal of advancing the field of EM in Greece. The HeSEM is currently advocating for the establishment of Greece's first EM residency training program while also enhancing EM training for ED-based physicians who are not EM-certified. The goal is to standardize ED practices and elevate emergency care quality nationwide. International collaborations, political lobbying, certified educational activities, and scientific meetings have helped further the EM cause in Greece.

Despite this, the 52 EDs across Greece are currently staffed with just 263 physicians; however, only a small fraction of these are certified as EM-supraspecialists. Thus, Greek EDs today are largely run by non-EM trained but ED-based physicians from other specialties. The Greek model of emergency care by non-certified EM attendings is not unique in Europe or globally; however it is under-studied, making it imperative to determine whether frontline physicians feel adequately trained to serve the full breadth of emergency patients. It is unclear whether the physicians practicing in Greek EDs feel prepared for or satisfied by the challenges of a clinical career in EM, nor is it clear what their specific needs might be as far as additional training or support. To this end, we conducted an anonymous, electronic survey of physicians practicing in Greek EDs.

Population Health Research Capsule

What do we already know about this issue?
Greek EDs are staffed by non-EM trained doctors. Some are EM certified. Their preparedness, satisfaction, and training needs are unknown.

What was the research question?
Do Greek emergency physicians feel comfortable treating patients in the ED, and how do they perceive the need for formal EM training?

What was the major inding of the study?
EM-certified doctors felt more comfortable treating pediatrics, trauma and critical care patients than those trained in other specialites (P=0.0096).

How does this improve population health?
Identifying physician comfort and training needs informs policy to improve emergency care and, consequently, patient outcomes in Greek EDs.

METHODS

This was a cross-sectional, observational, mixed-methods study (quantitative and qualitative) conducted via electronic survey of physicians practicing in Greek EDs. First, co-authors SA and ER convened an expert committee of medical directors of two major Greek EDs (co-authors DT and DB) who practice clinical EM to discuss the main issues facing physicians practicing in Greek EDs. A de novo survey was then derived, comprised of questions aimed to assess emergency physicians' training, job satisfaction, perceived competencies in critical areas of EM practice, and perceptions of the need for formal EM training.

The survey was translated from English to Greek and back-translated to English by fluent, bilingual native Greek speakers. The survey was uploaded to an online survey tool (Qualtrics International, Inc, Provo, UT). An initial pilot version of the survey went live and was completed by a subset of participants, who then filled out the final version of the survey. Questions 30-32 were consequently added, and modifications to language and question numbering were made. A link to the final version of the survey was disseminated via email from ED medical directors to their staff on April 3, 2024. Upon following the link, study subjects were prompted to create a unique identifier to decrease the likelihood of duplicate responses and to enable them to return to their survey later to complete it. The study questionnaire began with an informed consent question followed by 30 questions. The survey took approximately 15-25 minutes to complete. The study ran until June 17, 2024. Please see Appendix 1 for the English-language version of the survey. Descriptive analysis was done via Microsoft Excel (Microsoft Corporation, Redmond, WA), with missing responses excluded from the relevant analyses.

We performed a Pearson chi-squared test to assess the association between comfort level and certification status using R (R Foundation for Statistical Computing, Vienna, Austria). We created a contingency table based on the observed frequencies of comfort levels across pediatric, trauma, and critically ill patients and certification status. Standardized residuals were extracted to evaluate the strength of the association between categories with the significant threshold set at $|R| > 2$. Qualitative data was uploaded for analysis to NVivo 14 (Lumivero LLC, Denver, CO).

Table. Characteristics of respondents to survey in a study of physician attitudes regarding need for emergency medicine training in Greece.

Characteristic	Number of respondents	Percent (%)
EM Certification		
Yes	40	38.1%
No	63	60.0%
Missing	2	1.9%
Primary Training Area		
Anesthesiology	5	4.8%
Cardiology	12	11.4%
General practice	17	16.2%
Orthopedics	8	7.6%
Pathology	21	20.0%
Pediatrics	4	3.8%
Pulmonology	7	6.7%
Surgery	15	14.3%
Missing	16	15.2%
Health District		
1st Regional Directorate	18	17.1%
2nd Regional Directorate	25	23.8%
3rd Regional Directorate	7	6.7%
4th Regional Directorate	28	26.7%
5th Regional Directorate	10	9.5%
6th Regional Directorate	13	12.4%
7th Regional Directorate	1	0.1%
Missing	3	2.9%

EM, emergency medicine.

RESULTS

The survey was distributed to 263 physicians across all 52 EDs in Greece, representing the nation's seven healthcare administrative regions. There were 171 responses. Of these, 19 were duplicates, 47 surveys had no answers filled out, and two were only partially completed. We excluded from the analysis the 66 duplicates and unanswered surveys. Thus, the response rate was 39.9%. Basic characteristics of the respondents are noted in the Table. Figure 2 shows levels of comfort with pediatric, trauma, and critically ill patients in the ED. We performed a Pearson chi-squared test to examine whether there was a significant difference between levels of comfort and EM certification. Due to inadequate power, we combined pediatric, trauma, and critically ill questions. The chi-squared test revealed a significant association between comfort level and certification status ($X^2 = 13.37$, P-value = .0096). Standardized residuals were then done to examine which comfort levels contributed most to the test statistic. The "not comfortable" and "very comfortable" categories showed strong, statistically significant deviations ($|R| = 2.50$ and 2.16, respectively). Specifically, the "not comfortable" category showed a significant over-representation for those who were not EM certified ($R = 2.50$) and an under-representation for those who were EM certified ($R = -2.50$). Similarly, the "very comfortable" category exhibited a significant under-representation for those who were not EM certified ($R = -2.16$) and an over-representation for those who were EM certified ($R = 2.16$). The remaining answers did not show statistically significant differences.

A total of 95 (92.2%) respondents reported that training in EM is a necessity in Greece. These findings can be contextualized by the fact that 36 (35.0%) respondents reported asking for a consultation from other medical professionals on more than 20% of their patients. "When it is outside the scope of my main specialty" was the most common reason for seeking consultation, making up 34 (33.0%) responses. Notably, a significant proportion of physicians working in Greek EDs also reported feeling overwhelmed, with 20 (19.1%) reporting that they treated more than 4.5 patients per hour.

A minority of respondents attended accredited supplemental training courses, and even fewer were currently accredited in updated training, with lack of time and cost listed as the main factors why these were not attained.

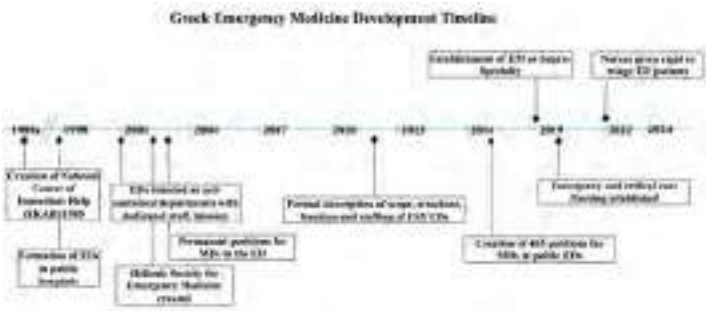

Figure 1. Timeline of the development of emergency medicine in Greece.
EM, emergency medicine; *ED,* emergency department; *EKAB*, National EMS Services; *ESY*, Εθνικό Σύστημα Υγείας; *MD,* physician.

Advanced Life Support is the most commonly held certification, with 34 (32.4%) individuals certified. Fundamentals of Critical Care Support and European Master in Critical Care are the least common, with only two (1.9%) and one (1.0%) respondents certified in these courses, respectively. The remaining distribution is highlighted in Figure 3 below. Notably, 30 (28.6%) participants held instructor status in one of these courses. Please see Appendix 2 for a description of each of these certifications.

The qualitative analysis found that many physicians who work in Greek EDs report being unable to attend further training and certification classes due to cost, lack of time, and concern about their ability to learn new skills at an older age. This is despite reporting that they felt they lacked in skills and confidence and needed improved training in critical care, trauma, and pediatrics. The qualitative analysis also found that they had low levels of job satisfaction. This is despite findings within the quantitative analysis that found that 62 (64.1%) physicians reported that they felt they had made a "good choice" in working in the ED, and only 23 (22.3%) physicians reported that they had "made a mistake." The remaining 14 (13.6%) physicians reported that they still weren't sure whether it was a good choice to work in the ED.

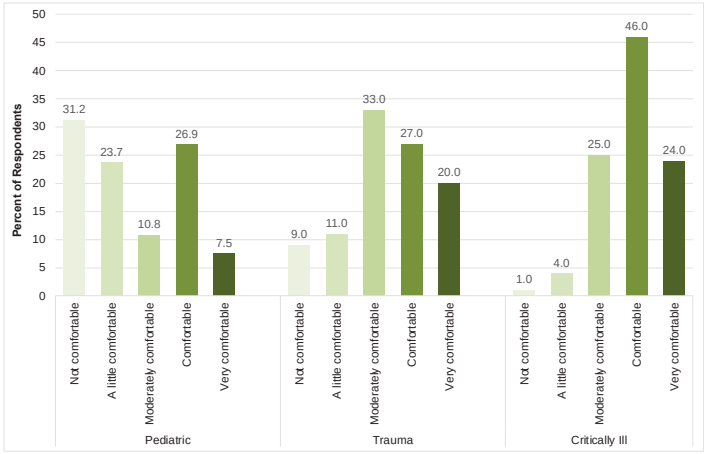

Figure 2. Emergency physician comfort levels when treating patients according to patient type in a study of physician attitudes regarding need for emergency medicine training in Greece.

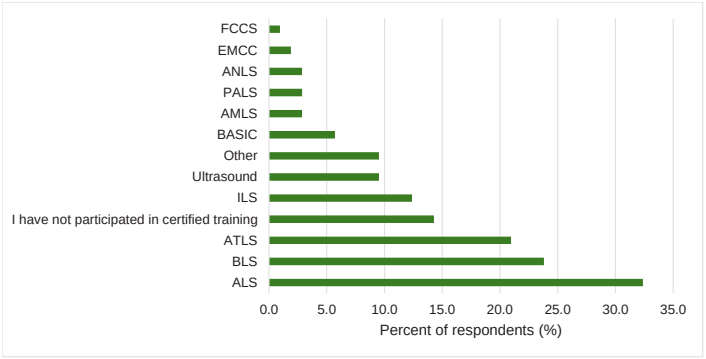

Figure 3. Certifications attained by respondents in a study of physician attitudes regarding need for emergency medicine training in Greece.
FCSS, Fundamentals of Critical Care Support; *EMCC*, European Master in Critical Care; *ANLS*, Advanced Neonatal Life Support*; PALS,* Pediatric Advanced Life Support; *AMLS,* Advanced Medical Life Support; *BASIC,* Basic Assessment and Support in Intensive Care*; ILS,* Immediate Life Support; *ATLS*, Advanced Trauma Life Support*; BLS,* Basic Life Support*; ALS,* Advanced Life Support.

DISCUSSION

The creation of EM specialty training is considered necessary by most physicians practicing on the front lines of Greek emergency care. Working in the ED has provided these physicians insight into the Greek EM system, which include deficiencies that could be addressed by formal EM training. Emergency medicine, which was a largely unknown medical specialty in Greece until recently, represents an exciting, much-needed paradigm shift for a system with ancient ties to medicine. Nevertheless, it lacks many crucial elements of more modern EM practiced in other high-income countries.

This study revealed that despite the availability of additional training opportunities in EM such as workshops and internationally accredited seminars, many physicians who work in Greek EDs have been unable to attend, citing cost, time, and concern about their ability to learn new skills at an older age. The lack of training may contribute to the reported feelings of clinical discomfort and is corroborated by the chi-squared analysis that suggests certification status is strongly associated with comfort levels. Overall, respondents were more comfortable treating critically ill patients than pediatric or trauma patients. Access to training and professional development opportunities may play a crucial role in improving comfort in treating the full breadth of ED patients.

The study illustrates a malign cycle, depicted in Figure 4, in which Greek emergency physicians feel trapped. The lack of formal EM training and the reliance on non-EM-trained physicians may contribute to low job satisfaction, which

diminishes motivation for professional development. This cycle ultimately leaves physicians inadequately prepared to meet the demands of emergency care, perpetuating a system that fails both clinicians and patients. In the background, there are other factors at play that contribute to this cycle, including low wages, high number of clinical hours, crowded EDs, and no direct path to EM from medical school (Figure 4).

The field of health promotion is not new: in 1986, the Ottawa Charter established basic strategies for health promotion advocacy and enhancing factors that promote health. In 2010, the World Health Organization (WHO) published its *Conceptual Framework for Action on Social Determinants of Health,* which stated that while societies produce both health and disease, the responsibility of promoting health equity lies with policy-makers and leaders.[8] Furthermore, it has previously been shown that the WHO framework can be used to inform the development of conceptual models that describe and visualize the key components of interventions designed to promote health.[9] Finally, it is known that health interventions prospectively tailored to address particular barriers to healthcare are more likely to succeed.[10,11]

Guided by the established frameworks of health promotion and with the goal of creating an integrated strategy to address barriers to emergency care in Greece, we developed a conceptual framework to describe a targeted strategy to improve emergency care in Greece (Figure 5).[8]

The emergency medicine optimization strategy (EOS, *Gr:Εώς,* means *"dawn";* it is also the name of the goddess of the dawn in ancient Greek mythology) is a framework that

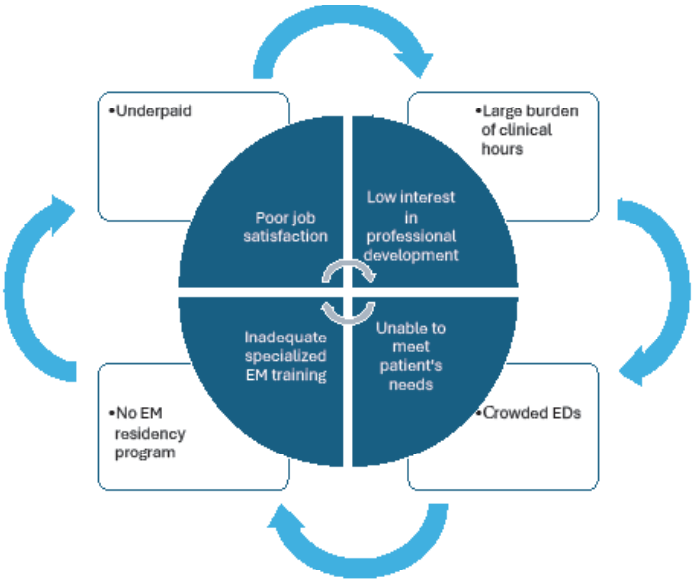

Figure 4. Malign cycle inhibiting Greek emergency physicians from pursuing professional development in a study of physician attitudes regarding need for emergency medicine training in Greece.
EM, emergency medicine; *ED,* emergency department.

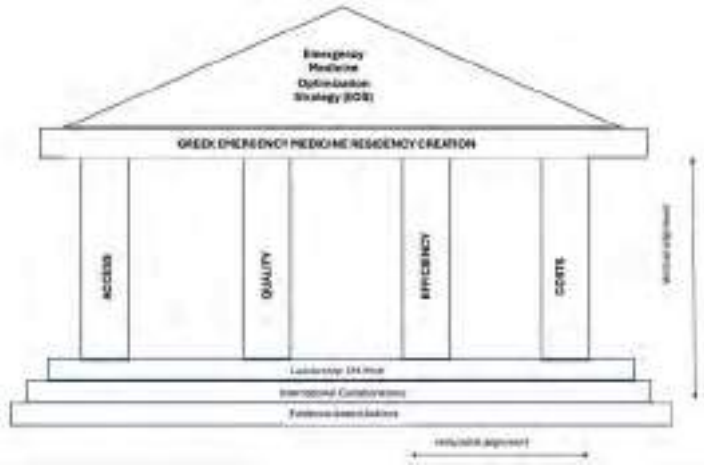

Figure 5. Theoretical framework for optimization of emergency medicine in Greece.
EOS, emergency medicine optimization strategy; *EM-MoH,* Emergency Medicine-Ministry of Health.

describes how the creation of EM residency programs could improve access to care, quality of care, and efficiency of care and costs. Importantly, this requires support by a foundation of leadership at the national level, international collaborations, and research infrastructure to ensure evidence-based practices. Creating an EM residency would improve access to care across Greece's health system by re-allocating non-EM-physicians to their clinics. When non-EM specialists staff an ED, they are often diverted from their primary duties, such as working in operating theatres, specialty clinics, and outpatient services, which leads to delays in patient care.

The quality of emergency care also suffers under this model, primarily due to insufficient training in clinical EM and, secondarily, a lack of exposure to the culture of EM. This includes essential aspects such as teamwork for managing complex, critical patients, patient advocacy, and effective communication with clinicians across specialties. The efficiency of the current system is suboptimal, due to the number of patients needing to be seen by more than one attending, as multiple consultations between specialties are common. This leads to prolonged ED evaluations and lengths of stay, resulting in crowding.

The cost of staffing Greek EDs with non-EM trained specialists is currently being studied. Preliminary data suggest that staffing Greek EDs with EM-trained physicians could reduce staffing costs by nearly 50% due to the pluripotency of emergency physicians who are able to care for the breadth of patients presenting to the ED, thus necessitating fewer consultations and providing more efficient care than non-EM trained colleagues.[12] Furthermore, staffing hospitals in the Greek Aegean Islands with emergency physicians would likely further decrease costs due to a potential decreased need for expensive air transfers for specialty consultation from the islands to the mainland.

LIMITATIONS

There are several study limitations. First, we did not stratify survey responses by number of years in practice, which may have masked differences arising from clinical experience. Because the qualitative results were short-answer responses, these short answers were not as in-depth compared to conducting interviews or adding focus-group interviews with a subset of study participants. Additionally, The study was disseminated by department medical directors, which may have resulted in response bias despite the anonymous nature of the survey. The observational nature of the study means that the results indicate associations rather than causation. The self-respondent nature of the survey may have resulted in sampling bias: respondents who lie within the median of emergency physicians may have been missed. Finally, the study was cross-sectional in nature and, thus, is only representative of the time during which respondents completed the survey.

CONCLUSION

To our knowledge, this is the first assessment of the attitudes, clinical preparedness, and perceived need for EM residency training from physicians on the front lines of emergency care in Greece. Many physicians practicing in Greek EDs report being ill-prepared for the job at hand and seeing large volumes of patients. As Greece continues to take steps to improve the provision of emergency care, it will be critical to ensure that the experiences of those practicing on the frontlines are regularly heard, potentially through annual or biennial surveys, supplemented by focus-group discussions that could take place at the annual national conference. Next steps should focus on aligning actions to improve emergency care in Greece with the needs identified by physicians in the survey, including improved educational initiatives, enhancing the superspecialty training program to produce more trained EM attendings and, most critically, the creation of an EM residency training pathway in Greece.

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Characteristics and Outcomes of Patients with Self-directed Violence Presenting to Trauma Centers in the United States

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Introduction: Psychiatric conditions are common presentations to the emergency department, and their prevalence has been steadily increasing. Part of this spectrum of presentations is self-directed violence. Self-directed violence involves suicidal acts and non-suicidal self-injuries that can result in serious morbidity and mortality. This study examines characteristics and outcomes of patients who presented to US trauma centers with self-inflicted injuries and identifies factors associated with survival to hospital discharge in this patient population.

Methods: We extracted data in a retrospective, observational manner from the 2020 National Trauma Data Bank (NTDB) 2020. The NTDB includes data from over 900 trauma centers (900/2,294 total trauma centers in the United States, 39.2%). We performed a descriptive analysis of characteristics, injury patterns and outcomes. All variables were tabulated by outcome (died: yes/no). We then conducted a multivariable logistic regression using a stepwise technique to identify factors associated with the patients' survival to hospital discharge.

Results: A total of 12,824 patients with self-inflicted injuries were included in this analysis. Their median age was 35 years (interquartile range 25-50), and they were mostly males (74.7%) and White (69.6%). Patients were mostly transported by ground ambulance (78.9%) to Level I (60.6%) and Level II (33.5%) trauma centers. Most patients had a pre-existing condition (70.2%). These included mental/personality disorder (48.2%), alcohol use disorder (11.5%), and substance use disorder (17.7%). The most common mechanism of injury was penetrating trauma (71.6%), followed by blunt trauma (18.0%) and burns (1%). Cutting/piercing was the most common penetrating mechanism (60%) compared with firearm-related trauma (40%). Severe injury (Injury Severity Score ≥ 16) was present in 32.8% of patients. A positive alcohol screen and/or a positive drug screen were reported in 30.2% and 31.2% of patients, respectively. Most patients were admitted to hospital (86%). Overall mortality rate at hospital discharge was 21.7%. We identified Important factors associated with survival to hospital discharge in this patient population.

Conclusion: Patients with self-inflicted injuries treated at US trauma centers have high rates of injury severity and a high mortality rate. This study sheds light on the complex and resource- intensive care needed for this vulnerable patient population. [West J Emerg Med. 2025;26(4)1008–1020.]

INTRODUCTION

Suicide is a significant cause of mortality worldwide. In the United States alone, the US Centers for Disease Control and Prevention (CDC) estimated in 2020 that over 45,000 people successfully completed acts of suicide annually and that 1.2 million attempted suicide.[1,2] This makes suicide the 12th leading cause of death domestically. Emergency department (ED) visits related to suicide attempts have also been increasing over recent years based on data from the National Syndromic Surveillance Program.[3] An additional analysis performed by Ting et al found that the average annual number for these ED-for-attempted- suicides visits more than doubled from 1993–1996 to 2005–2008.[4]

However, not all individuals who engage in acts meant to harm themselves do so with the intent to end their lives. These acts are defined as non-suicidal self-injury (NSSI)[5]. The difference between suicidal acts and NSSI is the intent of the individual; thus, the characterization of suicidal acts compared with NSSI remains ambiguous due to NSSI possibly leading to death.[6,7] Self-directed violence (SDV) is a term that covers both suicidal acts and NSSI. A previously published analysis by Klonsky in *Psychological Medicine* found that the intent behind SDV functioned to alleviate negative emotions, to communicate with others/get attention, or to escape a situation/responsibility.[8]

Previous ED-based studies have examined the prevalence of SDV and the characteristics of these patients presenting to the ED; however, there is limited information regarding the severity of these presentations and their resource needs.[4, 9, 10] In a previous analysis of patients presenting to the ED with SDV, Doshi et al found that patients are usually younger (15-19) with average age 31 years, female sex, and Black race with the primary means of SDV being poisoning followed by penetrating (cutting/stabbing) trauma.[9] An additional analysis performed by Ceniti et al found that patients presenting with SDV have a history of psychiatric conditions, substance use, and lower socioeconomic status.[10]

Similar to previous studies, Klonsky found that SDV was associated with younger age, being unmarried, and with a history of mental health treatment. Other studies found no association with sex or race/ethnicity.[8.] There was also no association with educational history or household income.[8] One of the common characteristics seen in these patients is an underlying psychiatric condition. Patients who are contemplating or engaging in SDV often have underlying psychiatric illness and would benefit from comprehensive and sustained psychiatric care.[11] Unfortunately, there is a shortage of mental health clinicians in the US. Currently, over 57 million Americans suffer from a mental illness.[12] Despite this need, the shortage is expected to get worse with the estimated shortage in 2024 of ≈30,000 psychiatrists.[13] As these patients are increasingly unable to access outpatient psychiatric resources, they will turn to emergency services. Since EDs are seeing greater numbers of patients seeking care for psychiatric illness, understanding this vulnerable patient population will be crucial in developing best practices for meeting their needs and optimizing clinical outcomes.[14]

Population Health Research Capsule

What do we already know about this issue?
Patients with self-inflicted injuries are a vulnerable population with a high rate of adverse health outcomes.

What was the research question?
This descriptive study examined the characteristics and clinical outcomes of patients with self-inflicted injuries who were treated at US trauma centers.

What was the major finding of the study?
This study describes important demographic and outcome information for patients with self inflicted injuries.

How does this improve population health?
This study serves as a first step to developing best practices and improving mortality for this vulnerable patient population.

The COVID-19 pandemic also highlighted additional challenges with access to mental health resources as well as increasing prevalence of anxiety/depressive disorder, sleep disorders, grief reactions, and substance use disorder.[15-17] The reason for this is multifactorial[17-20] with social isolation contributing to the pathophysiology of psychiatric disorders and suicidal behavior.[21] An increase in SDV and suicide rates was, therefore, expected after the COVID-19 pandemic.[22]

Regardless of intent, individuals who engage in SDV represent a unique and vulnerable patient population. A 2012 study performed by Varley et al examined self-harm as an independent risk factor for intensive care unit (ICU) mortality in trauma and burn patients; however, there is a paucity of literature examining the specific injury patterns, injury severity, and outcomes of patients engaging in SDV.[23] In a 2016 analysis of the National Trauma Data Bank (NTDB), Mathews et al examined data from 2010–2012 to describe the epidemiology, sex-related differences, and mortality of violent suicide attempts presenting to trauma centers.[24] Additional studies performed by Foote et al and Martain et al specifically evaluated firearm injuries and hanging injury patterns, respectively.[25,26] In this study we sought to add to this literature by examining characteristics of patients presenting to US trauma centers with all types of self-inflicted injuries and to identify factors associated with survival in this patient population.

METHODS

Study Design and Setting

We performed a retrospective observational study using the NTDB 2020 dataset of 1,133,053 records. The NTDB is the largest aggregated traumatic data in the US gathering information from over 900 trauma centers. Patients are included in the NTDB if they sustained one or more traumatic injuries with the diagnosis being one of the following *International Classification of Diseases*, *10th Rev, Clinical Modification* (ICD-10-CM) codes: S00-S99, T07, T14, T20-T28, T30-T32, and T79.A1-T79.A9. Furthermore, patients sustaining any of the following ICD-10-CM codes of superficial wounds are excluded from the dataset: S00, S10, S20, S30, S40, S50, S60, S70, S80, and S90. The NTDB encompasses demographic and clinical information, injury data, pre-existing conditions, diagnoses, hospital procedures and events, and ED and hospital outcomes. The definitions of all variables are available in the NTDB dictionary for the database users. An exemption letter from the Institutional Review Board office at the University of Maryland School of Medicine was obtained for using the NTDB de-identified dataset.

Selection of Participants

The sample was selected from the variable "injury intentionality" that includes five different responses: 1) unintentional; 2) self-inflicted; 3) assault; 4) undetermined; and 5) other. All patients who had an injury intent as self-inflicted were eligible to be included in the study sample of 14,536. This inclusion minimized the occurrence of any selection bias. Exclusion criteria consisted of 73 patients whose age was not recorded, and 219 with unknown ED discharge disposition (not known/not recorded/not applicable); 18 who left against medical advice: 799 "other" (jail, institutional care, mental health, etc) ; and 607 who transferred to another hospital. A total of 12,824 patients constituted the study sample. We did not calculate the sample size because all eligible patients were pulled from the NTDB database. Figure 1 shows the inclusion and exclusion criteria.

Data Management and Statistical Analysis

We conducted data management and analyses using the Statistical Package for Social Sciences, SPSS v 27.0 (IBM Corporation, Armonk, NY). For instance, data handling was needed to extract the body region and the nature of injury from all patients' diagnoses. We carried out descriptive analysis to tabulate the frequencies and percentages of the categorical variables. Age was summarized by reporting its median and interquartile range (IQR) and mean and its standard deviation. Some clinical continuous variables (systolic blood pressure) and ordinal variables (Injury Severity Score, Glasgow Coma Score) were divided into groups based on the adopted categorizations in several peer-reviewed articles. Meaningful recoding for some of the variables (race, mechanism of injury, nature of injury) that have categories

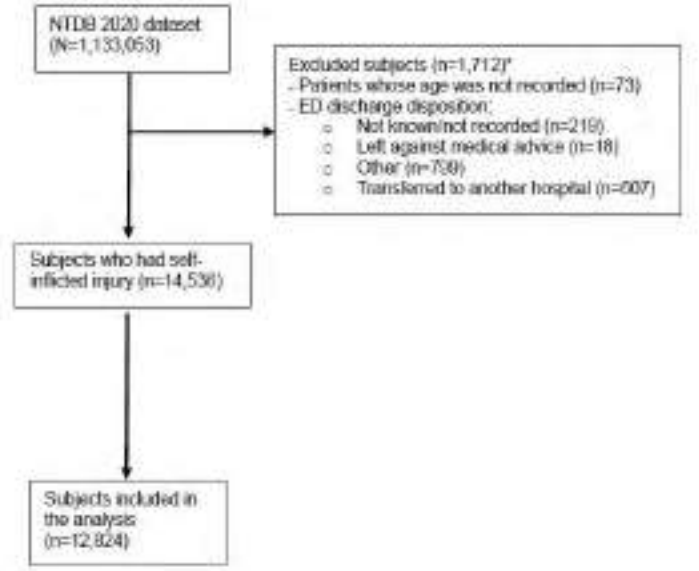

Figure 1. Study participants' selection from the National Trauma Data Bank 2020.
*There are overlaps among the categories of the excluded variables. Some patients with unknown age had as ED disposition one of the excluded categories. These overlaps explain why the final number on which the data analysis was conducted cannot be calculated just by subtracting the number of excluded patients from the selected sample.
ED, emergency department; *NTDB,* National Trauma Data Bank.

with small counts was done with the aim of simplifying the data presentation and interpretation. Variables with missing data >5% (ethnicity, 5.4%; transfusion blood [4 hours], 5.6%; and transfusion platelets [4 hours], 5.6%) were treated by multiple imputation to report accurate estimates. The patients' demographic and clinical characteristics were stratified by the study outcome (died: yes/no) using the Pearson chi-square or Fisher exact tests for the categorical variables and the Kolmogorov-Smirnov Z test for the age variable.

We conducted a multivariable logistic regression using a stepwise technique to identify the factors associated with the patients' survival to hospital discharge. All statistically and clinically significant factors were controlled for while carrying out the regression analysis, except for the following surgical procedures that were performed for very few patients: endocrine system, 36 (0.3%;) eye, 242 (1.9%); ear, 174 (1.4%); hemic and lymphatic system, 178 (1.4%); male genital organs, 94 (0.7%); female genital organs, 13 (0.1%); and obstetrical, 2 (0%). In addition, we did not adjust for the trauma type because it conveys some information that can be retrieved from the mechanism of injury through adopting the CDC matrix that presents the trauma type and the injury intentionality of each mechanism of injury. The c-statistic indicated that the final model had an outstanding discrimination between survivors and non-survivors (area under the curve 0.980; *P* value < .001; 95% confidence

Table 1. Basic characteristics of patients sustaining self-inflicted injuries.

	Total	Died		
	N=12,824	No (n=10,040)	Yes (n=2,784)	P-value
Age (years)				
Mean ± SD	38.65 ± 16.923	37.88 ± 16.027	41.41 ± 19577	<.001*
Sex				
Male	9,581 (74.7%)	7,248 (72.2%)	2,333 (83.8%)	<.001
Female	3,237 (25.2%)	2,787 (27.8%)	450 (16.2%)	
Not known/ not recorded	6 (0%)			
Race				
Black	1,767 (13.8%)	1,454 (14.9%)	313 (11.8%)	
White	8,931 (69.6%)	6,870 (70.3%)	2,061 (77.9%)	<.001
Other Race	1,723 (13.4%)	1,450 (14.8%)	273 (10.3%)	
Not known/ not recorded	403 (3.1%)			
Primary method of payment				
Medicaid/Medicare	5,325 (41.5%)	4,422 (44.9%)	903 (33.4%)	<.001
Self-pay	2,469 (19.3%)	1,568 (15.9%)	901 (33.3%)	
Private/commercial insurance	3,502 (27.3%)	2,806 (28.5%)	696 (25.7%)	
Not billed (for any reason) and other Government and other	1,265 (9.9%)	1,058 (10.7%)	207 (7.6%)	
Not known/ not recorded	263 (2.1%)			
Transport mode				
Ground ambulance	10.124 (78.9%)	7.941 (79.2%)	2,183 (78.4%)	<.001
Helicopter ambulance and fixed-wing ambulance	1,832 (14.3%)	1,258 (12.6%)	574 (20.6%)	
Private/public vehicle/walk-in	629 (4.9%)			
Police and other	220 (1.7%)	617 (6.2%)	12 (0.4%)	
Not known/ not recorded	19 (0.1%)	206 (2.1%)	14 (0.5%)	
Facility level: hospital teaching status				
Community	4,428 (34.5%)	3,442 (35.0%)	986 (36.2%)	<.001
Non-teaching	1,932 (15.1%)	1,458 (14.8%)	474 (17.4%)	
Academic	6,201 (48.4%)	4,939 (50.2%)	1,262 (46.4%)	
Not known/ not recorded	263 (2.1%)			
Trauma Designation Level				
I	7,775 (60.6%)	6,158 (61.4%)	1,617 (58.1%)	.001**
II	4,301 (33.5%)	3,310 (33.0%)	991 (35.6%)	
III	690 (5.4%)	533 (5.3%)	157 (5.6%)	
IV	23 (0.2%)	14 (0.1%)	9 (0.3%)	
Not applicable	15 (0.1%)	8 (0.1%)	7 (0.3%)	
Not known/ not recorded	20 (0.2%)			

*Indicates that the Kolmogorov-Smirnov Z test was used to calculate the P-value.
**Indicates that the Fisher exact test was used to calculate the P-value.
[1]Other race is the combination of the following categories: Asian and Pacific Islander, American Indian, and other.

interval 0.977-0.983]. All tests were interpreted at a predetermined significance level (≤0.05). Of note, we adopted the terms the NTDB uses in its dataset throughout the write-up of the results and the data presentation.

RESULTS

Demographics: Age, Sex, and Race

Patients with self-inflicted injuries had a median age of 35 (IQR 25-50) years and were mostly males (74.7%) and White

Table 2. Presence of underlying illness, psychiatric conditions, and substance use disorders in patients sustaining self-inflicted injuries.

		Died		
	Total N=12,824	No (n=10,040)	Yes (n=2,784)	P-value
Pre-existing Condition				
No	3,431 (26.8%)	2,039 (20.4%)	1,392 (56.8%)	<.001
Yes	8,997 (70.2%)	7,937 (79.6%)	1,060 (43.2%)	
Not known/ not recorded	396 (3.1%)			
Alcohol Use Disorder				
No	10,805 (84.3%)	8,563 (86.4%)	2,242 (94.6%)	<.001
Yes	1,479 (11.5%)	1,352 (13.6%)	127 (5.4%)	
Not known/ not recorded	540 (4.2%)			
Current Smoker				
No	9,022 (70.4%)	6,937 (69.9%)	2,085 (87.9%)	<.001
Yes	3,275 (25.5%)	2,989 (30.1%)	286 (12.1%)	
Not known/ not recorded	527 (4.1%)			
Advanced Directive Limiting Care				
No	12,143 (94.7%)	9,838 (99.3%)	2,305 (97.2%)	<.001
Yes	140 (1.1%)	74 (0.7%)	66 (2.8%)	
Not known/ not recorded	541 (4.2%)			
Attention-Deficit/Hyperactivity Disorder				
No	11,843 (92.4%)	9,515 (96.0%)	2,328 (98.3%)	<.001
Yes	441 (3.4%)	400 (4.0%)	41 (1.7%)	
Not known/ not recorded	540 (4.2%)			
Mental/Personality Disorder				
No	6,125 (47.8%)	4,267 (43.0%)	1,858 (78.3%)	<.001
Yes	6,175 (48.2%)	5,659 (57.0%)	516 (21.7%)	
Not known/ not recorded	524 (4.1%)			
Substance Abuse Disorder				
No	10,015 (78.1%)	7,814 (78.8%)	2,201 (92.9%)	<.001
Yes	2,273 (17.7%)	2,105 (21.2%)	168 (7.1%)	
Not known/ not recorded	536 (4.2%)			

(69.6%). Patients' basic characteristics are shown in Table 1.

Method of Arrival and Underlying Mental Illness

Most patients were transported by ground ambulance (78.9%), mainly to Level I (60.6%) and Level II (33.5%) trauma centers. Medicaid/Medicare were the most common payer (41.5%). (Table 1). The majority of patients had a pre-existing condition (70.2%). These include "mental/personality disorder" (48.2%), "alcohol use disorder" (11.5%), and "substance use disorder" (17.7%) (Table 2).

Mechanism of Injury

The most common mechanism of injury was penetrating trauma (71.6%) followed by blunt trauma (18.0%), with burns (1%) being the least common. Cutting and piercing was the most common mechanism of injury, accounting for 43% of all cases. Firearm injuries were second, accounting for 28%, and falls accounted for 10% (Table 3). In a subgroup analysis of penetrating trauma, cutting/piercing trauma accounted for 60% of cases, while firearm-related trauma accounted for 40% of penetrating cases at a ratio of 3:2.

Injury Severity

We quantified injury severity using the Injury Severity Score (ISS). Severe injury, defined as an ISS ≥16, was present in 32.8% of all patients with self-inflicted injuries. Nearly 60% of all patients had an open wound on arrival. Approximately 40% had a fracture, and 42% had an internal

Table 3. Severity, mechanism of injury, and nature of injury for patients sustaining self-inflicted injuries.

		Died		
	Total N=12,824	No (n=10,040)	Yes (n=2,784)	P-value
ISS				
≤ 15	8,619 (67.2%)	8,253 (82.2%)	366 (13.1%)	<.001
≥ 16	4,205 (32.8%)	1,787 (17.8%)	2,418 (86.9%)	
GCS Assessment Qualifiers: Patient Chemically Sedated or Paralyzed				
No	11,308 (88.2%)			
Yes	1,516 (11.8%)	9,186 (91.5%)	2,122 (76.2%)	<.001
GCS		854 (8.5%)	662 (23.8%)	
Severe ≤ 8	3,908 (30.5%)			
Moderate 9 – 12	603 (4.7%)	1,365 (14.1%)	2,543 (93.8%)	<.001
Mild 13 – 15	7,881 (61.5%)	554 (5.7%)	49 (1.8%)	
Not known/ not recorded	432 (3.4%)	7,763 (80.2%)	118 (4.4%)	
SBP				
< 90	1,770 (13.8%)			
≥ 90	10,615 (82.8%)	668 (6.8%)	1,102 (44.1%)	<.001
Not known/ not recorded	439 (3.4%)	9,220 (93.2%)	1,395 (55.9%)	
Blood transfusion (4 hours)				
No	10,323 (80.5%)			
Yes	2,501 (19.5%)	8,539 (85.0%)	1,784 (64.1%)	<.001
Transfusion platelets (4 hours)		1,501 (15.0%)	1,000 (35.9%)	
No	12,147 (94.7%)			
Yes	677 (5.3%)	9,680 (96.4%)	2,467 (88.6%)	<.001
Trauma type		360 (3.6%)	317 (11.4%)	
Blunt	2,304 (18.0%)	2,079 (20.7%)	225 (8.1%)	
Penetrating	9,179 (71.6%)	6,913 (68.9%)	2,266 (81.4%)	
Burn	134 (1.0%)	112 (1.1%)	22 (0.8%)	
Other/unspecified	1,207 (9.4%)	936 (9.3%)	271 (9.7%)	
Injury intentionality				
Self-inflicted	12,824 (100%)	10,040 (100%)	2,784 (100%)	
Mechanism of injury				
Cut/pierce	5,538 (43.2%)	5,390 (53.7%)	148 (5.3%)	<.001
Fall	1,398 (10.9%)	1,237 (12.3%)	161 (5.8%)	
Firearm	3,641 (28.4%)	1,523 (15.2%)	2,118 (76.1%)	
Other specified, not elsewhere classifiable	857 (6.7%)	715 (7.1%)	142 (5.1%)	
Other	1,390 (10.8%)	1,175 (11.7%)	215 (7.7%)	
Nature of injury: fracture				
No	7,625 (59.5%)	6,693 (66.7%)	932 (33.5%)	<.001
Yes	5,199 (40.5%)	3,347 (33.3%)	1,852 (66.5%)	
Nature of injury: blood vessel				
No	11,025 (86.0%)	8,447 (84.1%)	2,578 (92.6%)	<.001
Yes	1,799 (14.0%)	1,593 (15.9%)	206 (7.4%)	

ISS, Injury Severity Score; *GCS,* Glasgow Coma Score, *SBP,* systolic blood pressure.

Table 3. Continued

	Total N=12,824	Died		P-value
		No (n=10,040)	Yes (n=2,784)	
Nature of injury: internal organ injury				
No	7,413 (57.8%)	6,723 (67.0%)	690 (24.8%)	<.001
Yes	5,411 (42.2%)	3,317 (33.0%)	2,094 (75.2%)	
Nature of injury: superficial and contusion				
No	9,696 (75.6%)	7,673 (76.4%)	2,023 (72.7%)	<.001
Yes	3,128 (24.4%)	2,367 (23.6%)	761 (27.3%)	
Nature of injury: open wound				
No	5,159 (40.2%)	3,219 (32.1%)	1,940 (69.7%)	<.001
Yes	7,665 (59.8%)	6,821 (67.9%)	844 (30.3%)	
Nature of injury: other specified injury				
No	11,409 (89.0%)	8,791 (87.6%)	2,618 (94.0%)	<.001
Yes	1,415 (11.0%)	1,249 (12.4%)	166 (6.0%)	
Nature of injury: other*				
No	11,147 (86.9%)	8,814 (87.8%)	2,333 (83.8%)	<.001
Yes	1,677 (13.1%)	1,226 (12.2%)	451 (16.2%)	
Body region: torso				
No	8,095 (63.1%)	5,914 (58.9%)	2,181 (78.3%)	<.001
Yes	4,729 (36.9%)	4,126 (41.1%)	603 (21.7%)	
Body region: extremities				
No	7,084 (55.2%)	4,753 (47.3%)	2,331 (83.7%)	<.001
Yes	5,740 (44.8%)	5,287 (52.7%)	453 (16.3%)	
Body region: head and neck				
No	5,508 (43.0%)	5,209 (51.9%)	299 (10.7%)	<.001
Yes	7,316 (57.0%)	4,831 (48.1%)	2485 (89.3%)	
Body region: spine and back				
No	11,544 (90.0%)	8,914 (88.8%)	2630 (94.5%)	<.001
Yes	1,280 (10.0%)	1126 (11.2%)	154 (5.5%)	

organ injury. Injuries affected were mainly head/neck (57%), extremities (44.8%), and torso (36.9%) (Table 3).

Substance Use

Approximately one third of patients had a positive alcohol screen (30.2%), and a positive drug screen was reported in 31.2% of patients. Cannabinoid was most common (17.7%), followed by amphetamines (9.5%), benzodiazepines (7.2%), cocaine (4.4%), opioid (4%), and methamphetamine (3%) (Table 4).

Disposition

Most patients were admitted to the hospital (86%); 567 (4.4 %) were discharged from the ED, and 1,227 (9.5%) were declared dead in the ED. Of the admitted cohort, 3,513 (27.4%) were sent directly to the operating room, and 3,749 (29.2%) required ICU-level care. For patients admitted to the hospital from the ED, only 3,360 (26.2%) were discharged home; 5,953 (46.4%) required transfer to another facility and 160 (1.2%) left against medical advice. Overall, 1,562 (12.2%) died during their hospitalization. A total of 10,040 patients (78.3%) survived to hospital discharge, and 2,784 patients (21.7%) died in the ED or hospital. Differences between the two groups by outcome (died: yes/no) are presented across the different tables. Results of the multivariate logistic regression analysis are presented in Table 5. We identified important factors positively and negatively associated with survival in patients with self-inflicted injuries.

DISCUSSION

To our knowledge, this is the first study to examine the characteristics and outcomes of patients with self-inflicted injuries who presented to trauma centers. This study offers

Table 4. Alcohol and drug screen results on trauma center arrival in patients sustaining self-inflicted injuries.

		Died		
	Total N=12,824	No (n=10,040)	Yes (n=2,784)	P-value
Alcohol Screen				
No	3,514 (27.4%)	2,207 (22.0%)	1,307 (47.0%)	<.001
Yes	9,298 (72.5%)	7,827 (78.0%)	1,471 (53.0%)	
Not known/ not recorded	12 (0.1%)			
Alcohol Screen Result				
Negative screening	6,490 (69.8%)	5,504 (70.3%)	986 (67.0%)	<.001
Mild to moderate	1,814 (19.5%)	1,470 (18.8%)	344 (23.4%)	
Severe	994 (10.7%)	853 (10.9%)	141 (9.6%)	
Drug Screen				
No	8,720 (68.0%)	6,427 (64.6%)	2,293 (82.9%)	<.001
Yes	4,001 (31.2%)	3,529 (35.4%)	472 (17.1%)	
Not known/ not recorded	103 (0.8%)			
Drug Screen: AMP (Amphetamine)				
No	11,603 (90.5%)	8,964 (89.3%)	2,639 (94.8%)	<.001
Yes	1,221 (9.5%)	1,076 (10.7%)	145 (5.2%)	
Drug Screen: Barbiturate				
No	12,738 (99.3%)	9,967 (99.3%)	2,771 (99.5%)	.14
Yes	86 (0.7%)	73 (0.7%)	13 (0.5%)	
Drug Screen: Benzodiazepines				
No	11,896 (92.8%)	9,204 (91.7%)	2,692 (96.7%)	<.001
Yes	928 (7.2%)	836 (8.3%)	92 (3.3%)	
Drug Screen: Cocaine				
No	12,264 (95.6%)	9,550 (95.1%)	2,714 (97.5%)	<.001
Yes	560 (4.4%)	490 (4.9%)	70 (2.5%)	
Drug Screen: Methamphetamine				
No	12,439 (97.0%)	9,698 (96.6%)	2,741 (98.5%)	<.001
Yes	385 (3.0%)	342 (3.4%)	43 (1.5%)	
Drug Screen: Ecstasy				
No	12,756 (99.5%)	9,986 (99.5%)	2,770 (99.5%)	.82
Yes	68 (0.5%)	54 (0.5%)	14 (0.5%)	
Drug Screen: Methadone				
No	12,774 (99.6%)	9,996 (99.6%)	2,778 (99.8%)	.10
Yes	50 (0.4%)	44 (0.4%)	6 (0.2%)	
Drug Screen: Opioid				
No	12,312 (96.0%)	9,561 (95.2%)	2,751 (98.8%)	<.001
Yes	512 (4.0%)	479 (4.8%)	33 (1.2%)	
Drug Screen: Oxycodone				
No	12,713 (99.1%)	9.935 (99.0%)	2,778 (99.8%)	<.001
Yes	111 (0.9%)	105 (1.0%)	6 (0.2%)	
Drug Screen: Phencyclidine				
No	12.776 (99.6%)	9.995 (99.6%)	2,781 (99.9%)	.01
Yes	48 (0.4%)	45 (0.4%)	3 (0.1%)	

Table 4. Continued.

	Total N=12,824	Died		P-value
		No (n=10,040)	Yes (n=2,784)	
Drug Screen: Tricyclic Antidepressant				
No	12.773 (99.6%)	9.991 (99.5%)	2,782 (99.9%)	< .01
Yes	51 (0.4%)	49 (0.5%)	2 (0.1%)	
Drug Screen: Cannabinoid				
No	10.592 (82.6%)	8.099 (80.7%)	2,493 (89.5%)	<.001
Yes	2.232 (17.4%)	1941 (19.3%)	291 (10.5%)	
Drug Screen: Other				
No	12.720 (99.2%)	9.948 (99.1%)	2,772 (99.6%)	.01
Yes	104 (0.8%)	92 (0.9%)	12 (0.4%)	

insight into key characteristics of this unique and vulnerable patient population. Overall, patients were young with a median age of 35 (IQR 25-50). White was the most commonly reported race, and most were male. This data from the NTDB matches closely with aggregate data regarding suicide from the CDC. Per the CDC, the rates of suicide are highest among middle-aged White men, with men approximately three times more likely to complete suicide compared to women.[2]

This study shows that patients with self-inflicted injuries across trauma centers have very high injury severity and require resource-intensive care. Approximately 33% of patients with self-inflicted injuries had an Injury Severity Score (ISS) of ≥16 on arrival. The ISS is a scoring system used to determine the severity of a traumatic injury, with a score of > 15 considered to be "major trauma."[27] In contrast, the study of motor vehicle collision (MVC) victims using the same database found that only 24% of patients had an ISS of ≥16 or greater on arrival.[28] Of course, there is potentially some overlap of the data between this study and the MVC study as there is evidence that single-occupancy MVCs may be an under-recognized method of suicide.[29] Similarly, another study examining patients with penetrating trauma reported that only 20% of patients had an ISS of > 15 on arrival.[30]

Patients with self-inflicted wounds also went to the operating room (OR) more frequently than MVC victims: 27% of all patients with self-inflicted wounds had to be taken to the OR compared to only 12% of MVC victims.[28] Additionally, approximately 30% of all patients with self-inflicted injuries required ICU-level care after presentation to the hospital. In fact, only 4% of patients with self-inflicted injuries were discharged home from the ED. This indicates that the majority of patients who present with self-inflicted injuries will require hospital resources beyond their initial evaluation and stabilization. This has significant implications for ED throughput and resource utilization. Multiple prior studies have shown that patients with psychiatric complaints who require hospitalization have significantly longer lengths of stay in the ED compared to patients with non-psychiatric complaints.[31-33] Additionally, patients with psychiatric complaints often require additional resources such as sitters to maintain safety while in the ED. Their prolonged boarding times also prevents EDs from using those beds to treat other patients seeking care with one study estimating that EDs lose over $2,000 per boarding patient with a psychiatric complaint.[33]

Similarly, even when patients are medically stabilized, 46.4% of these patients are transferred from the hospital where they initiated their medical care. This is likely because these patients, once medically stabilized, also often require psychiatric stabilization best accomplished in the inpatient setting. Unfortunately, with the current shortage of inpatient psychiatric resources, many hospitals are unable to provide that service.[34] Currently, trauma centers are not required to have inpatient psychiatric capabilities. However, the high rate of patient presentation to trauma centers, both directly and via transfer, raises the question of whether these resources should be more regularly incorporated into trauma centers.

What is perhaps the most striking feature of the data, however, is the high mortality rate among this patient population. Approximately 10% of this patient population die in the ED and trauma bay. Of the patients who survive their initial resuscitation, another 12% will die during their hospitalization. In total, this means that approximately 22%, or more than one in five, patients with a self-inflicted injury will die at some point during their hospitalization. Again, this is in sharp contrast to MVC patients, for whom the mortality rate was ≈2% for both the ED and hospital.[28] This mortality rate is also higher than all-cause penetrating trauma; only 10% of those patients die in the ED or hospital.[30]

Important factors were found to be associated with decreased survival in this patient population. Increasing age, male sex, and White race were negatively associated

Table 5. Factors positively and negatively associated with survival to hospital discharge in patients sustaining self-inflicted injury, presented as an odds ratio.

	Adjusted odds ratio	95% CI	P-value
Age (years)	0.975 per year	0.969 – 0.981	<.001
Sex [Male]			
Female	1.657	1.289 – 2.131	<.001
Race [Black]			
White	0.561	0.406 – 0.776	<.001
Other Race	0.925	0.615 – 1.390	.71
Primary method of payment [Medicaid/Medicare]			
Self-Pay	0.683	0.516 – 0.905	< .01
Private/Commercial Insurance	1.090	0.850 – 1.398	.50
Not Billed (for any reason) and Other Government and Other	1.013	0.685 – 1.498	.95
Transport Mode [Ground Ambulance]			
Helicopter Ambulance and Fixed-wing Ambulance	1.388	1.069 – 1.803	.01
Private/Public Vehicle/Walk-in	3.228	1.008 – 10.339	.05
Police and Other	1.924	0.568 – 6.518	.29
Pre-existing Condition [No]			
Yes	2.305	1.853 – 2.867	<.001
ISS [≤ 15]			
≥ 16	0.145	0.112 – 0.187	<.001
GCS Assessment Qualifiers: Patient Chemically Sedated or Paralyzed [No]			
Yes	1.992	1.546 – 2.566	<.001
GCS [Mild 13 – 15]			
Severe ≤ 8	0.034	0.026 – 0.046	<.001
Moderate 9 – 12	0.262	0.165 – 0.416	<.001
SBP [≥ 90]			
< 90	0.332	0.257 – 0.429	<.001
Transfusion blood (4 hours) [No]			
Yes	0.674	0.508 - 0.894	.01
Transfusion platelets (4 hours) [No]			
Yes	0.634	0.444 – 0.905	.01
Mechanism of Injury [Cut/pierce]			
Fall	0.482	0.298 – 0.779	< .01
Firearm	0.223	0.160 – 0.312	<.001
Other specified, not elsewhere classifiable	0.850	0.533 – 1.357	.50
Other	0.771	0.510 – 1.166	.22
Alcohol Screen [No]			
Yes	2.067	1.631 – 2.621	<.001
Drug Screen [No]			
Yes	1.746	1.380 – 2.209	<.001
Nature of injury: Internal organ injury [No]			
Yes	0.612	0.471 – 0.795	<.001

Brackets in column 1 "[...]" correspond to the reference standard for each comparison.
CI, confidence interval; *GCS,* Glasgow Coma Scale; ISS, Injury Severity Score; *SBP,* systolic blood pressure.

Table 5. Continued.

	Adjusted odds ratio	95% CI	P-value
Nature of injury: Other [No]			
Yes	0.735	0.541 – 0.997	.05
Body Region: Head and Neck [No]			
Yes	0.417	0.314 – 0.554	<.001
Body Region: Spine and Back [No]			
Yes	1.593	1.106 – 2.294	.01
Body Region: Unclassifiable by body region [No]			
Yes	0.707	0.472 – 1.057	.09
Operations on the nervous system [No]			
Yes	3.197	2.286 – 4.470	.001
Operations on the nose; mouth; and pharynx [No]			
Yes	3.652	2.091 – 6.381	<.001
Operations on the respiratory system [No]			
Yes	1.731	1.347 – 2.225	<.001
Operations on the cardiovascular system [No]			
Yes	0.575	0.458 – 0.722	<.001
Operations on the digestive system [No]			
Yes	3.243	2.427 – 4.334	<.001
Operations on the musculoskeletal system [No]			
Yes	2.592	1.931 – 3.480	<.001
Operations on the integumentary system [No]			
Yes	2.687	2.062 – 3.501	<.001

Brackets in column 1 "[...]" correspond to the reference standard for each comparison.
CI, confidence interval.

with survival. This is supported by data from the CDC and the National Institute of Mental Health showing significant disparities in fatalities across demographic groups, with White males dying by suicide at approximately 2x the rate of Black males, and 3–4x more than Ehite females, and up to 10x more than Black females .[35,36] Increasing clinical severity represented by ISS ≥ 16, systolic blood pressure <90, GCS ≤ 8 or GCS 9-12, and the need for transfusion of blood or platelets within four hours, was negatively associated with survival in this patient population. Similarly, injury resulting from fall or firearm (compared to cut/pierce), internal organ injury, injury to head/neck, and injuries requiring operations to cardiovascular system were also negatively associated with survival. These findings are expected and in line with previous literature examining factors associated with mortality in other trauma populations.[37] These findings also highlight high-risk injuries that are associated with worse outcomes in patients with self-inflicted injuries and offer evidence for more awareness and prevention campaigns to reduce the heavy burden of this type of trauma.

Rates of mental illness in this country are increasing, and access to outpatient psychiatric care is decreasing. This unfortunate combination means that EDs and trauma centers are likely to see increasing numbers of patients with self-inflicted injuries. This retrospective review suggests that approximately one in five of these patients are not surviving their hospitalization. That number is shocking and should prompt serious discussions across medical specialties about how to lower the mortality rate for this vulnerable patient population. Determining best practices for their care is not only imperative from a resource-utilization perspective but also may be lifesaving.

LIMITATIONS

The limitations of this analysis are like those of all data registry studies. The quality of the analysis is directly limited by the quality of data reported to the registry. There is variability in the quality of the collected data, an absence of prehospital data, and limited information on complications as well as long-term outcomes. Specific to this analysis, patients were identified by searching for "injury intentionality." This relies on the coding clinician to add diagnostic codes associated with "self-inflicted." which may not always be done due to variations in clinician coding habits and the

constraints of providing emergency care. Similarly, "self-inflicted" does not allow for determining the patient's intent as it does not distinguish between a suicide attempt and non-suicidal, self-injurious behavior. It is likely that this analysis under-represents the prevalence of self-directed violence given the dataset's reliance on diagnostic codes. Additionally, the presence of a concomitant mental health disorder or substance use disorder may be under-represented for the same reason. Thus, the presence or absence of prescribed psychotropic medications as well as medication compliance in the setting of a known mental health disorder is unknown. Neither is the final disposition of these patients (ie, discharge to psychiatric facility vs outpatient psychiatric follow-up vs rehabilitation facilities) known due to the nature of the database. This limits some of the conclusions that can be drawn from this retrospective database analysis.

Additionally, the dataset contains information only for patients who were brought to trauma centers. This inherently does not account for patients with self-inflicted injuries who initially presented to non-trauma hospitals for treatment. Patients transported to trauma centers usually fit the prehospital trauma-triage criteria, which might have biased the selection of a study population with an observed higher mortality. Many patients present with minor injuries to hospitals who do not meet criteria for trauma service activation and, therefore, are not included in the national trauma database. Studies examining self-inflicted injuries and using ED based- registries might report lower mortality rates. The study findings do, however, reflect the complexity of trauma care needed to treat patients with self-inflicted injuries.

CONCLUSION

Patients with self-inflicted injuries treated at US trauma centers have high rates of injury severity and a high mortality rate. This study sheds light on the complex and resource-intensive care needed for this unique and vulnerable patient population.

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Impact of Dobbs on Evaluation and Treatment of Ectopic Pregnancy: National Survey of Emergency Physicians

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Introduction: Inconsistent and ever-changing state abortion laws across the United States raise the possibility of deviation from established standards of emergency care. Yet the experiences of emergency physicians in this era have not been captured. We sought to examine the experiences of US emergency physicians in the management of presumed ectopic pregnancy since the *Dobbs* Supreme Court ruling and passage of new abortion restrictions affecting clinical decision-making around pregnancy termination.

Methods: This was a cross-sectional survey of US emergency physicians administered online between April 1–15, 2024. The survey was completed by 150 board-certified US emergency physicians—50 physicians each from states categorized as abortion restrictive, semi-restrictive, or permissive—who were queried about any reported delays in or adaptations to the assessment and/or management of patients with known or suspected ectopic pregnancy.

Results: We found that 24% of physicians in restrictive or semi-restrictive states reported delays in the management of patients with suspected or confirmed ectopic pregnancy, and 54% of physicians reported adaptations to care of these patients including repeat testing and arranging alternative care in cases where they might previously have delivered definitive care in the emergency department.

Conclusion: In a post-*Dobbs* practice environment, emergency physicians across the United States, practicing in states with various abortion restrictions, reported delays and adaptations of care for patients with presumed or suspected ectopic pregnancy including deviations from standard of care in emergency medicine. [West J Emerg Med. 2025;26(4)1021–1024.]

BACKGROUND

In June 2022, the US Supreme Court ruling, *Dobbs v Jackson Women's Health Organization*, reversed the constitutional protection of abortion and returned the power to regulate abortion access to individual states. In the wake of this decision, many states placed new restrictions on abortion.[1] As of this writing, 21 states have restrictions on abortion access that would not have been possible prior to the passage of *Dobbs*.[2] The practical implication of these laws is that healthcare clinicians may be unsure whether they are violating laws when they provide any care that includes pregnancy termination, including the treatment of ectopic pregnancy.

Management of ectopic pregnancy, a time-sensitive, often lethal condition, is a stark use case for the impact of legal restrictions on emergency care, as its unambiguous treatment is a medical or surgical abortion. Ruptured ectopic pregnancy is the leading cause of first trimester maternal death.[3] For over a century, pregnancy termination has been established as the standard of care for ectopic pregnancy, with medical termination being used for over 50 years.[3,4] Since the inception of emergency medicine as a specialty there has been no change in the best practices for treatment of ectopic

pregnancy.[4,5] In the best of circumstances, effective, life-saving management for ectopic pregnancy is challenging due to the initial silent nature of the condition and how rapidly individuals may progress to clinical instability. Delays in care or lack of adherence to standard clinical assessment and management place patients at risk for poor maternal outcomes. Even though the American College of Obstetricians and Gynecologists (ACOG) distinguishes an elective abortion from a medically necessary abortion (such as in the case of ectopic pregnancy) physicians including obstetricians and emergency physicians have been confronted with institutional and clinical barriers when treating patients with pregnancy termination for ectopic pregnancy.

The experiences of obstetricians practicing under restrictive abortion policies have been described previously.[6] The objective of this study is to explore the experiences of U.S. emergency physicians in the management of ectopic pregnancy since Dobbs and the subsequent implementation of restrictive state abortion laws.

Population Health Research Capsule

What do we already know about this issue?
The Supreme Court Dobbs decision has impacted emergency medicine (EM) clinical care of pregnant patients.

What was the research question?
How has EM physician clinical decision making changed post Dobbs with regards to the treatment of ectopic pregnancy?

What was the major finding of the study?
Twenty-four percent of EM physicians in abortion restrictive states reported delays or adaptations in care of patients with ectopic pregnancy.

How does this improve population health?
This study reveals that there are clinical impacts in emergency medicine with regards to care of patients with ectopic pregnancy following the Dobbs decision.

METHODS

This was a cross-sectional survey of a convenience sample of clinically active US emergency physicians administered online over a two-week period between April–15, 2024. The questionnaire addressed changes in clinical care during the period of interest, defined as the time since the *Dobbs* decision in June 2022. We developed the initial questionnaire, which related to a variety of aspects of emergency reproductive healthcare, and then refined it through iterative rounds of expert review and face validity testing with practicing emergency physicians. For this study, we evaluated questions specifically related to the assessment and management of ectopic pregnancy (see Supplement A), which consisted of 8-11 items, depending on skip logic.

We divided states into three general categories, based on the policies in place at the time of survey dissemination, in March 2024: restrictive; semi-restrictive; and permissive states.[7-9] We defined "restrictive" states as those with bans from conception to six weeks, "semi-restrictive" states as those with new bans implemented since the *Dobbs* decision but that still allowed for post-six-week abortion access, and "permissive" states as those that either had no new restrictions or had expanded protections for abortion access since June 2022. The states in each category are shown in Supplement B.

Those working in restrictive and semi-restrictive states were asked about delays in or adaptations to care of suspected or confirmed ectopic pregnancy. Permissive states were asked about calls or transfers into their state from more restrictive states. All respondents received questions about whether any new protocols or care plans were developed by their hospitals related to ectopic pregnancy. To ensure a common clinical understanding of care standards, we also included two clinical case questions (see questions 10 and 11 in Appendix) on management of ectopic pregnancy or potential ectopic pregnancy, using scenarios with an established standard of care.[10]

The survey was distributed electronically by InCrowd,[10] a company that administers health professional surveys.[11] InCrowd validates physician status by National Provider Identifier and maintains current demographic information of physicians in its database, including age, sex, race and ethnicity, location of practice, and years since completion of residency training. The survey was closed to further participation within each category once the goal number of participants was achieved. Survey respondents received honoraria between $23–$31, depending on time spent completing the survey.

We calculated summary statistics (counts, means, percentages) for item responses by state categories. The study was approved by the Institutional Review Board of Stanford University.

RESULTS

A total of 150 physicians, 50 respondents from each category, responded from 38 states. Participant characteristics are summarized in Table 1.

Twenty-four percent of respondents in restrictive and semi-restrictive states reported experiencing delays in care for patients with known or suspected ectopic pregnancy since the *Dobbs* decision (Table 2). Among those reporting delays, the most common reason for delays (58%) was needing a higher threshold of certainty for a definitive ectopic pregnancy

Table 1. Survey participant characteristics (N=150).

Years since residency graduation [mean (median)]	13 (12)
Sex [n (%)]	
Female	63 (42%)
Male	86 (57%)
Non-binary	1 (1%)
Race [n (%)]	
Asian	22 (15%)
Black	3 (2%)
White	115 (80%)
Other	3 (2%)
Hispanic/Latino [n (%)]	5 (3%)
Facility location [n (%)]	
Critical access	4 (3%)
Rural	17 (11%)
Suburban	71 (47%)
Urban	58 (39%)
Facility type* [n (%)]	
Academic	10 (15%)
Academic affiliated	28 (19%)
Community	70 (47%)
Freestanding	21 (14%)
Other**	16 (11%)

*Due to rounding, total does not equal 100%
**Other includes Veterans Affairs medical centers, pediatric emergency departments, and religiously affiliated hospitals.

Table 2. Survey responses from emergency physicians in restrictive and semi-restrictive states who reported delays in care of patients with known or suspected ectopic pregnancy (N=24).

Higher threshold of certainty required for ectopic diagnosis	58% (95% CI 37-77%)
Unsure of legality of standard clinical care in my state	29% (14-52%)
Certainty that standard clinical care is legally or institutionally prohibited	25% (11-47%)
Higher threshold of threat to mother's life	25% (11-47%)
System or peers would not support indicated clinical care	17% (6-39%)

CI, confidence interval.

diagnosis. Fifty-four percent of respondents in restrictive and semi-restrictive states reported adaptations in care made since the *Dobbs* decision (Table 3), including arranging close follow-up in cases where they might previously have delivered definitive care (31%) or obtaining additional imaging (26%) or beta-human chorionic gonadotropin (B-hcg) levels (24%) prior to treatment.Twenty percent of respondents in permissive states reported an increase in patients from abortion-restricted states coming to their ED for pregnancy-related care. Ten percent of respondents in these states reported receiving calls from clinicians regarding patients coming to their facility to receive pregnancy care due to restrictions in their states. Across all state categories, few physicians (7%) reported new protocols or care plans for patients with known or suspected ectopic pregnancy. Most emergency physicians responded to clinical scenarios in a manner consistent with clinical standards, without differences across state categories (75% restrictive states and 76% permissive states).

DISCUSSION

Our results suggest that physicians are shifting practice in a way that has the potential to increase harmful outcomes among patients with ectopic pregnancies. A significant percentage of emergency physicians in states with post-*Dobbs* abortion restrictions–24%–reported delays in or adaptations to their management of patients with known or suspected ectopic pregnancy. Respondents reported requiring additional testing beyond a B-hcg level of 4000 milligrams per deciliter (mg/dL); this is above the current recommendation by ACOG for discriminatory zone of a B-hcg of 3500 mg/dL for decision-making in ectopic pregnancy.[12]

Such patients could be discharged from emergency departments (ED) with presumed or suspected ectopic pregnancies when they previously would have been treated with pregnancy termination or experienced delays in definitive care of their ectopic pregnancy with pregnancy termination.

The possibility of alterations in clinical practice for patients requiring pregnancy termination in EDs was anticipated by leaders in the field. Last year, the American College of Emergency Physicians, the largest national organization representing emergency practice, issued a policy statement, asserting that abortion "is a medical procedure, and as such [is a decision] to be made only by healthcare professionals with their patients."[13] This study's data suggests concerns about impact on clinical decision-making were valid.

The role of EDs in pregnancy termination has come into focus due to questions about the authority of a 1986 federal law, the Emergency Medical Treatment & Labor Act (EMTALA), which defines a minimum standard for EDs, requiring that they ensure stability of those who present to care. Recently, in two cases, *Moyle v United States* and *Idaho v United States*,[14] the Supreme Court was asked to determine the extent to which emergency physicians must balance obligations under EMTALA against state laws that have outlawed abortion care, even when provided for medical stabilization. In June, the Court dismissed the cases, sending them back to proceed through lower courts. The Supreme Court's failure to rule decisively on EMTALA means that physicians will continue to face uncertainty about protections of care for patients requiring termination of a pregnancy as part of emergency care.

LIMITATIONS

This study has several limitations. As an exploratory study, it was a non-random sample limited to 38 of the 50 states surveyed. Only physicians were surveyed, missing the input of physician assistants and nurse practitioners working in EDs. Participation bias may mean that those who completed

Table 3. Survey responses from emergency physicians in restrictive and semi-restrictive states (N=100) about any adaptations of care to stay within legal parameters.

Arranging close follow-up in cases where you might previously have delivered definitive care	31% (95% CI 23-41%)
Additional imaging prior to treatment	26% (18-36%)
Additional B-hcg measurements prior to treatment	24% (17-33%)
Waiting until the patient is more advanced clinically (eg, more pain, hemodynamic instability) prior to treatment	3% (1-9%)
Transfer to a facility with different abortion-related laws	2% (0.5-8%)

CI, confidence interval; *B-hcg,* beta-human chorionic gonadotropin.

the survey had relatively strong feelings about abortion bans, whether positive or negative, and may not reflect the general experience of practicing emergency physicians around the country. Recall bias may mean clinicians under- or over-reported cases occurring over the previous 22 months.

CONCLUSION

This study reports, for the first time, perceived impacts on post-*Dobbs* restrictions on the emergency management of patients with suspected ectopic pregnancy. In states with new abortion restrictions 24% of the clinicians surveyed reported changes in clinical decision-making for what is commonly held to be a clearly defined exception to abortion bans, raising the possibility that other aspects of patient care previously assumed to be protected by clinical standards of care and good faith physician judgment are affected by these restrictions. Further research is needed to determine the impact of these restrictions on all aspects of reproductive health care in emergency medicine.

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Physician Orders for Waiting Room Patients: Ethical Considerations

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With increasing emergency department (ED) boarding and crowding, EDs have introduced several novel care-delivery initiatives including split-flow models (e.g., fast tracks), non-linear patient flow models (e.g., protocol bays), nursing triage order sets, physician-in-triage, and the use of non-traditional care areas (e.g., ED hallways). One such emerging practice is the placement of orders for patients in the waiting room (WR) by physicians prior to in-person physician evaluation (e.g., based on triage documentation and the patient's medical record). This paper describes key ethical obligations to WR patients that support this practice, as well as other considerations that must be balanced against these obligations, including potential risks. [West J Emerg Med. 2025;26(4)1025–1029.]

INTRODUCTION

The Emergency Medical Treatment and Labor Act (EMTALA), a federal law enacted in 1986, underscores the obligation of emergency departments (ED) in the United States to provide care for all people, including those who are ultimately found to have a low-acuity condition.[1] Under this federal mandate, with mounting pressure of ED crowding and boarding, many hospitals have experimented with novel care delivery initiatives. It is important to note that none of these novel delivery-care initiatives absolve the foundational EMTALA obligation for a medical screening exam by qualified medical personnel. These processes include split-flow models (e.g., fast tracks), non-linear patient flow models (e.g., protocol bays), nursing triage order sets, physician-in-triage (PIT), and the use of non-traditional care areas (e.g., ED hallways).

Studies evaluating the effects on operational metrics of these initiatives, which largely look at PIT, are weak and show mixed results. While some studies have reported decreased time in room (TIR)[2] or ED length of stay (LOS)[3-10] associated with this practice, others have found no significant reduction in LOS.[11,12] Among these attempts to improve the care and efficiency of crowded EDs is the practice of physicians placing orders on patients in the waiting room (WR)—beyond standardized nursing triage protocols—based upon the written triage report but prior to face-to-face evaluation of the patient by a physician. There is no empiric data published regarding the efficacy of this practice, or its impact on patient quality outcomes or resource utilization. While this remains important and needed research, objections to this practice often cite philosophical rather than empiric concerns.

In this paper, we explored the ethical implications of this practice of placing orders on waiting room patients because each novel care-delivery initiative deserves its own unique analysis of benefits and risks. This practice differs from other types of accelerated ordering models, such as the use of routine triage nursing protocols or a PIT model, as it lacks an in-person evaluation by the emergency physician (EP) but requires their active engagement in WR patient care. In our exploration of this topic, we first define ethical obligations held for all ED patients including those unique ethical obligations to WR patients who have not yet received in-person evaluation by an EP. These considerations support placing orders to the potential benefit of WR patients. We then explore the risks and logistical issues to this practice that must

be considered. Our goal in this ethical analysis iss to provide focused guidance for clinicians and administrators to appropriately use this evolving practice in the crowded ED.

OBLIGATIONS TO ALL PATIENTS

Emergency physicians are bound by both a moral and legal obligation to evaluate and treat all patients seeking emergency care,[13-15] for it is only because of their ED care that an emergent medical condition may be ruled out or managed. To ensure the greatest amount of good is achieved for the greatest number of patients, those patients with the highest acuity of illness are generally prioritized over those presenting with a lower acuity condition.[16] This is the moral and pragmatic foundation for triage. Triage-driven diagnostic testing such as electrocardiograms (ECG), labs, and imaging performed in the WR may aid in more accurately stratifying patient acuity.[17]

Considering this obligation to all patients—both low and high acuity, roomed and waiting—it is important to emphasize that the strongest obligation of clinical ED staff is to provide care for the highest acuity patients.[2] As more attention is turned to triage and WR medicine with ED crowding, recognition that WR patients are more likely to leave without being seen (LWBS) is inevitable.[6] The ED processes should optimize triage accuracy and efficiency, improve overall access to care, and reflect patient-oriented outcomes, yet these processes cannot compromise the care of higher acuity patients.[4] This is in keeping with EDs obligations to all patients.

OBLIGATIONS TO WAITING ROOM PATIENTS

For the patient presenting to the ED requesting evaluation, we have already established the clear obligation EPs have to the WR patient. Because the EP and WR patient have not initiated a traditional physician-patient relationship prior to in-person assessment, however, this may be contested or diminished. Nonetheless, the EP's actions and priorities are clearly and undeniably linked to the WR patient's well-being and, thus, require dedicated attention here.

Emergency physicians are not able to uncouple the effects of their actions on WR patients. As an extreme example, it would be clearly ethically unacceptable for an EP who recognizes a potential emergent situation (e.g., stroke alert) to leave for a coffee break. Similarly, pursuing non-emergent care of patients while they occupy an ED bed, without weighing the negative effects of further delays in care for WR patients, fails to respect the principle of non-maleficence. In other words, an ethical obligation and link between the EP and the WR patient exists, even prior to the establishment of a direct patient-physician relationship.

Conversely, actively engaging in the care of WR patients before in-person physician evaluation can provide expedited care and enhanced triage prioritization for waiting patients. For example, a concerning ECG obtained on an elderly WR patient with generalized weakness will likely result in earlier recognition of critical hyperkalemia and improved outcomes. This simple example illustrates how the placement of orders on WR patients can clearly benefit patients; thus, the justification for placing such orders can be said to be founded upon the ethical principle of beneficence toward WR patients.

Commensurate with these obligations to benefit and avoid harm of WR patients by EP action or inaction are two responsibilities for the EP:

1. The EP must have a good understanding of the resources available to them as well as the need for prioritization among patients needing those resources. This is triage, fundamentally. The stratification of patient acuity can and should be enhanced by appropriate testing orders to accomplish the utilitarian goal of triage.
2. EPs have a responsibility to optimize each WR patient's care, despite the limitations of triage and regardless of whether they have not yet personally evaluated the patient. Placing orders on WR patients is one way this can be accomplished, which may benefit those patients in the form of enhanced triage information, enhanced flow through the ED, and screening for acute conditions not immediately obvious from triage nursing assessments.

LIMITATIONS OF THE OBLIGATION TO PROVIDE CARE

While we defended an ethical obligation to WR patients that could necessitate EP orders, there must also be a prima facie limitation on these obligations as there is an important, added value to a patient's evaluation by a physician. An EP's history and examination are the gold standard for the evaluation of an emergent medical condition because of their ability to elicit critical findings and weigh clinical significance. Furthermore, the brief and potentially less-private nature of triage may lead to incomplete or withheld information, limiting the EP's ability to make appropriate decisions prior to an in-person evaluation. We also acknowledge, as highlighted earlier, that these arguments are conceptual and philosophical in nature and that there is no empiric data on patient-oriented outcomes of EP orders on patients in the WR to validate any potential benefit; however, there is equally no empiric data of any potential harms. Future research in this area would be a valuable next step given that the ethical framework here supports exploring this practice.

The practical execution of orders on WR patients will always be limited by the ED staff's bandwidth to accomplish these tasks, which is likely already spread thin by a crowded ED precipitating the conditions to consider this practice. In keeping with appropriate triage and the obligations to all patients, it would be inappropriate for ED staff to prioritize WR orders over orders for patients with higher triage priorities who are already under physician evaluation and management. A physician ordering tests on WR patients must consider these logistical considerations and limitations.

RISKS OF WAITING ROOM ORDERS AND OTHER CONSIDERATIONS

Stewardship and Resource Utilization

In emergency medicine, stewardship is not just a fiscal concern but an ethical imperative. The American College of Emergency Physicians advocates for resource allocation that maximizes patient benefit while minimizing unnecessary expenditure as an ethical obligation to stewardship.[18] Hence, when EPs order tests based solely upon triage records, the potential to over-use resources poses an ethical risk. This is a risk that must be weighed against potential benefits to the patient previously established.

The decision to exclude specific tests in the WR setting such as magnetic resonance imaging or computed tomography (CT) is nuanced and the cost-benefit analysis complex; blanket exclusions may not always serve patient interests. Instead, a case-by-case approach, as informed by national guidelines and EP judgment, is recommended.[19] While these modalities may have higher risks and limitations, they may also have greater benefits for select patient populations.

Over-testing Consequences for the Patient

Over-testing can lead to anxiety and subsequent unnecessary testing in the case of false positives. While most repeated tests would not be medically dangerous to the patient, some (e.g., biopsies) could pose an additive risk. Additionally, ordering CT prior to examination, for example, could bring harm in the form of unnecessary costs and radiation exposure.[20]

Patient Communication and Consent

The *New York Times* and other media outlets have highlighted the fragile nature of patient trust in emergency settings.[21] Such trust is a paramount consideration when patients agree to undergo tests before seeing a physician. To honor this trust, the ED must strive for a transparent strategy to communicate the nature and necessity of the WR orders. This may include notices in waiting areas and, perhaps more importantly, verbal communication from medical staff, which can address any patient concerns and ensure that genuinely informed consent has been obtained. Ultimately, the onus is on healthcare professionals to ensure that consent goes beyond a mere signature to an authentic understanding.[22]

Shared decision-making on the choice of diagnostic test is also important. Shared decision-making maximizes autonomy, is associated with physician comfort with ordering fewer tests,[23] and should be the preferred or default approach in most ED situations.[24] Shared decision-making may not be available when orders are placed on WR patients, but patients should be made aware that they have the autonomy to decline testing prior to physician evaluation.

Follow-up on Results

Follow-up procedures for patients who leave without being seen (LWBS) can be fraught with ethical and operational challenges. Direct patient access to test results mandated by the 21st Century Cures Act, enacted in 2016,[25] may appear to empower patients but could also contribute to patients making misinformed decisions about their need for further medical care.[26] Patients must be cautioned early in the triage process that any test results obtained from screening tests ordered in the WR should not be interpreted by the patient alone.

The ED's role as the primary safety net for many vulnerable populations adds a layer of ethical responsibility for ensuring appropriate follow-up on especially critical medical findings after the ED encounter. The follow-up implications for results after a patient LWBS should be part of the informed consent process.

Liability Implications

The potential for malpractice liability is a significant concern for EPs who order tests for patients whom they have not personally evaluated. The central question of whether such preemptive orders establish a physician-patient relationship carries substantial legal implications. If a relationship exists, the physician could be held to the same standards of care as when they have conducted a complete evaluation. Comparing this to the indirect medical control model used in emergency medical services (EMS) might provide a suitable framework for understanding the legal differences involved. Under this model, EMS personnel operate under the oversight of physicians who are granted added legal protections due to the indirect nature of their patient care.[27]

However, the applicability of such protections to the ED setting is still a matter of legal interpretation. Despite the EP's physical proximity to patients in the WR, the indirect and asynchronous orders on WR patients are more akin to EMS oversight than the traditional medical care model, which we believe should confer the added legal protections. This distinction is crucial in determining the appropriate threshold for liability, which hinges upon a standard of recklessness rather than negligence.[28]

The Slippery Slope of Systemic Acclimatization

The routine use of WR orders, as a stopgap measure in the setting of significant ED crowding, could lead to acclimatization to systemic issues such as crowding and resource limitations. If such practices become normalized, there is a risk of diminishing the standards of emergency care. Ethical analyses warn of the potential long-term implications of accepting suboptimal conditions as standard.[29] Even if certain throughput metrics (e.g., LWBS) show improvement, these benefits should be scrutinized for their patient-oriented value and must be weighed against the long-term potential for such practices to establish a lower standard of care for ED patients. By accommodating such practices, there may be less impetus to address the underlying causes of crowding and find sustainable, systemic solutions.

CONCLUSION

Data is sparse regarding the efficiency and clinical impact of physician orders for patients in the waiting room prior to in-person evaluation. Therefore, the decision to engage in this practice should be reliant upon the EP's clinical judgment, driven by an obligation to reserve its use for situations in which the benefits of this approach outweigh the risks. The benefits—potentially enhancing patient triage and advancing their medical care—are material and should not be dismissed wholesale despite the potential risks and limitations of this practice. However, the limitations and risks of this practice must also be acknowledged and mitigated, including challenges with overutilization, informed consent, and acclimatization. These benefits and risks may be especially important in the setting of extreme ED crowding, where this practice is most likely to be necessary.

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Performance of Microsoft Copilot in the Diagnostic Process of Pulmonary Embolism

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Introduction: Patients with pulmonary embolism (PE) often present with non-specific signs and symptoms mimicking other conditions and complicating diagnosis. In this study we aimed to evaluate the performance of an artificial-intelligence tool, Microsoft Copilot, in the diagnostic process of PE, using clinical data including demographics, complaints, and vital signs.

Methods: We conducted this study using 140 clinical vignettes, including 70 patients with and 70 patients without PE. The vignettes were derived from published case reports within the last 10 years. We used Copilot for its free GPT-4 integration to analyze clinical data and answer two questions after each vignette. We compared Copilot's ability to identify PE within the top 10 differential diagnoses, and its ability to predict the risk of PE when compared to the use of the Wells score by two independent investigators.

Results: Copilot correctly included PE in the differential diagnosis in 94.3% of cases by listing it within the top 10 conditions. Risk assessment by Copilot yielded significantly higher levels in patients with PE ($P<.05$). No statistically significant difference was found in the Wells scores between patients with PE and without PE ($P>.05$). Copilot demonstrated better discriminatory power than the Wells score in risk assessment of PE (area under the curve 0.713 vs 0.583), with statistical significance ($P<0.001$ vs $P=.091$). Sensitivity, specificity, positive predictive value, and negative predictive value for discriminating between the combination of low- and intermediate- vs high-risk categories were 34%, 97.1%, 92.3%, and 59.6%, respectively.

Conclusion: This study explores the potential of Copilot as a tool in clinical decision-making, demonstrating a high rate of correctly identifying PE and improved performance over the Wells score. However, further validation in larger populations and real-world settings is crucial to fully realize its potential. [West J Emerg Med. 2025;26(4)1030–1039.]

INTRODUCTION

Pulmonary embolism (PE) is a life-threatening medical emergency. It occurs when a thrombus blocks the pulmonary artery or its branches. After heart attack and stroke, it is the third most common acute cardiovascular syndrome.[1] A timely diagnosis is crucial because PE is associated with high mortality rates. If left untreated, 30% of PE patients, whereas 8% die after timely treatment.[2]

The diagnosis of PE is challenging due to a range of issues from subtle and non-specific symptoms to the complexities of medical imaging interpretation. The diagnosis of PE heavily relies on a computer tomography pulmonary angiography (CTPA) for its high sensitivity and specificity.[3] However, this imaging technique is costly and time-consuming, and requires radiologists' expertise. Furthermore, it carries some risks that might primarily affect patient safety such as ionizing radiation exposure, anaphylactic response to contrast agent, contrast-induced nephropathy, dye extravasation, and incidental findings causing unnecessary procedures.[4,5] To avoid overuse of CTPA, current guidelines recommend using a pre-test probability

approach by using empirical clinical assessment or standardized clinical prediction rules for hemodynamically stable patients.[6] However, these widely accepted traditional scoring systems often lack the desired accuracy. Additionally, adherence to these risk scores is still low.[7]

As the healthcare landscape continues to evolve, there is a growing recognition of advanced technologies in the diagnostic process of PE. A potential approach to improve diagnosis could be the utilization of advanced methods for clinical data analysis. By leveraging machine-learning algorithms, artificial intelligence (AI) can analyze vast amounts of clinical data and identify patterns that may indicate the presence of PE. Recent studies indicate that AI demonstrates proficiency in detecting PE while extending its capabilities to risk assessment, risk stratification, and even mortality prediction.[8-11]

The exploration of potential applications of large language models (LLM) within the medical field has gained momentum over the past year. Notably, the introduction of ChatGPT (OpenAI, San Francisco, CA), Bard (Google LLC, Mountain View, CA) and Copilot (Microsoft Corporation, Redmond, WA) stands out as a significant contributor to this trend. Recent studies have demonstrated the multifaceted capabilities of these LLMs in several medical domains, including streamlining clinical workflows,[12] contributing to personalized learning,[13] conducting comprehensive literature reviews, and providing up-to-date medical information.[14] Furthermore, these LLMs have shown high accuracy by generating differential diagnosis lists based on provided clinical vignettes.[15,16]

A study by Hirosawa et al demonstrated that ChatGPT-4 correctly identified PE in 83% of cases when included in the top 10 differential diagnoses.[16] However, Hirosawa and colleagues analyzed a broad range of diseases using a relatively small sample size of 52 cases from a single department, limiting its generalizability. Given the potential of AI tools to aid in identifying PE, further research is needed to assess their performance in a more focused and systematically controlled setting. In this study, we evaluated the effectiveness of an LLM-based generative AI tool in improving the diagnostic process and enhancing the estimation of pre-test probability for PE using previously published case reports. We do not propose Copilot as a definitive diagnostic tool or a replacement for CTPA. Instead, we evaluate how AI can assist in determining which patients would benefit most from further diagnostic testing, potentially optimizing resource use and improving patient outcomes.

Concerns have been raised regarding the accuracy of LLMs in providing scientific answers during emergency situations. A recent study by Yau et al highlighted significant deficiencies in free versions of ChatGPT, Bard, Bing, and Claude AI, including inadequate medical and scientific accuracy, incomplete information, dissemination of dangerous information, and absence of source citations.[17] However, to date there has been no study conducted to evaluate the capability of these LLMs in diagnosing specific medical emergencies.

Population Health Research Capsule

What do we already know about this issue?
Diagnosing PE is challenging due to the nonspecific nature of its symptoms and the complexities associated with imaging. AI and LLMs show promise but face accuracy concerns.

What was the research question?
Can Copilot aid PE diagnosis by generating accurate differential diagnosis list and estimating pre-test probability using clinical data.

What was the major finding of the study?
Copilot identified PE in top 10 diagnoses with 94.3% accuracy and demonstrated a higher area-under-the-curve (AUC) for the receiver operating characteristic (ROC) curve than Wells score (0.713 vs. 0.583).

How does this improve population health?
By improving the diagnostic process of PE, Copilot may be able to optimize resource use, reduce unnecessary tests, and enhance patient outcomes, which may contribute to better population health..

In this study, we used the free version of Microsoft Copilot, a widely used but under-represented AI model in the medical literature. By leveraging Copilot, we introduce a novel approach that mirrors how clinicians construct differential diagnoses and assess PE risk levels. At the start of the study, Copilot offered several advantages over OpenAI's ChatGPT. For example, Copilot provides three different chat tones: creative; balanced; and precise. The precise mode is designed to provide concise, search-focused answers. On the other end of the spectrum, the creative mode generates responses that are more elaborate and descriptive. The balanced mode, as the name suggests, strikes a balance between the two, offering responses that are neither too brief nor too detailed.[18] Since December 2023, Microsoft Copilot has been available on the Android operating system, which provides direct access to the chatbot. Additionally, it allows using GPT-4 with the "use GPT-4" button at no cost.

MATERIALS AND METHODS

Definition of Outcomes

The primary outcome of this study was the ability of Microsoft Copilot to accurately identify PE based on clinical data. We assessed the performance of Copilot in listing PE within the top 10 differential diagnosis list.

Including 10 possible diagnoses allowed us to better assess Copilot's "diagnostic" capabilities, evaluate its performance in complex cases, and ensure comparability with existing literature.

The secondary outcome was to assess the ability of Copilot to accurately determine the risk of PE. The Wells score, also known as the Wells criteria, is widely used to determine the risk of PE.[19] This scoring system helps healthcare professionals estimate the probability of PE based on various clinical factors. The Wells score incorporates both clinical signs and symptoms to stratify patients into low, moderate, or high probability categories (Table 1).[20] By assigning points to different criteria, the Wells score aids in guiding further diagnostic testing and determining the most appropriate management strategies for individuals. In this study, the Wells score was independently calculated by two investigators based on review of clinical vignettes. These investigators were not blinded to the full text of the case reports, which may have introduced bias given the likely knowledge of the true diagnosis in calculating the "most likely diagnosis" component of the Wells score. Discrepancies between the two investigators were resolved through discussions. The risk assessment was conducted through Microsoft Copilot by asking: "Can you rate the risk of PE in this case as low risk, intermediate risk, or high risk?"

Study Design

We conducted this study using clinical vignettes derived from published case reports. To be enrolled in the study, case reports had to meet the following criteria: 1) published in the last 10 years; 2) written in the English language; 3) involved adult patients (≥ 18 years) and available in full text at no cost; 4) provided key clinical details for crafting clinical vignettes; 5) involved patients with suspected PE; and 6) confirmed or excluded PE through CTPA. We excluded case reports that had incomplete diagnostic information, inconclusive CTPA results, or described embolization of other materials into the pulmonary circulation. We also excluded case reports involving postmortem diagnoses or patients who had already been hospitalized for more than three days.

The study was conducted in accordance with the Standards for Reporting Diagnostic Accuracy (STARD) guidelines for reporting diagnostic accuracy. Approval by the ethics committee was not obtained, since the study only used case vignettes from published case reports.

Literature Search and Case Report Selection

In September 2023, two authors conducted a systematic search on the PubMed database using the search terms "((pulmonary embolism) AND (acute)) OR ((dyspnea) AND (acute))." By selecting "case report" as the article type, a total of 7,611 case reports were retrieved. Following additional filters, including "adult," "English," "10 years," and "free full text," 1,184 case reports were selected for the initial assessment.

First, we assessed titles and abstracts to exclude cases that were clearly irrelevant. Then, we reviewed full-text reports. Based on the inclusion and exclusion criteria, we identified 438 case reports for patients with suspected PE who underwent CTPA. Based on CTPA results, the patients were divided into two groups: those with PE (study group, 260 cases) and those without (control group, 178 cases). Using a manual exact-matching process, each PE patient was paired with a non-PE patient whose age was within ±1 year and whose sex matched. Following meticulous evaluation and matching, we divided 140 of these case reports (70 in the study group and 70 control group), which represented the maximum number of cases that qualified for inclusion after applying our case selection and matching criteria. The case selection process is visually presented in Figure 1.

Clinical Vignettes

In October 2023, one of the authors extracted the data from the selected case reports and displayed them as detailed clinical

Table 1. Wells score for pulmonary embolism.

Characteristics		Points
Clinical signs and symptoms of DVT		3
An alternate diagnosis is less likely than PE		3
Heart rate >100 beats/minute		1.5
Immobilization or surgery in the previous 4 weeks		1.5
Previous DVT / PE		1.5
Hemoptysis		1
Malignancy (treatment currently, in the previous 6 months, or palliative)		1
Risk	Points required	Risk of PE
Low	0-1	3.6%
Moderate	2-6	20.5%
High	>6	66.7%

DVT, deep vein thrombosis*; PE*, pulmonary embolism.

vignettes (Appendix). Each clinical vignette was written in English and included the following: age; sex; chief complaint; chronic medical conditions; history of present illness; vital parameters; and physical examination findings. The results of routine laboratory tests, imaging studies, differential diagnoses, final diagnosis, titles, figures, legends, and tables were removed and not included in the clinical vignettes.

In December 2023, we submitted each clinical vignette to Microsoft Copilot. After inputting the clinical vignette, the following questions were prompted, and the answers were recorded:

1. Can you list 10 possible diagnoses for the clinical vignettes above, ordered from most likely to least likely?
2. Can you rate the risk of PE in this case as low risk, intermediate risk, or high risk?

By employing this two-step process, we introduced a novel approach that mirrors the real-world diagnostic workflow commonly used in emergency departments, aiming to enhance the diagnostic process. An example of conversation between one of the authors and Copilot is shown in Figure 2. After recording the answers, to prevent any potential interference from prior responses, we cleared the conversation every time before introducing new clinical vignette.

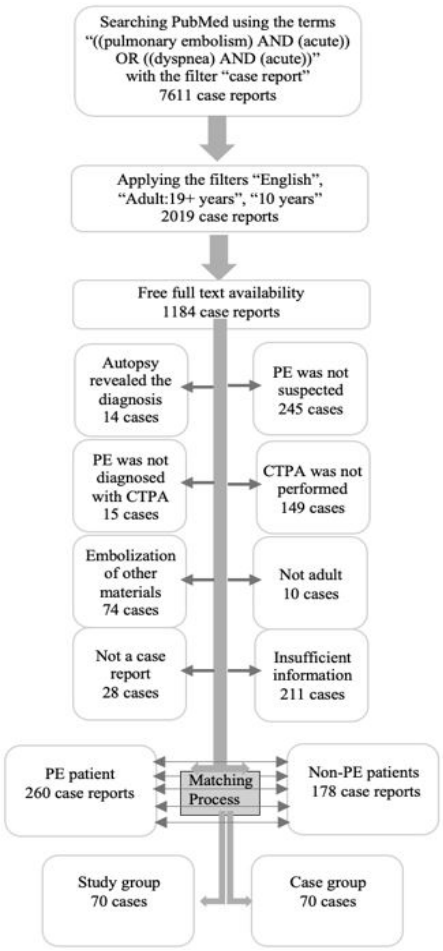


Figure 1. Case selection process in a study of the ability of Microsoft Copilot to aid in the diagnostic process for pulmonary embolism.
PE, pulmonary embolism, *CTPA,* computed tomography pulmonary angiography.

Microsoft Copilot

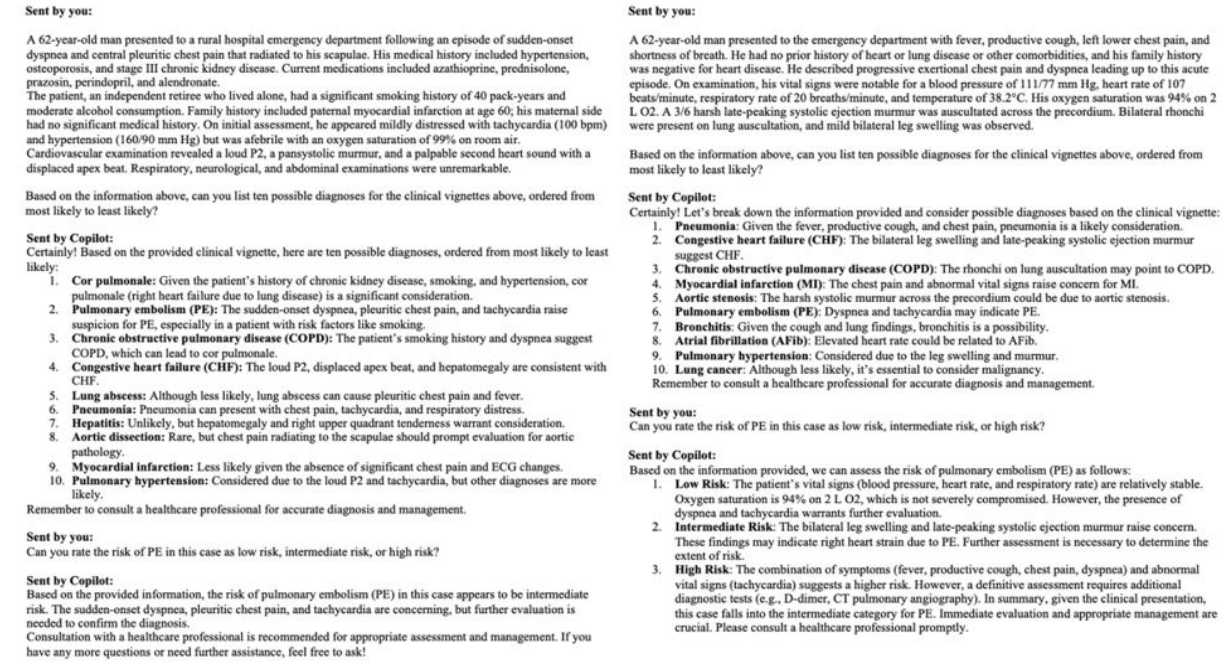
Microsoft Copilot is an AI-powered productivity tool designed to assist users in various tasks. It employs a combination of LLMs, a type of AI algorithm that uses deep-learning methods and extensive data sets to comprehend, summarize, predict, and generate content.[23] It runs on pre-trained models such as Generative Pre-trained Transformer-4 (GPT-4) to excel in these tasks. While GPT-4 is considered to be the most advanced language model,[24] details of its architecture are not publicly available. For this study, we chose the "precise" mode to ensure concise and focused answers.

Statistical Analysis

We performed statistical analyses using SPSS software v28.0 (SPSS Statistics, IBM Corp, Armonk, NY). Descriptive statistics, including means, standard deviations, medians, minimum, maximum values, frequencies, and percentages were reported. To evaluate the normality of the distribution of continuous variables, we applied the Shapiro-Wilk test. For normally distributed data, the independent samples *t*-test was used to compare the means between two independent groups. We used the Mann-Whitney U test to compare the medians of ages, and the chi-square test to compare the distribution of categorical variables such as the proportions of male and female patients, Copilot's risk assessment, and the Wells score risk assessment between two groups. The receiver operating characteristic (ROC) analysis was conducted to evaluate the performance of variables. This involved calculating the area under the ROC curve (AUC), which provides a measure of how well a parameter can distinguish between two diagnostic groups (eg, PE vs non-PE). The AUC values range from 0.5 to 1. An AUC of 0.5 indicates no discrimination ability, while values below 0.7 suggest poor performance. An AUC value greater than 0.7 reflects a reasonably good model, and an AUC of 1 denotes perfect discrimination.

RESULTS

We conducted this study with a total of 140 clinical vignettes, including 70 patients with PE (study group) and 70 patients without PE (control group). Ages of the patients ranged from 21-86 years with a mean of 54 ± 16.3. Most patients in each group were female (54.3%). We were unable to detect a statistically significant differences between the two groups by age (P = .96) and sex (P = 1.00) by design. Dyspnea was the most frequent presenting symptom among all patients, but notably more prevalent in those without PE (92.8% v 70%). Symptoms such as chest pain and syncope were more prevalent in patients with PE, occurring in 47.1% and 15.7% of cases, respectively, compared to 21.4% and 1.4% in those



Sent by you:

A 62-year-old man presented to a rural hospital emergency department following an episode of sudden-onset dyspnea and central pleuritic chest pain that radiated to his scapulae. His medical history included hypertension, osteoporosis, and stage III chronic kidney disease. Current medications included azathioprine, prednisolone, prazosin, perindopril, and alendronate.
The patient, an independent retiree who lived alone, had a significant smoking history of 40 pack-years and moderate alcohol consumption. Family history included paternal myocardial infarction at age 60; his maternal side had no significant medical history. On initial assessment, he appeared mildly distressed with tachycardia (100 bpm) and hypertension (160/90 mm Hg) but was afebrile with an oxygen saturation of 99% on room air.
Cardiovascular examination revealed a loud P2, a pansystolic murmur, and a palpable second heart sound with a displaced apex beat. Respiratory, neurological, and abdominal examinations were unremarkable.

Based on the information above, can you list ten possible diagnoses for the clinical vignettes above, ordered from most likely to least likely?

Sent by Copilot:
Certainly! Based on the provided clinical vignette, here are ten possible diagnoses, ordered from most likely to least likely:

1. **Cor pulmonale:** Given the patient's history of chronic kidney disease, smoking, and hypertension, cor pulmonale (right heart failure due to lung disease) is a significant consideration.
2. **Pulmonary embolism (PE):** The sudden-onset dyspnea, pleuritic chest pain, and tachycardia raise suspicion for PE, especially in a patient with risk factors like smoking.
3. **Chronic obstructive pulmonary disease (COPD):** The patient's smoking history and dyspnea suggest COPD, which can lead to cor pulmonale.
4. **Congestive heart failure (CHF):** The loud P2, displaced apex beat, and hepatomegaly are consistent with CHF.
5. **Lung abscess:** Although less likely, lung abscess can cause pleuritic chest pain and fever.
6. **Pneumonia:** Pneumonia can present with chest pain, tachycardia, and respiratory distress.
7. **Hepatitis:** Unlikely, but hepatomegaly and right upper quadrant tenderness warrant consideration.
8. **Aortic dissection:** Rare, but chest pain radiating to the scapulae should prompt evaluation for aortic pathology.
9. **Myocardial infarction:** Less likely given the absence of significant chest pain and ECG changes.
10. **Pulmonary hypertension:** Considered due to the loud P2 and tachycardia, but other diagnoses are more likely.

Remember to consult a healthcare professional for accurate diagnosis and management.

Sent by you:
Can you rate the risk of PE in this case as low risk, intermediate risk, or high risk?

Sent by Copilot:
Based on the provided information, the risk of pulmonary embolism (PE) in this case appears to be intermediate risk. The sudden-onset dyspnea, pleuritic chest pain, and tachycardia are concerning, but further evaluation is needed to confirm the diagnosis.
Consultation with a healthcare professional is recommended for appropriate assessment and management. If you have any more questions or need further assistance, feel free to ask!

Sent by you:

A 62-year-old man presented to the emergency department with fever, productive cough, left lower chest pain, and shortness of breath. He had no prior history of heart or lung disease or other comorbidities, and his family history was negative for heart disease. He described progressive exertional chest pain and dyspnea leading up to this acute episode. On examination, his vital signs were notable for a blood pressure of 111/77 mm Hg, heart rate of 107 beats/minute, respiratory rate of 20 breaths/minute, and temperature of 38.2°C. His oxygen saturation was 94% on 2 L O2. A 3/6 harsh late-peaking systolic ejection murmur was auscultated across the precordium. Bilateral rhonchi were present on lung auscultation, and mild bilateral leg swelling was observed.

Based on the information above, can you list ten possible diagnoses for the clinical vignettes above, ordered from most likely to least likely?

Sent by Copilot:
Certainly! Let's break down the information provided and consider possible diagnoses based on the clinical vignette:

1. **Pneumonia**: Given the fever, productive cough, and chest pain, pneumonia is a likely consideration.
2. **Congestive heart failure (CHF)**: The bilateral leg swelling and late-peaking systolic ejection murmur suggest CHF.
3. **Chronic obstructive pulmonary disease (COPD)**: The rhonchi on lung auscultation may point to COPD.
4. **Myocardial infarction (MI)**: The chest pain and abnormal vital signs raise concern for MI.
5. **Aortic stenosis**: The harsh systolic murmur across the precordium could be due to aortic stenosis.
6. **Pulmonary embolism (PE)**: Dyspnea and tachycardia may indicate PE.
7. **Bronchitis**: Given the cough and lung findings, bronchitis is a possibility.
8. **Atrial fibrillation (AFib)**: Elevated heart rate could be related to AFib.
9. **Pulmonary hypertension**: Considered due to the leg swelling and murmur.
10. **Lung cancer**: Although less likely, it's essential to consider malignancy.

Remember to consult a healthcare professional for accurate diagnosis and management.

Sent by you:
Can you rate the risk of PE in this case as low risk, intermediate risk, or high risk?

Sent by Copilot:
Based on the information provided, we can assess the risk of pulmonary embolism (PE) as follows:

1. **Low Risk**: The patient's vital signs (blood pressure, heart rate, and respiratory rate) are relatively stable. Oxygen saturation is 94% on 2 L O2, which is not severely compromised. However, the presence of dyspnea and tachycardia warrants further evaluation.
2. **Intermediate Risk**: The bilateral leg swelling and late-peaking systolic ejection murmur raise concern. These findings may indicate right heart strain due to PE. Further assessment is necessary to determine the extent of risk.
3. **High Risk**: The combination of symptoms (fever, productive cough, chest pain, dyspnea) and abnormal vital signs (tachycardia) suggests a higher risk. However, a definitive assessment requires additional diagnostic tests (e.g., D-dimer, CT pulmonary angiography). In summary, given the clinical presentation, this case falls into the intermediate category for PE. Immediate evaluation and appropriate management are crucial. Please consult a healthcare professional promptly.

Figure 2. Example of the rankings generated by Copilot for two different patients.
Both patients were 62-year-old males admitted to an emergency department. The first patient was diagnosed with pulmonary embolism,[21] and the second was diagnosed with acute viral bronchitis, severe bicuspid aortic valve stenosis, and coronary-pulmonary artery fistulas.[22]

without PE. Treatment patterns also differed between groups, with a higher percentage of PE patients (78.6%) receiving medical treatment compared to those without PE (58.6%). Regarding outcomes, most patients were discharged, but PE patients were more likely to be admitted to the intensive care unit (ICU) than those without PE (10% v 1.4%). The study population is described in detail in Table 2. Microsoft Copilot correctly listed PE in the top 10 differentials for 66/70 (94.3%) cases in the study group and 58/70 (82.9%) in the control group. Patients with PE were 3.41 times more likely to have PE in the top 10 differential diagnoses compared to patients without PE (odds ratio 3.41; 95% confidence interval [CI] 1.04-11.17) (Table 3).

The risk of PE was assessed based on the distributions of patients across different risk categories ("high," "intermediate," and "low"), as determined by Copilot and the Wells scores. Copilot classified patients without PE as follows: 2 patients (2.9%) as high risk; 28 patients (40%) as intermediate risk; and 40 patients (57.1%) as low risk. Patients with confirmed PE were also classified by Copilot as follows: 24 patients (34.3%) as high risk; 27 patients (38.6%) as intermediate risk; and 19 patients (27.1%) as low risk. The level of risk determined by Copilot was significantly higher in the study group than the control group ($P < .05$). Remarkably, we were unable to detect a statistically significant difference in the Wells scores between the groups with and without PE ($P > .05$) (Table 4).

We evaluated the performance of Copilot and the Wells score in risk assessment for PE through AUC analysis. The AUC was 0.713 (Cl 95% 0.628 - 0.798) for Copilot. The Wells score had a lower AUC (0.583, Cl 95% 0.489 - 0.677) that was not statistically significant ($P = .09$), indicating poor performance in the risk assessment (Table 5). The AUCs of the ROC curves for Copilot and the Wells score are shown in the same figure (Figure 3). The agreement between these tools was 47.9% with a Cohen kappa of 0.26 (Table 6).We calculated the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of Copilot based on risk levels (Table 7). For the discrimination between low + intermediate and high-risk categories, the sensitivity, specificity, PPV, and NPV were 34%, 97.1%, 92.3%, and 59.6%, respectively. Conversely, for the discrimination between low and intermediate + high-risk categories, these values were 72.9%, 63%, 57.1%, and 67.8%, respectively.

DISCUSSION

The current study involved a total of 140 clinical vignettes presenting patients with suspected PE. Patients were equally distributed into two groups according to the CTPA results: patients with and without PE. The evaluation was based on clinical data including age, sex, chief complaint, medical history, vital parameters, and physical examination findings. The demographic distribution in terms of age and sex was statistically similar in both groups ($P < .05$). We employed a two-step process to generate and prioritize differential diagnoses and determine risk levels for PE. Our findings underscore the remarkable performance of Copilot in generating differential diagnosis lists and demonstrating better

Table 2. Demographic and clinical characteristics of the population in a study of the ability of Microsoft Copilot to aid in the diagnostic process for pulmonary embolism. (n=140).

		Pulmonary embolism (-) (n=70)				Pulmonary embolism (+) (n=70)				
		Mean±SD n-%		Median	I.Q-3.Q	Mean±SD n-%		Median	I.Q-3.Q	*P*-value
Age		54 ±	16.3	57.0	43.8-63.5	53.9 ±	16.4	57.0	43.8-63.5	0.955[m]
Sex	Female	38	54.3			38	54.3			1.000x[2]
	Male	32	45.7			32	45.7			
Chief complaint	Dyspnea	65	92.8			49	70			
	Cough	18	25.7			14	20			
	Chest pain	15	21.4			33	47.1			
	Fever	5	7.1			10	14.3			
	Leg pain	4	5.7			9	12.9			
	Hemoptysis	3	4.3			3	4.3			
	Syncope	1	1.4			11	15.7			
Chronic medical condition	HT	24	34.3			20	28.6			
	Cancer	12	17.1			6	8.6			
	DM	9	12.9			5	7.1			
	HL	7	10			5	7.1			
	Asthma	5	7.1			2	2.9			
	COPD	5	7.1			4	5.7			
	Obesity	5	7.1			9	12.9			
	PE	4	5.7			6	8.6			
	DVT	3	4.3			5	7.1			
	None	19	27.1			26	37.1			
Treatment	Medical	41	58.6			55	78.6			
	NSI	15	21.4			8	11.4			
	Surgery	14	20			7	10			
Outcome	Discharged	59	84.3			59	84.3			
	ICU	1	1.4			7	10			
	Deceased	10	14.3			4	5.7			

[m], Mann-Whitney U test; [X²], chi-square test

HT, hypertension; *DM,* diabetes mellitus; *HL,* hyperlipidemia; *COPD,* chronic obstructive pulmonary disease; *PE*, pulmonary embolism*; DVT,* deep vein thrombosis; *NSI,* non-surgical intervention; *ICU,* intensive care unit.

capabilities in predicting the risk of PE compared to the Wells score, especially in complex clinical scenarios.

The literature has investigated the effectiveness of AI in diagnosing PE and recognizing patients at high risk. By analyzing vast clinical data and identifying patterns and trends within this information, AI offers invaluable support to clinicians and augments the precision of medical diagnoses. For example, Rucco et al used data on 28 variables such as age, previous deep vein thrombosis (DVT), and hemoptysis of 1,427 patients with suspected PE. Their neural hypernetwork correctly recognized 94% of the PE cases.[25] In a separate study, Ryan et al tested three distinct machine-learning (ML) models on clinical data extracted from electronic health records of 60,297 patients and demonstrated the capability of ML-based models to identify patients at high risk for developing PE.[26]

Copilot leverages a combination of advanced algorithms, LLMs and ML techniques to comprehend user input and generate appropriate responses. We hypothesized that Copilot's ML algorithms could be configured to analyze extensive clinical data, including patient demographics, medical history, and symptoms to identify patterns indicative of PE, similar to the approaches undertaken by Rucco et al and Ryan et al.[25,26] With this study, we aimed to evaluate the potential of Copilot in two specific tasks: to enhance the diagnostic process with generating accurate differential diagnosis lists; and to improve the estimation of pretest probability for PE with an ultimate goal to determine whether AI can support and improve clinical decision-making and workflow in emergency medicine.

Copilot also included PE in the differential diagnosis for

Table 3. Ranking of pulmonary embolism (PE) in a differential diagnosis list, along with the distribution of cases with PE and without PE.

		Pulmonary embolism (-)			Pulmonary embolism (+)			
	Rank in the list	(n)	(%)	Cumulative (%)	(n)	(%)	Cumulative (%)	*P*-value
Microsoft Copilot	1	2	2.9%	2.9 %	22	31.4%	31.4 %	.034*
	2	8	11.4%	14.3%	14	20.0%	51.4%	
	3	10	14.3%	28.6%	9	12.9%	64.3%	
	4	16	22.9%	51.5%	9	12.9%	77.2%	
	5	10	14.3%	65.8%	5	7.1%	84.3%	
	6	6	8.6%	74.4%	1	1.4%	85.7%	
	7	2	2.9%	77.3%	1	1.4%	87.1%	
	8	1	1.4%	78.7%	2	2.9%	90%	
	9	3	4.3%	83%	2	2.9%	92.9%	
	10	0	0.0%	83%	1	1.4%	94.3%	
	≥11	12	17.1%	100%	4	5.7%	100%	

*Chi-square test.

82.9% of the control group cases. This may raise questions about the tool's reliability and the potential randomness of these occurrences. However, it is crucial to consider that case reports published in the medical literature often involve highly complex scenarios, featuring rare presentations or unique clinical settings. Likewise, the clinical vignettes included in our study mostly fell into the intermediate-high risk group risk (84.3% in the study group and 74.3% in the control group). This emphasizes the challenging nature of the task undertaken by Copilot. However, even within this highly complex environment, our comparative analysis revealed a consistent trend: Copilot consistently listed the correct diagnosis near the top diagnosis in the study group ($P < .05$). This suggests that Copilot can prioritize PE based on the presented symptoms and patient history and could serve as valuable clinical decision-support tools, providing meaningful assistance to clinicians.

As the second task, Copilot was directed to predict the risk of PE for each vignette. Notably, the risk (low-intermediate-high) determined by Copilot was significantly higher in patients with confirmed PE. On the other hand, a statistically significant difference in the Wells scores between the groups was not detected. The Wells score is a widely accepted clinical prediction tool used to classify patients suspected of having PE into low, intermediate, or high-risk groups. This classification aids clinicians in selecting the next investigative step, such as D-dimer testing, CTPA, or lung scintigraphy. Even though the Wells score is an essential part of determining the likelihood of PE, its accuracy in certain patient populations has been subject to scrutiny.[27,28] Girardi et al reported that the Wells score is unreliable for predicting PE in ICU patients.[29] Contrary to the reported incidence rate of 1.3% for the low-risk group,[30] they detected PE in 26.8% of patients classified as low probability by the Wells score. This discrepancy may be due to the fact that factors associated with high risk for PE may be more prevalent in ICU patients and clinical prediction tools may exhibit varied performance depending on the settings. Similarly, our study found that 15.7% of patients categorized as low risk by the Wells score had PE.

The AUC values observed in our study (Copilot=0.713 vs Wells=0.583) may suggest that Copilot demonstrated better discriminatory ability than the Wells score for stratifying PE risk, particularly in complex cases. Several factors may contribute to Copilot's better performance. First, Copilot, with

Table 4. Comparison of risk assessment between patients with pulmonary embolism and without pulmonary embolism.

	Pulmonary embolism (-)		Pulmonary embolism (+)		
	N	%	n	%	*P* (x^2)
Copilot					
Low	40	57.1%	19	27.1%	
Intermediate	28	40.0%	27	38.6%	< .001
High	2	2.9%	24	34.3%	
Wells Score					
Low	18	25.7%	11	15.7%	
Intermediate	46	65.7%	46	65.7%	**.118**
High	6	8.6%	13	18.6%	

X^2, chi-square test.

Table 5. Data on area under the curve in a study of the ability of Microsoft Copilot to aid in the diagnostic process for pulmonary embolism.

	Area under curve	95% Confidence interval	P-value
Copilot	0.713	0.628 - 0.798	< .001
Wells score	0.583	0.489-0.677	.091

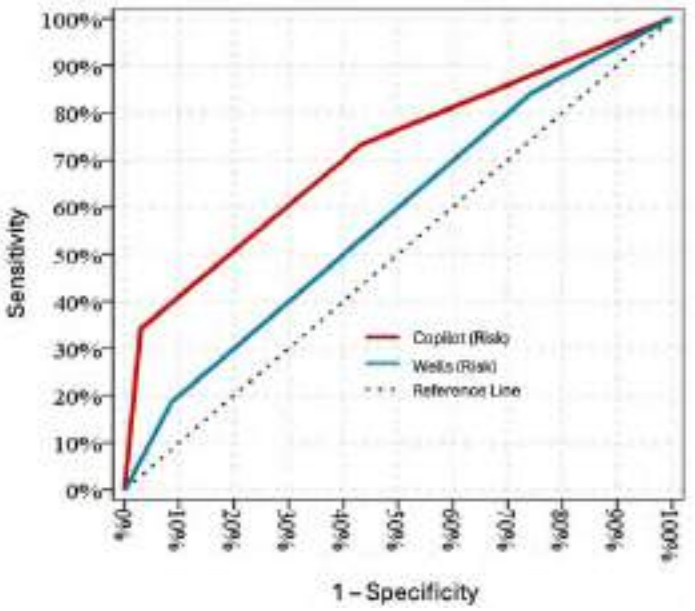


Figure 3. The areas under the curve of the receiver operating characteristic for Copilot and the Wells score.

its advanced AI foundation, was able to process large amounts of patient data and assess a broader array of variables and their interactions. On the other hand, the Wells score relies on a limited set of predefined criteria, such as history of DVT, surgery, or cancer. This broader analysis may lead to a more nuanced understanding of individual patient risk, particularly in cases with complex or ambiguous presentations. These findings suggest that Copilot may be more sensitive in identifying patients who are truly at higher risk for PE, allowing for better triage decisions and timely interventions. However, validation with larger populations is warranted in future studies.

LIMITATIONS

Regarding the limitations of this study, it is crucial to acknowledge the potential impact of publication bias in the included case reports. Our data rely on clinical vignettes derived from case reports. There is a tendency for case reports with positive outcomes to be preferentially published, thereby introducing a potential source of bias. Additionally, written clinical vignettes may not fully represent the breadth of presentations encountered in actual clinical practice, and omit the general appearance of the patients, which could affect medical decision-making. Real-world emergency departments see a mix of low, moderate, and high-risk patients, while published cases may disproportionately feature high-risk or ambiguous cases. However, our findings deviate from the reported incidence rates in terms of severity of the disease. In our study, PE was present in 15.7% of the low-risk group, 65.7% in the intermediate-risk group, and 18.6% in the high-risk group according to the Wells score, whereas Ceriani et al reported lower rates of 6%, 23%, and 49%, respectively, in their meta-analysis.[31] This disparity may result from the fact that published cases often involve unique or rare aspects of a disease, unusual presentations, or rare complications.

Over-representation of complex cases can introduce a form of selection bias. These limitations affect the generalizability of our study by potentially skewing the results toward more complex or atypical cases, which may not accurately reflect the broader population of patients encountered in routine emergency settings. Another potential limitation is the possibility that Copilot may have been previously exposed to some of the clinical vignettes used during its training, as they were sourced from publicly available materials. This could have influenced the model's performance and limit the generalizability of the findings. Also, case matching was performed based only on age and sex, which are not strong predictors of PE risk. Other potential confounding factors, such as comorbidities and clinical presentation, were not controlled for, which may have led to baseline differences between the groups. The investigators who adjudicated the Wells score were not blinded to the full text of the vignette, which may have introduced bias, particularly in assessing whether PE was the most likely diagnosis. Lastly, the probabilistic nature of LLMs introduces variability in outputs, which may affect reproducibility. This inherent characteristic, along with potential updates to the model, can lead to differences in results even when using the same clinical vignettes, limiting the consistency of findings over time.

CONCLUSION

This study suggests that Microsoft Copilot may have potential in generating differential diagnoses and assisting in risk prediction for patients with suspected pulmonary embolism. Copilot identified PE within the top 10 differential

Table 6. Agreement between the Wells score and Copilot for the classification of all patients into the three risk levels (low, intermediate and high) in a comparison study of the ability of Copilot and Wells score to risk-stratify patients from published case reports into risk categories for pulmonary embolism.

		Pretest probability using Copilot				
		Low	Intermediate	High	Rapport	*P*/kappa
Pretest probability using the Wells score	Low	20	9	0	47.9%	***.002/0.26***
	Intermediate	37	38	17		
	High	2	8	9		

Table 7. Sensitivity, specificity, positive predictive value, and negative predictive value for discriminating patients with and without pulmonary emboliism based on different risk categories.

	Pulmonary embolism (-)	Pulmonary embolism (+)	Sensitivity	PPV	Specificity	NPV	*P*
Copilot							
Low+Intermediate	68	46	34.3%	92.3%	97.1%	59.6%	< .001
High	2	24					
Low	40	19	72.9%	63.0%	57.1%	67.8%	*.001*
Intermediate+High	30	51					

PPV, positive predictive value; *NPV,* negative predictive value.

diagnoses with 94.3% accuracy and demonstrated a higher AUC than the Wells score in risk stratification (0.713 vs 0.583). Additionally, Copilot accurately identified PE near the top diagnosis in the study group, indicating its possible utility as a clinical decision-support tool. By integrating with electronic health records and analyzing extensive clinical data, Copilot can serve as a real-time decision-support tool for clinicians. It can offer recommendations based on the patient's history, symptoms, and other relevant data, aiding in more informed decision-making. Additionally, its ability to stratify PE risk into low, intermediate, and high categories could contribute to more tailored patient management strategies with individual risk levels. However, this study serves as a preliminary analysis of Copilot's feasibility. Further validation with larger populations and real-world clinical settings is essential to confirm its efficacy and reliability.

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Improved Outcomes and Cost with Palliative Care in the Emergency Department: Case-Control Study

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Introduction: Palliative care consultation teams provide significant advantages for patients, healthcare professionals, and hospitals, particularly in pain management, family support, and clinician satisfaction. Numerous studies show that inpatient palliative care services yield benefits regardless of the timing of initiation, contributing to shortened hospital stays and cost savings. Recent studies have focused on the timing and setting of palliative care, especially in emergency departments (ED), highlighting improved patient outcomes when initiated early. This study explores the potential of embedding hybrid physicians (double-boarded physicians in palliative and emergency medicine) in the ED to further enhance patient care and reduce hospital resources.

Methods: This small pilot case-control study included a subset of all patients referred by emergency physicians and hospitalists for palliative care within 24 hours of registration, physically present in the ED. Cases consisted of all the patients seen by hybrid physicians embedded in the ED. Matched controls were seen by palliative care-boarded clinicians (various other primary specialties) during palliative care rounds in the hospital. Matches were based on diagnosis, comorbidities, and referral date. Outcomes measured included hospital length of stay, total charges, discharge disposition, code status changes, and ED visits not resulting in admission. Statistical analyses used chi-square tests for categorical data and Wilcoxon rank-sum test for continuous data.

Results: In a four-year period, 68 cases were attended by hybrid physicians over 57 disparate days. These cases had significantly shorter hospital stays (median 2.1 days) compared to controls (6.5 days, $P<.001$). Total charges were also lower for cases ($37,800) than for controls ($78,000, $P<.001$). A notable secondary outcome was that 26.5% of ED visits in the case group did not result in hospital admission, compared to 100% of controls ($P<.001$). In addition, more cases than controls had a code status of comfort care at discharge ($P=.07$)

Conclusion: Embedding hybrid physicians in the ED significantly shortened hospital stays and reduced charges for seriously ill patients. These findings support the further exploration of integrating such physicians into ED settings to enhance patient care and optimize hospital resources. [West J Emerg Med. 2025;26(4)1040–1046.]

INTRODUCTION

The advantages of incorporating palliative care consultation teams for patients, clinicians, and hospitals have been extensively documented, particularly in areas such as improving pain management, bolstering family support, and enhancing clinician satisfaction.[1] Research conducted over the past two decades has consistently demonstrated the positive impact of inpatient palliative care services, irrespective of the timing of their initiation. These benefits have been observed across various complex metrics, including studies conducted on a national population scale, such as in Canada,[2] as well as within community healthcare settings.[3]

While acknowledging the inherent value of inpatient palliative care services as an initial point of intervention, recent studies have underscored the critical role of timing and the clinical setting in which consultations take place.[4] These findings counter a previous review from 2016 that had suggested inconclusive benefits associated with palliative care services initiated in the emergency department (ED).[5] In contrast, a 2019 review argued that existing data supports the feasibility and potential quality-of-life improvements associated with palliative care in the ED setting, without apparent adverse effects on patient survival.[6]

Furthermore, studies have consistently shown that early initiation of palliative care services can yield substantial cost reductions, shorter hospital stays,[7] and lower readmission rates.[8] For example, while initiating inpatient consultations within three days has demonstrated clear benefits, a retrospective analysis revealed that ED-initiated consultations were associated with significantly shorter lengths of stay (LOS) for hospitalized patients. This aligns with the patient- and family-centered benefits of palliative care and contributes to reduced inpatient resource utilization.[9] A recent study by Macmillan et al even showed that consultations initiated within 24 hours were significantly associated with reduced LOS and lower hospital charges, regardless of the underlying disease.[10] It is worth noting the downstream effects on inpatient services, particularly since rapid response team calls often relate to end-of-life symptoms.[11]

Williams et al emphasized the necessity for earlier palliative referrals and highlighted the potential to identify patients at high risk of in-hospital mortality upon admission, using the Criteria for Screening and Triaging to Appropriate Alternative Care (CriSTAL) criteria tool to encourage prompt palliative referrals.[11] The CriSTAL is a tool designed to identify elderly patients nearing the end of life. Developed using objective criteria derived from existing scales and research, CriSTAL is one of several screening tools available to help determine patients who may benefit from goals-of-care discussions. Admission triggers have already demonstrated their benefits, with criteria such as end-stage illness, functional limitations, and clinician anticipation of in-hospital death.[7] Consequently, it is reasonable to hypothesize that rapid palliative interventions hold similar value.

Population Health Research Capsule

What do we already know about this issue?
Palliative care in the ED improves patient outcomes, reduces hospital stays and costs, and enhances clinician satisfaction, especially when initiated early.

What was the research question?
Does embedding hybrid palliative-emergency physicians in the ED improve patient outcomes and reduce costs?

What was the major inding of the study?
Palliative care cases had shorter hospital stays (median 2.1 days) compared to controls (6.5 days, P<0.001), and lower total charges ($37,800 vs. $78,000, P<.001). Admissions were 26.5% of ED visits with palliative care vs. 100% of controls.

How does this improve population health?
Embedding palliative care in the ED enhances early goals-of-care discussions, reduces unnecessary admissions, lowers costs, and improves end-of-life care quality.

The integration of palliative care into EDs addresses a significant need, as many patients present without advance directives or established goals of care. A systematic review published found that only 36.7% of US adults had completed an advance directive, with 29.3% having living wills. Notably, the completion rates were similar between patients with chronic illnesses (38.2%) and healthy adults (32.7%), indicating that a significant proportion of individuals with serious health conditions lack documented end-of-life care preferences.[12] Studies also indicate that a substantial proportion of older adults, 56%-99%, do not have advance directives available upon ED admission.[13] Additionally, research has shown that among patients who underwent cardiopulmonary resuscitation in a respiratory care unit, 59% died within 24 hours, highlighting the critical importance of timely palliative interventions.[14] Furthermore, a second systematic review found that approximately 17% of patients visiting the ED had a terminal illness, emphasizing the ED's pivotal role in initiating palliative care discussions.[15] These findings underscore the necessity for early palliative care involvement in the ED to facilitate discussions on goals of care and advance directives, ultimately improving patient outcomes and ensuring that treatment aligns with patient preferences.

Collectively, the studies above illustrate the superiority of initiating consultations within 24 hours and within the ED

setting. Given the proven advantages of having palliative-minded ED personnel and effective tools for identifying palliative-appropriate patients as early as possible, the logical next step would be to explore the potential benefits of having hybrid physicians (dual-boarded in palliative and emergency medicine [EM]) in the ED available for immediate consultation. The number of patients presenting to the ED daily, whether due to hospital readmissions, preexisting hospice enrollment, or catastrophic injuries, further supports embedding palliative medicine within this setting. Having EM-trained physicians with specialized palliative expertise is a strategic approach to enhancing the healthcare system's overall function. The earlier we engage patients and families in critical goals-of-care discussions, the greater the potential to improve the value and impact of these conversations. In this hybrid physician case-control study we aimed to assess the effectiveness of deploying hybrid physicians onsite to evaluate patients referred for consultation in the ED, comparing these encounters to referrals made by emergency physicians (EP) to the current standard of inpatient palliative care teams.

METHODS

We conducted this investigation at a community-based, urban, tertiary-care hospital in central California, which is affiliated with a local university and has ≈700 beds. The hospital's inpatient palliative care team is responsible for handling consultations across various hospital departments, including the ED, intensive care units (ICU), and general inpatient floors. The Community Health System Institutional Review Board approved this study as exempt under 45 CFR 46, and patient consent was waived under 45 CFR 46.116 (d).

Study Design

For this case-control study, we collected and analyzed records from the palliative care department encompassing referrals and consultations made between August 2018–December 2022. Consults at our hospital are need-based with reasons for a consult including the following: goals-of care-discussions; hospice patients; advance care planning; comfort care patients; pain and symptom management; and frequent ED visits or hospitalizations. The palliative care department at our hospital conducted an average of 2,360 consults a year during the study, for an average of 6.5 consults per day. As this was a pilot project, our double-boarded physicians were only working in this hybrid role on limited days because the hybrid physicians were working as EPs as well as being scheduled on the general inpatient palliative service. This role was only possible when all our inpatient palliative teams were fully staffed and allowed for an additional hybrid physician to be embedded in the ED to collect cases. Furthermore, during the pandemic, fewer days were possible because of alternative needs of the palliative department across the hospital on the inpatient service. We categorized patients into two groups:

Cases

These were patients who received a palliative care referral from an emergency clinician within 24 hours of their initial hospital registration and were attended to by a hybrid physician embedded in the ED (available to respond urgently during scheduled palliative shifts in the ED). Cases were all seen by the hybrid physicians during the study period

Controls

Controls were selected on a one-to-one basis from a randomized list of patients who received referrals within 24 hours of their initial hospital registration by an EP while the patient was still in the ED; but these patients were attended to by a palliative care clinician who did not specialize in EM during routine palliative care rounds.

To mitigate bias, the selection of controls was based on three variables: underlying diagnosis; comorbidities; and the date of referral. Specifically, we considered the patient's underlying medical condition, distinguishing it from the billable diagnosis, which is a standard practice carried out by palliative care team members. Additionally, we used the Charlson Comorbidity Index (CCI), a validated tool for assessing disease burden. This index assigns scores on a scale from 0-36, with age factoring into the score, whereby older patients accrue more points. Controls were matched to cases by ensuring that the CCI scores were within three points of each other.

We also matched controls to cases using the dates of the referrals, ensuring that they occurred within a three-month window (either before or after the case referral). The data used for matching cases to controls was derived from palliative care records and included information such as underlying disease (categorized by malignancy type or chronic/terminal illness), admission and discharge dates and times, and the date and time the palliative care order was placed. Data needed to calculate the CCI scores were obtained through a review of patient charts.

Outcome Measures

In our analysis we considered potential patient-specific confounders, such as age, sex, and race/ethnicity, which were sourced from palliative care records. We also assessed potential differences in the treatment of cases and controls, considering discharge disposition, code status changes, code status at discharge, physician orders for end-of-life treatment, and any ED visits that did not result in hospital admission as a secondary outcome measure. The primary outcome variables under investigation included the length of hospital stay and total charges incurred over the course of care.

Statistical Analysis

We used chi-square tests to compare categorical data to test for differences between cases and controls. Non-parametric Wilcoxon rank-sum tests were used to compare

continuous data. We tested matching variables to check on effectiveness of the match process. Basic demographics that were not part of the match were tested for differences between cases and controls. A two-sided *P*-value of less than .05 was considered statistically significant. We used SAS software v 9.4 (SAS Institute Inc, Cary, NC) for all analyses.

RESULTS

In the four years and four months we conducted this study, a total of 68 cases were seen over 57 days, averaging 1.2 consults per day. On days that the hybrid physicians were working in this role, they saw 18.5% of the total consults for that day. Table 1 shows the underlying diseases for the cases and matched controls. Non-hematologic cancer was 37% of the sample with dementia the next highest at 21%. We were able to find controls that matched all the cases. The matching variables of CCI score and date of referral were not significantly different (median, *P*-value: CCI 0, .93; referral date -27; .06).

Table 2 shows the demographic characteristics of the cases and controls. Of note, only race/ethnicity was significantly different with more White patients as cases and more Hispanic patients as controls ($P < .01$).

Table 3 contains the outcomes we tested. Of note, we found significant differences in our primary outcomes of length of hospital stay and total charges. The median hospital LOS for cases was 2.1 days (Q1 - Q4; 0.5 - 5.1) while controls stayed 6.5 days (Q1 - Q4; 4.2 - 12.2; $P < .001$). The median total charge for cases was $37,800 (Q1 - Q4; $15,200 - $67,800), while the controls median total charge was $78,000 (Q1 - Q4; $34,600 - $135,900; $P < .001$). One secondary outcome was significant; 26.5% of ED visits that did not have an hospital admission occurred in the case group and were seen by the hybrid physician while all controls were admitted to the hospital ($P < .001$). In addition, more cases than controls had a code status of comfort care at discharge ($P = .07$). Patients who changed code status after palliative care consultation overwhelmingly changed to comfort care.

Table 1. Underlying diseases of cases and matched controls in a study of outcomes of emergency department palliative care physician intervention.

Underlying disease	N	Percentage [a]
Aneurysm	1	1
Chronic heart failure	5	7
Chronic obstructive pulmonary disease	6	9
Cardiovascular accident	2	3
Cyclic vomiting syndrome	1	1
Cirrhosis	1	1
Debility/frailty	2	3
Dementia	14	21
End-stage renal disease	8	12
Malignancy (hematologic)	3	4
Malignancy (non-hematologic)	25	37
Total cases	68	99

[a]Percentages do not add up to 100% due to rounding error.

Table 2. Demographic characteristics of cases and controls in a study of outcomes of emergency department palliative care physician intervention.

Characteristic	Cases	Controls	P-value
Age, years (median, Q1-Q3)	75 (62.5 – 87)	71 (62 – 81)	.23
Sex (%)			.30
Female	62	53	
Male	38	47	
Race / Ethnicity (%)			<.01
Black	10	13	
Hispanic	26	51	
White	53	26	
Other [a]	5	6	

Q1 is the value in the 25th percentile; Q3 is the value in the 75th percentile.

[a]Other race/ethnicity includes American Indian, Asian, East Indian, and Pacific Islander.

DISCUSSION

The uptick in EPs transitioning into the field of palliative medicine is noteworthy.[16] We have personally seen more EM-trained physicians apply to our hospice and palliative medicine (HPM) fellowship and have trained three EPs as of January 2025. In our training program we have two EM-trained physicians on our HPM faculty. One of those physicians was hired specifically to look at the effectiveness of placing them in the ED. We know there is an association with decreasing LOS and hospital charges the faster our palliative care team sees patients,[10] but what would the impact be if that team or a physician was embedded in the department where there are established relationships and a chance to see patients even sooner?

The number of patients that end up in the ED daily, whether it is hospital readmissions, patients already on hospice, or catastrophic injuries, warrants that palliative medicine physicians embed themselves in the ED.[10] Having EM-trained physicians who obtained a specialty in palliative medicine seems prudent to the overall functioning of the healthcare system. The further upstream we encounter patients and families to have critical goals-of-care discussions the better we can impact the value of these discussions.

Our study showed that among patients with a variety of underlying diseases who were seen by our hybrid physician, there was a median reduction in LOS and total hospital charges. Patients seen by the hybrid physician stayed in the hospital four fewer days than controls. In both cases and controls, when a code status was changed, it was

Table 3. Outcome characteristics of cases and controls in a study of outcomes of emergency department palliative care physician intervention.

Characteristic	Cases	Controls	P-value
Code status at discharge (%)			.07
Comfort care[a]	48.5	29.4	
DNR/DNI	30.9	39.7	
Full code	20.6	30.9	
Code changed (%)			.31
No	38.2	47.1	
Yes	61.8	52.9	
If code changed, was to comfort care[b] (%)			.80
No	11.9	13.9	
Yes	88.1	86.1	
Discharge status[c] (%)			.15
Died	29.4	14.7	
Home	29.4	39.7	
Hospice	22.1	26.5	
Skilled nursing facility	16.1	19.1	
Other	2.9	0.0	
Physician orders for life-sustaining treatment (%)			.16
No	57.4	69.1	
Yes	42.6	30.9	
Emergency department visit only (%)			< .001
No	73.5	100.0	
Yes	26.5	0.0	
Emergency department visit after this palliative care consult[d] (%)			.75
No	58.3	55.2	
Yes	41.7	44.8	
Hospital admission after this palliative care consult[d] (%)			.79
No	64.6	62.1	
Yes	35.4	37.9	
Hospice consult (%)			.16
No	67.6	55.9	
Yes	32.4	44.1	
Intensive care unit admission (%)			.19
No	86.8	77.9	
Yes	13.2	22.1	
Hospital length of stay, median days (Q1 – Q3)	2.1 (0.5 – 5.1)	6.5 (4.2 – 12.2)	< .001
Total charges, median $1,000 (Q1 – Q3)	37.8 (15.2 – 67.8)	78.0 (34.6 – 135.9)	< .001

Q1 is the value in the 25th percentile; Q3 is the value in the 75th percentile.
[a]Comfort care refers to patients who have essentially been transitioned to hospice and are receiving goal-directed care that focuses on comfort and no aggressive or life-sustaining treatments.
[b]Calculated using patients who changed their code status (42 cases and 36 controls).
[c]Percentages do not add up to 100% due to rounding error.
[d]Calculated using patients still alive (48 cases and 58 controls).
DNR/DNI, do not resuscitate/do not intubate.

overwhelmingly changed to comfort care (88.1% and 86.1%, respectively), illustrating the impact that palliative care consultation can have in general. The interventional group also saw a reduction in total hospital charges by approximately $40,000. Of the cases seen by our hybrid physician, 26.5% were not admitted to the hospital compared to the controls, who were all admitted. The patients who were not admitted could have been discharged somewhere such as home, with hospice, or died under the care of the EP without admission. Avoiding unnecessary admissions and shortening LOS, thereby resulting in decreased resource utilization, were the goals of this pilot study. Additionally, more cases from the study group were transitioned to comfort care and had a higher mortality. This is an important finding since transitioning to

comfort care often leads to shortening the LOS and resource utilization as they are typically moved into hospice care outside the hospital.

Transitioning to comfort care is for patients who have essentially been transitioned to hospice in the hospital and are receiving symptom-directed care that focuses on comfort and no aggressive or life-sustaining interventions. This avoids expensive studies and investigations that often lead to more suffering for patients and decreases high-value care. Another finding is that the cases had fewer hospice consults compared to the controls, although this difference was not statistically significant and was not a primary focus of our study. One possible explanation is that patients who prompted earlier palliative involvement in the ED by the hybrid physician may have been less stable for a transition to outpatient hospice. Instead, these patients may have transitioned to comfort measures and died in the hospital. These findings align with a recent study on embedding palliative care in an ED, emphasizing early integration of palliative care to improve patient outcomes and resource utilization.[17] The study reported a significant increase in ED consultations, high satisfaction among clinicians and nurses, reduced hospitalization and costs, and a notable 6.7 times return on investment.[17] Embedding palliative care in the ED was found to streamline workflows and improve patient care, suggesting its potential as a model for enhancing care for seriously ill patients in other healthcare systems.[17]

Two of our hybrid physicians were involved in direct patient encounters. Understanding the complexities of the ED setting makes them better equipped to handle complex end-of-life discussions in this environment, theoretically. These hybrid physicians are well versed in the operations of both the ED and the palliative care department. Because the hybrid physicians are attending physicians in EM, they have professional relationships with all their EM colleagues enabling a more seamless collaboration. Lastly, by being available, hybrid physicians were able to deal with complex urgent palliative needs such as goals-of-care discussions that arose in the ED. Specifically, urgent goals-of-care conversations with patients with terminal diagnoses that otherwise would have been intubated and admitted to the ICU could occur. These urgent goals-of-care conversations could result in a transition to comfort measures and subsequent in-hospital death.

From our data, we conclude that more programs and hospitals should explore embedding dually trained physicians in EM and HPM to work in the ED setting. Additionally, adding a full complement of palliative care staff (registered nurse, chaplain, and social worker) might better meet the needs of patients receiving care in the ED.

LIMITATIONS

Limitations to this study include basing the study on one hospital system vs multiple hospitals, as well as the low number of patients in our intervention group. However, we believe our methods add robustness even with this low number. Additionally, we did not document acuity at the time of presentation. Instead we included underlying disease and a measure of comorbidity status in our matching criteria. All cases and controls were matched within a ± three-month date of referral to address changes in the system/circumstances over time.

Acquiring cases for the study took a long time due to several factors. We began our study before the COVID-19 pandemic, and staffing issues made it difficult for our faculty emergency/ palliative physicians to work in the hybrid role and gather cases. This role was only feasible when inpatient palliative teams were fully staffed, allowing an additional hybrid physician to be placed in the ED. As a result, emergency/palliative physicians worked in this role for about 57 days. Additionally, many consults originated in the ED from hospitalists, and we aimed to differentiate these from the usual consults we received from the hospitalist group.

During the days that cases were being collected, EPs were informed of the possibility of getting a consult from the hybrid physician if needed. However, they were not informed that a study was taking place. Since referrals are need-based it is possible that bias was introduced by this knowledge.

CONCLUSION

Our study at a university-affiliated community-based hospital in central California demonstrates that consults for palliative care seen by dually trained palliative/emergency physicians in the emergency department provides a significant association in reduced length of stay and hospital charges in patients regardless of their underlying disease.

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Impact of Twice-weekly Scheduled Dialysis Through the Emergency Department for Patients with End-stage Renal Disease

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Introduction: Patients with end-stage renal disease (ESRD) who do not have access to standard dialysis often rely on emergency-only dialysis (EOD) through the emergency department (ED). Compared to standard dialysis, EOD leads to higher hospitalization rates, hospital days, and higher mortality. Our objective in this this study was to examine hospitalization rates and total hospital days after transitioning patients with ESRD from ED EOD to scheduled ED dialysis, and subsequently to standard outpatient dialysis.

Methods: We performed this retrospective study at a single, academic teaching hospital over the course of 10 years (2014–2023). Patients >18 years of age who received dialysis primarily through the ED for more than one year were included in the study. We studied two cohorts. Cohort 1 consisted of patients with ESRD who transitioned from ED EOD to twice-weekly ED dialysis. Cohort 2 was composed of patients who were transitioned from twice-weekly ED dialysis to standard outpatient dialysis. We performed paired patient analysis using the Wilcoxon signed-rank test. Primary outcomes included hospitalizations per month and total hospital days.

Results: Overall, there were seven patients in cohort 1 (mean age 39 years, 86% female) and 20 patients in cohort 2 (mean age 44, 50% female). Patients who transitioned to twice-weekly ED dialysis from ED EOD had lower hospitalizations per month (1.44 vs 0.26, P <.05) and fewer total hospital days per month (2.18 vs 1.20, P < .05). Patients who transitioned from twice-weekly scheduled ED dialysis to standard outpatient dialysis had even lower hospitalizations per month (0.10 vs 0.02, P < .01) and total hospital days (0.31 vs 0.08, P < .01).

Conclusion: Introducing scheduled twice-weekly ED dialysis sessions for unfunded patients with end-stage renal disease was associated with lower overall hospitalization rates and hospital days than emergency-only dialysis. These measures were decreased further after transitioning patients from ED scheduled dialysis to standard dialysis. [West J Emerg Med. 2025;26(4)1047–1054.]

INTRODUCTION

Undocumented immigrant patients represent a vulnerable population, especially those who carry the burden of chronic illness. It is estimated that there are between 6,000-9,000 undocumented immigrants with end-stage kidney disease (ESRD) in the United States.[1] In 2019, it was estimated that only 12 states provided statewide access to standard outpatient dialysis (three times a week) for undocumented patients

through Medicaid or emergency Medicaid. The remainder of states did not have uniform access to standard dialysis, leaving many patients dependent upon emergency-only dialysis (EOD).[2-6] An estimated 30-50% of undocumented immigrants with ESRD receive EOD, which is provided to patients who present to the emergency department (ED) with critical conditions including life-threatening hyperkalemia, hypoxemia, uremia, and metabolic acidosis.[7]

Although most undocumented immigrants with ESRD are reported to be younger and healthier than US citizens who have ESRD,[8-9] undocumented patients who rely on EOD have been shown to have higher mortality and hospitalization rates, and higher healthcare utilization compared to patients receiving standard outpatient dialysis.[10-11] This has significant implications for EDs that strive to care for this population including increased ED visits, long ED length of stays (LOS) and increased frequency of observation hours.[12]

Transitioning undocumented patients from EOD to standard dialysis has been shown to result in an overall decrease in ED visits, hospitalizations, and blood transfusions.[13] Furthermore, providing standard dialysis to such patients has been associated with a more than four-fold decrease in average monthly emergency Medicaid service dialysis expenditures.[2] A study in Texas also reported a net savings of nearly $6,000 per person per month after transitioning patients to traditional dialysis.[11]

The social and emotional impacts of EOD on both patients and clinicians are profound. Undocumented patients often report psychosocial distress due to unpredictable access, episodes of life-threatening illness, distressing symptoms, and the family and social impacts of EOD.[14-15] Undocumented patients who transitioned from emergency to standard outpatient dialysis in Colorado reported improvements in quality of life and symptom burden, and felt that their humanity had been restored.[15] Clinicians who provide EOD care report emotional exhaustion from witnessing needless suffering and high mortality as well as moral distress from the perception of propagating injustice.[17-18]

Our objective in this study was to evaluate hospitalization rates and total hospital days for undocumented patients with ESRD who presented to the ED for EOD and were transitioned to twice-weekly scheduled ED dialysis. Additionally, we examined the same outcomes for patients who were subsequently transitioned from twice-weekly scheduled ED dialysis to standard outpatient dialysis after a Centers for Medicare & Medicaid (CMS) rule change went into effect. We hypothesized that providing twice-weekly ED dialysis would reduce hospitalization rates and shorten the number of total hospital days among undocumented patients with ESRD compared to the period when they received EOD. Additionally, we hypothesized that transitioning to standard outpatient dialysis would result in a further reduction of hospitalization rates and hospital days compared to the twice-weekly ED dialysis.

Population Health Research Capsule

What do we already know about this issue?
End-stage renal disease (ESRD) in undocumented immigrant patients who rely on emergency-only dialysis (EOD) face major health challenges.

What was the research question?
We evaluated hospitalization rates and days for undocumented immigrant patients with ESRD transitioning from EOD to scheduled dialysis through the emergency department (ED).

What was the major finding of the study?
When compared to EOD, scheduled ED dialysis reduced hospitalization rates by 1.18 hospitalizations per month (1.4 vs 0.3, $P < .05$).

How does this improve population health?
Implementation of scheduled ED dialysis for undocumented immigrant patients with ESRD decreased inpatient healthcare utilization.

METHODS

Design and Setting

This study was a retrospective analysis of data collected from patient encounters at an academic ED with an annual volume of 57,000 visits. We obtained data through chart review for records between January 1, 2014–December 31, 2023. Patients were identified by a primary ED diagnosis of ESRD in the electronic medical record. Immigration status was confirmed for each patient via case management records. We included in the study patients who had primarily accessed dialysis care through the ED for at least 12 consecutive months during two consecutive treatment periods (ED EOD and scheduled ED dialysis, scheduled ED dialysis and outpatient dialysis, or all three treatment periods). Patients were excluded from the analysis if they used the ED for dialysis care for <12 consecutive months (ie, the ED was used as a temporary bridge to outpatient dialysis) or if their care only spanned one treatment period (no comparison period for paired analysis).

We identified a total of 109 patients. Of these, 54 patients used the ED on consecutive months during the study period for their dialysis care. Twenty-seven patients required short-term ED dialysis (<12 months). Of these, 11 used the ED during only one treatment period (no comparison period for paired analysis). Median time of ED dialysis for patients in the short-term dialysis group was 4.5 months. Twenty-seven patients required long-term ED dialysis (>12 months); three

patients were excluded because they used the ED during only one treatment period (no comparison period for paired analysis). The median time of ED dialysis for the patients who relied on the ED for long-term dialysis care was 29 months.

Data abstraction included total time (in months) that the patient used the ED for dialysis care. Period times were delineated by time (in months) that the patient received emergency-only dialysis (Period 1) in the ED, scheduled ED dialysis (Period 2), and standard outpatient dialysis (Period 3). Scheduled ED dialysis was defined as the time the patient was switched to scheduled twice-weekly dialysis days in the ED until the time the patient was accepted into an outpatient dialysis center. These events were recorded in both case management and nephrology notes. Additional variables included hospitalizations per month and hospital days per month for each of the three treatment periods. A hospitalization was recorded if the patient was admitted to an inpatient service. All hospitalizations were counted whether it was primarily for a dialysis-related issue or for other medical or surgical issues. Lastly, mortality was recorded if the patient death occurred during the study dates. Chart abstraction was performed by one person who was trained prior to chart review. The abstractor was aware of the study hypothesis. The study received an ethical exemption from the institutional review board.

Dialysis Protocol

Period 1: Prior to August 2016, undocumented patients received EOD through the ED based on the following criteria: hypoxia; hyperkalemia; uremia; metabolic acidosis; or electrocardiogram changes. Patients would present to the ED when they felt that they needed dialysis. After evaluation by an emergency physician, the patient was admitted to the ED observation (OBS) unit (11-bed unit) for dialysis, unless the patient's condition required inpatient care. The patients would be taken to the inpatient dialysis unit (5-bed unit) for dialysis and then returned to the ED OBS unit after dialysis. During Period 1, patients received two dialysis sessions of 4 hours each within 24 hours to minimize the risk of disequilibrium. Patients with hemoglobin levels <7 grams per deciliter (g/dL) received blood transfusions, but no advanced treatments such as erythropoietin were administered. Patients receiving dialysis through either the ED or ED OBS unit were counted as ED visits.

Period 2: In August 2016, patients using the ED for EOD were instructed to present to the ED on assigned days of the week, instead of when they felt that they needed dialysis. This was an operational decision to help streamline care, reduce ED crowding, and minimize delays in inpatient dialysis caused by the simultaneous presentation of multiple dialysis patients needing EOD on the same day. The nephrology team assigned each patient designated days for dialysis (eg, Monday/Thursday, Tuesday/Saturday). Patients would present to the ED on their designated days and be evaluated in triage by an emergency clinician. After evaluation, stable patients would wait in the ED waiting room until the inpatient dialysis unit was able to accommodate them. The patient would complete one dialysis session and then be discharged by the ED team. Patients were only roomed in the ED if they required temporizing measures or had a condition that required a private room for dialysis (eg, COVID-19). During Period 2, patients would receive dialysis regardless of whether they met criteria for emergency-only dialysis or not.

Period 3: In 2020, the CMS instituted a rule change that allowed undocumented patients with ESRD to receive standard dialysis at outpatient dialysis centers. Once enrolled, patients were assigned to outpatient dialysis centers to receive standard dialysis care and no longer came to the ED for routine dialysis care.

Program Support

Undocumented patients presenting to the ED for EOD were managed with existing ED resources throughout all three study periods. There were no facility modifications made to either the ED or inpatient dialysis unit during the study. During Period 1, the inpatient dialysis unit added an additional 2.0 full-time equivalents of dialysis nursing staff to accommodate the overall increased dialysis volumes in patients presenting to the ED for EOD. Subsequent dialysis staffing was not adjusted further during other study periods. Inpatient dialysis nurses dialyze a maximum of five patients at a time during a four-hour dialysis session. The estimated nursing cost for eight hours of dialysis per week for one year is $22,058 for a maximum of five patients. Each dialysis session was four hours in duration with an average cost of $2,650 per session. Patients presenting through the ED for dialysis in this study typically required a minimum of two dialysis sessions per week, or eight hours of dialysis per week.

In Period 2, patients who used the ED for EOD were instructed to present to the ED on specific days of the week for their dialysis. This was purely an operational change that allowed stable patients to be assessed in triage and, if stable, wait in the waiting room until the inpatient dialysis unit was ready for them. In contrast to Period 1, where the patient often required an overnight observation stay for their two dialysis sessions, in Period 2 the patient would go home after dialysis and return later in the week for their second dialysis session. The base dialysis sessions/week were similar between Periods 1 and 2. During Period 1, the patients received two dialysis sessions over two consecutive days, and during period 2, the patients had one dialysis session twice a week on assigned weekdays (unless admitted). To our knowledge, the switch to scheduled ED dialysis did not require any additional resources from either the ED or the institution.

In Period 3, after the CMS rule change, undocumented patients who had been using the ED for dialysis became eligible to receive dialysis in an outpatient dialysis center; as a result, the overall ED utilization by this population for dialysis decreased significantly. The overall ED dialysis patient census varied over the 10-year study period and was dependent upon

new patients entering the system, funding availability, patient relocation, and mortality. At current state, with the ability to obtain funding for undocumented patients with ESRD for outpatient dialysis, the ED typically manages between three and five patients who are either awaiting funding approval, fistula placement, or fistula maturation.

Dialysis Patient Management

Dialysis patient management is a collaborative effort between case management, ED leadership, and the inpatient nephrology services. Patients seeking care for dialysis are flagged by hospital case managers who meet individually with the patients to assist them in obtaining funding, when feasible. Initial financial screening typically takes between 1-2 hours per patient. If the patient does not qualify for funding, nephrology and ED leadership are alerted, and the patient is directed to use the ED for subsequent dialysis needs. Patients who do not qualify for funding have no other ongoing interaction with case management. Individual care plans for each patient are developed by ED and nephrology leadership. The care plans are entered and updated in the individual patient record by the ED medical director. When the medical record is accessed, a care management flag alerts healthcare personnel that the patient has a specific care pathway in place.

After the CMS rule change, patients eligible for funding would meet with case management and then would be referred to an outpatient dialysis program. The referral process would typically take two hours per patient. After moving the bulk of these patients over to outpatient facilities, the ED typically manages between 3-5 dialysis patients on an ongoing basis who are either awaiting funding approval, arteriovenous fistula (AVF) placement, or AVF maturation. Currently, the case managers' time commitment varies between 0-4 hours per week depending on how many new patients are being managed. No additional case manager resources were added during the study period.

Study Population

The study included undocumented patients, ≥18 years of age who previously received emergency dialysis primarily through the ED for a period of one year or more. We collected data from two cohorts. Cohort 1 consisted of undocumented individuals who initially were receiving ED EOD dialysis and later transitioned to twice-weekly dialysis through the ED. Cohort 2 was composed of undocumented patients who transitioned from twice-weekly ED dialysis to standard outpatient dialysis. Four of the 27 patients studied were represented in both cohorts. This was a paired analysis; thus, patients who only received dialysis during one period (no comparison time frame) were not included in the analysis.

Variables and Measures

The primary outcomes measured were hospitalization rate and number of hospital days. The hospitalization rate was calculated as the number of hospitalizations per month, and hospitalization days were reported as the total hospital days per month.

Data Analysis

We summarized descriptive statistics for the baseline characteristics in cohort 1 and cohort 2. Median hospitalization rates and hospital days were calculated for three treatment periods: EOD; twice-weekly ED dialysis; and standard outpatient dialysis. Given that the data were not normally distributed, the Wilcoxon signed-rank test was used to examine the statistical significance and magnitude of the differences in median hospitalization rates and hospital days between patients who transitioned to twice-weekly dialysis from EOD, as well as between patients who transitioned to standard dialysis from twice-weekly dialysis. The Wilcoxon signed-rank test examines the difference between matched pairs for non-parametric data. For the purposes of this study, we compared the primary outcomes for individual patients during each of the different periods. All analyses were performed using SPSS Statistics v29 (IBM Corp, Armonk, NY).

RESULTS

Baseline Characteristics

In cohort 1, the study population included a total of seven undocumented patients with ESRD, six (85.1%) of whom were females. The median age for this group was 39 years (interquartile range [IQR] 21-49). Four of the seven patients (57%) had an AVF in place. In cohort 2, there were 20 patients, 10 of whom were females (50%). The group's median age was 46 years (IQR 32-56). Eight of the 20 patients in cohort 2 had an AVF in place (40%). Table 1 presents the median hospitalizations per month and hospital days for both cohorts by treatment regimen (EOD, twice-weekly dialysis, and standard dialysis).

Comparison Between Treatment Regimens

Our analysis demonstrated that in cohort 1, transitioning from EOD dialysis to twice-weekly dialysis significantly reduced the median hospitalization rates by 1.18 hospitalizations per month (1.44 vs 0.26, $P < .05$). Additionally, the switch led to a median one-day reduction in total hospital days per month (2.18 vs 1.20, $P < .05$). In cohort 2, our findings revealed that transitioning from twice-weekly dialysis to standard dialysis resulted in significantly fewer hospitalizations per month (0.10 vs 0.02, $P < .01$) and decreased hospital days by a median of 0.23 days per month (from 0.31 to 0.08, $P < .01$) (Table 2).

Hospitalizations

Inpatient hospitalizations during each period are detailed in Table 3. The percentage of hospitalizations for dialysis-related conditions decreased from 98% in Period 1 to 74% in Period 2, and further decreased to 62% in Period 3. Hospitalizations categorized as directly related to ESRD were inpatient

Table 1. Baseline characteristics in a study of patients with sporadic emergency dialysis in the emergency department (ED) transitioning to twice weekly scheduled ED dialysis.

Cohort 1 (N= 7)		Cohort 2 (N=20)	
Age		Age	
Mean ± SD	39.2 ± 15.4	Mean ± SD	44.1 ± 13.6
Median (IQR)	39.0 (21-49)	Median (IQR)	46.0 (32-56)
Sex		Gender	
Male	1 (14.3%)	Male	10 (50.0%)
Female	6 (85.7%)	Female	10 (50.0%)
Emergency-only dialysis		Twice-weekly dialysis	
Hospitalization/month Median (IQR)	1.44 (1.11-1.66)	Hospitalization/month Median (IQR)	0.10 (0.06-0.19)
Total hospital days Median (IQR)	2.18 (1.50-2.55)	Total hospital days Median (IQR)	0.31 (0.18-0.91)
Total hospital days Number of days	15.30	Total hospital days Number of days	13.53
Twice-weekly dialysis		Standard dialysis	
Hospitalization/month Median (IQR)	0.26 (0.12-0.30)	Hospitalization/month Median (IQR)	0.02 (0.0 -0.05)
Total hospital days Median (IQR)	1.20 (0.36-2.10)	Total hospital days Median (IQR)	0.08 (0.0 -0.33)
Total hospital days Number of days	8.18	Total hospital days Number of days	4.81

IQR, interquartile range; *EOD,* emergency-only dialysis.

admissions due to hyperkalemia, volume overload, metabolic acidosis, uremia, and/or a combination of the above. Dialysis and non-dialysis-related medical, and surgical admissions are detailed in Table 4.

DISCUSSION

This study examined the rates of hospitalization and number of hospital days per month for individual patients during two different treatment periods, thus comparing rates for the same patient under different treatment scenarios. Two cohorts were studied. Cohort 1, comprising seven undocumented patients, demonstrated that transitioning from ED EOD dialysis to twice-weekly ED dialysis significantly reduced hospitalization rates by 1.18 hospitalizations per month. Additionally, the switch led to a one-day reduction in hospital days per month. Cohort 2 consisted of 20 patients and demonstrated that switching from twice-weekly dialysis to standard dialysis resulted in significantly fewer hospitalizations per month and fewer hospital days per month compared to the twice-weekly dialysis regimen. Overall hospital admissions for acute management of dialysis-related conditions decreased over the study period.

Our study supports prior reports that have shown that undocumented patients with ESRD treated with EOD have more hospitalizations and spend more days in the hospital than those receiving standard outpatient dialysis.[10,11,13] The overall mortality rate for patients in this study was 25% over the 10-year study period. The study did span the peak of the COVID-19 pandemic. The impact of the pandemic on overall mortality of the group is unknown.

To date, no studies have assessed the impact of undocumented patients with ESRD presenting to the ED on scheduled days for dialysis instead of relying on EOD. In this

Table 2. Comparison between treatment regimes in a study of patients with sporadic emergency dialysis in the emergency department (ED) transitioning to twice weekly scheduled ED dialysis: Wilcoxon signed-rank test.

Dialysis protocol	EOD	Twice weekly	Difference	*P*-value
Hospitalization/month	1.44	0.26	1.18	.02
Hospital days	2.18	1.20	0.98	.04
Dialysis protocol	Twice weekly	Standard	Difference	*P*-value
Hospitalization/month	0.10	0.02	0.8	.002
Hospital days	0.31	0.08	0.23	.005

EOD, emergency-only dialysis.

Table 3. Hospitalization by time period.

Time Period	Total Admissions	ESRD	Medical Conditions	Surgical Conditions	*Subtotal*
Dialysis-related Conditions					
Period 1	241	231	4	2	237 (98%)
Period 2	112	66	9	8	83 (74%)
Period 3	47	6	3	20	29 (62%)
Non-dialysis-related Conditions					
Period 1	241		4	0	4 (2%)
Period 2	112		23	6	29 (26%)
Period 3	47		15	3	18 (38%)

ESRD, end-stage renal disease.

study, scheduled patients with no other acute complaints had a venous blood gas obtained on Day 1 to assess potassium and hemoglobin levels. Blood transfusions were administered for hemoglobin levels <7 g/dL. No additional labs or diagnostic testing were otherwise obtained unless dictated by patient condition or clinician concern. On Day 2 of scheduled dialysis, diagnostic testing was not obtained, unless dictated by patient condition or clinician concern. Dialysis was provided twice weekly regardless of whether the patient met criteria for emergency dialysis. None of the patients in our study received peritoneal dialysis. Our study did show significant reduction in hospitalization and overall number of hospital days when patients were switched to scheduled dialysis but, importantly, our study suggests that better access to healthcare and standard outpatient dialysis is optimal for patient health outcomes and resource utilization.

The study population was limited due to being conducted at a single site with a relatively low estimated number of eligible participants in the study area. It is estimated that approximately 95,000 undocumented residents reside in the state where the study took place.[19] Based on limited data, the estimated race-adjusted incidence rate of ESRD is nearly 500 cases per 1,000,000. This suggests that there are likely fewer than 50 undocumented immigrants with ESRD in the entire state.[5] Given our small sample size and skewed data, we employed the Wilcoxon signed-rank test to compare different dialysis protocols. A notable strength of this test lies in its nonparametric nature, which ensures robustness even when dealing with skewed distributions like ours. By allowing us to compare paired observations within the same individuals, the test effectively assessed changes in hospitalization rates and hospital days over time.

Table 4. Dialysis- and non-dialysis-related hospital conditions.

	Medical issues	Surgical issues
Dialysis-related conditions		
	Uremic pericarditis/pericardial effusion	AV fistula complications
	Bacteremia/endocarditis from infected tunneled dialysis catheter (TDC)	TDC complications requiring surgical intervention
Non-dialysis-related conditions		
	Severe infections	Ischemic gut
	Pneumonia	Amputation due to osteomyelitis
	Sepsis/septic shock	Orthopedic procedures
	Cardiovascular conditions	Parathyroidectomy
	Arrhythmia	Appendicitis
	Cardiac arrest	
	Acute coronary syndrome	
	Neurological conditions	
	Intracerebral hemorrhage	
	Subdural hematoma	
	Cerebral vascular accident	

AV, arteriovenous.

LIMITATIONS

This study has several important limitations that should be noted. Its retrospective design may have introduced biases and limited the ability to establish causality. With respect to adherence to methodological standards in medical record review,[20] our study had a single abstractor who was not blinded to the study hypothesis, which could have introduced bias into how the data were abstracted. Our study was limited only to patients who used the ED for dialysis for more than a 12-month period, which limits the interpretation of this data for patients who use ED-only dialysis as a short-term bridge to outpatient dialysis. In addition, our study was conducted at a single hospital in one state. Thus, the findings may not be generalizable to other healthcare systems or populations. As well, the relatively small sample size may have reduced the study's statistical power and external validity. Additionally, financial impacts were not assessed as part of this study. Lastly, we had limited data on potential confounders such as comorbidities, socioeconomic status, and access to healthcare. These uncontrolled factors could have influenced the observed outcomes. Future research should include a larger sample size, multiple healthcare settings, and account for potential confounders to enhance the validity and generalizability of the findings.

CONCLUSION

In this small, single-site retrospective study, the implementation of scheduled twice-weekly dialysis among undocumented patients with end-stage renal disease through the ED significantly reduced overall hospitalization rate and number of hospital days. Furthermore, transitioning to standard outpatient dialysis resulted in even greater reductions in hospitalizations and hospital days. Further research in this area, with a larger sample size and consideration of other potential confounding factors, would yield valuable insights into healthcare and resource utilization.

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Cognitive Frame and Time Pressure as Moderators Of Clinical Reasoning: A Case Control Study

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Introduction: Emergency physicians (EP) are uniquely positioned to benefit from a deeper understanding of cognitive bias, particularly in the context of limited processing time. The framing effect—the tendency to evaluate identical information inconsistently given varying methods of presentation— presents a particular challenge within emergency medicine (EM). Understanding how the presentation of clinical information affects medical decision-making is paramount, given variability in how information is received. In this study we aimed to assess whether the imposition of a cognitive frame and time pressure affected participants' differential diagnoses.

Methods: We recruited attending physicians in emergency medicine (EM) and third-year EM residents via email from our university hospital. They were asked to review two case vignettes: one consistent with pulmonary embolism (PE), the other with interstitial lung disease. Each vignette had two versions, one emphasizing features consistent with the respective diagnoses. Each pair of vignettes contained objectively identical clinical information. Subjects were randomly assigned to one of four conditions based on 1) the specific or non-specific-frame version of each case and 2) the inclusion or exclusion of time pressure. Subjects provided their top three differential diagnoses for each case. Our primary outcome measure was identification of intended diagnosis.

Results: A total of 39 subjects completed the study. Two-sided Fisher exact tests showed that varying cognitive frames affected the likelihood of EPs identifying PE as a diagnosis of interest (P = .01). Among EPs who identified PE, the likelihood of this diagnosis leading their differential diagnosis was also related to frame (P = .01).

Conclusion: The results of this work reveal that cognitive frame and time pressure may independently influence diagnostic reasoning among emergency physicians, bearing implications for medical education. [West J Emerg Med. 2025;26(4)1055–1061.]

INTRODUCTION

Diagnostic errors are a major source of preventable harm in medical care. Between 40,000-80,000 deaths result from misdiagnosis in the United States each year,[1] and approximately 5% of autopsies reveal a diagnostic error that, if identified during diagnosis, could have prevented the patient's death.[2] As of 2013, diagnostic error was the leading category of medical malpractice claims and accounted for the highest proportion of total payments.[3] As medicine advances, more viable therapeutic options become available when a condition is accurately diagnosed. A delay in implementing these options for management means that diagnostic error is more likely to allow for progression to an intractable stage of disease that might otherwise have been averted.[4]

A key and under-investigated source of diagnostic error is the framing effect. The framing effect is a type of cognitive bias that

manifests as the tendency to evaluate identical information inconsistently given varying presentation methods.[5] For instance, patients who are told that a procedure has a 5% mortality rate may be less likely to elect for a procedure than those who are told that 95% survive. This phenomenon presents a particular challenge to clinicians and significantly impacts patient care.[6-9] Although factors that exacerbate the framing effect in medical care are less comprehensively understood, reduced processing time may also negatively affect physician decision-making.[10]

Physicians may be especially susceptible to cognitive bias in the acute care setting,[11,12] possibly contributing to the high diagnostic failure rate in fast-paced, information-limited clinical specialties such as emergency medicine (EM). Previous literature suggests that diagnostic failure in EM ranges from 10-15% overall[13] and can reach up to 55% when assessing more elusive pathologies.[14]

Emergency physicians (EP) are expected to interview, examine, diagnose, and manage patients with a diverse spectrum of disease, while lacking the benefits of trust and history afforded to an established primary care physician. The acute nature of emergency department (ED) complaints means that patients may also not be able to provide accurate histories of present illness given varying levels of consciousness, increasing reliance on information filtered through the lens of other healthcare professionals.[15,16] The unpredictable and chaotic environment inherent to the typical ED makes these challenges still more difficult. Clinicians face pressure to integrate limited and ambiguous data to make simultaneous and rapid medical decisions about undifferentiated patients, and a single mistake can lead to downstream patient morbidity and mortality.[16,17]

A key source of cognitive bias is the misuse of heuristics—cognitive shortcuts. Although heuristics carry inherent limitations, they are necessary to efficiently practice EM.[13,18] As a result, the corresponding need for EPs to self-monitor for cognitive bias is paramount. Moreover, understanding the effect of time pressure on diagnostic accuracy is vital within medical specialties such as EM in which EPs must balance multiple patients simultaneously, and a delay in treatment could dictate life or death.[19]

While previous studies have assessed the isolated effects of the framing bias and time pressure on diagnostic reasoning, how the confluence of the two affects clinical acumen has not been previously uninvestigated. In this study, we evaluated these two factors in tandem to model the likely experience of an EP in daily practice. We asked EPs to evaluate hypothetical case vignettes and provide their top three differential diagnoses to investigate whether cognitive frame-attributed changes in differential diagnoses generated by EPs were exacerbated by limiting processing time.

Population Health Research Capsule

What do we already know about this issue?
Diagnostic error affects patient safety. Cognitive bias is a key source of error in specialties like emergency medicine in which time and information are limited.

What was the research question?
Does the imposition of a cognitive frame and time pressure affect participants' differential diagnoses?

What was the major finding of the study?
Varying cognitive frame, but not time pressure, affected the likelihood of emergency physicians identifying a diagnosis of interest (P = .01).

How does this improve population health?
Understanding factors that affect diagnostic reasoning is especially important when managing vulnerable patients for whom costly testing is not accessible.

METHODS

Study Design and Setting

This cross-sectional study was distributed electronically via an institutional Qualtrics account (Qualtrics International Inc, Provo, UT). We collected data over a two-month period between October–December 2021. The Thomas Jefferson University Institutional Review Board (IRB) approved the study (approval #21G.084). All experiments were performed in accordance with relevant guidelines and regulations (such as the Declaration of Helsinki). Informed consent was obtained from all subjects.

Participants were recruited using an email listserv of EPs at Thomas Jefferson University in the metropolitan Philadelphia, PA, area. Inclusion criteria included attending EPs and third-year EM residents who were employed at a hospital affiliated with the Jefferson Health System. Demographic information collected, including age range, sex, and years of post-residency practice, was not identifiable. Participants were enrolled via email and invited to complete the study at their convenience. A $20 prepaid debit card was offered to participants.

Interventions

To assess for cognitive bias, we used two cases from a New Zealand study related to cognitive bias by Popovich et al.[9] These cases, originally written to address complaints germane to emergency and internal medicine, were selected with the goal of replicating findings among a novel cohort of EPs while minimizing confounders. While interstitial lung disease (ILD) is not a commonly diagnosed pathology in American EDs, we incorporated both cases with the goal of

more broadly reproducing the authors' findings. We included a unique variable through the imposition of time pressure. Each case has two associated vignettes (four vignettes total), which we modified slightly to reflect American medical terminology and US conventional references, ranges, and units. After reading each vignette, participants were asked to provide their top three differential diagnoses.

The pair of vignettes associated with each case (Appendices 1 and 2) contain identical objective clinical information; the syntax varies, but each can be rearranged to reproduce the other. The difference between each pair of vignettes lies in whether the information emphasized features consistent with a specific diagnosis, namely, pulmonary embolism (PE) or ILD. Cases that emphasized features consistent with specific diagnoses like PE would highlight familiar clinical correlates (ie, buzzwords) that classically cue this diagnosis, such as recent surgery, "hemoptysis," "tachycardia") at the beginning of the case. In contrast, a control PE case would scatter the same findings throughout the vignette, with non-specific terminology, such as "blood-tinged sputum," "heart rate of 110 bpm," and "past surgical history of cholecystectomy." These differences constitute the operationalization of a framing effect.

To establish a feasible constraint for time pressure, we conducted a pilot study in which 11 EPs (excluded from the final study measurements) read the vignettes and provided their three most likely differential diagnoses. The time taken by each EP to read a vignette was measured as the difference between the time at which the text loaded and the time at which the EP advanced to the screen for diagnosis entry. Based on a review of the literature surrounding time pressure conditions for reading tasks,[20,21] participants in the time pressure arm were allocated 62 seconds via a countdown timer displayed at the bottom of the survey screen. The survey automatically advanced to the entry of differential when this time expired.

The figure shows the process flow chart associated with this study. For each of the two cases, participants were randomly assigned to one of four groups in Qualtrics based on 1) a specific-frame or nonspecific-frame vignette and 2) the inclusion or exclusion of time pressure. This led to a 2x2 design. We intentionally presented the case associated with PE first to all participants as we hypothesized that it would have greater relevance to EPs given the disease's life-threatening nature, thereby avoiding practice effects.

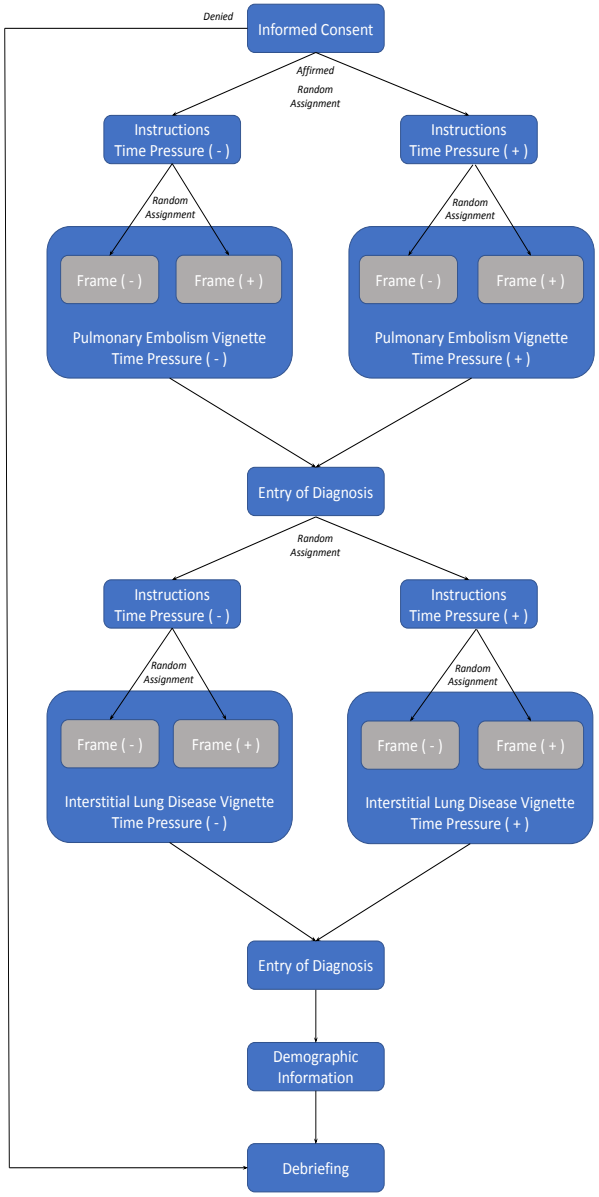

Figure. Participant process flow in a study of cognitive frame and time pressure as moderators of clinical reasoning.

Outcomes and Analysis

The primary outcome measure associated with each condition was the frequency with which EPs identified an expected diagnosis (PE for the first case; ILD for the second). The secondary outcome measure was the rank order for each recorded differential diagnosis. Two researchers (AM, XCZ) evaluated responses and recorded whether the disease suggested by the vignette appeared in the list of three diagnoses provided by each participant. Disagreements were resolved through consensus by study investigators. A diagnosis was scored based on whether it included the main component of the diagnosis or a commonly accepted abbreviation (eg, "PE" for pulmonary embolism). Disagreements were resolved through discussion. Using IBM Statistical Package for the Social Sciences (IBM Corp., Armonk, NY), we performed two-sided Fisher exact tests and unpaired *t*-tests to compare the groups.

RESULTS

Characteristics of Study Subjects

The study population included all EM attendings and third-year EM residents employed by Jefferson Health,

comprising approximately 120 physicians. In total, 48 physicians (40%) responded to our request, 39 of whom completed at least one case and 36 who completed both. Participants were permitted to exit the study at any time. Missing data were handled by omission from further analysis.

A total of 37 participants provided demographic information. The modal age ranges were 26-30 (11) and 31-35 (11). Twenty-four respondents (64.8%) identified as male and 13 (35.2%) as female; no respondents endorsed a non-binary gender identity. Twenty-seven respondents primarily identified their ethnicity as White (73.0%) or Asian (7, 18.9%). One participant self-identified as Asian and White; another did not identify with a category of ethnicity. Four respondents were residents (postgraduate year 3), and 33 were attending physicians. The range of post-residency years of practice was 0-35, with a mean (SD) of 7.4 (8.5).

Main Results

Across the two associated vignettes, only 9% of EPs identified ILD as a diagnosis of interest; accordingly, there were insufficient relevant responses from which to draw statistical conclusions. Beyond their nationality, it is unclear how our physicians differed from those who participated in the study conducted by Popovich et al,[9] who identified ILD at a rate of 52%, particularly since rates of identifying PE in the corresponding vignettes between our two studies were closer (82% in our study vs 78% in Popovich et al) Accordingly, we conducted our analysis of frame using data gathered from the PE vignette (39).

Two-sided Fisher exact tests (FET) showed that varying cognitive frames affected the likelihood of EPs identifying PE as the intended diagnosis in the corresponding vignettes (P = .01, FET). We did not observe an association between the application of time pressure and the appearance of expected pathology in the differential diagnosis (P = .09, FET). However, there was a significant difference between the time EPs took to generate a differential diagnosis when time pressure was imposed. A two-sample t-test revealed that those participants exposed to time pressure used significantly less time (t_{36} = 3.091, P <.01).

We conducted a subgroup analysis among 32 participants who identified PE as a diagnosis of interest. In this group, PE was more likely to be first on a part icipant's differential if exposed to a vignette with a specific frame (P = .01, odds ratio [OR]13.6, 95% confidence interval [CI] 2.2-85.9, FET). Similarly, PE was significantly more likely to be listed as the first diagnosis of interest by participants exposed to time pressure than by those who were not (P = .02, OR 13.0, 95% CI 1.4-121.4, FET). These results are summarized in .

We did not observe a significant relationship between the likelihood of identifying PE/ILD and age range or years of practice. Analysis when stratified by the presence or absence of time pressure was also unremarkable.

DISCUSSION

Our goal in this study was to investigate the effects of cognitive frame and time pressure on diagnostic reasoning. We hypothesized that the imposition of frame and time pressure would lead to observable changes in clinical reasoning. Based on the variation in differential diagnoses observed among EPs who assessed our case suggestive of PE, it seems that cognitive frame affects diagnostic reasoning. We further discovered that imposition of a cognitive frame may influence the order in which EPs noted an intended pathology in their differential diagnosis. We did not observe a relationship between time pressure and diagnoses provided.

Our results affirm the findings of Popovich et al that varied cognitive frames lead to significant differences in the generation of differential diagnoses. Emergency physicians were more likely to list PE as their first-line diagnosis when a frame toward PE was imposed. Although typically investigations are ordered to rule out any life-threatening pathologies in the ED, this finding may be most relevant in cases where time is most limited. When an EP must make a decision to initiate treatment quickly, accurately identifying the primary diagnosis of interest is critical. If reasoning can be swayed by frame and time pressure, it warrants considering whether a specific analytical approach might be consciously implemented in cases of the highest acuity.

We did not find a statistically significant relationship between time pressure and EPs' likelihood of identifying an expected diagnosis in their differential. One might expect EPs to default to heuristics and select a more easily retrieved diagnosis given the imposition of time pressure, and prior research has corroborated the logical suspicion that time pressure leads to impaired diagnostic reasoning.[10] However, other work showed that the two variables are independent. Norman et al[22] and Monteiro et al[23] each found that no differences in diagnostic accuracy emerged between groups who were asked to assess a case as fast or as thoroughly as

Table. Main results in a study of cognitive frame and time pressure as moderators of clinical reasoning.

	Likelihood of identifying intended diagnosis		Likelihood of identifying intended diagnosis first among differential	
Condition	*P*	*n*	*P*	*n*
Application of cognitive frame	.01	39	.01	32
Application of time pressure	.09	39	.02	32

possible, respectively. The variation among findings may be attributed to variations in experimental design, including the difficulty of the simulated cases and the intensity of time pressure imposed, and the experience levels and specialty training of participants.

At the core of this study is the principle that a clinician may arrive at a different conclusion if objective data are arranged or delivered differently. Emergency physicians commonly leverage external record-reviewing as a source of composite information about a patient's medical history, as they may not be able to recall or relay specific complexities of prior care. Diagnoses ascribed in prior visits provided rationale behind ambulatory referrals, and choices of narration in a hospital course are both crucial for understanding of patient care and influential in how a patient will be managed. Awareness of cognitive bias is crucial for physicians whose jobs are intractably tied to time constraints and limited information. Future studies might assess the role of cognitive bias based on whether physicians prioritize narrative text from others (eg, discharge summaries) or objective, documented data (eg, lab results) when receiving a patient.

Differential diagnosis is especially important in EM, where undifferentiated patients present for an initial point of care; moreover, the patients who receive primary care in the ED are often those who are the most vulnerable.[24,25] A broad differential diagnosis is critical for disposition planning and outcomes. Interestingly, an EP's differential can prime those physicians who later assume the patient's care, resulting in further unwarranted diagnostic momentum.[26]

The clinical paradigm affected by the framing bias includes a physician's cognitive services—what doctors can offer when diagnostic tests are not viable, whether for time, expense, or clinic resources.[27] As the number of uninsured individuals in the United States continues to increase,[28] a physician's capacity to diagnose without the use of costly studies remains critical. The expanding population of patients who stand to benefit the most from this research may be those who require immediate care and cannot afford comprehensive care.

Moreover, patients increasingly wish to be a part of decisions made about their care, a process known as shared decision-making.[29,30] Perceived misdiagnosis was found to be the most commonly reported complaint levied against EPs.[31] The results of this study affirm that it is incumbent upon the physician to not only successfully de-bias patient data while evaluating a case but also to present information in a way that does not impose a cognitive frame for the patient.

We would be curious to see how this effect bears out in a simulated session, in which information is presented verbally, as this would more accurately represent how information is processed in the clinical setting. If borne out in research, a logical next step from this work would be to explore how to mitigate diagnostic errors attributable to cognitive bias. Affirming evidence in this domain is somewhat limited. A recent review by Hartigan et al[32] explores a variety of strategies but notes that evidence supporting error reduction is thus far weak. For instance, while there is a strong theoretical background for using cognitive- forcing strategies,[33] they have, in practice, been shown to fail to reduce diagnostic errors.[34,35] Deliberate, guided reflection seems to be the debiasing strategy with the strongest empirical promise thus far[36,37]; however, future study is needed.

LIMITATIONS

The primary limitation of this study is its qualified verisimilitude to realistic decision-making processes in a clinical setting. In the ED, an EP may receive information verbally, through a narrative in text, as data in tabulated form, or, commonly, some combination of the three. Moreover, while patient information may be collected and refined in advance, as with our case vignettes, it may arrive in chunks, leaving the EP to process relevant data in real time. Susceptibility to frame may be weakened or exacerbated by this mutability of data presentation in the clinical setting.

This study presented data in text, which does not account for the complexities above and does not account for differing rates of reading or limitations such as dyslexia. Given the remote, asynchronous distribution of the survey instrument, neither were we able to discern whether other distractions were at hand and whether participants were allocating their full attention to the task, which might have affected both the differential diagnosis provided and time taken. A benefit of this approach is the removal of real-life confounders present in the typical ED, isolating the impact of the cognitive frame and time pressure over diagnostic reasoning. This is both a limitation with regard to clinical applicability and a strength with regard to studying the effects at hand.

Another limitation of this study is construct validity. While the core methodology of this paper reflects a previously published study to assess the framing effect, other cognitive biases and principles of reasoning are likely also at play. The availability heuristic, for instance, likely played a role in the ILD vignette, wherein the evaluating EP likely encountered a similarly presenting or mentally prominent case more recently. More broadly, the conditions of this study evoke thinking along the two prongs of dual-process theory, wherein System I is fast and intuitive and System 2 is slow and deliberate.[32] Although the intent of this work was to place emphasis on adjusting for frame, future work might examine the interplay between these constructs. Nuanced simulation cases might be better able to distinguish how EPs respond to cases when each is invoked individually.

Over the course of this study, it occurred to us that a more natural fit to study the framing bias within emergency care may be during sign-out rather than during the initial patient presentation. Framing is a significant aspect of transferring care of a patient between EPs, during which the departing physician elaborates upon their dominant line of thinking to alert the

incoming physician to key points in patient care. For instance, mitigation of frame in this context might include expanding one's presentation to include a differential. We propose further study to investigate how sign-out culture can be assessed and reformed within the context of this cognitive bias.

We also encountered unexpected difficulty with the EP evaluation of the case vignettes suggestive of ILD. We could not evaluate for effects related to the ILD cases given the low frequency of identification within differential diagnoses. While nitrofurantoin-induced ILD is a rare occurrence, it is reasonable to consider ILD as a differential diagnosis for non-specific pulmonary cases. The sample in the study from which the case vignettes were sourced[9] was able to recognize ILD with a frequency appropriate for inferential statistical analysis. One potential explanation is that our study included only EPs compared to a blended sample of emergency and internal medicine physicians. Diagnoses of ILD are typically made in the outpatient pulmonary setting. These patients may present to the ED undifferentiated with non-specific respiratory symptoms that require admission and inpatient evaluation after appropriate stabilization. While ILD may be the etiology of a medical emergency, it is not an issue that must immediately be ruled out in the ED; accordingly, it may not be front of mind among EPs. Future research using this case may also consider adjustment such that identification of ILD is more obtainable.

An important aspect of our pilot study was using pre-existing cases without altering their content, recognizing that some pathologies may not be as apparent to EPs as they are to internists. We prioritized the PE case given its clinical relevance to a cohort of EPs, by presenting it first to all physicians. This further ensured that practice and attrition effects would spare the data related to the assessment of PE. Future studies that assess for the framing bias would benefit from creating test cases tailored toward medical pathologies with the participants' specialty in mind rather than previously studied vignettes.

This investigation was a small, grant-funded, single-site pilot study. Our sample size was limited based on funding availability. A larger sample size might have strengthened existing findings or allowed investigation of those associations for which significance was not achieved, particularly the effect of time pressure upon diagnostic reasoning, which has previously been demonstrated among internal medicine residents.[10] Our original goal was to test for an interaction effect between cognitive frame and time pressure, but our sample size was insufficient. The study population of EPs additionally limits generalizability to other groups of clinicians.

CONCLUSION

Cognitive framing appears to influence both the likelihood of identifying a diagnosis and the order in which a diagnosis of interest is identified. This finding demonstrates an important source of diagnostic influence that clinicians must strive to mitigate. Future investigations should introduce a cognitive frame into a more realistic clinical situation via simulation or explore an alternative point of the care process, such as sign-out, while using cases tailored to the specialty of participants. Research into debiasing efforts is also critical to help diagnosticians avoid this cognitive pitfall.

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Outcomes of Copperhead Snake Envenomation Managed in a Clinical Decision Unit

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OBJECTIVES: Copperhead envenomations are the most common snakebite in the United States, and the majority are categorized as mild-moderate severity. The need for prolonged observation to monitor for signs of envenomation supports observation in a clinical decision unit (CDU). To our knowledge, no articles to date have reported on the clinical outcomes of patients managed in a snakebite CDU protocol.

METHODS: We performed a five-year structured, retrospective cohort study of adult patients managed in a single-center CDU, compared to a 10-year period of historical cohort managed inpatient at the same institution. Several clinical parameters were abstracted for comparison. The primary outcome was effective management in CDU observation as measured by length of stay (LOS), disposition, and documented return for care within the hospital system. Secondary outcomes were management comparisons between groups, as measured by LOS, frequency of antivenom use and vials administered, and surgical interventions.

RESULTS: The two cohorts included 59 patients on CDU observation protocol compared to 36 patients as historical inpatient management. Fifty-four patients (92%) were discharged from observation. Five patients converted to inpatient admission, mostly secondary to uncontrolled pain. After discharge, six patients in the CDU cohort (10.2%) returned for care within the network for wound checks and/or concern for extremity swelling; all were discharged. Compared to the inpatient cohort, patients managed in CDU observation had shorter LOS, less antivenom administered, and fewer surgical interventions.

CONCLUSION: Copperhead snakebites can be managed effectively in clinical decision unit observation. The majority of patients were discharged from observation with few return visits. Few patients required admission; those who did were secondary to pain control issues. Anticipated gains of CDU observation are shortened length of stay and lower resource utilization. [West J Emerg Med. 2025;26(4)1062–1069.]

INTRODUCTION

In the United States, approximately 4,700 native venomous snakebites were reported to poison centers in 2020, with very few deaths.[1] The majority of envenomations belong to the Crotalinae (crotalid) subfamily of Viperidae that includes rattlesnakes, cottonmouths, and copperheads. Of these, copperheads (genus *Agkistrodon*) are the most reported envenomation, and the majority of these envenomations (approximately 90%) are coded as minor or moderate outcomes, with only approximately 2% meeting the criteria for severe outcomes.[1]

At our institution in North Carolina, most patient presentations for snakebites are from the eastern copperhead (*Agkistrodon contortrix*). Compared to other pit vipers, copperhead envenomations are less severe, rarely causing hemodynamic compromise or clinically significant coagulopathy. The most common clinical finding is local tissue effect including swelling, ecchymosis, erythema, and/or pain.[2–4] Patients may present with minor tissue effects and subsequently develop significant signs of envenomation after a latent period. Additionally, for all snakebites, approximately 25% of envenomations are dry bites, such that no venom effects are seen.[5] Expert consensus recommends an observation period of at least eight hours to delineate dry bites, and 12-24 hours for minor envenomations.[6]

As most copperhead envenomations present with minor or no systemic symptoms and non-clinically significant hematologic effects, management is confined to treatment with antivenom based on tissue injury, pain control, and patient education. Based on expert consensus recommendations, even apparently dry or minor envenomations need prolonged observation. The need for prolonged observation and hemodynamic stability of this patient population makes it amenable to management in a clinical decision unit (CDU) snakebite-observation protocol. To our knowledge, no articles to date have reported on the utility and clinical outcomes of patients managed in a snakebite CDU protocol. Our objective was to provide descriptive data for clinical outcomes and management of copperhead bites in a CDU protocol and compare it to inpatient care outcomes. We performed a structured, retrospective chart review of patients managed in our CDU, which we then compared to an inpatient historical cohort.

Population Health Research Capsule

What do we already know about this issue?
Copperhead envenomations need a prolonged period of observation prior to disposition.

What was the research question?
We performed a retrospective chart review of copperhead envenomations to demonstrate effective management in a clinical decision unit (CDU).

What was the major finding of the study?
Copperhead bites managed in a CDU had a 92% discharge rate, most occurring < 24 hours with low return rates, and a 50% shorter stay compared to inpatient care.

How does this improve population health?
CDU observation for copperhead envenomation, the most commonly reported snakebite in the US, could result in shortened length of stay and decreased use of inpatient resources.

METHODS

The study design was a five-year structured, retrospective cohort chart review[7] of adult patients managed in a single-center CDU snakebite protocol (2013-2017), compared to a 10-year period of a historical cohort managed as inpatients at the same institution (2003-2012). We identified medical records as described below by querying the hospital electronic health records (EHR) database (Epic Systems Corporation, Verona, WI). This study was approved by the institutional review board.

Adult snakebite patients were considered CDU candidates based on copperhead identification by the patient, family member, or clinician and hemodynamic stability. We excluded patients with active comorbid illnesses CDU observation status based on predetermined criteria. Specific monitoring and treatment components of the protocol were designed based on review of published snakebite observational protocols and management algorithms, and expert consultation with two board-certified medical toxicologists (MW, JH). A specific observation order set was created for this population, and all advanced practice practitioners (APP) staffing the CDU were provided an educational module that reviewed treatment goals and monitoring parameters, indications for antivenom administration, goals of discharge, and follow-up care recommendations that included return precautions. The CDU clinicians could consult with local medical toxicologists and/or the regional poison center as desired.

For the CDU cohort retrospective chart review, the EHR was queried for patients managed with the ED/CDU snakebite envenomation observation order set. We abstracted the age and sex of patient, snake species identified, transfer status from a regional hospital, time from envenomation to initial presentation, location of injury, worst documented extremity swelling, systemic symptoms, laboratory values, antivenom administration, surgical intervention, total hours admitted, and final disposition (admitted to the hospital, discharged, left against medical advice). Abstracted systemic symptoms included the following: low blood pressure; chest pain; shortness of breath; nausea; vomiting; diarrhea; headache; diaphoresis; weakness; dizziness; and/or paresthesia. For all patients, an overall severity grading was assigned as per Table 1, based on the worst assessment of documented swelling, and consideration of hematologic and systemic symptoms. This grading scale is a minor modification of standard criteria, such that entire extremity swelling is categorized as severe.[8]

Table 1. Snakebite severity grading scale in a study of copperhead envenomations managed in a clinical decision unit vs. inpatient care.

Mild	Local swelling, pain, ecchymosis
Moderate	Swelling less than full extremity
	Non-life-threatening systemic signs (nausea, vomiting, etc.)
	Non-significant coagulation study abnormalities
Severe	Swelling of the entire extremity
	Systemic illness (AMS, severe hypotension, respiratory insufficiency, serious bleeding or significant coagulation abnormality)

AMS, altered mental status.

We use Crotalidae Polyvalent Immune Fab Ovine (FabAV) (BTG International Inc, West Conshohocken, PA) do not routinely administer maintenance FabAV vials for copperhead envenomation. Thus, for FabAV dosing, we abstracted total number of vials administered to gain control of envenomation (defined as cessation of continued tissue swelling), and any further vials administered. We recorded worst hematologic laboratory abnormalities. Acute hypersensitivity reactions (rash, urticaria, dyspnea, angioedema, hypotension) temporally related to administration of FabAV were documented. Additionally, we reviewed whether any patients discharged presented again at any of our network hospitals for concerns related to the envenomation and ultimate disposition. We excluded any patient who entered observation care and subsequently left against medical advice (AMA).

To determine patterns of care prior to use of CDU observation, we reviewed the records of adult patients admitted to the hospital over a 10-year period immediately preceding implementation of the snakebite observation protocol whose discharge diagnosis included "toxic effect of snake venom." This time frame was chosen as a convenience sample based on access to the EHR for data abstraction (Older patient encounters were not reliably identifiable from the predating EHR system.) Patients were identified by *International Classification of Disease*s Rev, 9 and 10 ICD-9 and ICD-10 codes, and patient data were abstracted for similar findings. We excluded any records with snake species identified as non-copperhead, left AMA during admission, or secondary evaluation for snakebite (not primary admission). Patients were admitted to a variety of services (ie, hospitalist, family medicine, or surgical specialty). Specialty consultation with local medical toxicologists and/or the regional poison center was available if requested by the inpatient clinician.

One author (AB), who was trained in the CDU protocol, management, and snakebite severity assessment abstracted the variables into a structured Excel spreadsheet (Microsoft Corporation, Redmond, WA). One of the authors who is a medical toxicologist reviewed an initial pilot of 15 charts to confirm accuracy of data abstraction. He periodically met in person with the abstractor to confirm training on assignment of envenomation severity grade, and ad hoc to resolve any questions in data abstraction. Any confounders or questions related to outcome measures were resolved by a second author, who is also a medical toxicologist. We included any case with missing variables in the analysis, and missing variables were noted in the statistical analysis.

The primary outcome of the CDU protocol was effective management of this patient population in CDU observation status. Typical ED CDU outcome metrics were chosen,[8] including length of stay (LOS), final disposition (discharge or inpatient conversion), and ED return for recheck after discharge (with final disposition) at the main or affiliate hospitals. Secondary outcome measures were comparisons between cohorts for the number of patients treated with antivenom, number of FabAV vials administered, LOS, surgical interventions, and return for recheck (with final disposition).

We analyzed the data using SAS 9.4 (SAS Institute Inc, Cary, NC). Chi-square test or the Fisher exact test were used as appropriate to compare frequencies of categorical variables between the CDU and historical cohorts. Medians and Kruskal-Wallis tests were used to compare continuous variables between groups. Formal power analysis was not performed, as the cohort size was fixed by the time intervals examined. An alpha of 0.05 was held to be statistically significant.

RESULTS

For the two cohorts, we screened all patient encounters for inclusion and exclusion criteria, resulting in encounters that were further chart reviewed, as shown Figure 1.

The two groups included 59 patients in the CDU cohort vs 36 patients in the historical cohort. Baseline demographics for patients and bite characteristics are shown in Table 2.

All evaluated parameters were balanced between groups, with no significant statistical difference between groups. While there were slightly more males and upper extremity bites in the historical cohort compared to the CDU cohort, these were not statistically significant. For the parameters of age and time since envenomation to presentation, the results were not a normal distribution; nonparametric analysis showed no significant difference.

Systemic symptoms and hematologic abnormalities are shown in Table 3.

For the primary outcome of effective CDU observation care, we reviewed observation LOS, disposition, and ED revisitation rates. The median LOS in observation care was 16 hours (see Table 4). For disposition, 92% of patients were discharged from observation. Five patients of moderate-severe clinical severity were converted to inpatient management: four patients secondary to continued pain (one patient with a severe lower extremity bite, three patients with moderate severity hand bites), and one patient secondary to temporary closure of the CDU. No patient received further antivenom administration as an inpatient. Of patients discharged home

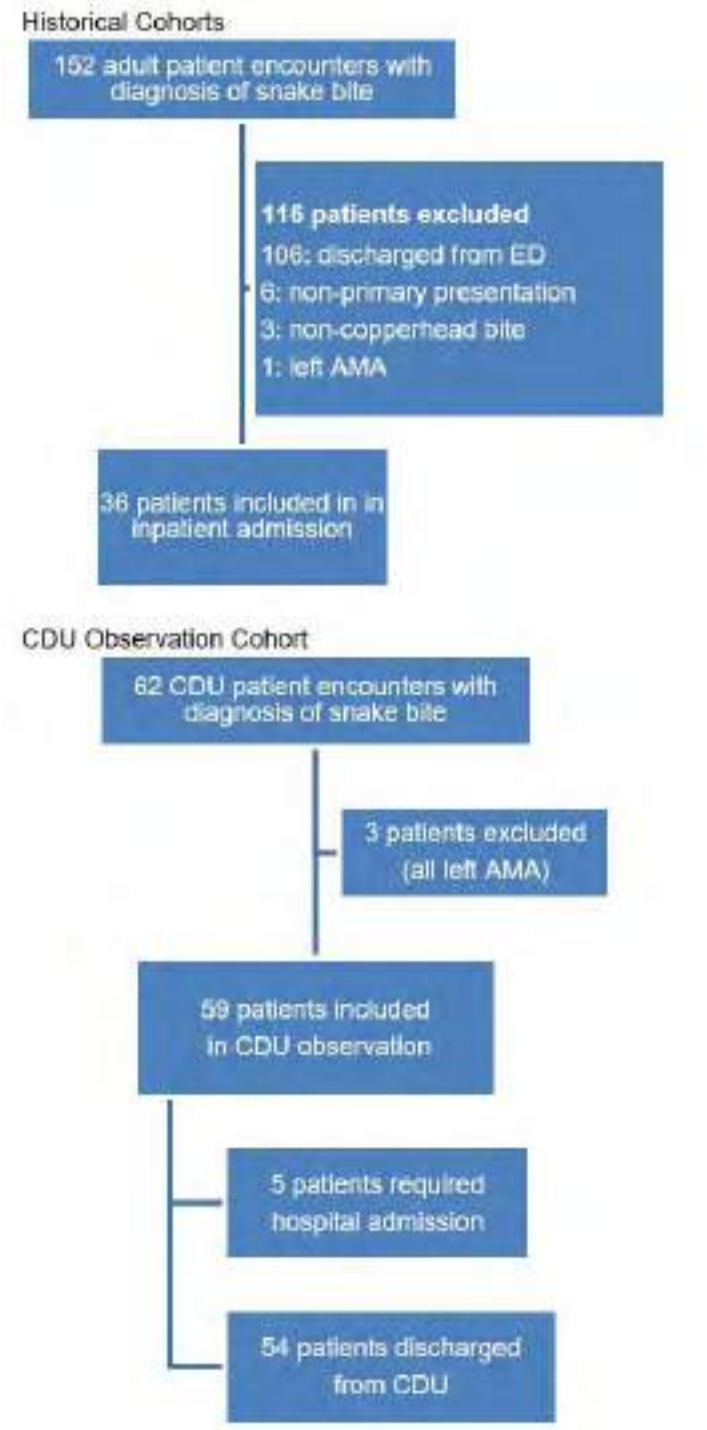

Figure 1. Patient encounters screened in a study of copperhead envenomations managed in a clinical decision unit vs. inpatient care. *ED,* emergency department; *CDU*, clinical decision unit; *AMA*, against medical advice.

from the CDU, 10.2% returned to one of our network emergency departments (ED) for wound check and/or concern for extremity swelling. All exams were uncomplicated and reassuring, and all patients were discharged from the ED. We had one minor deviation from protocol conditions in which a nonstandard dosing of antivenom (three vials) was administered as no more was available at the affiliate hospital at time of the infusion. Per protocol, no patient automatically received maintenance dosing of antivenom. One patient received a subsequent dose of two vials of antivenom for treatment of recurrent envenomation symptoms.

When comparing secondary outcome measures between the cohorts, it became apparent that the inpatient historical cohort had a higher percentage of moderate and severe envenomations. The overall distribution of clinical severity categorized as mild, moderate, or severe between the CDU cohort vs the historical cohort were 30.5%, 52.5%, and 17.0% vs 8%, 75%, and 17%, respectively. Because of this uneven distribution, all comparisons between cohorts incorporated clinical severity.

Initial comparison between cohorts included the frequency of FabAV administration and number of vials administered. The total number of patients that received FabAV, stratified by severity of envenomation and treatment group, is shown as frequency of FabAV administration in Table 5.

Overall, FabAV was administered less frequently in the CDU cohort compared to historical cohort (45.76% vs 77.78%). To account for the unequal clinical severity distribution between cohorts, a secondary analysis (not represented) that excluded mild envenomations from the CDU cohort found no significant difference in the number of patients treated with FabAV between cohorts (63.41% of CDU cohort vs 75.76% historical cohort, $P = .25$). Further analysis based on clinical severity showed that compared to historical cohort, patients cared for in the CDU cohort were significantly less frequently treated with antivenom in the mild and moderate groups (Fishers exact test, $P < .01$ and $P = 0.02$, respectively), and more frequently treated with antivenom in the severe group (Fisher exact test, $P = 0.04$).

Additional comparisons between cohorts included LOS, surgical interventions, and return for recheck. Length of stay for observation in the CDU vs inpatient LOS is represented in Table 4. When comparing LOS between the CDU cohort vs the historical cohort, the median LOS in hours (hrs) was statistically significantly shorter (16 vs 32 hrs, respectively, Kruskal-Wallis, $P < .001$). Even after mild envenomations were excluded from analysis, the LOS remained significantly shorter for the CDU cohort compared to the historical cohort (Kruskal-Wallis, $P < .001$). When reviewing LOS stratified by envenomation severity, the CDU cohort LOS was significantly reduced for mild and moderate envenomation compared to historical cohort (see Table 4). While severe envenomation LOS in the CDU group was slightly shorter, this was not statistically significant.

Four cases of surgical interventions occurred in the historical cohort: two incision and drainage of hand bites with wound vac placement, and two decompressive fasciotomies of upper extremities. No patients in the CDU protocol group received surgical intervention. When comparing second ED visits for wound check, there was no statistically significant

Table 2. Patient demographics and characteristics in a study of copperhead envenomations managed in a clinical decision unit vs. inpatient care.

Characteristics	CDU Cohort	Historical Cohort	Statistical Difference P-value
N	59	36	
Male, N (%)	34 (57.63)	26 (72.22)	.15†
Age, median year (range)	41 (20 – 86)	47.5 (19 – 82)	.35‡
Time since envenomation, median hour (range)	2 (0.25 – 28)	3* (0.5 – 30)	.11‡
Transfer from OSH, %	35.59	41.67	.55†
Anatomic bite location, N (%)			.28†
Upper extremity	31 (52.54)	23 (63.89)	
Lower extremity	28 (47.46)	13 (36.11)	
Snake type identified, N (%)			.81†
Copperhead	48 (81.36)	30 (83.33)	
Unknown	11 (18.64)	6 (16.67)	

†Chi-square test, ‡Kruskal-Wallis test.
*Time could not be determined in one patient based on chart review .
CDU, clinical decision unit; *OSH*, outside hospital.

difference between cohorts with six (10.2%) CDU cohort patients vs two (5.56%) historical cohort patients returning to the ED. In both cohorts, all patients were discharged, and no specific interventions were provided.

DISCUSSION

To our knowledge, no previous publication provides descriptive outcomes of snakebite patients managed in a CDU protocol or compares management outcomes to similar type of envenomation managed in inpatient care. Copperhead envenomations are the most common snakebites at our institution and are usually devoid of clinically significant bleeding or systemic effects. Expert consensus recommends a prolonged period of observation of snakebites prior to disposition. For copperhead bites, the goals of care focus on monitoring of tissue effects, treatment of pain, and administration of antivenom when indicated. Thus, copperhead bites are good candidates for CDU observation.

Table 3. Systemic symptoms and hematologic abnormalities in a study of copperhead envenomations managed in a clinical decision unit vs. inpatient care.

Symptoms	CDU Cohort N (%)	Historical Cohort N (%)
Nausea	12 (19.7)	2 (5.6)
Vomiting	2 (3.3)	1 (2.8)
Chest tightness or pain	2 (3.3)	0
Dyspnea	1 (1.6)	0
Hypotension	2 (3.3)	1 (2.8)
Headache	2 (3.3)	0
Dizziness	4 (6.6)	0
Platelet count < 150/ mL	7 (12.7)*	4 (7.3)**
INR >1.2	5 (9.1)*	6 (17.1)**
Rash post FabAV	0	3 (8.3)

*Data available for 55 of 59 patients, **Data available for 35 of 36 patients.
Gastrointestinal effects were the most common systemic effect, occurring in 20% of CDU patients. A minor number of patients had other systemic symptoms. A small number of patients had abnormal prothrombin time and/or abnormal platelets. No cases of hematologic abnormalities were clinically significant.
CDU, clinical decision unit; *FabAV*, Crotalidae Polyvalent Immune Fab Ovine.

Based on a five-year review of CDU observation data, copperhead bites can be effectively managed in a CDU protocol. The standard time for ED CDU observation care is <24 hours, and most studies show that the approximate LOS for observation care is approximately 15 hours. A general guideline for observation care is a discharge rate of 80% with inpatient conversation of 20%.[9] In our CDU cohort, the majority (92%) of patients were discharged from observation care with a median LOS of 16 hrs, and all patients deemed stable for discharge were dispositioned < 24 hrs. Of the five patients converted to inpatient admission, the indication for admission was for continued pain management or unanticipated closure of the CDU. In review of the charts of patients admitted for pain, onr patient had a severe lower extremity bite, and three had moderate severity hand bites. None required further antivenom or specific interventions. After discharge, few patients (10.2%) bounced back within the network hospital system for re-evaluation of their snakebite wound or extremity swelling. All patients had reassuring exams and were discharged from the ED without intervention. We did not have any readmissions within our network hospitals after discharge. We had minimal deviation from the condition-specific treatment protocol.

Comparing the CDU cohort to the historical inpatient cohort, the most clinically impactful finding was that patients

Table 4. Length of stay in a study of copperhead envenomations managed in a clinical decision unit vs. inpatient care.

Severity	CDU Cohort LOS hours, median (range)	Historical Cohort LOS hours, median (range)	Statistical Significance*
All	16 (2.3 – 105.5)	32 (13.5 – 94.5)	*P* < .001
Mild	9.9 (2.3-22)	32.5 (16 – 70)	*P* = .01
Moderate	18.5 (6.8- 105.5)	36 (14 – 94.5)	*P* < .001
Severe	21.1 (11 – 85)	23.6 (13.5 – 66)	*P* = 1

*By Kruskal-Wallis test.
LOS, length of stay; *CDU,* clinical decision unit.

managed in CDU observation had a statistically significantly lower LOS. For all patients, the CDU observation cohort vs historical inpatient cohort LOS was 16 hrs vs 32 hrs, respectively. Even after adjusting for the larger proportion of mild envenomations in the CDU observation cohort, the LOS remained significantly shorter for the CDU cohort compared to the historical cohort. Despite this decreased LOS, there was no statistically significant difference between cohorts for patients returning to the ED for wound check or wound complications. While we found other interesting statistically significant findings, such that CDU patients were significantly less likely to receive antivenom for mild-to-moderate envenomation, and more likely to receive antivenom for severe envenomations, the clinical significance is unknown. This could be related to a more unified care practice delivered in the CDU secondary to protocolized care and APP training. Of note, both cohorts had availability to specialized consultation with medical toxicologists and/or local poison center, under the discretion of the cinician directing patient care.

Our CDU observation patient population aligns with published snakebite victim demographics. As in other studies, most snakebite patients were male, with predominantly upper extremity bites.[2,10] As previously published, gastrointestinal symptoms were the most common systemic effect after copperhead bites,[2] although we did not track whether symptoms occurred in relation to opioid administration. We found low rates of minor coagulopathy, consistent with published literature for copperhead bites.[2] Based on our modified severity grading, 30.5%, 52.5%, and 17% were classified as mild, moderate, and severe, respectively. Direct comparison to other published copperhead envenomation is difficult secondary to non-uniform scoring of extremity swelling and grading of overall clinical severity. In one retrospective poison center study, 33% of admitted copperhead bites developed swelling of greater than half of the envenomated extremity.[11] A second retrospective study of southern copperhead bites found that 85% of patients developed only local swelling.[10] By comparison, our patients trended toward a more severe envenomation based on local tissue injury.

General recommendations for FabAV administration include progressive signs or symptoms after a crotaline snakebite.[6] The package insert recommends initial dosing of 4-6 vials, to be repeated until control has been achieved, followed by maintenance therapy (2 vials every 6 hours for 3 doses).[12] Maintenance vials are not routinely administered at our institution for copperhead envenomations, and the use of empiric maintenance therapy varies across institutions.[6] Forty-six percent of our protocol patients were treated with FabAV; the median dose of antivenom to obtain control was four vials [range 3-14 vials]. In comparison, a 2007 poison center study showed that approximately 36% of copperhead bites were treated with antivenom, with the trend of increasing administration over the study period.[13] A 10-year review of copperhead snakebites reported to Ohio poison control centers through 2016 showed that 45% of patients were treated with antivenom and the frequency of antivenom use did not increase over time.[14] In contrast to poison control center data, a recent hospital-based retrospective review

Table 5. Frequency of FabAV administration stratified by cohort and severity in a study of copperhead envenomations managed in a clinical decision unit vs. inpatient care.

Severity	All patients receiving FabAV/ Total patients (%)	CDU patients receiving FabAV/ Total patients (%)	Historical patients receiving FabAV/ Total patients (%)	OR (95% CI)†	P-value
Mild envenomation	4/21 (19.1)	1/18 (5.6)	3/3 (100.0)	0.06 (0.01-0.37)	<.01*
Moderate envenomation	40/58 (69.0)	17/31 (54.8)	23/27 (85.2)	0.21 (0.06-0.76)	.02*
Severe envenomation	11/16 (69.0)	9/10 (90.0)	2/6 (33.3)	18 (1.24-260.92)	.04*
All envenomation	55/95 (57.9)	27/59 (45.8)	28/36 (77.8)	0.24 (0.09-0.62)	< .01†

† OR with 95% CI reflects change since protocol implementation, *Statistically significant difference by Fisher exact test, † Statistically significant difference by chi-square test.
FabAV, Crotalidae Polyvalent Immune Fab Ovine; *CDU,* clinical decision unit; *CI,* confidence interval; *OR,* odds ratio.

looking at predictors of FabAV use in copperhead envenomation found that 75% of patients received antivenom with a median number of 10 vials given.[15] For copperhead envenomations, total FabAV to obtain control typically averages 4-6 vials (range 4-10).[2,4,16] An incidental finding was the low rate of reaction to antivenom, similar to recent published rates for FabAV.[17,18]

Using ED CDU observation care for snakebite management resulted in significantly lower LOS compared to LOS reported in the literature. In one retrospective study of admitted copperhead envenomations, patients with swelling of less than half of the envenomated extremity or greater than or equal to half of the envenomated extremity, LOS was 1.7 days (range 1-5) or 3.5 days (range 1-7), respectively.[11] In a separate study of admitted copperhead envenomations, average LOS was 40 hrs.[4] In the North American Snakebite Registry, approximately 44% of copperhead bites were admitted for less than 24 hrs.[2] Our findings support utilization of CDU observation for copperhead envenomations to minimize inpatient resource utilization and decrease LOS.

An additional potential benefit of CDU observation care is that APPs develop expertise in managing snakebites. Our APPs' comfort level and clinical judgment has increased though years of care delivery for this diagnosis. In the absence of a CDU observation, patients may be admitted to a wide range of care units under a variety of services. As a result, clinicians are often uncomfortable taking care of patients with snakebite envenomations given the low frequency of bites overall.

LIMITATIONS

This study has all the limitations of a retrospective chart review and includes only adult patients. During construction of the review, the abstractor was not blinded to case assignments. While the abstractor met with the author to resolve questions, we did not sample charts for expert interobserver reliability. Patients and/or family members identified the snake type, and in some instances the snake type was unknown. However, based on epidemiologic data for our area, copperhead envenomation was most likely. While there may be geographic variation of venom within the species,[19] our results are likely generalizable to copperhead bites in other regions of the US. Despite a protocol-driven guideline for treatment, there is clinician variance in administration of FabAV, particularly in moderate envenomations.

Additionally, CDU observation excluded patients with active comorbid illness (eg, uncontrolled diabetes), and this may have impacted our comparison results, specifically LOS. There are several limitations in the historical cohort comparison. We did not track comorbid illness and/or chronic medical conditions that might impact outcome comparators, especially LOS. Additional limitations of interpreting the comparison to historical inpatient cohort include that FabAV administration was not protocolized, that clinical observations were likely under-reported, and there were very few mild envenomations. We suspect that many of the envenomations were observed in the ED, classified as mild, and subsequently discharged; thus, this population would not have been captured in our study design and possibly introduced bias into the results. We attempted to account for the heterogeneity of the data in our statistical analysis by taking into account the worst recorded severity of envenomation during comparisons.

For both cohorts, consultation with local poison control and/or medical toxicology was at the discretion of the admitting clinician. Thus, although specialty resources were available for both cohorts, differences in LOS and/or frequency of FabAV administration may have been impacted by resource utilization for the CDU cohort, including protocolized care, education of APPs providing observation care, and/or medical toxicology consultation. Therefore, our CDU outcomes might not be applicable to all institutions. While our CDU dataset does not extend beyond 2017, we do not believe that this significantly impacted our findings. We have not made changes to our CDU protocol since onset, our regional indication for FabAV administration and/or dosing has not changed, and expert guidance for snakebite management has not significantly altered.

CONCLUSION

Based on our review, copperhead snakebites can be effectively managed in ED CDU observation care using outcome measures of LOS and low rate of conversion to inpatient admission. In our observation unit, we discharged the majority of patients from observation care within 24 hours. Patients who were admitted after observation were admitted for pain control only. We had few patients return for care within our network hospital system after discharge for re-evaluations of their wounds; all were discharged from the ED after reassuring examinations without specific interventions. Anticipated gains of ED CDU observation care for copperhead bites include shortened length of stay and decreased utilization of inpatient resources.

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Low Frequency, High Complexity: Assessing Skill Decay in Transesophageal Echocardiography Post-Simulation Training

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Introduction: Resuscitative transesophageal echo (rTEE) is a promising adjunct to cardiac arrest resuscitation. However, it is a high-acuity diagnostic tool that is rarely used in this setting and its safety establishment is limited because of low occurrence. High-acuity, low occurrence skills such as rTEE during cardiac arrest inevitably decay. In this study we examined the content and percentage of rTEE skill decay following simulation-based education (SBE).

Methods: Resuscitative TEE-naïve emergency physicians (EP) were trained using a combination of clinical exposure, web-based didactics, and monthly hands-on sessions with a high-fidelity rTEE simulator for four months. The COVID-19 pandemic created a natural wash-out phase where EPs did not perform any actual or SBE for six months after initial training. Unadvertised assessment of rTEE skill occurred at month 6 after rTEE training to test skill decay and at month 7 to determine the effect of spaced repetition. One year later, the EPs completed a questionnaire assessing rTEE comfort. Statistical measures were used to measure skill decay.

Results: Seven EPs were individually evaluated in four domains: name recall; probe manipulation (rotation); probe manipulation (omniplane); and image acquisition adequacy. At the end of training, all participants reached a full proficiency score of 32. At month 6, the mean score was 19 of 32 (SD ±7), reflecting a 41% decay (95% confidence interval (CI) -54%, -27%; $P < .001$) for eight standard rTEE views. Following spaced repetition at month 7, the median score improved to 26 (IQR 23-30), representing a 19% decay (95% CI -35%, -4%; $P < .02$). For the three guideline-recommended views, the overall decay percentage was 26% (95% CI -36%, -16%; $P < .001$), although image acquisition skills did not show significant decay. Spaced repetition resulted in a 23% increase in mean scores (95% CI 9-37%), and the average time to obtain all eight rTEE views decreased from 7.3 minutes at month 6 to 5.7 minutes at month 7.

Conclusion: After focused, proficiency-based SBE in rTEE, hands-on image acquisition skills showed the least decay compared to name recall and probe manipulation. Spaced repetition mitigated decay over one month, although not back to baseline. [West J Emerg Med. 2025;26(4)1070–1077.]

INTRODUCTION

Resuscitative transesophageal echocardiography (rTEE) is being explored as a potential tool to enhance cardiac arrest management in the emergency department (ED) by providing real-time cardiac imaging.[1-4] Although preliminary evidence suggests rTEE may improve clinical decision-making, minimize interruptions to chest compressions, and offers better diagnostic images, its benefits in cardiac arrest remain preliminary and inconclusive.[5-7] As rTEE skills are not typically taught in traditional emergency medicine curricula, structured training is necessary, especially post-residency, to reduce skill decay and optimize clinical use.[8-10,11] Our department intended to incorporate TEE into cardiac arrest management, and as part of this initiative, we began training to assess the logistics of implementation, including content, time requirements, and the need for refresher training.

Skill decay, a well-documented but often overlooked issue, refers to the reduction in performance over time and is influenced by factors such as skill complexity and frequency of use.[12,13] Decay is used to describe the reduction in performance from baseline across time points, with percentages indicating the relative decline in assessment scores. Many factors contribute to the rate of skill decay, including the complexity of the skill, frequency of skill repetition in the workplace, and mastery level of skill performance.[14-16] While simulation-based education (SBE) improves rTEE skills in novices, less is known about long-term retention and the ideal timing for retraining.[17-22] Therefore, our primary objective was to assess the decay of rTEE image acquisition skills over time and evaluate the impact of repeated SBE on skill retention.

Population Health Research Capsule

What do we already know about this issue?
Resuscitative transesophageal echo (rTEE) is a promising but underused tool in cardiac arrest resuscitation, with limited research on skill decay and safety.

What was the research question?
How does simulation-based education affect rTEE skill decay in emergency physicians?

What was the major finding of the study?
At month 6, we found a 41% decay in rTEE skills ($P < .001$); spaced repetition reduced decay to 19% ($P < 0.02$).

How does this improve population health?
Improving rTEE skill retention in emergency physicians could enhance cardiac arrest outcomes through better diagnostic capabilities.

METHODS

Study Design and Setting

This was a single-group, pre/post-test natural experiment study design made possible by the COVID-19 pandemic. The study took place at a quaternary-care academic center with over 300 annual cardiac arrests and 70 emergency physician (EP) faculty. Prior to the study, rTEE was not performed by EPs in our institution and endorsement to incorporate rTEE into cardiac arrest was newly disseminated from the American College of Emergency Physicians (ACEP).[5,23] Eligible subjects received no prior targeted rTEE educational exposure, indicated interest in rTEE during cardiac arrest, and agreed to monthly educational exposures for a period of four months. Subjects with prior transthoracic echocardiography experience in the ED (standard at our institution) were recruited.

Baseline

At the outset of this study, volunteering participants had limited exposure, skills, or knowledge regarding rTEE at baseline. Due to lack of familiarity with any rTEE principles, we performed no assessment of skills as it was presumed to be negligible to meet eligibility criteria.

Education Program

This pilot rTEE education curriculum was developed at our institution by incorporating combined elements of educational theory and exemplars of training from other specialties, such as anesthesiology and surgery.[24-26] The multimodal training program was organized into clinical introduction, synchronous didactics, and simulator training.

Clinical Introduction and Asynchronous Didactics

Clinical rTEE introduction in the intensive care unit or operating room involved observation of clinical rTEEs with the opportunity to manipulate the probe under the supervision of clinical experts. Asynchronous didactic content was based on the Toronto General Hospital Department of Anesthesia Perioperative Interactive Education library available on its website (pie.med.utoronto.ca/rTEE/index.htm) and HeartWorks pathology modules (Inventive Medical Ltd, London, UK; now owned by MedaPhor Group).[27]

Monthly rTEE Simulator Criterion Based Proficiency Training

The HeartWorks rTEE was used in this study for spaced repetition (Figure 1, Image from https://www.intelligentultrasound.com/heartworks/**)**. Spaced repetition is defined as separation of training into several discrete sessions over a prolonged period with measurable intervals between training sessions. The training instructor emphasized probe manipulation and repeated acquisition of the required images performed in the same order every time. The rTEE instructor

Figure 1. HeartWorks rTEE high fidelity simulator.
rTEE, resuscitative transesophageal echo.

is board certified in critical care echocardiography and passed the National Board of Echocardiography Examination for Special Competence in Adult Echocardiography examination.

Eight rTEE views were selected for training based on high-yield anticipatory imaging during cardiac arrest and testing including three critical views recommended by ACEP to be used in the ED during cardiac arrest.[10] The eight views, which represent basic images for rTEE basic certification, are as follows: 1) mid-esophageal four-chamber (ME-4C); 2) mid-esophageal aortic valve short axis (ME AV SAX); 3) mid-esophageal right ventricular inflow-outflow; 4) mid-esophageal bi-caval views; 5) mid-esophageal two-chamber (ME 2C); 6) mid-esophageal long axis view (ME LAX); 7) transgastric left ventricle short axis (TG SAX),;and 8) upper esophageal aortic long- and short-axis views. The ACEP guideline-recommended views were defined as the ME-4C, the ME LAX, and the TG SAX.

Skill Assessment

Manual skills and image knowledge were assessed monthly on the simulator via direct observation by an rTEE expert until criterion-based proficiency was achieved. Proficiency was defined as the errorless acquisition of eight adequate rTEE views on cue, including correct identification of anatomical targets, transducer omniplane setting, and probe rotation. The same rTEE instructor assessed proficiency each month. Training continued for four months, even after proficiency was met. By the end, all seven participants demonstrated the ability to acquire eight adequate views on demand, correctly naming each view, omniplane, and probe rotation.

We developed a checklist-based assessment tool to assess rTEE skill. The rTEE assessment score (see table, Supplemental Digital Content 1, which shows rTEE assessment variables) consisted of eight views or structures. There were four domains and the maximum score achievable was 32 points. Participants were awarded 1 point per domain (view named, probe adjustment described [rotation and omniplane], and simulated image obtained without instruction) and 0 points if elements were not obtained, respectively. No accessory recall tools, assistance, or feedback were provided during the assessment. The time to completion of the entire examination was recorded by the same training instructor supervising the study.

Intervention

The COVID-19 pandemic created a six-month wash-out phase to study decay where EPs were unable to use rTEE on actual patients immediately after reaching criterion-based proficiency on a rTEE simulator. No further didactics, workshops, or SBE related to rTEE occurred during the six-month wash-out period. Participants were evaluated immediately after the wash-out period (month 6 after training) and one month later (month 7) to assess the impact of spaced repetition by SBE. Following the guidance from the COVID-19 pandemic that research studies should limit face-to-face interactions during the crisis, the rTEE assessment was conducted by the same rTEE expert who provided the didactic training using the HeartWorks simulator.

Primary Outcome

Unadvertised scoring of rTEE skill occurred after the six-month natural interruption caused by the COVID-19 pandemic. For the purposes of the study, we defined decay as the difference between full proficiency (a score of 32 points on

our assessment tool) and the six-month assessment score. At month 7, scoring was repeated to determine a spaced repetition effect. Participants were unaware in advance of the assessments and were blinded to the results of the other participants. Performance results from the assessments were not reviewed with participants.

Secondary Outcomes

Guideline Based Windows

We calculated the decay scores focused on three windows recommended by the ACEP published guidelines in cardiac arrest since this was the primary focus of rTEE in the ED.[10] We also timed each participant using the simulator's built-in timer.

Survey Development & Dissemination

We developed a 16-item questionnaire using a Likert scale to assess participants' comfort with naming, describing, or performing rTEE views after SBE. One-year post-training, EPs were invited to complete the survey online, using REDCap electronic data capture tools hosted at Washington University School of Medicine. The survey, with no compensation offered, was pilot tested by two EPs (CM, DT) for relevance, clarity, and time to complete. The final survey is available in Supplemental Digital Content 2. Responses were linked to recall assessments, focusing on comfort with the eight rTEE views, SBE's impact on comfort, and its translation to independent performance and teaching.

Statistical Analysis

To assess skill decay, we compared rTEE naming, probe manipulation, and simulator view assessment scores at full proficiency, month 6, and month 7. Scores at month 6 were compared to baseline proficiency, and scores at month 7 were compared to both baseline and month 6. We analyzed continuous variables using the Wilcoxon signed-rank test, with results presented as mean scores and standard deviations. Categorical variables are presented as percentages. A repeated measures analysis with fixed effects was used to evaluate differences in image acquisition success between assessments at month 6 and month 7. We compared time to complete the simulation between month 6 and month 7 using appropriate statistical methods. All tests were two-sided at a 5% significance level, conducted using SAS 9.4 (SAS Institute Inc., Cary, NC).

Survey data were exported from RedCap and analyzed with descriptive statistics. For ordinal data, we calculated median and interquartile range (IQR), and for continuous data, means with 95% confidence intervals (CI) were used. The Kendall tau correlation assessed the relationship between performance on the image acquisition test and participants' comfort levels

The study was approved by the institutional review board. The material support was provided by departmental funding and consisted of educational website didactics and a rTEE Simulation Center. Manuscript preparation was conducted following the Consensus-Based Checklist for Reporting of Survey Studies (Table, Supplemental Digital Content 3, which shows the CROSS checklist),[28] and STROBE[29] guidelines (Table, Supplemental Digital Content 4, which shows the guide).

Sample Size

We hypothesized a 30% decline in each participant's rTEE score using our assessment tool (four assessed domains: name recall, probe omniplane, probe rotation, and image acquisition

Table 1. Decay scores after a six-month washout and the effect of an interspaced learning intervention.

Time Interval Between Full Proficiency (score of 32) and Re-assessment	Mean Score (±SD)	Mean Score Decay[1] (%) (95% CI)	*P*-value
8 Views[2]			
6-month score	19 (7)	-41 (-54, -27)	<.001
7-month score (following spaced repetition)	26 (4)	-19 (-35,-4)	.02
Score following spaced repetition (7 month vs 6 month)	n/a	23 (9, 37)	.003
3 Views[3] **(Guideline Recommended)**			
6-month score	9 (2)	-26 (-36,-16)	<.001
7-month score	11 (1)	-8 (-19, 2)	.10
Score following spaced repetition (7 month vs 6 month)	n/a	18 (8, 28)	.002
6-month image acquisition score[4]	3 (0)	0 (-8, 8)	1.00
6-month naming score[4]	2 (1)	-29 (-51, -6)	.02
6-month probe adjustment score[5]	4 (1)	-38 (-52, -23)	<.001

[1]Negative score indicates decay,
[2] Maximum score 32 (includes naming, omniplane manipulation, probe rotation, and image acquisition).
[3] Maximum score 12 (includes naming, omniplane manipulation, probe rotation, and image acquisition)'
[4] Maximum score 3.
[5] Maximum Score 6.

adequacy, with a maximum possible score of 32 points) at month 6. Our rationale was that a 30% decay would reflect a relevant decline in performance requiring intervention. We conducted a Wilcoxon signed-rank test for matched pairs with 90% power and estimated that seven EPs would be needed to detect a significant effect, assuming one participant might decline re-testing.[15,30,31]

RESULTS

A total of seven EMPs participated in the study, achieving full proficiency in February 2020, after four months of training. The participants included four females and three males, holding academic faculty appointments as clinical instructors (n=2) and assistant professors (n=5). All were proficient in transthoracic echocardiography (TTE) but novice in transesophageal echocardiography. Five participants had completed an emergency ultrasound fellowship.

Decay Scores and Effect of Spaced Repetition

Table 1 shows the decay scores for all eight rTEE views at months 6 and 7, as well as the effect of spaced repetition. At month 0 (end of training), full proficiency is achieved, and performance score is 32/32. At month 6, there was a 41% decay in performance compared to baseline proficiency, and a 19% decay at month 7. For the three ACEP guideline-recommended rTEE views, a 26% decay in performance was observed that reduced to 8% at month 7. Spaced repetition helped reduce decay in both eight- and three-view assessments, and although statistically significant, scores did not return to baseline proficiency. In the three views, decay was most evident in naming images and recalling probe adjustments, while no decay occurred in image acquisition.

Achievement by Domain

Figure 2 presents the median and IQR of scores by domain and test month. At month 6, the total median score was 20 (IQR 12-25), and at month 7, the total median score increased to 25 (IQR 23-30), although this change was not statistically significant (P = 0.61). While median scores improved across domains, no significant changes were observed.

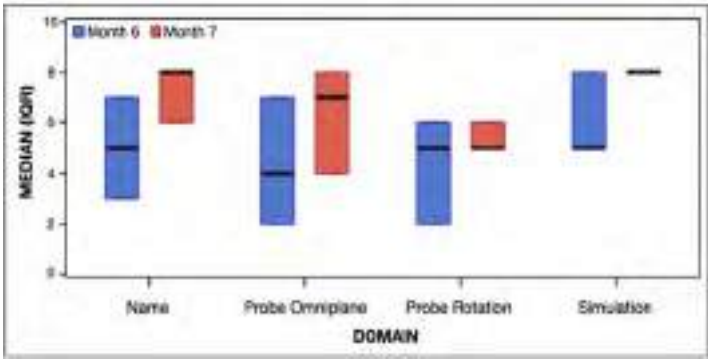

Figure 2. Median and interquartile ranges of achievement by domain and test month.
The highest achievable score of each attempt was 32, with 8 possible points allotted to each of the four domains.
IQR, interquartile range.

Comparison of First Attempts at Month 6 and Month 7

Table 2 compares first attempts at month 6 and month 7. The largest improvement was in name recall for the AV SAX view, with a mean difference of 0.71 (95% CI 0.26-1.17), P = .008. This indicates a 71% increase in correct identification at month 7. Simulation performance for the AV SAX view also improved, showing a 71% increase in mean scores (95% CI 0.26, 1.17, P = .008). This was the only view with statistically significant improvement. Improvements were observed for name recall and probe adjustment in other views, but these differences were not statistically significant.

Time Decay

Figure 3 illustrates the time decay results. At month 6, the mean time for the first attempt to obtain all eight views was 7.3 minutes, decreasing to 4.6 minutes on the second attempt. At month 7, the first attempt time decreased to 5.7 minutes, and the second attempt time decreased to 4.0 minutes. However, the time decay between the first attempts at months 6 and 7 was not statistically significant (P = 0.12).

Survey Results

The survey had a 100% response rate, with detailed results in the Appendix. Most participants felt simulation training effectively prepared them for rTEE during cardiac arrest, particularly in their comfort level with the three ACEP guideline views and confidence in performing rTEE. Participants were more comfortable with the simulator than human subjects and more confident with the three ACEP views compared to all eight views. Confidence in teaching others was lower. Strong correlations were found between comfort with view naming, probe manipulation, and simulation performance, particularly for omniplane position (0.73, P = .06 at month 6; .91, P = .004 at month 7).

DISCUSSION

While several studies have assessed rTEE skill acquisition among EPs, few have examined skill decay over extended periods without retraining or clinical use.[30,32-34,35] Our data highlights three key findings relevant to curriculum development for learners. First, similar to previous studies our data shows that rTEE proficiency declines by over 30% after six months without retraining (spaced repetition) or clinical exposure.[36,37] This supports the notion that skill decay can occur relatively quickly without reinforcement. However, due to the lack of clinical application in our study, it is unclear whether this decay would occur in real-world settings. While prior studies suggest a wide range of skill retention patterns, our findings point to the potential need for periodic retraining in

Table 2. Repeated measures analysis between month 6 and 7 in four domains.

	Naming		Probe Omniplane		Simulation	
	Mean Difference (95% CI)	*P*-value	Mean Difference (95% CI)	*P*-value	Mean Difference (95% CI)	*P*-value
1. ME 4/5 Chamber	0.29 (-0.17, 0.74)	.17	0.14 (-0.21, 0.49)	.36	100% Achievement	
2. ME AV SAX	0.71 (0.26, 1.17)	.008	0.29 (-0.17, 0.74)	.17	0.71 (0.26, 1.17)	.008
3. ME RV In-Out	0.43 (-0.07, 0.92)	.08	0.29 (-0.17, 0.74)	.17	0.14 (-0.21, 0.49)	.36
4. ME 2 Chamber/LAA	0.14 (-0.5, 0.78)	.60	0.14 (-0.5, 0.78)	.60	0.43 (-0.07, 0.92)	.08
5. ME Bicaval	0.29 (-0.17, 0.74)	.17	0.29 (-0.17, 0.74)	.17	0.14 (-0.21, 0.49)	.36
6. ME LAX	0.14 (-0.21, 0.49)	.36	0.43 (-0.07, 0.92)	.08	-0.14 (-0.49, 0.21)	.36
7. TG Mid SAX	0.14 (-0.21, 0.49)	.36	0.43 (-0.07, 0.92)	.08	100% Achievement	
8. ME Dec/Asc Aorta LAX/SAX	0.43 (-0.07, 0.92)	.08	100% Achievement		0.43 (-0.07, 0.92)	.08

Results are reported as proportions which are expressed as means (SE).
ME, midesophageal; *AV*, aortic valve; *SAX*, short axis; *RV*, right ventricle; *LAA*, left atrial appendage; *LAX*, long axis; *TG*, Transgastric; *Dec*, descending; *Asc*, ascending; *CI,* confidence interval.

skills like rTEE procedures, where clinical opportunities may be limited.[35,38,39,40] Further research is needed to determine an optimal time frame for rTEE proficiency maintenance, especially in high-acuity, low-occurrence procedures like rTEE.

Second, despite overall performance decay, participants retained the ability to perform a focused set of three key rTEE views, as recommended by guidelines. This phenomenon may be explained by participant's motivation to focus on guideline recommendations or because overtraining (ie, training to greater standards than the three guideline recommended views) on these views helped minimize decay. While the impact of overtraining is debated, it may help preserve procedural skills like image acquisition more than cognitive tasks.[13,41,42] These findings can inform simulation-based training curriculums, although further research is needed to understand the effects of overtraining and its long-term benefits.[13]

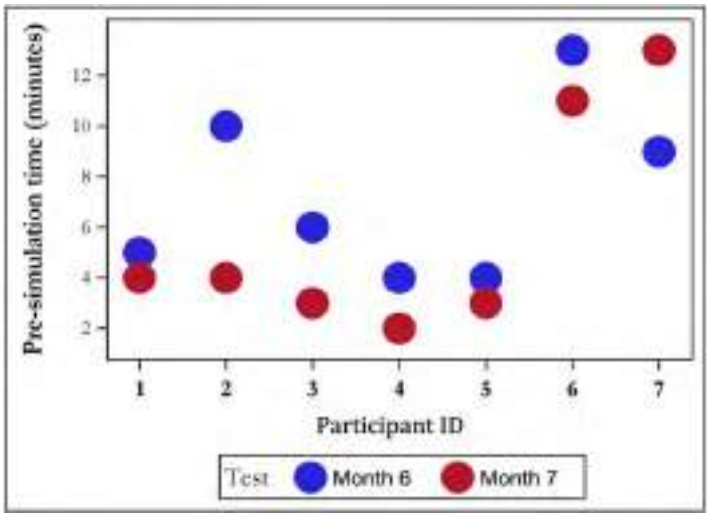

Figure 3. Eight view image acquisition time (minutes) during months 6 and 7 during simulation.

Third, one year after simulation training, participants showed greater confidence in obtaining three focused rTEE views (ME 4Ch, ME LAX, TG SAX) compared to all eight views. Consistently higher scores for the three views in name recall, probe adjustment, and simulation suggest that participants were more comfortable with these key views. This may be due to their similarity to familiar TTE views, which could have contributed to improved performance and confidence in acquiring and interpreting these specific views during cardiac arrest.

These results inform rTEE curriculum development, highlighting the value of simulation for skill acquisition.[9,29,37,38] While one hour of simulation has shown effectiveness in previous studies, our findings suggest that extended simulator time and overtraining may be key for achieving proficiency.[18,27] Our data also suggests that complex physical tasks like rTEE experience more decay in cognitive skills (eg, name recall) than in procedural skills (eg, image acquisition).[12] Similar to other studies, we found that spaced repetition plays a role in diminishing skill decay, but further work is necessary to define optimal repetition intervals.[13,41] Our pilot curriculum indicates that a didactics-simulation model, with spaced repetition, can effectively counter skill decay.

LIMITATIONS

This study's small sample size and single-institution design limit generalizability to other rTEE training programs. Using the same educator for training, proficiency assessments, and post-assessments may have introduced bias, particularly regarding skill decay. While participants were rTEE-naïve, their prior ultrasound experience may have led to higher skill retention, limiting generalizability to a broader EP population. The sample was also homogeneous in ultrasound knowledge; so future studies with more varied trainee populations are needed to validate these results. Our study focused on image acquisition of

"normal" cardiac anatomy, and while pathology was covered in didactics, we did not assess image interpretation in clinical scenarios. The potential for training to transfer to real-world pathology identification remains unclear as clinical exposure was not evaluated. Finally, the simulator may be easier than clinical practice due to the absence of complications like probe insertion or chest compression motion. Thus, the simulator should be viewed as a complementary tool rather than a replacement for traditional, hands-on training.

CONCLUSION

Proficiency-based overtraining on a resuscitative transesophageal echocardiography simulator demonstrated significant decay in rTEE skills after six months of non-use, although the ability to acquire focused rTEE windows persisted. Monthly spaced repetition statistically improved skill levels but did not fully reverse decay. Further studies are needed to optimize rTEE curricula, refine training intervals, and develop strategies to minimize skill decay, especially in the context of cardiac arrest management.

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Pupillometry in the Emergency Department: A Tool for Predicting Patient Disposition

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Introduction: The ability to accurately assess and predict the disposition of comatose patients from within the emergency department (ED) remains a critical challenge. Traditional methods lack precision and consistency. Our goal was to evaluate the prognostic capability of the neurological pupil index (NPI) in predicting patient disposition from within the ED.

Method: This prospective observational study followed 50 comatose patients (Glasgow Coma Scale [GSC] score < 9) who were enrolled via convenience sampling and subsequently treated in the ED at a Level 1 trauma center and public safety-net hospital in San Francisco, CA. We calculated NPI scores and collected data on patient demographics, clinical characteristics, and outcomes. The NPI scores were categorized into three groups: 0 (very poor); 0.1-3.0 (poor to moderate); and 3.1-5.0 (good). We used ANOVA, the Pearson chi-squared test, Wilcoxon rank-sum test, and Fisher exact test to assess the association between NPI scores and discharge status. Results were reported as odds ratios with 95% confidence intervals, with a *P*-value < .05 considered statistically significant.

Results: The median age of patients in this study was 58 years (IQR 42-74), and 66% were male. Higher NPI scores (five-point scale with 3.1-5.0 considered normal) were significantly associated with an increased likelihood of ED discharge (82%), , while lower NPI scores (0, nonreactive pupil) were predominantly associated with hospital admission (92%) (P < .001). Significant predictors of discharge status included patient age, GCS scores, and coma etiology.

Conclusion: This study highlights the utility of the NPI in predicting patient disposition from within the ED. Higher NPI scores were strongly associated with an increased likelihood of ED discharge. These findings support the idea that NPI has the potential to enhance the accuracy of prognostic assessments, in comparison to subjective characterizations of pupil activity. Additional research with larger, multicenter cohorts are needed to confirm these results and establish standardized protocols for integration of NPI in ED workflow. [West J Emerg Med. 2025;26(4)1078–1085.]

INTRODUCTION

The ability to accurately assess and prognosticate the disposition of comatose patients from within the emergency department (ED) remains a critical challenge. Traditional methods, such as manual pupillary light reflex (PLR) assessments, lack precision and consistency.[1] Recent advancements in automated, quantitative pupillometry provide a more reliable approach to measuring neurological function made possible by the advent of the neurological pupil index (NPI).[2] While it is important to note that this tool should not be used in isolation, its utility as a clinical adjunct offers a promising means of evaluating patients with low Glasgow

Coma Scale (GCS) scores, especially in cases involving drug overdoses, where rapid and accurate assessment is crucial for determining outcomes and guiding clinical decisions.[3,4]

For patients who are comatose, it is crucial that emergency clinicians have the ability to accurately prognosticate health outcomes. These assessments can guide critical decision-making processes, such as determining whether a patient should be discharged or admitted for further workup. Accurate prognostication ensures that patients receive the appropriate level of care, ultimately impacting their recovery, and can guide clinical decision-making to avoid poor health outcomes. For comatose patients, traditional prognostic methods of pupil assessment often rely on subjective characterizations such as "brisk" and "sluggish," which may lead to variability in clinical decisions.[5] The NPI offers an objective, reliable measure that can enhance the accuracy of these prognostic assessments and provides a standardized metric that is less susceptible to interobserver variability.[6,7]

The rising incidence of drug overdoses, particularly those involving opioids and combinations with other substances like methamphetamine and cocaine, has intensified the need for reliable diagnostic tools in the ED. The city of San Francisco has seen a significant increase in overdose deaths, primarily driven by fentanyl and its combination with other drugs.[8] The complex and negative effects on health caused by these drugs necessitate advanced methods to accurately differentiate between drug effects and underlying neurological conditions. Studies have demonstrated the robustness of the NPI even in the presence of significant drug-induced miosis and other ocular effects, supporting its use as a stable measure of neurological function across an array of intoxication scenarios.[9,10]

Most of the currently available literature on the NPI is based in intensive care unit (ICU) settings, where it has demonstrated utility in mapping the trajectory of neurological function. Research has shown that the NPI has been effective in the assessment of traumatic brain injury, predicting outcomes in patients with intracerebral hemorrhage and aiding in the prognostication of comatose patients following out-of-hospital cardiac arrest.[5,11] While NPI applications have been well-documented in ICU populations, our aim in this study was to investigate the effectiveness and utility of this tool in predicting patient discharge or admission for further workup in comatose patients presenting to the ED. We hypothesized that higher NPI scores would correlate with increased likelihood of discharge. By correlating NPI measurements with clinical outcomes, we sought to validate the NPI as a reliable tool for early neurological assessment and decision-making from within the ED.

Population Health Research Capsule

What do we already know about this issue?
Quantitative pupillometry has shown prognostic value in ICU settings but is understudied in emergency department populations.

What was the research question?
Can the neurological pupil index (NPI) predict ED disposition in comatose patients?

What was the major finding of the study?
Higher NPI scores were significantly associated with ED discharge ($P < .001$; 95% CI 1.3-4.2).

How does this improve population health?
Objective pupillometry may aid emergency physicians in disposition decisions, optimizing resource use and reducing unnecessary admissions.

METHODS

Study Design

This prospective observational study was designed to evaluate the effectiveness of the NPI in predicting patient disposition. We obtained institutional review board approval from our institution (IRB number 22-38188) and received funding in research grant support from NeurOptics. As each comatose patient automatically had a pupillary assessment at the time of the study, the need to obtain consent was waived per the IRB.

For the purposes of this study, we defined coma as a GCS ≤8, consistent with the Neurocritical Care Society definition. This threshold represents a severe impairment of consciousness, where patients exhibit limited or absent meaningful responses to external stimuli. While different clinical interpretations of coma exist, this definition allows for a standardized approach to identifying patients with significant neurological dysfunction requiring urgent assessment and management.

Study Setting and Population

From June 2023–February 2024, we conducted this study at the Zuckerberg San Francisco General Hospital, a public, safety-net hospital and Level I trauma center in the city of San Francisco, CA. Participants were enrolled via convenience sampling, given that pupillometer measurements were not mandated by protocol and were instead obtained at the discretion of the individual performing the assessment. Since this was not a universally applied assessment, the total number of enrolled patients was determined by the frequency with which clinicians opted to use the device rather than a predefined sample-size calculation.

The inclusion criteria for the study were adult patients ≥18 years of age who presented to the ED with a GCS score of <9 and had a comatose state of presumed non-traumatic etiology. Patients in cardiac arrest or pulseless on arrival were not automatically excluded from the study. However, we included in the analysis only those who achieved return of spontaneous circulation at some point during their ED course, as we aimed to assess neurological outcomes and disposition rather than immediate resuscitation outcomes. Patients who received a pupillometer measurement upon ED arrival were included. Exclusion criteria were patients <18 years of age and those with coma resulting from traumatic brain injury or eye injury precluding the use of pupillometry.

Protocol

The NPi-200 pupillometer (NeurOptics Inc, Irvine, CA) is a handheld, portable infrared device designed to provide objective, quantitative measurements of pupillary response. Roughly the size of a barcode scanner, the device is placed close to the eye where it emits a controlled light stimulus while recording high-resolution video of the pupil's reaction that can be seen in real time by the user through a screen. The device automatically calculates multiple pupillary parameters including pupil size prior to constriction, minimum diameter at peak constriction, latency of constriction, constriction velocity, and dilation velocity.

The personnel tasked with obtaining pupillometer measurements included emergency physicians, nursing staff, a clinical research coordinator, and a medical student. All device users underwent standardized training on the proper handling and operation of the pupillometer consisting of an instructional video.

Upon presentation to the ED, each patient meeting the inclusion criteria underwent a pupillometer measurement as part of the standard ED resuscitation protocol. Pupillometer measurements were conducted using the NPi-200 pupillometer with a single-use safety guard to ensure sterility and tagged with a specific identification number. We then linked these measurements to the patient's medical record number via electronic health records (Epic Systems Corporation, Verona, WI); physiology data (Moberg CNS System (Natus Medical Inc, Pleasanton, CA); electroencephalography (Natus); and radiology (Picture Archiving and Communication System).

This study was funded by NeurOptics; however, the manufacturer had no role in the study design, data collection, data analysis, or decision to publish the findings. Additionally, we did not receive any direct or indirect compensation related to this study.

Measures

The primary variables in this study included the NPI. Values for this variable range from 0-5 and were categorized based on the NPI Pupil Reactivity Assessment Scale: "0" indicates a non-reactive pupil with potential severe neurological impairment; 0.1-3.0 indicates abnormal or sluggish reactivity, suggesting possible neurological dysfunction; and 3.1-5.0 indicates normal reactivity reflecting typical neurological function. We assessed GCS scores upon admission to categorize the severity of coma. Secondary variables included demographic data such as age, sex, urine toxicology results, and cause of coma.

The primary outcome measure was ED disposition, specifically whether patients were discharged or admitted to the hospital. For the purposes of this analysis, we included patients who died in the ED in the "admitted" category. The dataset distinctly categorizes patient outcomes as either "discharged" or "admitted," without any overlap between the two. Consequently, no patients categorized as "discharged" had a recorded death in the ED.

Data Analysis

We conducted statistical analysis to summarize patient demographics and clinical characteristics. Continuous variables were reported as means and standard deviations or as medians and interquartile ranges (IQR), depending on their distribution. We summarized categorical variables using frequencies and percentages. To evaluate the association between NPI scores and discharge status, we used ANOVA while adjusting for potential confounders. The results are presented as odds ratios (OR) with 95% confidence intervals (CI), and a *P*-value of less than 0.05 was considered statistically significant.

In our analysis, we categorized NPI measurements based on the first recorded measure for each patient, unless it was a non-readable error. This approach was chosen to maintain consistency in our data analysis and to minimize potential bias from selecting higher or lower values from repeated measurements. If the left and right measurements were discrepant, this was noted as it might have been indicative of the cause of coma.

We specified the primary patient outcome as ED disposition, or admission/discharge status. The associations between admission outcome and NPI score categories (primary) and patient demographic characteristics (secondary) were tested using chi-square or Fisher exact tests. We tested associations between outcome and age with the Wilcoxon rank-sum test, and a *P*-value of less than 0.05 was considered statistically significant.

RESULTS

We assessed 60 patients for eligibility in our study. Of these, 10 were excluded: five did not meet the inclusion criteria; two were initially identified as meeting inclusion criteria but subsequently demonstrated improved mental status, thereby allowing them to verbally decline participation before pupillometer measurements were obtained; and three were excluded due to incomplete data entry. The resultant 50 patients were enrolled in the study, underwent pupillometer

measurement, and were included in the final analysis.

After reviewing the medical record for one patient who was initially assigned an NPI score of 0, a second measurement was taken shortly after the first. The first reading was determined to be unreliable, given that an NPI of 0 did not correlate with the patient's clinical exam, raising concerns for user error. Potential sources of error could include improper device positioning against the patient's orbit or movement during scanning. Consequently, a second NPI score of 2.3 was obtained and used in the analysis. It is important to note that this patient was ultimately discharged from the ED. Following this adjustment, the updated analysis showed that all 11 patients with an NPI score of 0 were categorized in the admitted group (ie, no patients with an NPI score of 0 were discharged).

The overall median age of patients within our study sample was 58 years (IQR 42-74). Patients who were admitted for further workup had a significantly higher median age of 67 years (IQR 58-80) compared to those who were discharged from the ED, who had a median age of 50 years (IQR 38-72) (P = .01) (Table 1). When examining the age distribution of our patients across their respective NPI score categories, the median ages were 63 years (IQR 53-73) for an NPI score of 0, 77 years (IQR 48-89) for NPI score of 0.1-3.0, and 52 years (IQR 40-73) for an NPI score of 3.1-5, with no significant difference found between these groupings (p = .30) (Table 2). Our study enrolled 17 females (34%) and 33 males (66%). Both groups were equally likely to be admitted or discharged (P = .30) (Table 1). Stratification by NPI score categories revealed that males comprised 64% of patients with an NPI score of 0, 33% of patients in the NPI 0.1-3.0 group, and 73% of those in the NPI 3.1-5 group. Of note, females comprised a larger proportion of the NPI 0.1-3.0 group (67%) (P = .20) (Table 2). Of the 50 patients included in this study, 66% were male and 34% were female. There was no significant difference in admission or discharge status based on sex (P = .3). Regarding ethnicity, 18% of patients were of Hispanic/Latino origin, 68% were non-Hispanic/Latino, and 14% were categorized as other/unknown, with no significant differences in disposition (P = .20). A more detailed breakdown of sex and ethnicity distributions is provided in Table 2.

When patients were stratified based on GCS scores, we found a significant difference between those who were admitted and discharged (P = .02) (Table 1). Most patients with a GCS score of 3 were admitted (84%) compared to those discharged (42%). When stratified by NPI score, 92% of patients with an NPI score of 0 had a GCS of 3, compared to 17% in the NPI 0.1-3.0 group and 52% in the NPI 3.1-5 group. (P = .65) (Table 2).

The causes of coma varied significantly between admitted and discharged patients (P < .001) (Table 1). Cardiac causes were predominant among admitted patients (74%), while drug overdoses were more common among discharged patients (55%). When analyzed by NPI score, cardiac causes were most frequent in the NPI 0 group (91%), whereas drug overdoses were most prevalent in the NPI 3.1-5 group (47%). Neurological causes were also notable, comprising 9.1% of the NPI 0 group, 17% of those with NPI 0.1-3.0, and 28% of the NPI 3.1-5 group (P < .001) (Table 2). Toxicology screening revealed that, overall, 22% of patients tested positive for methamphetamine, 6% for opioids, 16% for cocaine, 18% for benzodiazepines, and 46% for other substances, while 42% had no substances detected (Table 1). There were no significant differences in toxicology screen results between admitted and discharged patients for methamphetamine (P = .50), opioids (P = > .90), cocaine (P = > .90), benzodiazepines (P = .50), other substances (P = .30), and those with no substances detected (P = .20). Stratification by NPI scores showed no significant differences for methamphetamine (P = .30), opioids (P = .40), cocaine (P = .30), benzodiazepines (P = .20), other substances (P = .80), and no substances detected (P = .60) (Table 2).

DISCUSSION

The advent of pupillometry has paved the way for an objective measure of autonomic nervous system function, a tool with possible high utility in the ED. Our study demonstrates that the NPI is a valuable prognostic tool as it provides a reliable means of assessing the likelihood of patient discharge. The data indicate that higher NPI scores are closely associated with an increased probability of discharge, thereby underscoring the index's potential as a robust measure for evaluating neurological function in the ED setting. This is particularly relevant in the fast-paced environment of the ED where critical decisions are made rapidly. The consistent performance of NPI across different clinical scenarios (ie, drug overdoses, cardiac issues, and non-traumatic etiologies) in our study highlights the versatility of this tool and has also been reported in prior research examining the stability of pupillometry in dynamic environments.[3,12,13]

Prior to the development of pupillometry, clinicians mainly relied on traditional methods of assessing neurological function, such as manual PLR evaluations, which use subjective terms like "brisk" or "sluggish" to describe pupillary responses. Studies comparing manual and automated pupillometry have demonstrated poor concordance between the two techniques, wherein manual assessments fail to detect a significant proportion of cases with anisocoria or abnormal PLR responses. In a study by Couret et al, investigators found an 18% overall discordance rate between the two techniques, which increased to 39% for smaller pupils (< 2 millimeters).[5] Another study by Nyholm et al demonstrated that automated pupillometry had twice the reproducibility and repeatability of manual assessments, highlighting the former's superiority as an objective and reliable tool.[14]

The NPI offers a standardized, quantitative approach that reduces interobserver variability and enhances the precision of bedside neurological assessments. This observation is mostly

Table 1. Comparison of demographic, clinical, and toxicological characteristics by admission status in comatose emergency department patients.

	Overall N = 50	Admitted n = 19	Discharged n = 31	P-value
Age, median (IQR)	58 (42, 74)	67 (58, 80)	50 (38, 72)	.01
Sex, n (%)				.30
Male	33 (66%)	11 (58%)	22 (71%)	
Female	17 (34%)	8 (42%)	9 (29%)	
Race				>.90
Asian	10 (20%)	4 (21%)	6 (19%)	
Black	13 (26%)	6 (32%)	7 (23%)	
White	12 (24%)	4 (21%)	8 (26%)	
Other/unknown	15 (30%)	5 (26%)	10 (32%)	
Ethnicity, n (%)				.20
Hispanic/Latino Origin	9 (18%)	2 (11%)	7 (23%)	
Non-Hispanic/Latino Origin	34 (68%)	16 (84%)	18 (58%)	
Other/unknown	7 (14%)	1 (5.3%)	6 (19%)	
GCS total, n (%)				.02
3	29 (58%)	16 (84%)	13 (42%)	
4	2 (4.0%)	1 (5.3%)	1 (3.2%)	
5	2 (4.0%)	1 (5.3%)	1 (3.2%)	
6	8 (16%)	1 (5.3%)	7 (23%)	
7	5 (10%)	0 (0%)	5 (16%)	
8	4 (8.0%)	0 (0%)	4 (13%)	
Cause of coma, n (%)				<.001
Cardiac	17 (34%)	14 (74%)	3 (9.7%)	
Pulmonary	1 (2.0%)	0 (0%)	1 (3.2%)	
Drug overdose	18 (36%)	1 (5.3%)	17 (55%)	
Neurological	12 (24%)	3 (16%)	9 (29%)	
Metabolic	2 (4.0%)	1 (5.3%)	1 (3.2%)	
Tox screen positive for				
Methamphetamine	11 (22%)	3 (16%)	8 (26%)	.50
Opioid	3 (6.0%)	1 (5.3%)	2 (6.5%)	>.90
Cocaine	8 (16%)	3 (16%)	5 (16%)	>.90
Benzodiazepine	9 (18%)	2 (11%)	7 (23%)	.50
Other	23 (46%)	7 (37%)	16 (52%)	.30
Tox screen negative	21 (42%)	10 (53%)	11 (35%)	.20

ED, emergency department; *IQR,* interquartile range, *GCS,* Glasgow Coma Scale.

supported by research exploring the use of NPI in the ICU setting. A study by Cha et al analyzed the use of NPI in predicting neurocognitive outcomes in patients with acute carbon monoxide poisoning by obtaining initial pupil measurements in the ED.[15] Their results showcased that NPI was superior to standard PLR using a penlight in predicting one-month neurocognitive sequelae. Among patients in their study sample with a GCS < 12, they found that an NPI < 1 was a highly specific predictor of poor outcomes. These results align with our findings that lower NPI scores are associated with worse clinical outcomes, thereby reinforcing the potential role of NPI as a prognostic tool specifically in ED settings.

The influence of demographic and clinical variables on NPI measurements and patient outcomes is a significant aspect of our study. Factors such as age, sex, and the underlying cause of coma were found to impact NPI scores and, consequently, the likelihood of patient discharge or admission. For instance, older patients with lower NPI scores were more likely to be admitted, while younger patients with higher NPI scores had a greater chance of being discharged. This highlights the importance of considering these variables when

Table 2. Distribution of demographic, clinical, and toxicological characteristics by neurological pupil index score categories in comatose emergency department patients.

	NPI Score Category			
	0, N = 12	0.1-3.0, N = 6	3.1-5.0, N = 32	P-value
Discharged	0 (0%)	4 (67%)	27 (82%)	<.001
Age, median (IQR)	63 (53, 73)	77 (48, 89)	52 (40, 73)	.20
Sex, n (%)				.20
Male	7 (64%)	2 (33%)	24 (73%)	
Female	4 (36%)	4 (67%)	9 (27%)	
Race				.20
Asian	2 (18%)	4 (67%)	4 (12%)	
Black	3 (27%)	1 (17%)	9 (27%)	
White	2 (18%)	0 (0%)	10 (30%)	
Other/unknown	4 (36%)	1 (17%)	10 (30%)	
Ethnicity, n (%)				.90
Hispanic/Latino Origin	2 (18%)	0 (0%)	7 (21%)	
Non-Hispanic/Latino Origin	8 (73%)	5 (83%)	21 (64%)	
Other/unknown	1 (9.3%)	1 (17%)	5 (15%)	
GCS total, n (%)				.07
3	11 (100%)	1 (17%)	17 (52%)	
4	0 (0%)	0 (0%)	2 (6.1%)	
5	0 (0%)	0 (0%)	2 (6.1%)	
6	0 (0%)	3 (50%)	5 (15%)	
7	1 (8.3%)	1 (17%)	4 (12%)	
8	0 (0%)	1 (17%)	3 (9.1%)	
Cause of coma, n (%)				.001
Cardiac	10 (91%)	1 (17%)	6 (18%)	
Pulmonary	0 (0%)	1 (17%)	2 (6.1%)	
Drug overdose	0 (0%)	3 (50%)	15 (45%)	
Neurological	1 (9.1%)	1 (17%)	10 (30%)	
Metabolic	0 (0%)	0 (0%)	2 (6.1%)	
Tox screen positive for				
Methamphetamine	2 (18%)	3 (50%)	6 (18%)	.30
Opioid	0 (0%)	1 (17%)	2 (6.1%)	.40
Cocaine	2 (18%)	2 (33%)	4 (12%)	.30
Benzodiazepine	0 (0%)	1 (17%)	8 (24%)	.20
Other	4 (36%)	3 (50%)	16 (48%)	.80
Tox screen negative	6 (55%)	3 (50%)	12 (36%)	.60

NPI, neurological pupil index; *IQR,* interquartile range; *GCS,* Glasgow Coma Scale.

interpreting NPI scores in the ED. Additionally, the cause of coma—whether cardiac, drug-related, or neurological—played a critical role in determining outcomes.[4,7] The variation in NPI scores across different demographic groups and clinical conditions underscores the need for a comprehensive approach when using NPI as a prognostic tool. While NPI is a valuable predictor, it should be used in conjunction with a full clinical assessment to ensure accurate prognostication.

The application of NPI in the context of the increasing number of drug overdose cases is particularly pertinent. With the ongoing opioid crisis and the increase in polysubstance use, the ability to quickly and accurately assess neurological function in intoxicated patients is crucial.[8,10] Our study found that NPI remains a stable and reliable measure even in the presence of drug-induced effects such as miosis, a common outcome of opioid use.[9] This stability is vital for ensuring accurate assessments and appropriate management of intoxicated patients in the ED. By offering an objective measure unaffected by the

confounding effects of drugs, NPI enhances a clinician's ability to make informed decisions for patients experiencing a drug overdose. This application of NPI not only supports timely and accurate diagnosis but also aligns with broader efforts to improve care in emergency settings amid the opioid epidemic.

Our study stands out by focusing on the use of NPI in a broad ED patient population with diverse coma etiologies, rather than limiting the scope to specific conditions such as traumatic brain injury or cardiac arrest. While prior research has explored NPI in ICU settings, our research uniquely demonstrates its feasibility and utility in the ED, a more dynamic and varied clinical environment.[13,16] Unlike studies that concentrate on single conditions, our research covers a wide range of clinical presentations, from drug overdoses to neurological and cardiac causes, providing a comprehensive view of NPI's applicability across different patient groups. This broader scope both enhances the generalizability of our findings and supports the integration of NPI into standard ED protocols as a clinical adjunct for early neurological assessment and decision-making.

LIMITATIONS

While the findings of this study are promising, several limitations should be acknowledged. First, the relatively small sample size of 50 patients may restrict the generalizability of our results. To strengthen the validity of these findings, larger studies involving multiple centers are essential. Such studies would help confirm the utility of the NPI in the ED and facilitate the development of standardized protocols for its use. Secondly, the fact that our study was conducted at a single-center, safety-net Level 1 trauma center may have contributed to selection bias. The clinical practices and specific patient population may not be representative of those in other settings, which could impact the applicability of our results to broader contexts. One way we attempted to mitigate this bias was to include all eligible adult patients with a GCS score < 9 and all non-traumatic causes of coma. As a result, we were able to capture a diverse and representative sample of the population seen in EDs.

Additionally, we considered the possibility that certain demographic variables such as age, GCS score, and coma etiology could confound both NPI scores and patient outcomes. To mitigate these effects, our statistical analysis was adjusted to isolate the prognostic impact of the NPI. Specifically, we categorized patients' first NPI measurement for consistency, and if discrepant left and right pupil measurements were recorded the higher of the two NPI classifications were included in our analysis. Lastly, the observational nature of this study limits our ability to draw causal inferences. We can report associations between NPI scores and discharge outcomes, but establishing causality would require more rigorous study designs such as randomized controlled trials.

CONCLUSION

This study highlights the effective use of quantitative pupillometry in the ED, demonstrating its potential as a valuable tool for assessing autonomic nervous system function in a more objective and reliable way. The neurological pupil index provides a quantitative measure that enhances the accuracy of neurological assessments, moving beyond the limitations of traditional subjective methods. Our findings suggest that NPI may serve as a valuable adjunct in the assessment of comatose patients in the ED by providing an objective measure of neurological function. However, further multicenter studies with larger sample sizes are needed to validate these findings and establish standardized protocols for the use of NPI in clinical decision-making in the ED.

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Comparative Efficacy of Face-to-Face and Right-Rear Upright Intubation in a Randomized Crossover Manikin Study

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Introduction: Upright intubation is essential for managing difficult airways but can be challenging, especially for less experienced clinicians. Face-to-face intubation may lower first-pass success rates due to unfamiliar orientation. New videolaryngoscope devices have the potential to improve intubation success. We aimed to compare first-pass success rates, intubation duration, and glottic view between the right-rear and face-to-face approaches, using channeled videolaryngoscope, hyperangulated videolaryngoscope, and video stylet for upright intubation.

Methods: We conducted a cross-over manikin simulation study involving 30 participants—19 attending physicians, six residents, and five nurse practitioners—to compare the efficacy of these devices to a standard Macintosh videolaryngoscope, using both right-rear and face-to-face approaches.

Results: We used Cox regression analysis to calculate hazard ratios for the following variables: first-pass success rate; intubation time; glottic view quality (Cormack-Lehane grade [C-L]); and percentage of glottis opening score (POGO]. The right-rear approach demonstrated a substantial improvement in first-pass success rates compared to face-to-face, with rates of 93% vs 78% and a hazard ratio of 2.10 (95% confidence interval 1.58-2.80). Additionally, both the video stylet and channeled videolaryngoscope techniques further optimized first-pass success rates and enhanced glottic visualization, achieving a CL grade I view and POGO scores of 100%, even in the inverted face-to-face orientation. These devices outperformed the standard Macintosh and hyperangulated videolaryngoscopes.

Conclusion: The right-rear approach was associated with higher first-pass success rates and provided a more familiar orientation for operators during upright intubation. Video stylets and channeled videolaryngoscopes also contributed to improved success rates, shorter intubation times, and better glottic visualization. [West J Emerg Med. 2025;26(4)1086–1094.]

INTRODUCTION

Compared to the supine intubation position, the upright position for oxygenation and pre-intubation preparation offers several physiological advantages, especially in patients with respiratory compromise or those at risk of hypoxia.[1,2] It reduces abdominal pressure on the diaphragm, allowing for greater lung expansion and enhanced diaphragmatic movement. This leads to increased tidal volumes and improved ventilation. Computed tomography has shown that inspiratory and expiratory lung volumes are 5.3-14.7% higher in the upright position when compared to the supine position,[3] and functional residual capacity increases by approximately 450 milliliters.[4]

The upright posture also improves gas exchange by optimizing the ventilation-perfusion ratio, particularly in the lung bases, where perfusion is greatest.[1,2] In contrast, the supine position may promote ventilation of less-perfused regions, increasing physiological dead space and impairing oxygenation.[4] These benefits make upright positioning especially valuable during pre-oxygenation and in patients requiring prolonged airway management.

In patients with elevated intra-abdominal pressure (eg, those with obesity, ascites, or in late-stage pregnancy), the upright position reduces diaphragmatic compression, facilitates full lung expansion, and extends the safe apnea time for intubation.[5,6] Additionally, the supine position can lead to upper airway obstruction due to posterior displacement of the tongue and pharyngeal tissues, particularly in sedated or paralyzed patients.[5] The upright position helps preserve airway patency, improving ventilation and oxygenation in critical settings.[1,2,5,6] Upright positioning is also preferred in patients with limited neck mobility, such as those with ankylosing spondylitis, cervical spine injury, or prior head and neck radiation therapy, as it reduces the risk of spinal trauma and facilitates safer airway access.[10–13] In confined environments, such as vehicles, tunnels, or disaster scenes, the upright position may be the only viable option for airway management.[14]

In these scenarios, the face-to-face approach is often described in emergency and prehospital literature as a practical method for upright intubation.[9,15] However, despite its reported equivalence to supine intubation in terms of first-pass success and intubation time,[15] face-to-face can be technically challenging due to its inverted spatial orientation and non-standard hand positioning. The right-rear approach appears to offer a more ergonomic and intuitive alternative, but its effectiveness has not been thoroughly evaluated.

In parallel, the evolution of videolaryngoscopy, including channeled, hyperangulated, and video stylet designs, has significantly impacted airway management strategies.[12,17–19] While these devices have become more prevalent, especially post-COVID-19, evidence regarding their performance in upright intubation remains limited.[18-20] Most prior studies have focused on the supine position, leaving a gap in data regarding upright scenarios, particularly when combined with different approach techniques.

Although flexible fiber-optic intubation offers precise control and is advantageous for managing complex airways, its application in emergency and prehospital settings is limited by several practical constraints. First, it requires substantial technical proficiency, including fine motor skills and familiarity with the equipment—skills that necessitate extensive training and may be difficult to acquire or retain in time-critical environments.[21] Second, the technique depends on a clear and unobstructed airway, which is often compromised in prehospital scenarios due to blood, secretions, or limited lighting and visibility.[22] Third, its performance in real-world emergencies remains inconsistent; for instance, recent data indicate a 12.7% first-attempt failure rate during emergency fiber-optic intubations, emphasizing the need for more intuitive and broadly accessible alternatives.[23] These limitations underscore why, despite its theoretical benefits, fiber-optic intubation may not be the most practical first-line method for upright airway management in high-acuity or resource-constrained environments such as emergency departments (ED) or prehospital care.

Population Health Research Capsule

What do we already know about this issue?
Upright intubation offers physiological advantages in respiratory distress. The face-to-face method is technically challenging; videolaryngoscopy may enhance success rates.

What was the research question?
Which approach yields a higher success rate for upright intubation: face-to-face or right-rear?

What was the major finding of the study?
The right-rear approach had a 93% first-pass success rate vs 78% with face-to-face; hazard ratio 2.10 (95% CI 1.58-2.80, P < .001).

How does this improve population health?
Optimizing upright intubation by using the right-rear approach with a video stylet or channeled videolaryngoscope can improve patient safety and outcomes.

In this study we aimed to identify the most effective methods and tools for upright intubation using advanced videolaryngoscopes. We compared the right-rear and face-to-face approaches across four devices: the standard geometric Macintosh videolaryngoscope; channeled videolaryngoscope; hyperangulated videolaryngoscope; and video stylet. Primary outcomes included first-pass and overall intubation success rates, intubation time, and glottic view quality. Through this investigation, we sought to inform best practices for upright airway management, especially in challenging clinical and environmental conditions.

METHODS

This randomized, cross-over manikin trial was approved by the institutional review board on November 28, 2023 (approval no.: TCHIRB-11211008-E), and was funded by the Department of Health, Taipei City Government (grant number: 11401-62-

012). A total of 30 participants were recruited from multiple medical centers across Taiwan, including 19 attending physicians, six residents, and five nurse practitioners (NP). The participants had an average of 11.9 ± 6.43 years of clinical experience in either emergency medicine or anesthesiology. All participants had performed over 100 intubations annually and had at least two years of clinical practice in their respective specialties. To minimize bias, none had prior experience with upright face-to-face or right-rear intubation, which could have otherwise conferred a potential advantage.

Prior to the study, all participants underwent structured training in both intubation approaches (Figure 1A and 1B) using each of the four devices (Figure 1C), resulting in eight total approach-device combinations. Participants were required to achieve a minimum of three successful intubations per combination to ensure procedural proficiency and readiness for study participation. Additionally, the chart abstractors were blinded to the study hypothesis to prevent bias during data collection.

Figure 1. A. Right rear approach: Participants stood at the upper right, posterior side of the patient during intubation. Using their left hand to control the videolaryngoscope and their right hand to pass the tube, they maintained a consistent spatial orientation. B. Face-to-face approach: Participants used their right hand to push the tongue to the right, creating a clear path for tube insertion with their left hand. This approach involved an inverted orientation. C. Device labels:

1. Standard geometric Macintosh videolaryngoscope
2. Channeled videolaryngoscope
3. Hyperangulated videolaryngoscope
4. Video stylet

Protocol

Four intubation devices were used: the standard geometric Macintosh videolaryngoscope (Touren Corporation, Gurgaon, India), channeled videolaryngoscope (ITL-SL, AWS-S200, Pentax Corporation, Tokyo, Japan), hyper-angulated videolaryngoscope (HyMac 3, VisionPRO, HEINE Optotechnik GmbH & Co. KG, Germany), and videostylet (TVI-4102, Trachway, Grandmedical Enterprise LTD., Taichung, Taiwan). Each device was tested with two approaches—right-rear (Figure 1A) and face-to-face (Figure 1B)—resulting in eight different approach-device combinations. A conventional 7.0-millimeter internal diameter tracheal tube (Covidien, Mallinckrodt Pharmaceuticals Ltd., Surrey, United Kingdom) was used for intubation without additional assistance, with the manikin (Laerdal Airway Management Trainer, Stavanger, Norway) positioned at a 45-degree upright angle. All procedures were recorded by video clips and reviewed.

Using random.org (https://www.random.org/lists/), we randomized each participant's sequence of eight approach-device combinations before the study. We defined successful intubation as the passage of the tube through the vocal cords within 90 seconds. Intubation time was measured from insertion of the laryngoscope into the manikin's mouth until the tracheal tube passed the vocal cord marker and reached a depth beyond 20 centimeters at the level of the incisors. We retrospectively analyzed additional metrics, including time to obtain a proper glottic view, and overall intubation success or failure, through video review.

Measurements

We recorded participants' years of experience in the hospital and their specialties (attending physicians, residents, or NPs). The primary outcome measured was the first-pass intubation rate across the eight subgroups, while secondary outcomes included the overall success rate and the total intubation duration.

Data Analysis

We performed a sample size calculation using the chi-square test for two independent proportions. This calculation was based on successful intubation rates of 78% and 42%, as observed in the standard Macintosh videolaryngoscope group in a previous study involving various intubation scenarios.[16] To achieve 80% statistical power at an alpha level of 0.05, a minimum of 28 participants per group was required. To account for potential variability due to repeated measures within the same participants, we recruited a total of 30 participants per group.

The primary outcomes of this study were the first-pass success rate. We also analyzed participants' characteristics, glottic views during intubation (using the Cormack-Lehane classification and the percentage of glottic opening score), overall success rate, and intubation times. The intubation

times were divided into 1) the duration from start to glottis visualization, and 2) the duration from glottis visualization to intubation completion.

To evaluate the time to successful intubation, we plotted Kaplan-Meier survival curves to identify trends. To account for correlated data arising from multiple intubation attempts by the same participants, we applied Cox proportional hazards regression models with stratification. These models estimated hazard ratios (HR) for successful intubation, adjusting for potential confounders such as participants' years of experience, professional roles, intubation devices used, and approach positions.

We conducted data analyses using SAS v9.4 (SAS Institute Inc., Cary, NC) and STATA v17 (StataCorp, College Station, TX).

RESULTS

The 30 participants included 19 attending physicians, six residents, and five NPs (Table 1). The first-pass success rate for all intubation attempts was 85%. The first-pass success rate for the right-rear approach was 93%, compared to a lower rate of 78% for the face-to-face approach, with all intubations successful within 90 seconds (Table 2). The median times to achieve successful intubation were 10 seconds for the right-rear approach and 13 seconds for the face-to-face approach. Within the right-rear approach, the first-pass success rate was 93% using the standard Macintosh device, 100% with the channeled videolaryngoscope, 77% with the hyperangulated videolaryngoscope, and 100% with the video stylet. Conversely, under the face-to-face approach, the first-pass success rate was 67% with the standard Macintosh videolaryngoscope , 100% with the channeled video laryngoscope, 47% with the hyperangulated videolaryngoscope, and 100% with the video stylet (Table 2). The median intubation times varied with the device and approach. For the right-rear approach, the standard Macintosh device was 10.5 seconds; the channeled videolaryngoscope 9 seconds; the hyperangulated videolaryngoscope 10.5 seconds, and the video stylet 7 seconds; for the face-to-face approach, the standard Macintosh device took 16 seconds, the channeled videolaryngoscope 11 seconds, the hyperangulated videolaryngoscope 26.5 seconds, and the video stylet 11 seconds

Table 1. Participant characteristics.

Variable		Mean	Standard deviation
Age (years)		39.33	±6.15
Duration of practice (years)		11.9	±6.43
Total participants	N=30		
Attending physician	19		
Resident	6		
Nurse practitioner	5		

Figure 2 presents a Kaplan-Meier plot comparing the first-pass success rates over time for two intubation approaches: right-rear and face-to-face. The right-rear approach demonstrates an earlier visualization of the glottis compared to the face-to-face approach. Once the glottis was visualized, most intubations in the right-rear group were successfully completed within 20 seconds. The median time to glottic visualization was three seconds for the right-rear approach and five seconds for the face-to-face approach (Table 2). In contrast, the face-to-face approach not only required more time to complete intubation but also demonstrated a lower overall first-pass success rate. Figure 3 further compares the time from glottic visualization to successful intubation across four different intubation devices. Notably, the face-to-face approach is associated with significantly longer times when using the standard Macintosh device and the hyperangulated videolaryngoscope devices compared to the right-rear approach.

In the multivariate Cox regression analysis, no significant effects were found for participants' age, duration of service, device order, or tenure (Table 3). However, the right-rear approach showed a significant effect, with a HR of 2.10 compared to the face-to-face approach, achieving a *P*-value of <.001 and 95% confidence intervals (CI) ranging from 1.58-2.80. When compared to the standard geometric videolaryngoscope, the channeled videolaryngoscope had a HR of 1.61 (*P*=.02). The hyperangulated videolaryngoscope had a HR of 0.62 (*P*=.03), and for the video stylet, the HR was 1.88 (*P*=.001). There was no significant difference in intubation success between attending physicians, residents, and NPs (Table 3). However, when using the face-to-face approach, attending physicians achieved a better glottic view compared to residents and NPs, with a Cormack-Lehane grade I vs grade IIa, respectively (Table 2).

DISCUSSION

This randomized crossover simulation manikin study evaluated two upright intubation techniques—right-rear and face-to-face—using four videolaryngoscopic devices. Among experienced clinicians, the right-rear approach yielded significantly higher first-pass success rates (93% vs 78%), faster intubation times, and superior glottic visualization, with a HR of 2.10 (95% CI 1.58-2.80, $P < .001$). The right-rear approach also consistently achieved favorable Cormack-Lehane grade I views and 100% percentage of glottic opening scores, compared to grade IIa and 90% percentage of glottic opening score with the face-to-face approach (Table 2). These findings suggest that the right-rear approach provides a more ergonomically intuitive alignment, resembling conventional midline intubation, which may ease hand-eye coordination and reduce the technical challenges associated with the inverted face-to-face orientation.

Importantly, device selection also played a critical role in performance. Both the video stylet and channeled

Table 2 Study outcomes across two approach methods and four intubation devices.

Variables	N	First-pass success rate Mean±SD	Overall success rate Mean±SD	Time to glottis (s) Median (IQR)	Glottis to success (s) Median (IQR)	Time to success (s) Median (IQR)	POGO score (%) Median (IQR)	CL-grade Median
Right-rear approach	120	0.93±0.26	1.00	3 (2-32)	6 (4-7)	10 (7-13)	100 (80-100)	I
Face-to-face approach	120	0.78±0.41	1.00	5 (3-7)	8 (5-12.5)	13 (10-21.5)	90 (60-100)	IIa
Variables of right-rear approach								
Attending physician	76	0.92±0.27	1.00	3 (2-5)	6 (4-7)	9 (7-13)	100 (80-100)	I
Resident	24	0.96±0.20	1.00	5 (2.75-7.25)	5.5 (4-9)	11 (9-16.25)	100 (80-100)	I
Nurse practitioner	20	0.90±0.31	1.00	3 (3-4)	5 (3-6)	9 (6.75-12)	100 (95-100)	I
SGVL	30	0.93±0.25	1.00	4.5 (2-6)	6 (5-8.75)	10.5 (8-14.75)	80 (60-100)	IIa
Channeled VL	30	1.00	1.00	3 (2-4.75)	6 (4-7)	9 (7-11)	100 (100-100)	I
HAVL	30	0.77±0.43	1.00	4 (2.25-5.75)	6 (5-8)	10.5 (9-14)	80 (80-100)	IIa
VS	30	1.00	1.00	3 (2.25-5.75)	4 (3-5)	7 (6-10.75)	100 (100-100)	I
Variables of face-to-face approach								
Attending physician	76	0.78±0.42	1.00	5 (3-7)	8 (5-13)	13 (10.75-22)	100 (60-100)	I
Resident	24	0.92±0.28	1.00	5.5 (4-7.25)	8.5 (6-11.25)	14 (10-20.25)	90 (60-100)	IIa
Nurse practitioner	30	0.65±0.49	1.00	4 (3-5.5)	7 (4-12)	13.5 (10-21.25)	80 (80-100)	IIa
SGVL	30	0.67±0.48	1.00	5 (4-7.75)	9 (7-12.75)	16 (12.5-18.75)	60 (50-80)	IIa
Channeled VL	30	1.00	1.00	3 (2-5)	7 (5-10.5)	11.5 (8-13.75)	100 (100-100)	I
HAVL	30	0.47±0.51	1.00	4.5 (3-6)	20.5 (9.25-31)	26.5 (13-33.75)	60 (60-80)	IIa
VS	30	1.00	1.00	6.5 (3-9.75)	4 (3-7.75)	11 (9.25-14.75)	100 (100-100)	I

s, seconds; *POGO*, percentage of glottic opening; *CL*, Cormack-Lehane; *IQR*, interquartile range 25th and 75th percentiles; *SGVL*, standard geometric Macintosh videolaryngoscope; *VL*, channeled videolaryngoscope; *HAVL*, hyperangulated videolaryngoscope; *VS*, video stylet.

videolaryngoscope achieved a 100% first-pass success rate across both approaches. Their consistent efficacy, even in the technically demanding face-to-face position, highlights their value in optimizing upright intubation. These devices reduce reliance on precise tube manipulation and glottic angle alignment, making them especially advantageous in scenarios where orientation or operator experience may be limited. Taken together, our results underscore that both approach familiarity and device design must be considered when planning upright airway management strategies.

Although the overall first-pass success rate of 85% in this study may be considered low, it reflects the technical challenges of upright intubation, particularly with the less familiar face-to-face approach. In contrast, the right-rear approach achieved a higher first-pass success rate of 93%, underscoring the importance of spatial orientation and ergonomic familiarity. The lack of significant differences in first-pass success rate among attending physicians, residents, and NPs may be attributed to their uniformly high experience levels and the standardized pre-study training. However,

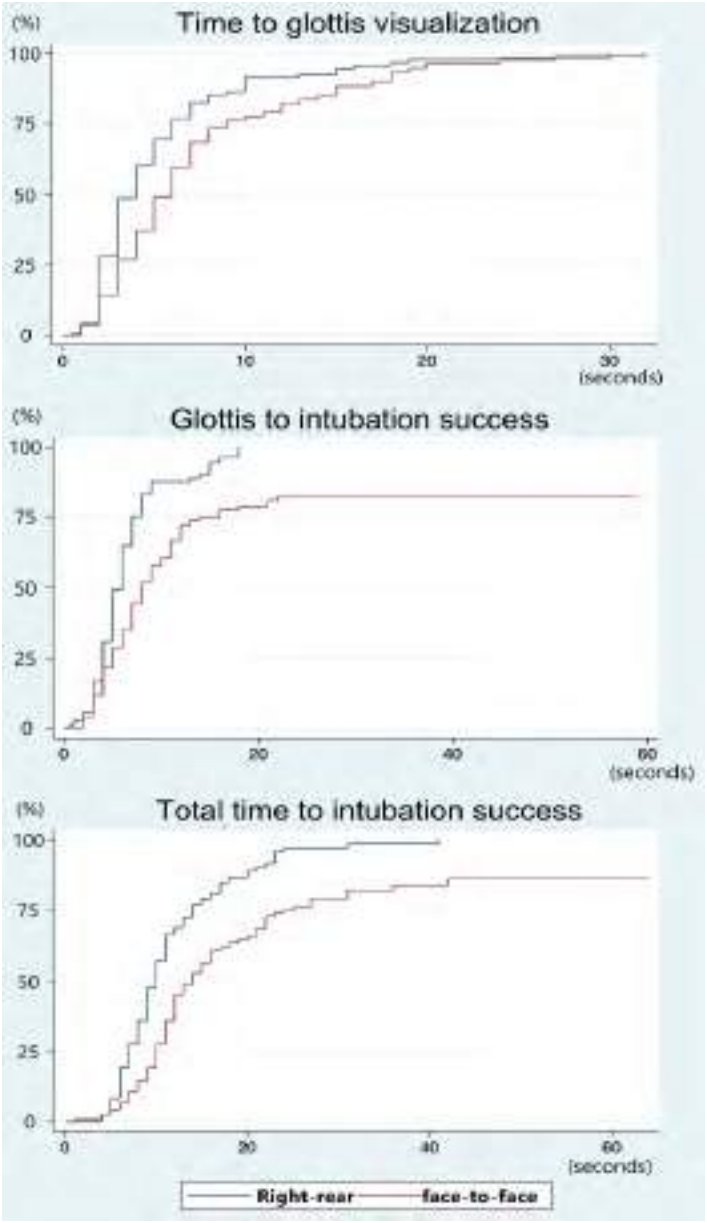

Figure 2. Kaplan-Meier failure estimates for first-pass intubation success: comparison of right-rear vs face-to-face approaches.

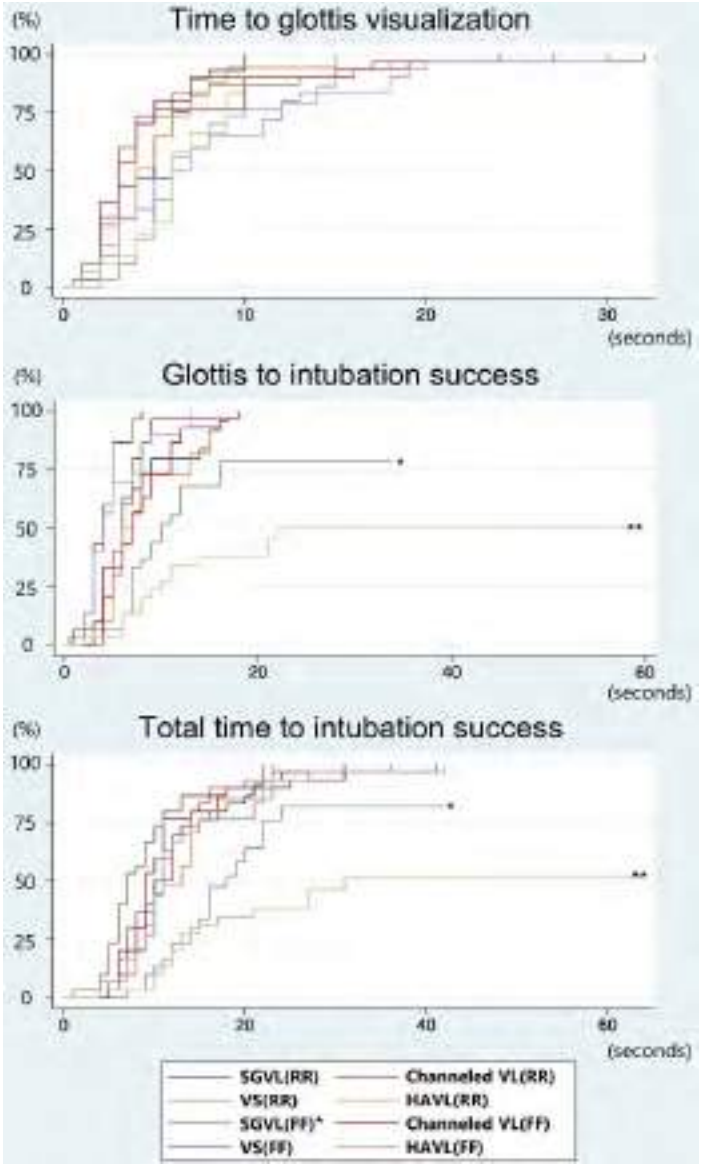

Figure 3. Kaplan-Meier failure estimates for first-pass intubation success across four devices and two approaches, totaling eight subgroups.
A)=. Time from the start of intubation to glottic visualization. B. Time from glottic visualization to successful intubation. C. Total duration from the start of intubation to success
The face-to-face approach with SGVL(*) and HAVL(**) devices showed lower success rates and longer times for tube passage and overall intubation success compared to other methods.
RR, right-rear approach; *FF*, face-to-face approach; *SGVL*, standard geometric videolaryngoscope; *VL*, channeled videolaryngoscope; *HAVL*, hyperangulated videolaryngoscope; *VS*, video stylet.

attending physicians demonstrated superior glottic views in face-to-face scenarios, suggesting subtle performance differences not fully captured by first-pass success rate alone (Tables 1 and 2).

Turner et al investigated the feasibility of intubating in an upright position in the ED, reporting that the first-pass success rate increased with every 5º increment in patient positioning, reaching its highest at ≥45 degrees. This challenges the traditional preference for the supine position and aligns with other observational studies suggesting that an upright position may enhance intubation success.[7,9] While face-to-face intubation is widely used in upright scenarios and has been reported as either superior or non-inferior to the standard midline approach,[9,15] we found that the right-rear approach significantly outperformed the face-to-face approach, with the same HR of 2.10 (95% CI 1.58-2.80, $P < 0.001$) (Table 3).

Additionally, the right-rear approach produced better glottic views, achieving Cormack-Lehane grade I and a percentage of glottic opening score of 100%, compared to

Table 3. Cox regression analysis of covariate results.

Variable	Hazard ratio	95% Confidence intervals	P-value
Age	1.00	0.93-1.07	0.93
Duration of practice	1.05	0.99-1.12	0.10
Device order	0.98	0.92-1.04	0.42
Approach			
Right-rear vs face-to-face approach	2.10	1.58-2.80	<0.001
Job title			
Nurse practitioner vs attending physician	1.07	0.72-1.58	0.76
Resident vs attending physician	1.53	0.99-1.12	0.13
Device comparison			
HAVL vs SGVL	0.62	0.40-0.96	0.03
Channeled VL vs SGVL	1.61	1.10-2.36	0.02
VS vs SGVL	1.88	1.28-2.77	0.001

SGVL, standard geometric videolaryngoscope; *VL*, channeled videolaryngoscope; *HAVL,* hyperangulated videolaryngoscope; *VS*, video stylet.

Cormack-Lehane grade IIa and 90% percentage of glottic opening with the face-to-face approach (Table 2). This difference may be attributed to the more familiar operator orientation in the right-rear position. Moreover, the right-rear approach uses the left hand for laryngoscope manipulation, aligning with standard practice, whereas the face-to-face approach requires the right hand in a mirrored position, which may hinder fine laryngoscope-tip control. Intubation in the face-to-face approach may also be delayed due to tube passage with the non-dominant left hand (Figure 2).

Regarding device performance, the hyperangulated videolaryngoscope has been reported to perform faster than other devices and has been proposed as an alternative to flexible fiber-optic laryngoscopy in awake, upright patients.[19] Similarly, channeled videolaryngoscope and video stylet have demonstrated greater efficiency than the standard Macintosh device in managing anatomically difficult airways.[16] Julliard et al. found no significant difference in first-pass success rates between upright and supine use of the hyperangulated videolaryngoscope in cadaver models.[15] However, in our study, the hyperangulated videolaryngoscope demonstrated the lowest first-pass success rate among the devices tested—even lower than the standard Macintosh device. Specifically, the hyperangulated videolaryngoscope showed a HR of 0.62 (95% CI 0.40-0.96, $P = .03$) (Table 3, Figure 3). Despite participants adapting the stylet angle to match the the hyperangulated videolaryngoscope blade, this adjustment added complexity. The face-to-face approach likely compounded the difficulty due to the required inverted orientation and limited maneuverability, potentially explaining the higher failure rates.

In contrast, the first-pass success rate was highest with the video stylet and channeled videolaryngoscope, outperforming the standard Macintosh device with HRs of 1.88 (95% CI 1.28-2.77, $P = .001$) and 1.61 (95% CI 1.10-2.36, $P = .02$), respectively (Table 3). The video stylet eliminates the need to lift or manipulate the tongue, maintaining consistent performance regardless of spatial orientation. The channeled videolaryngoscope likewise provides a central visual marker and a dedicated tube channel, facilitating efficient tube delivery, even in the inverted face-to-face position. Both devices consistently produced optimal glottic views (Cormack-Lehane grade I, 100% percentage of glottic opening score). In contrast, the standard Macintosh device and the hyperangulated videolaryngoscope had lower first-pass success rates (93% and 77% with the right-rear approach, and 67% and 47% with the face-to-face approach, respectively) and required longer intubation times, especially when used with the face-to-face approach. These differences may be attributed to the increased hand coordination required by the standard Macintosh device and the hyperangulated videolaryngoscope, particularly under non-standard orientations (Table 2, Figure 3).

LIMITATION

This study did not include induction techniques, which may affect intubation conditions and first-pass success in clinical settings. Our manikin-based simulation allowed for standardized comparisons but lacked patient-specific anatomical and physiological variability. Participants, although experienced in airway management, were more familiar with the head-elevated midline approach (25-30 degrees) than the fully upright (≥45 degrees) right-rear or face-to-face techniques.

The right-rear approach aligned more closely with standard ergonomics, while the face-to-face method involved an unfamiliar, inverted orientation. In practice, face-to-face intubation is rarely used and typically reserved for confined spaces or scenarios where upright positioning is required without prior training. Although simulation drills may improve proficiency, such training is not always feasible. We selected the

right-rear approach as a practical alternative to midline intubation for upright scenarios involving cervical spine immobilization or limited neck mobility. Its familiar orientation may make it more broadly applicable in real-world situations.

CONCLUSION

In this single-center simulation study, the right-rear approach to upright intubation provided a more familiar spatial orientation and was associated with a higher first-pass intubation success rate (93% vs 78%) and better glottic visualization compared to the face-to-face approach, particularly among clinicians without prior experience using the face-to-face technique. The right-rear approach demonstrated a hazard ratio of 2.10 relative to the face-to-face method.

Among the devices tested, video stylets and channeled videolaryngoscopes achieved the highest first-pass success rates and optimal glottic views, even when used in the technically challenging face-to-face orientation. Their design reduced the need for complex hand coordination and improved procedural efficiency. These findings suggest that combining the right-rear approach with either a video stylet or a channeled videolaryngoscope may enhance intubation performance in upright scenarios. However, further clinical studies are needed to validate these results in real-world patient care settings.

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Disaster Medicine Core Competencies: Comparative Analysis of Emergency Medicine Residency Training in Taiwan and the United States

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Background: Situated in the western Pacific Ocean, Taiwan has faced a diverse array of natural and man-made disasters. Since 2000, disaster medicine education has been progressively integrated into various medical professions, with a focus on training disaster medical assistance teams, managing chemical and radiological emergencies, and enhancing prehospital and hospital emergency management capabilities. Despite the key roles of emergency physicians (EP) as primary responders and crucial managerial personnel during disasters, a comprehensive assessment of the disaster medicine core competencies (DMCC) required for emergency medicine (EM) residency training might serve as a blueprint for Taiwan's EM residency core curriculum. We sought to survey the most critical DMCCs, prioritize them, and determine their appropriateness for the EM residency training program. We also compare dthe prioritization of DMCCs between Taiwan and the United States.

Methods: To accomplish these objectives, we employed a modified Delphi method over three rounds. Initially, three EPs developed a draft of DMCCs for Taiwan. This draft, including 42 DMCCs, was subsequently reviewed by a task force comprising 22 leaders in disaster medicine from EM residency training hospitals across Taiwan. The Delphi method facilitated consensus on the DMCCs through three iterative rounds of polling, with each round evaluating the appropriateness of the proposed competencies. The study also compared the prioritized DMCCs proposed in both Taiwan and the US.

Results: The following 15 DMCCs were rated as highly appropriate with high consensus agreement: personal protective equipment (PPE); decontamination; incident command systems; mass casualty incidents; basic concepts and nomenclature of disaster medicine; medical response to chemical emergencies; triage; identification, notification, activation, and information collection; medical response to radiation emergencies; medical response to bioterrorism and biological emergencies; mental health; disaster exercises; prehospital disaster management; communication and information management; and health consequences of different disasters. A comparison with DMCCs in the US revealed shared prioritization for PPE and decontamination competencies. However, Taiwan placed greater emphasis on prehospital disaster operation management, mental health implications, and health consequences across different disasters, while the US focused more extensively on emergency management within hospitals.

Conclusion: The expert-consensus-driven ranking of DMCCs in the study showed noteworthy agreement with the US. However, the roles of EPs, experience of previous disasters, and government policies may influence specific competencies. This underscores the importance of incorporating local context into disaster medicine training. [West J Emerg Med. 2025;26(4)1095–1104.]

INTRODUCTION

Taiwan is an industrialized island with a population of approximately 23.4 million, located in the subtropical Pacific Ocean of Southeast Asia. According to the World Bank, more than 73% of Taiwan's land area and population are exposed to three or more natural disasters annually.[1] Situated within the Pacific "Ring of Fire," Taiwan is prone to frequent earthquakes. The 1999 Chi-Chi Earthquake was the most devastating to date, resulting in 2,347 fatalities, 8,722 injuries, and estimated property damage exceeding 92 billion US dollars.[2] This catastrophic event prompted the government and society to prioritize disaster management, including the development of disaster medicine (DM) education.

Taiwan lies along the primary typhoon strike path in the Northwest Pacific region. Typhoons Nari in 2001[3] and Morakot[4] were among the most severe to hit the island, causing extensive damage and loss of life. Furthermore, the rapid growth of international transportation has facilitated the transmission of infectious diseases such as severe acute respiratory syndrome,[5] H1N1 influenza,[6] and coronavirus disease 2019 to the island.[7] These emerging infectious diseases have spread globally through large-scale transmission and pose significant challenges to communities worldwide. Over the past several decades, with rapid advancements in technology, manufacturing, and transportation, technical disasters such as fires and hazardous material accidents have also become increasingly prevalent in Taiwan. Moreover, the country currently faces a significant risk of potential military conflicts.[8]

Consequently, the Taiwanese government and various healthcare stakeholders have been actively and continuously developing DM education within the country, emphasizing the ability of medical personnel to respond to various types of disasters and emergencies. In Taiwan, emergency physicians (EP) play critical roles as frontline disaster responders before, during, and after disasters. They actively participate in the development and execution of disaster preparedness and response plans for medical and healthcare-related emergencies. During disasters, they manage mass casualties in both prehospital settings and emergency departments by coordinating triage, treatment, and casualty transfers. After disasters, EPs also engage in relief and recovery efforts, assisting in rehabilitation and rebuilding the healthcare system. As a result, DM education is particularly emphasized for emergency medicine (EM) residents. However, despite the diverse goals of DM, the core competencies for EM residency training in Taiwan have not yet been fully standardized.[9]

In the interdisciplinary context of DM education, establishing core competencies is particularly crucial.[10] Effectively addressing various natural disasters, man-made disaster events, and public health crises requires knowledge and skills spanning various professional domains. Clear definitions of core competencies can ensure that medical students and residents possess the necessary skills to prepare for disasters. Core competencies are currently being developed in the context of DM education, both internationally and in the United States.[11–13]

Establishing these core competencies is essential to ensuring comprehensive coverage and continuous improvement of education and training. By defining clear learning objectives and assessment criteria, adaptability and resilience can be cultivated in future medical professionals in order to better address challenges related to future disaster events.[7] Although the types of disasters in different areas may be similar, differences in geographical environments, cultures, disaster response mechanisms, and government systems necessitate regional variations in DM core competencies (DMCC). The adoption of "competency-based medical education" by the Accreditation Council for Graduate Medical Education (ACGME) in the US highlights a systems-based practice[14] that applies to DM as well. Comparative research on this topic is currently lacking in the literature.

Since disaster medicine covers a wide range of capabilities and skills, it is necessary to address the most critical DMCCs and include them in EM residency training. In this study we aimed to investigate the prioritized DMCCs for EM residency training during the limited EM training period in Taiwan. Subsequently, we compared these to the established practices in the US to evaluate the potential variations that may have arisen as a result of the different political or regional backgrounds of these two jurisdictions.

Population Health Research Capsule

What do we already know about this issue?
Disaster medicine core competencies (DMCC) are essential for training emergency medicine (EM) residents, but they vary by region and healthcare system.

What was the research question?
What are the most critical DMCCs for EM residencies in Taiwan compared to the US?

What was the major inding of the study?
The top five DMCCs were personal protective equipment (4.8); decontamination (4.7); incident management system (4.7); mass casualty incidents (4.6); and disaster medicine basics (4.6).

How does this improve population health?
Developing EM residency training based on DMCCs aligned with local disaster response needs is essential for strengthening healthcare system resilience.

METHODS

In 2023, a modified three-round Delphi method was used to formulate the recommended DMCCs for EM residency training in Taiwan. This study was reviewed and approved by the Research Ethics Committee D of the National Taiwan University Hospital (NTUH-REC No. 202207185W). Initially, three EPs serving as senior DM trainers systematically reviewed the relevant literature, including DMCCs for EM residency training in the US[12] and other publications addressing disaster medicine, competencies, and emergencies and disasters on PubMed and Web of Science,[11,13] so that potential elements of DMCC that would be later evaluated by the full panel of 22 experts would not omit any important topics for further consideration. Acknowledging the variations in governmental systems, healthcare infrastructures, and cultural contexts across nations and healthcare professions that could influence DMCCs, a Chinese version of the DMCCs, along with meticulously drafted detailed objectives, were subsequently developed and tailored specifically for the Taiwanese context. All three EPs agreed with the modifications and final draft.

A task force was established for this study, which included a total of 22 experts from February–October 2023. The task force comprised 20 members of the Disaster Response Committee of the Taiwan Society of Emergency Medicine and two senior DM trainers from the Taiwan Emergency Management Association. The participants of the task force all received specialized training in various subfields of disaster medicine—such as radiation incidents, chemical incidents, disaster medical assistance teams (DMAT), and hospital emergency management—after their residency and subsequently served as trainers in disaster medicine. They had a mean duration of professional experience of 12.8 years (SD 6.2) in the field of DM, and they were all DM program managers in EM residency training hospitals across Taiwan. Sixteen of the participants were employed at medical centers, while the remaining six practiced at regional hospitals. They were also senior leaders of the DMATs. Among the three EPs who initiated the draft, they have published five, eight, and nine articles in peer-reviewed English-language journals, respectively. Regarding the remaining 19 experts, they have collectively published 47 articles related to DM. Furthermore, at least 12 of these experts have authored at least one article in the DM literature.

Our primary goal was to identify and prioritize the most critical DMCCs and assess their appropriateness for the EM residency training program in Taiwan. To achieve consensus among the task force participants, we employed the modified Delphi method. This entailed three iterative rounds of polling the participants to characterize their initial degree of consensus. In each round, the participants rated the appropriateness of each DMCC on a five-point Likert scale (1 = very inappropriate, 2 = inappropriate, 3 = fair, 4 = appropriate, and 5 = very appropriate). Consensus determination was contingent on a high level of agreement after three rounds, defined as an interquartile range (IQR) of ≤1 and <2 participants changing scores between the final two rounds. Competencies without consensus were not deleted after the first round but were carried forward to the next rounds until a consensus was reached. The participants also revised the wording of the objectives for each DMCC. The experts were provided with feedback from all participants in the previous round to inform their decisions and aid in the establishment of a consensus during the second round. Based on expert input, modifications were made where necessary, which ultimately led to improved consensus. The Delphi panel did not merely re-rate the competencies; instead, adjustments were considered when substantial feedback suggested necessary refinements. The median score for each DMCC was used to rank its appropriateness.

The secondary goal of this study was to compare the prioritization of DMCCs between Taiwan and the US. To enhance the ranking and facilitate comparison with US results, we used mean scores to determine the priority order when DMCCs had the same median scores. The criteria (median and mean scores ≥4, and IQR of ≤1) for selecting the most appropriate DMCCs were determined a priori, before conducting the Delphi rounds.

The ACGME core competencies serve as a fundamental framework for EM residency training programs in Taiwan. This study also mapped the DMCCs to these six core competencies to ensure their integration into the overall development of EM residency training. A panel of five experts, comprising three EPs and two medical education experts, was convened for this purpose. Each DMCC was systematically mapped to the six core competencies: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and system-based practice. The experts independently assessed the correlations between each DMCC and the six core competencies. If more than four of the five experts agreed on the correlation, the DMCCs were categorized under the six core competencies of medical education. This threshold was established based on expert panel discussions to ensure that only competencies with strong consensus were classified as high agreement.

RESULTS

Applying the modified Delphi method, the task force completed three iterative rounds of polling to investigate DMCC-related consensus. As a result, 42 DMCCs were evaluated during the third round. In the final round, a consensus was reached regarding 34 DMCCs. Fifteen of these exhibited mean scores of ≥4, indicating high appropriateness. These were as follows: personal protective equipment; decontamination; incident management system; mass casualty incidents; basic concepts and nomenclature of DM; medical response to chemical emergencies; triage; identification, notification, activation, and information collection; medical

response to radiation emergencies; medical response to bioterrorism and biological emergencies; mental health; disaster exercises; prehospital disaster management; communication and information management; and health consequences of different disasters (Table 1).

The detailed objectives of each DMCC form the main context of the core competencies. The detailed objectives of the 15 DMCCs with high agreement and appropriateness listed in Table 2 were considered to form the context of disaster medicine training for EM residency. All of the DMCCs and their detailed objectives are presented in Appendix 1. The 42 DMCCs were mapped to the six core competencies defined by the ACGME for competency-based medical education. In cases where ≥4 raters among the five experts reached a consensus on the match, the DMCC was deemed to have been mapped to the selected core competencies (Table 3 and Appendix 2). Six of the 15 DMCCs with high levels of appropriateness were mapped to patient care, 12 to medical knowledge, one to interpersonal and communication skills, and seven to systems-based practice. None were determined to map to practice-based learning and improvement or professionalism. Eight DMCCs were mapped to two or more ACGME core competencies, and three DMCCs were mapped to three core competencies.The study compared the DMCCs in Taiwan to the established core competencies in the US to evaluate potential variations that may have arisen as a result of the different political or regional backgrounds of the two jurisdictions, as is summarized in Table 4.[12]

DISCUSSION

The 15 DMCCs with high levels of agreement, and those deemed highly appropriate for EM residency training in Taiwan, primarily consisted of two main aspects. First, they encompassed the fundamental knowledge of DM, which integrates emergency management and EM into a multidisciplinary specialty. It is crucial for EPs to develop their domain knowledge and acquire essential skills based on the "all-hazards approach,'"which applies to a wide range of disaster scenarios. Second, they must be proficient in response strategies and specialized skills for specific hazards, such as radiation, biological, and chemical incidents since EPs often serve as first responders within communities and healthcare systems when these types of hazards impact public health. These hazards present unique challenges in terms of response processes—requiring not only special medical care but also the protection of responders and facilities. Mishandling these hazards can exacerbate the situation and lead to further damage.

Nowadays, the DM training curriculum for EM residency in Taiwan consists of two main components, aligning with the two domains of DMCCs. Fundamental disaster medicine knowledge, including emergency command systems, disaster response frameworks, legislation, logistics, and public health, is delivered through an online multimedia program. Meanwhile, training for special incidents, such as chemical, radiological, and biological hazards, as well as hospital emergencies, combines online learning with real-world group simulations. However, we identified gaps in the current training, particularly in mental health, communication, and information management, which are rarely addressed. Additionally, we found that both hospital-based mass casualty incident (MCI) and prehospital disaster management should be equally emphasized, although this is not yet a universally accepted practice in Taiwan. Moreover, disaster exercises were highlighted in our findings but are not yet incorporated into the current curriculum. Our study provides clear objectives for future training design. To address these gaps, we plan to integrate mental health and communication training and develop new simulated scenarios for both prehospital and hospital MCI response to enhance practical disaster preparedness. Additionally, specific training for disaster exercises is still under development, requiring further refinement based on current consensus.

However, we acknowledge the challenges inherent in promoting the prioritized DMCCs according to our findings, in that time for residency training is limited. Spending time teaching these DMCCs to residents would necessarily require removing content in other areas. It is beyond the scope of this paper to determine what other topics might be sacrificed to include additional DMCC content. One potential approach to addressing this challenge is leveraging multimedia training. With the advancement of online education, some knowledge-based DMCCs, such as the fundamental concepts and nomenclature of DM, are now effectively delivered through online training programs. Meanwhile, DMCCs ranked as relatively lower priority, such as hospital emergency management, are considered more advanced competencies and are increasingly being integrated into DM subspecialty training.

The commonalities in EM residency training between Taiwan and the US suggest potentially universal elements across diverse countries, emphasizing considerations beyond governmental or cultural differences. However, some key differences were identified as well. In Taiwan, training for EPs places significant emphasis on prehospital disaster management, mental health, and the health-related consequences of different disasters—likely influenced by experiences and related disaster response strategies following events such as the Chi-Chi earthquake and various typhoons. During emergencies in Taiwan, when onsite medical assistance is required, EPs often serve as first responders dispatched to the scene, in a practice that mirrors that of Japan.[15] Consequently, training for EM residents frequently includes disaster medical assistance team training and exercises conducted in out-of-hospital settings. The EPs also work closely with the emergency medical service (EMS) system and serve as primary responders in prehospital settings. Many EPs in Taiwan also hold roles as medical directors within the EMS system, providing medical

Table 1. Final ranking of the disaster medicine core competencies for emergency medicine residency training in Taiwan.

Ranking	Competency	Median	Mean, SD	Interquartile range
1	Personal protective equipment	5.0	4.8, 0.4	0.0*
2	Decontamination	5.0	4.7, 0.5	0.8*
3	Incident management system	5.0	4.7, 0.5	1.0*
4	Mass casualty incidents	5.0	4.6, 0.5	1.0*
5	Basic concepts and nomenclature of disaster medicine	5.0	4.6, 0.5	1.0*
6	Medical response to chemical emergencies	5.0	4.5, 0.6	1.0*
7	Triage	4.5	4.5, 0.6	1.0*
8	Identification, notification, activation, and information collection	4.0	4.4, 0.7	1.0*
9	Medical response to radiation emergencies	4.5	4.3, 0.8	1.0*
10	Medical response to bioterrorism and biological emergencies	4.0	4.3, 0.6	1.0*
11	Mental health	4.0	4.2, 0.7	0.8*
12	Disaster exercises	4.0	4.2, 0.7	1.0*
13	Prehospital disaster management	4.0	4.0, 0.7	0.8*
14	Communication and information management	4.0	4.0, 0.5	0.0*
15	Health consequences of different disasters	4.0	4.0, 0.7	0.8*
16	Fire and burn mass casualty incidents	4.0	4.0, 1.0	1.8
17	Casualty transfer	4.0	3.9, 0.9	0.8*
18	Building collapse and medical response	4.0	3.9, 0.9	1.8
19	Vulnerable populations	4.0	3.8, 0.9	1.0*
20	Blast injuries	4.0	3.8, 1.0	1.8
21	Safety management	4.0	3.7, 0.8	1.0*
22	Casualty identification and tracking	4.0	3.7, 0.8	1.0*
23	Hospital emergency management	4.0	3.7, 0.9	1.0*
24	Isolation and quarantine	4.0	3.7, 0.8	1.0*
25	Legal issues	4.0	3.7, 0.7	1.0*
26	Ethical issues	4.0	3.7, 0.6	1.0*
27	Surge capacity and surge capability	4.0	3.6, 0.9	1.0*
28	Continuity of operation	4.0	3.5, 0.7	1.0*
29	Shelters	3.5	3.5, 0.8	1.0*
30	Hospital evacuation	3.0	3.4, 1.1	1.8
31	Tactical medicine	3.5	3.4, 1.0	1.8
32	Government and non-government organizations	3.5	3.3, 0.9	1.0*
33	Public health issues	3.0	3.3, 1.0	1.8
34	Public information	3.0	3.1, 0.8	1.8
35	Personal and family preparedness	3.0	3.0, 1.0	0.8*
36	Fatality management	3.0	3.0, 0.4	0.0*
37	Recovery	3.0	2.9, 0.7	0.8*
38	Terrorism	3.0	2.9, 1.1	1.8
39	Evidence preservation	3.0	2.9, 1.0	1.0*
40	Resource management	3.0	2.6, 1.0	1.0*
41	National stockpile of pharmaceutical and medical supply	3.0	2.6, 0.8	1.0*
42	Volunteer management	2.0	2.6, 1.1	1.0*

* A high level of agreement after three rounds was defined as an interquartile range of ≤1 and <2 participants changing scores between the final two rounds.

Table 2. Disaster medicine core competencies in emergency medicine residency training with high agreement and appropriateness, presented alongside their detailed objectives.

Ranking	Mean score	Competency	Detailed objectives
1	4.8	PPE	• Explain the purpose and effects of using PPE. • Emphasize the importance of correctly donning and doffing PPE. • Describe the training and inspection for PPE. • Explain the limitations, risks, and common issues in the use of PPE. • Outline the differences in PPE for radiation, biological, and chemical emergencies.
2	4.7	Decontamination	• Understand the indications and effects of decontamination. • Explain the potential hazards of decontamination procedures for patients and responders. • Describe the procedure, equipment, and facilities for emergency decontamination, gross decontamination, and technical procedures. • Explain the differences between decontamination of radiation and chemical emergencies. • Organize the decontamination post at the incident site, including entry control and casualty flow. • Explain the management of waste generated after decontamination.
3	4.7	Incident management system	• Explain the concept and importance of the incident management system. • Define the Incident Command System (ICS). • Describe the advantages and operational principles of applying the ICSto respond to emergencies or disasters, including common terminology, modular organization, unity of command, chain of command, and manageable span of control and unified command. • Outline the basic structure of the ICS and the primary tasks of each unit. • Explain the similarities and differences between hospital ICS and ICS, as well as their appropriate application. • Demonstrate the use of the ICS in exercises or real events. • Explain the steps of the planning cycle.
4	4.6	MCIs	• Understand the importance of planning for MCIs. • Understand the impact of MCIs on regional and local medical resources, as well as their effects on public health. • Explain the notification and activation procedures for MCIs in hospitals. • Describe common trauma and their management in traumatic MCIs. • Explain the potential causes, disease patterns, and management of non-traumatic MCIs.
5	4.6	Basic concepts and nomenclature of disaster medicine	• Define and explain the following disaster medicine terms: “emergency,” “disaster,” “multiple casualty incident.” and “MCI.” • Explain the following disaster medicine terms: Central Disaster Response System, Disaster Medical Response System, Regional Emergency Medical Operation Center, Incident Command System (ICS), “Emergency Management Program,” “Emergency Operation Plan,” and “Incident Action Plan.” • Explain the four phases of emergency management. • Explain the “All-hazard” approach in emergency management. • Explain the three components of hazard vulnerability analysis: probability of occurrence, impact, and level of preparedness.
6	4.5	Medical response to chemical emergencies	• Understand the manifestations of chemical exposure and intoxication of casualties in chemical emergencies. • Describe the immediate safety, medical, and other response procedures of first responders in chemical emergencies. • Explain the initial identification, notification, and mobilization procedures for chemical emergencies, encompassing both internal and external units. • Provide critical information promptly and initiate urgent responses to mitigate potential harm to responders, the environment, and the public. • Understand the common chemicals that may lead to emergencies at both regional and national levels, including their characteristics and proper management. • Understand the levels of PPE in chemical emergencies and their corresponding indications. • Properly don, doff, and dispose of PPEs in chemical emergencies.

PPE, personal protective equipment; *MCI*, mass casualty incident; *COVID-19*, coronavirus disease 2019.

Table 2. Continued.

Ranking	Mean score	Competency	Detailed objectives
7	4.5	Triage	• Explain the purpose and indication of triage. • Explain the differences between triage during emergencies and disasters and routine triage in emergency departments (Taiwan Triage and Acuity Scale). • Triage patients in disasters with varying resources. • Explain the differences between prehospital and hospital triage in disasters. • Understand the differences in triage for mass gatherings, chemical emergencies, radiation emergencies, and biological emergencies.
8	4.4	Identification, notification, activation, and information collection	• Explain the identification procedures of first responders during emergencies, including scenarios, geographical features, potential hazards, and required resources. • Explain the notification procedures during emergencies, including recipients, methods, and responsibilities of reporting. • Explain the activation procedures during emergencies, including recipients, methods, and responsibilities of activation. • Explain the common information collected during emergencies for subsequent analysis and review.
9	4.3	Medical response to radiation emergencies	• Explain the basic principles of radiation physics and protection. • Explain the resources of hospitals and the government for radiation injuries. • Explain the procedures of emergency departments for radiation emergencies prior to the arrival of casualties. • Explain the differences in medical response for casualties in chemical emergencies and radiation emergencies. • Properly don, doff, and dispose of PPE in radiation emergencies. • Understand acute radiation syndrome and explain the classification of casualties based on their initial presentation. • Explain the medical treatment for casualties exposed to high-dose radiation within 48 hours.
10	4.3	Medical response to bioterrorism and biological emergencies	• Explain the common bioterrorism agents, their modes of dissemination, and possible treatments. • Explain the differences between bioterrorism events and general infectious disease outbreaks. • Explain the impact of global pandemics, such as COVID-19 or new influenza, on the healthcare system. • Explain the response, reporting, and related procedures for suspected cases of unknown emerging infectious diseases or unknown pathogens. • Explain the types and differences in PPE for biological emergencies. • Describe the optimal PPE for tuberculosis, chickenpox, influenza, Ebola virus, COVID-19, dengue fever, and scabies. • Properly don, doff, and dispose of PPE for biological emergencies.
11	4.2	Mental health	• Explain the principles of Psychological First Aid. • Explain the clinical manifestations of acute stress disorder. • Explain the risk factors for post-traumatic stress disorder. • Explain the mental health issues in disasters and intervention strategies.
12	4.2	Disaster exercises	• Explain the importance of exercises in disaster preparedness. • Explain different types of discussion-based exercises (eg, seminars, workshops, tabletop exercises, and games) and operational exercises (eg, drills, functional exercises, and full-scale exercises). • Explain the pros and cons of discussion-based exercises and operational exercises. • Understand how to design an exercise, do hotwash, and write after-action reports and improvement plans.
13	4.0	Prehospital disaster management	• Explain onsite command systems during emergencies or disasters. • Explain the setup and functions of medical posts at the scene. • Explain the issues and strategies related to casualty referral in MCIs. • Explain the coordination and cooperation among various resources and responders at the scene, including police, firefighters, emergency medical technicians, and social workers.

PPE, personal protective equipment; *MCI*, mass casualty incident; *COVID-19*, coronavirus disease 2019.

Table 2. Continued.

Ranking	Mean score	Competency	Detailed objectives
14	4.0	Communication and information management	• Explain communication issues during disasters (both external and within hospitals), including assessing the accuracy of information. • Understand commonly used communication tools and their pros and cons, as well as alternative communication methods. • Understand the importance of maintaining internal and external communication, information exchange, and information security regarding organizational safety. • Understand the differences in communication rules within and between organizations.
15	4.0	Health consequences of different disasters	• Describe different types of injuries and potential health effects during different phases of different emergencies or disasters: earthquakes, floods, typhoons, cold waves, heatwaves, traffic accidents, chemical emergencies, radiation emergencies, building collapses, explosions, and biological emergencies. • Understand the potential impacts of disasters on community healthcare, water, food, and sanitation facilities. • Explain common health and medical issues in shelters and their coping strategies.

direction in real time. Therefore, EPs often represent the best adjuncts to prehospital medical responses during disasters. This unique disaster response system may have influenced the differences observed in the DMCCs of the EM resident training programs between Taiwan and the US. Consequently, when developing DMCCs for specialty training, factors such as governmental policies and regulations, roles within the healthcare system, and previous disaster experiences should all be considered.

Additionally, when mapping the DMCCs for EM residency training in our study with the six core ACGME competencies we observed that, beyond patient care and medical knowledge, the third most significant domain of the six core competencies was systems-based practice. This further reinforced our earlier observations regarding the importance of understanding the disaster response systems implemented by both community-level and governmental authorities. Although DMCCs were similar in Taiwan and the US, the detailed mechanisms and operational procedures, such as incident management systems, may vary significantly between countries. Therefore, the concept of systems-based practice plays a crucial role in program development, ensuring that training aligns with each country's specific disaster response framework and healthcare system.

It was also observed that there were no DMCCs mapped to practice-based learning and improvement among the top 15 DMCCs. Practice-based learning and improvement involves physicians' abilities to engage in lifelong learning and improvement by systematically analyzing their practice and incorporating new evidence to further enhance patient care.[14] Owing to the unpredictable and unprecedented nature of disasters, practical experience and scientific evidence specific to these situations remain limited. Therefore, learning from disaster-response experiences both nationally and internationally can significantly enhance DM training.

LIMITATIONS

This study was subject to several key limitations worth noting. First, the single-country nature of the study may limit its generalizability, although certain identified commonalities between Taiwanese and US EM residency education suggest potentially universal elements that transcend governmental or cultural differences. Second, since the initial draft was created by three EPs and not the whole task force, there might have been some unconscious bias during the drafting process. However, the three senior DM trainers were asked to minimally change the concepts in the original document[12] and only make the necessary changes for the context. All 22 participants were asked to revise the wording of the titles and objectives for each DMCC if they regarded them as unclear. The experts could also provide quantitative and qualitative feedback to aid in establishing a consensus during each round to minimize the potential bias from the initial drafting process.

Third, a formal Hazard Identification and Threat Assessment was incorporated into the development of our DMCCs, which may vary across different countries. However, the current DMCCs were reviewed by all participants, ensuring that all potential hazards and threats relevant to Taiwan were considered. Additionally, during the modified Delphi process, participants had the opportunity to propose additional competencies related to specific hazards. Ultimately, the current set of DMCCs likely provides a comprehensive consideration of potential hazards with the proviso that emerging external threats are continually evolving worldwide.[16] Many countries have already expanded their training programs for various medical professions to include tactical medicine; however, a general consensus on this subject is still forthcoming, which may somewhat under-represent its significance. Regular reviews based on hazard identification and threat assessments and adjustments to governmental policies and global scenarios are, therefore, crucial to the field.

Table 3. Mapping disaster medicine core competencies for emergency medicine residency training in Taiwan to the Accreditation Council for Graduate Medical Education's six core competencies.

		Six core competencies of medical education					
Ranking	DMCC	PC	MK	PBLI	ICS	P	SBP
1	Personal protective equipment		X				
2	Decontamination	X	X				
3	Incident management system		X				
4	Mass casualty incidents		X				X
5	Basic concepts and nomenclature of disaster medicine		X				
6	Medical response to chemical emergencies	X	X				X
7	Triage	X	X				
8	Identification, notification, activation, and information collection						X
9	Medical response to radiation emergencies	X	X				X
10	Medical response to bioterrorism and biological emergencies	X	X				X
11	Mental health	X	X				
12	Disaster exercises		X				
13	Prehospital disaster management				X		X
14	Communication and information management						X
15	Health consequences of different disasters		X				

ACGME, Accreditation Council for Graduate Medical Education; *DMCC*, disaster medicine core competencies; *PC*, patient care; *MK*, medical knowledge; *PBLI*, practice-based learning and improvement; *ICS*, interpersonal and communication skills; *P*, professionalism; *SBP*, systems-based practice.

Table 4. Examining core competencies of disaster medicine in emergency medicine residencies in terms of prioritization and consensus in Taiwan vs the United States.

Ranking	Taiwan	The United States^
1	Personal protective equipment*	Patient triage in disasters*
2	Decontamination*	Surge capacity/capability
3	Incident management system	Introduction to disaster medicine/ Nomenclature*
4	MCIs*	Blast injuries
5	Basic concepts and nomenclature of disaster medicine*	Hospital disaster mitigation, preparedness, response, and recovery
6	Medical response to chemical emergencies*	Chemical MCI and hospital response*
7	Triage*	Decontamination indications and issues*
8	Identification, notification, activation, and information collection	Trauma MCI*
9	Medical response to radiation emergencies*	Disaster exercises and training*
10	Medical response to bioterrorism and biological emergencies*	Biological agents*
11	Mental health	Personal protective equipment*
12	Disaster exercises*	Radiation MCI and hospital response*
13	Prehospital disaster management	
14	Communication and information management	
15	Health consequences of different disasters	

^The essential and high-priority disaster medicine educational competencies for emergency medicine residencies in the US.[12]
* The commonalities in EM residency training between Taiwan and the US.
PPE, personal protective equipment; *MCI*, mass casualty incident; *COVID-19*, coronavirus disease 2019.

CONCLUSION

The 15 expert- and consensus-driven disaster medicine core competencies in this report serve as a blueprint for EM residency training in Taiwan, emphasizing fundamental disaster knowledge and specialized response skills. While the current curriculum aligns with these domains, gaps remain in mental health, communication, and disaster exercises, and mass casualty incident-training with focus on both hospital

and prehospital settings. A lthough Taiwan and the US share common DMCCs, Taiwan places greater emphasis on prehospital disaster management, mental health, and disaster-related health impacts, shaped by past disaster experiences. These differences underscore the need to consider governmental policies, healthcare roles, and disaster response systems when developing DMCCs for EM residency training, ensuring EPs are better prepared to respond to disasters within their local context.

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Experience Sampling to Assess Burnout in Emergency Medicine: An Acceptability and Feasibility Pilot

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Introduction: Despite prior efforts to improve well-being in emergency medicine, clinician burnout in the specialty is rising. In this study we examined the acceptability and feasibility of using a method called "experience sampling" to explore factors important to clinician experience in emergency departments (ED). Experience sampling enables the measuring of work experience in real time, with more granular detail than in usual burnout surveys. The approach may reveal new opportunities for improving work experience in emergency medicine at a critical time.

Methods: We conducted this pilot study in a large, urban, academic, quaternary care ED. Iterative multidisciplinary focus groups were used to generate a brief, experience-sampling tool that was comprised of three different surveys to assess emergency clinician experience before, during, and after shifts. These were deployed using a smartphone application to a convenience sample of 11 clinicians (three attending physicians, two residents, five physician assistants, and one registered nurse) during four shifts each. A post-pilot survey was also sent to all participants to evaluate their experience of using the tool. Our primary outcome measures were feasibility, assessed by the survey response rates during the pilot, and acceptability, assessed by participant sentiment as expressed in the post-pilot surveys. Secondary outcomes were quantitative- and qualitative- experience data collected using the tool.

Results: The overall response rates for pre-shift, on-shift, and post-shift surveys were 79%, 73%, and 91%, respectively. All participants responded to the post-pilot survey and indicated they would be willing to use the experience-sampling tool again in the future. Many participants noted that the simple and open-ended on-shift questions were relatively easy to complete; some also said on-shift survey questions could present added difficulty during busy shifts. Four participants said the exercise of completing surveys itself improved on-shift experience by prompting reflection. Common themes associated with positive experiences included manageable patient volumes, excellent teamwork, interesting cases, adequate staffing, and feeling able to provide adequate care. Common themes associated with negative experiences included crowding, inadequate staffing, feeling overwhelmed, complex patient cases, difficult disposition plans, and feeling unable to provide adequate care.

Conclusion: Experience sampling is an acceptable and feasible method for measuring clinician experience in a busy academic ED. Further studies could potentially use this approach to identify targets for reducing burnout in emergency medicine. [West J Emerg Med. 2025;26(4)1105–1111.]

INTRODUCTION

Burnout among healthcare professionals is a threat to care quality, healthcare costs, and the availability of a robust healthcare workforce to serve the public.[1] Over 50% of physicians nationwide are experiencing professional burnout, with even higher numbers in other healthcare roles.[2,3] Amidst increasing well-being concerns broadly, emergency medicine (EM) is an outlier, with the highest physician burnout rate of

all specialties.[4–6] There was a large increase in burnout among emergency physicians between 2021 and 2022—from 43% to 60%—and emergency physician burnout remains above 60% as of 2024.[7] The escalating prevalence of burnout poses significant challenges to the future of the EM workforce.

As defined by Maslach, burnout is the triad of depersonalization, emotional exhaustion, and a decreased sense of personal accomplishment.[8] While traditional approaches to addressing burnout have largely focused on interventions aimed at individuals, mounting evidence suggests that organizational, administrative, and department-specific factors explain most of healthcare burnout.[9,10] Prior literature also suggests that interventions aimed at systemic organizational features are more likely to succeed in meaningfully decreasing burnout.[11] Despite this increasing understanding, the high EM burnout rate suggest that new approaches are needed to address the problems faced by our specialty.

Nearly all healthcare workplace-experience research to date has used surveys that ask personnel to reflect on weeks or months of work to identify features that increase or decrease work satisfaction. However, workplace-experience research in other fields has used a methodology called "experience sampling." Workplace-experience sampling is a way of gathering data with brief, repeated assessments of current experience while individuals are actively working; it allows an analysis of hour-to-hour work experience during specific activities. Over a defined period, researchers can gather a rich set of real-time, self-reported data points that provide a granular level of detail not possible with traditional surveys and with less risk of recall bias.[12] In other fields, experience sampling has deepened understandings of workplace experience and revealed novel areas for intervention, and one study of pediatric emergency clinicians has used a version of this methodology.[13–16]

It may be difficult to ask healthcare personnel to complete experience-sampling surveys in real time during busy workdays, particularly in EM where the pace of work is rapid and interruptions abound.[17] Yet an experience-sampling approach might reveal opportunities to improve the EM work experience that have thus far been overlooked. We, therefore, undertook an acceptability and feasibility pilot study of experience sampling in an EM context.

Population Health Research Capsule

What do we already know about this issue?
Experience sampling has revealed new insights about work experience in fields other than emergency medicine (EM).

What was the research question?
Is experience sampling through a mobile phone app acceptable and feasible in a busy emergency department?

What was the major finding of the study?
Response rates for all on-shift, experience-sampling prompts were >70%, and participants rated their experience favorably.

How does this improve population health?
Experience sampling may reveal new insights for improving burnout in EM, a critical workforce issue in our field.

METHODS

Study Setting and Design

We conducted this study in an urban, academic, quaternary-care center emergency department (ED) with approximately 120,000 patient visits per year. This ED has an EM residency program and a large physician assistant (PA) program. The study was approved by our institutional review board.

Development of the Experience Sampling Tool

An experience sampling tool for use in the ED setting requires validated approaches to assessing workplace experience, while also being brief enough to feasibly be completed during busy shifts. Our team used an iterative, focus-group approach to develop the different survey questions, bringing together frontline clinicians and experts to review validated surveys and pare them down to a usable tool. Key topics for the groups included the following: the positive or negative language used; the suitability of free-text vs multiple-choice responses; and the frequency and length of survey questions.

The first focus group was comprised of 12 ED personnel from our institution, including attending physicians, resident physicians, PAs, and nurses. During this focus group, participants were asked to rank the utility of questions from three previously validated work experience tools: the Maslach Burnout Inventory; the Utrecht Work Engagement Scale; and the Work-Related Flow Inventory (WOLF), which led to the prioritization of question types.[8,18,19] The group felt emergency clinicians would only have bandwidth for one quantitative question and one qualitative question for each on-shift survey question. They also believed it would be feasible to ask a longer list of follow-up questions after a shift to summarize experiences from that shift. Through iterative discussion, the group arrived at two concepts most important to encapsulate their work experience: the enjoyment of work, and pride in work.

They agreed the optimal on-shift question was a multiple-choice question, "Are you enjoying your shift?" followed by a qualitative question, "Why?" It was decided

that this survey question would be delivered every two hours during shifts, balancing a desire for repeated data collection with the need not to disrupt clinical work. For the post-shift survey, the group agreed that the most important question was, "Did you feel proud of your work today?" The group also decided to include a question about burnout explicitly, as well as questions about the ability of clinicians to meet the challenges they faced on shift, derived from the WOLF. Additionally, they decided it would be important to ask a few questions before each shift to assess clinician state of mind going into work. Finally, they noted that it would be important to encourage "quick thoughts" and sentence fragments in free-text responses, so that participants would not feel pressured to write long, carefully worded answers.

After the first focus group of frontline clinicians developed the drafted survey questions, a second focus group of experts in EM operations and experience coalesced at a national EM conference to review and refine the surveys. Members of this focus group largely echoed the sentiments of the frontline clinician groups, emphasizing the need for brief questions at spaced intervals, followed by a longer post-shift survey. The second group made small modifications to precise question language but did not suggest any major changes to the questions chosen or themes explored. Given the minimal modifications made by this group of experts to the initial draft of survey questions, we decided that a third focus group was not warranted. See Table 1 for the final list of survey questions.

Survey Delivery Platform

After exploring options and in discussion with our focus groups, we decided a mobile phone application would be the best approach to deliver real-time survey questions to clinicians. This approach would not require clinicians to carry any extra devices and would facilitate rapid, easy responses. We ultimately chose an existing mobile phone-survey delivery platform LifeData (LifeData, LLC. Marion, IN). The tool was programmed such that completion of the pre-shift survey would trigger timed notifications for the current experience (on-shift) and post-shift surveys, depending on shift length, as delineated in the pre-shift questions. For timed notifications during shifts, participants would receive a reminder if they did not answer a question after 15 minutes. If that question was not answered by the time the next timed question was sent, the participant would no longer have the option to answer the previous question.

Participant Recruitment and Pilot Design

To recruit a cohort of pilot participants, emails were sent out to a convenience sample of clinicians across the ED. A total of 14 emergency clinicians representing various role groups (attending physicians, resident physicians, PAs, and registered nurses) were invited via email to participate in the pilot program. Potential participants were asked to use the tool during four of their ED shifts and to fill out a post-pilot survey assessing the acceptability of the experience. Three individuals declined participation as they did not have four shifts during the pilot period. Therefore, the final participating cohort of 11 clinicians was comprised of three attending physicians, two resident physicians, five PAs, and one registered nurse. Participants each received a $10 gift card.

Detailed email instructions guided participants through the downloading and registration process for the LifeData mobile application. Participants were asked to provide four shifts during which they were willing to use the tool. Thirty minutes before the start of each designated shift, a reminder email was sent to participants to complete the pre-shift

Table 1. Survey questions for pre-shift, current experience, and post-shift surveys.

Pre-shift Questions	Which role group do you belong to? What area of the ED is your shift today? How long is your shift today? Are you looking forward to today's shift? (1 to 5, 1 = not at all, 5 = very much so) Why or why not? (free text)
Current Experience Questions	Are you enjoying your work right now? (1 to 5, 1 = not at all, 5 = very much so) Why or why not? (free text)
Post-shift Questions	I feel proud of my work today (1 to 5, 1 = not at all, 5 = very much so)
	I feel burned out by my work today (1 to 5, 1 = not at all, 5 = very much so)
	How did you feel about your ability to handle what was asked of you during the shift? (1 to 5, 1= I was completely bored, 3 = I was able to meet the challenge of the day, 5 = I was completely overwhelmed) What contributed most to the above feeling? (free text)
	What were the worst things about your shift today? (free text)
	What were the best things about your shift today? (free text)
	What could be changed to have made this a better shift? (free text)

ED, emergency department.

survey. Participants were reminded to check their emails just prior to the start of their shift. Successful completion of the pre-shift survey subsequently triggered the current experience (on-shift) survey questions to be delivered at two-hour intervals during their shift, and a post-shift survey to be delivered 30 minutes following the shift's completion.

Assessing Experience with the Tool

All participants also received a post-pilot survey assessing their overall experience using the experience sampling tool. The following survey questions were asked, and for several of the following questions, participants were asked to respond on a Likert scale:

- *Which role group do you belong to? (free text)*
- *What was your experience of filling out prompts during shifts? (free text)*
- *How did you find the length of the pre-shift survey? ("too long" [1] to "could have asked more" [3])*
- *How did you find the frequency of the prompts during shifts? ("too few" [1] to "too many" [3])*
- *How did you find the length of the post-shift survey? ('too long" [1] to "could have asked more" [3])*
- *How did you feel about the questions that were asked? (free text)*
- *Are there other questions you wish we had asked? (free text)*
- *We are considering asking staff broadly to fill these out during a portion of shifts. What do you think of this idea, and what would you suggest to make the effort successful? (free text)*
- *Would you be willing to use the tool during future shifts? (yes/no)*

Outcome Measures and Statistical Analysis

Primary outcome measures were feasibility, assessed by the survey response rates during the pilot, and acceptability, assessed via participant sentiments about using the tool expressed in the post-pilot survey. We performed simple quantitative and qualitative analyses for responses to surveys by the pilot participants. These were conducted only to explore the potential of the experience-sampling approach to generate useful data; the study was not powered to draw any conclusions from these responses. Quantitative measures were simple means and standard deviations for responses. We explored qualitative themes using an iterative coding approach, wherein one author created initial thematic codes and additional authors provided input for quotes where the theme was not immediately clear. Once thematic codes were finalized, we tabulated code frequencies.

RESULTS

Feasibility: Participation and Response Rates

Each of the 11 participating clinicians was asked to use the tool during four shifts, resulting in 44 possible shifts for the pilot. Of these 44 shifts, there was a response rate of 79% for the pre-shift survey. For shifts where the pre-shift survey was completed—and, therefore, the rest of the survey was triggered—the response rate for the on-shift questions was 73%, and the response rate for the post-shift survey was 91%.

Acceptability: Post-Pilot Survey Responses

The response rate for the post-pilot survey was 100%. In response to the question: "Would you be willing to use this tool during future shifts," 100% (11/11) of participants responded "yes." When asked about the frequency of survey questions, all 11 participants indicated that the every-two-hour frequency was optimal. Nine of 11 participants indicated the pre-shift survey was the right length, while two said it could have been longer. Ten of 11 participants indicated that the post-shift survey was the right length, while one participant indicated it could have been longer.

Multiple themes emerged in the qualitative responses to the post-pilot surveys. Seven participants noted that the simplicity and open-ended nature of the questions made responses relatively easy. Six participants said that it was difficult to respond to on-shift survey questions during the busiest parts of their shifts. Five participants noted that the mobile application was easy to use. Four participants stated that using the tool facilitated self-reflection about their shifts in a way that was helpful for their perceptions of work experience.

Quantitative Measures

In the pre-shift survey question that asked whether participants were looking forward to their shift, the average answer was 2.9 of 5 (SD 0.7). The current experience (on-shift) survey was sent to participants a total of four times in each shift (in two-hour intervals). The corresponding values for on-shift experience decreased over the course shifts on average. For the on-shift question of "Are you enjoying your work right now," the following were the average values (with SD) observed for each successive question, respectively: first, 3.4 (0.9); second, 3.4 (1.0); third, 2.9 (0.9); and fourth, 2.9 (0.4). The average score for "I feel proud of my work today" was 3.3 (SD 0.6). The average for "I feel burned out by my work today" was 3.0 (SD 0.6).

There were 15 shifts where participants stated they were able to appropriately meet the challenges of the day; during 14 shifts participants noted feeling overwhelmed and unable to meet the challenges of the day, while during eight shifts, participants noted feeling bored. See Table 2 for details. Above are the mean with SD for responses to select quantitative responses from our surveys. "Looking forward to shift" reflects answers to the pre-shift survey question: "Are you looking forward to today's shift?" (scale of 1-5). "Current experience" 1-4 reflect answers to the on-shift survey question "Are you enjoying your work right now?" (1-5) during the first, second, third, and fourth instances that it was asked during shifts. "Post-shift pride" reflects answers to the post-

shift survey question: "I feel proud of my work today" (1-5). "Post-shift burnout" reflects answers to the post-shift survey question: "I feel burned out by my work today" (1-5).

Qualitative Themes

Several themes emerged in the current experience (on-shift) and post-shift survey responses regarding both positive and negative experiences (Figure 1). The most common themes related to positive work experiences were manageable patient volume, excellent teamwork, interesting cases, adequate staffing, and an overall feeling of being able to provide adequate care. In contrast, the most common themes related to negative work experiences were high patient volumes, crowding, inadequate staffing, feeling overwhelmed, complicated patient cases, poor disposition plans, signing out late, and an inability to provide adequate care.

DISCUSSION

Overall, the results of our pilot study suggest that experience sampling using a mobile phone application is a feasible and acceptable approach to assessing work experience for emergency clinicians. This approach may reveal ways to decrease EM burnout that have not yet been explored. Participants engaged with the tool during nearly 80% of their designated shifts, with response rates to on-shift survey questions of over 70%, and response rates to post-shift surveys of over 90%. Of the participants, 100% stated that they would be willing to use the tool in the future, and most participants felt the length and frequency of the different survey components were appropriate. The main barrier to the approach appears to be that most participants found that it could be difficult to complete survey questions during the busiest parts of shifts; this was not surprising, and the response rates observed suggest that this can be overcome. Of note, a previous study of experience sampling in a pediatric ED used in-person prompters and a much longer list of questions[16]; while that study obtained rich data and bolstered the case for using experience sampling in healthcare contexts, our mobile phone approach may provide a more sustainable strategy for ongoing experience sampling in EM contexts.

Surprisingly, four of the eleven participants noted that use of the tool itself improved their work experience by encouraging them to reflect on their shifts. This raises the possibility that the experience sampling approach might have direct benefits for participants in addition to facilitating data collection. This finding may ease trepidation about the use of such tools during clinical work, but it also must be explored in more depth to assess whether it is durable.

The experience-sampling approach allowed for the collection of rich data about work experience, identifying themes associated with positive and negative work experiences in real time, including patient volumes, crowding, acuity, staffing, teamwork, and communication. These themes reflect prior burnout research that suggests systemic features of the workplace are highly relevant to feelings about work.[10,20,21] Interestingly, experience scores were higher during the first half of shifts, with lower scores later in shifts, which matches prior literature.[16] This pilot sample was too small to draw any firm conclusions, but it perhaps suggests questions that might be answered with a larger experience-sampling study.

An important potential benefit of experience sampling may be the ability to relate work experience to objective environmental and temporal features of ED shifts. Participant scores could be mapped to objective ED features such as patient arrivals, acuity mix, staffing levels, crowding, and team composition in a day-to-day or even hour-to-hour fashion, allowing researchers to assess relationships between clinician perceptions and operational realities. This might allow more causal explanations for work experience trends than is generally possible using burnout surveys that encompass weeks or months of experience.

LIMITATIONS

There were several limitations associated with this pilot study. It was conducted at a single site with a small convenience sample; larger multisite studies will be needed to confirm the feasibility of a mobile phone-based experience-sampling approach in EDs across role groups. The study was also too small to draw any conclusions about burnout from the clinician experience data itself; a larger study will be needed to answer questions about what may be most helpful for emergency clinician burnout that is not already being addressed.

CONCLUSION

Our study suggests that experience sampling is an acceptable and feasible method to study clinician experience in emergency departments and may allow the generation of rich data that can answer questions previously difficult to

Table 2. Mean scores and standard deviations (SD) for select survey questions.

Looking forward to shift		Current experience 1		Current experience 2		Current experience 3		Current experience 4		Post-shift pride		Post-shift burn out	
Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
2.92	0.70	3.38	0.85	3.36	1.03	2.85	0.88	2.85	0.43	3.32	0.57	2.96	0.62

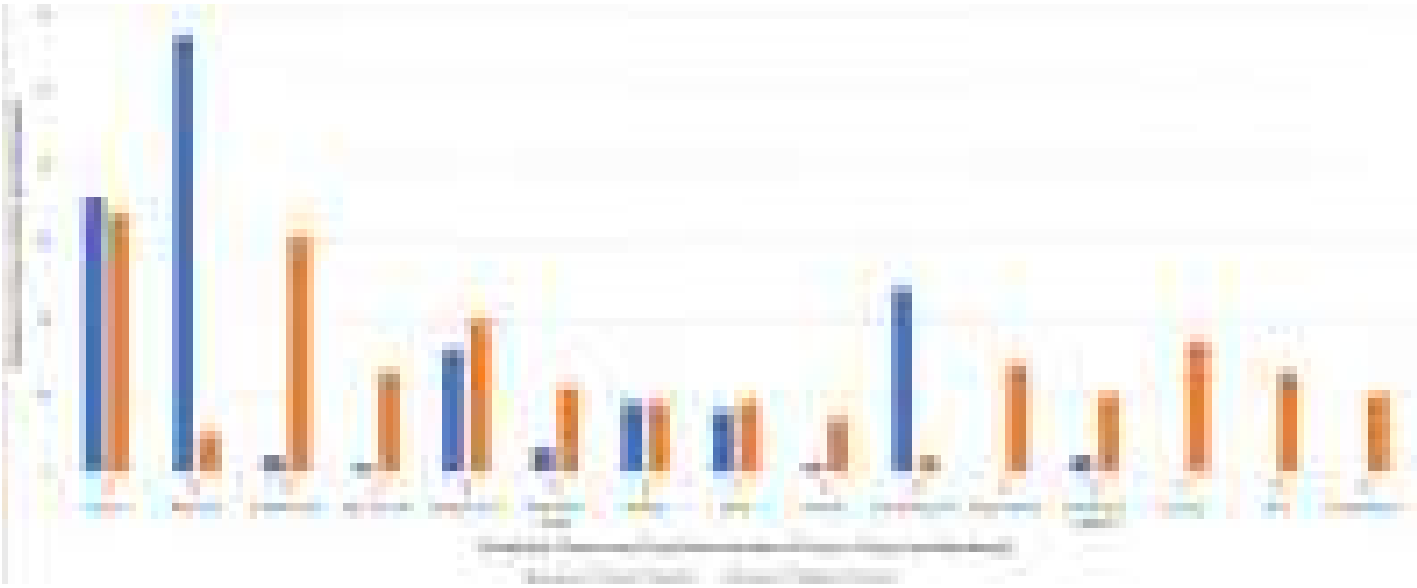

Figure. Qualitative themes and associated positive or negative valences for on-shift and post-shift survey responses using the emergency departpment experience-sampling tool.

examine with traditional surveys. Future work should test this approach in a larger sample as emergency medicine explores solutions for persistently high burnout in the field.

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Randomized Trial of Self-Selected Music Intervention on Pain and Anxiety in Emergency Department Patients with Musculoskeletal Back Pain

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Introduction: Acute musculoskeletal back pain is a frequent cause of emergency department (ED) visits, often with suboptimal relief from standard treatments. Recent evidence suggests listening to music may modulate pain and anxiety. In this pilot randomized controlled trial, we evaluated the impact of a brief session of patient-selected music vs noise cancellation on pain severity and anxiety in patients presenting to the ED with back pain.

Methods: Patients with acute back pain completed a baseline survey to assess demographics, medication information, and psychosocial factors. The ED patients were randomized to listen to self-selected music or to noise cancellation (control). Patients rated their pain and anxiety (0-10) before and immediately after the intervention. We used analyses of covariance to examine whether post-intervention pain and anxiety differed between the groups, while controlling for baseline trait pain catastrophizing. A mediation analysis was conducted to explore the role of post-intervention anxiety as a mediator of the group difference in post-intervention pain.

Results: Forty patients were enrolled with an average age of 47.2 years (range 21 - 81). and 27 patients (68%) were female. At baseline, patients in the music group reported higher pain catastrophizing compared to patients in the noise cancellation group. There were no other group differences in baseline characteristics. Post-intervention, patients in the music group reported significantly lower anxiety (3.0 ± 0.7 vs 5.5 ± 0.7, $P = 0.016$) and pain severity (6.1 ± 0.4 vs.7.5 ± 0.4, $P = 0.037$) compared to the noise cancellation group. A mediation analysis showed that post-intervention anxiety partially mediated the association between intervention group (music vs noise cancellation) and post-intervention pain.

Conclusion: A brief session of self-selected music resulted in lower pain and anxiety scores than noise cancellation among patients with musculoskeletal back pain in the ED. Patients who listened to music reported lower post-intervention anxiety, which partially contributed to lower post-intervention pain severity. [West J Emerg Med. 2025;26(4)1112–1119.]

INTRODUCTION

Back pain affects approximately 540 million people globally and is the leading cause of years lived with disability worldwide.[1] Acute exacerbations or new-onset low back pain can be distressing and result in temporary and long-term disability. While the etiology of back pain is variable, the most common reason individuals experience back pain is musculoskeletal.[2] When pain persists despite conventional over-the-counter (OTC) pharmacotherapy, or when the reason for pain is uncertain, individuals may use the emergency department (ED) for evaluation. There are more than 2.6 million annual ED visits in the United States for back pain, and back pain accounts for up to 4.4% of all ED visits worldwide.[3]

Low back pain can be difficult to manage in the ED. The pillars of pharmacological treatment, nonsteroidal anti-inflammatory drugs (NSAID) and acetaminophen, have been compared to various other therapeutic options such as opioids, benzodiazepines, and musculoskeletal relaxants like methocarbamol, baclofen and cyclobenzaprine.[4,5] Even with recommended pharmacotherapy, individuals may experience suboptimal relief and request other analgesics, including opioids for pain. Finally, the experience of pain is modulated by psychosocial factors, such as anxiety; this may be particularly true in the ED, with anxiety more strongly contributing to perceptions of pain.[6-8] Therefore, there is a critical need to develop adjuvant therapies to address musculoskeletal back pain that could provide acute relief in the ED.

One potential strategy that demonstrates promise in mitigating the experience of pain is music.[9] Music is unique in that it is nearly universally familiar and acceptable across different sociodemographic backgrounds, easily accessible, non-stigmatizing, and poses little to no risk of adverse effects.[10] Prior studies have explored the use of music to mitigate anxiety surrounding painful procedures or to address postoperative pain and anxiety.[11] Despite the potential for an effect, the use of music as an adjunct for treatment of acute pain in the ED has not been widely or systematically studied. In a prior study of patients who were admitted to an ED observation unit, we found that listening to 10 minutes of relaxing music was associated with decreased acute pain scores.[12] In the same study, we also demonstrated that music decreased anxiety, which is a known psychological modulator associated with worse pain.[12] This reduction in anxiety was correlated with reduced pain scores. In a laboratory setting with healthy adults, we additionally demonstrated that participants' pain threshold and tolerance were significantly higher (ie, less pain sensitive) when listening to their self-selected favorite music compared to control conditions,[13] suggesting that allowing patients to self-select their own music may be a promising strategy for reducing pain.

In the current study, we evaluated the effect of a brief session of patient-selected music vs noise cancellation on pain severity and anxiety in patients presenting to the ED with acute musculoskeletal back pain. We also explored user experiences and acceptability of using an adjunctive music intervention in the ED.

Population Health Research Capsule

What do we already know about this issue?
Musculoskeletal back pain is a frequent reason for pain-related ED visits. Listening to music may help decrease pain and anxiety.

What was the research question?
Does patient-selected music impact pain severity and anxiety in patients presenting to the ED with back pain?

What was the major finding of the study?
Music resulted in lower pain (6.1 ± 0.4 vs.7.5 ± 0.4, P =.037) and anxiety (3.0 ± 0.7 vs. 5.5 ± 0.7, P =.016) scores.

How does this improve population health?
Listening to music in the ED may be an adjunctive tool in the armamentarium of non-pharmacologic interventions for musculoskeletal back pain.

METHODS

Participants and Procedure

We recruited patients presenting to the emergency department (ED) with a chief complaint of acute back pain at Brigham and Women's Hospital in Boston, MA, a tertiary care, urban, academic ED with approximately 65,000 annual visits. Sample size for this pilot study was chosen to be 40 based on prior studies.[12,14] Research assistants identified and approached eligible patients to explain the study and gauge potential interest in participating. Inclusion criteria included reporting an initial pain severity rating of ≥5/10 at triage and being ≥18 years of age. Participants were excluded if they had hearing loss or were non-English speaking. Study procedures were approved by the Mass General Brigham Human Research Committee (protocol number 2022P000102). Formal written consent was obtained from all participants.

After providing informed consent, patients completed a baseline survey with basic demographic information, medication use, and questionnaires assessing psychosocial factors and clinical pain. Immediately prior to the music intervention, patients provided ratings for their current pain severity and level of anxiety, using a point scale from 0-10. Next, patients were randomized using REDCap (hosted at

Mass General Brigham) in a 1:1 fashion to a music or noise cancellation (control) group. In the music group, patients were lent a pair of headphones and asked to select an artist or genre of music from a streaming music service (Spotify Premium) to listen to for 10 minutes. Once selected, participants were not able to skip songs or change their music selection. In the noise cancellation group, patients were lent a pair of noise cancellation headphones to wear for 10 minutes. Immediately after each intervention, all patients completed a follow-up assessment to reassess current pain and anxiety ratings and were then also asked questions about their experience with the interventions.

Measures

Patients completed self-report measures assessing demographic characteristics (age, sex, race/ethnicity), self-reported use of opioids and non-opioid analgesics prior to presenting to the ED and completed validated brief questionnaires. We used the Patient Reported Outcome Measurement Information System (PROMIS) short forms to assess anxiety, depression, and sleep disturbance over the prior week.[15] The Perceived Stress Scale (PSS) was used to measure subjective stress experienced over the past week.[16] We measured trait pain catastrophizing, which involves negative pain-related cognitions, using the Pain Catastrophizing Scale (PCS).[17]

Prior to the intervention, patients reported their current pain at rest and during movement using a numeric rating scale (NRS) of 0-10 (0= no pain, 10= worst pain). These two pain ratings were averaged for a total pain severity index score. Patients also reported their current level of anxiety using a NRS (0=no anxiety, 10=worst anxiety). Immediately after the completion of the 10-minute interventions, all patients again reported their current pain severity and anxiety.

Analgesic medications administered during the ED visit, as well as upon discharge from the ED, were abstracted from patients' electronic health records and converted to morphine milligram equivalents (MME) using a publicly available opioid conversion calculator.[18]

We conducted a post-intervention survey to collect information about how patients normally used music or a music app for relaxation, how much they liked the intervention (1=strongly disliked, 5=strongly liked), whether the intervention changed the way they felt/thought about pain, and whether they thought they could deal with their pain using music therapy in combination with non-opioid medications.

Data Analysis

Descriptive data is presented as means and standard deviations for continuous variables and as percentages for categorical variables. We used independent samples *t*-tests and chi-square analyses to explore whether patients randomized to the music group differed compared to those randomized to the noise cancellation group based on baseline characteristics. Patient characteristics that significantly differed ($P<.05$) between the two groups at baseline were included as covariates in subsequent analyses. We used analyses of covariance (ANCOVA) to examine whether post-intervention ratings of pain severity and anxiety significantly differed between the music and noise cancellation groups, while controlling for baseline covariates.

We conducted a follow-up exploratory analysis to explore whether post-intervention anxiety mediated, or contributed to, the group (music vs noise cancellation) difference in post-intervention pain severity. First, Pearson correlations were conducted to examine the association between post-intervention anxiety and post-intervention pain. Next, using the PROCESS macro for SPSS, we conducted a bias-corrected mediation analysis using 5,000 bootstrapped resamples to examine the role of post-intervention anxiety as a potential mediator of the group difference in post-intervention pain severity, controlling for patient characteristics that showed group differences at baseline. Estimates of indirect effects were considered significant when zero was not included in the 95% confidence intervals.

RESULTS

Patient Characteristics

We screened 297 individuals, of whom 104 were eligible (Figure 1). We enrolled 40 participants between July–October 2022. Common reasons for nonparticipation were lack of interest in research or too much pain. There were 40 patients with an average age of 47.2 years (SD 16.9, range: 21-81) and 27 (68%) were female. Seventeen participants identified as White (42.5%), 11 as Black (27.5%,), two as Asian (5%), one Native Hawaiian or Pacific Islander (2.5%,), two more than one race (5%), four "other" (10%), three (7.5%) did not report their race, and of all participants, 10 (27%) identified as Hispanic.

A total of five (13%) patients self-reported using opioids, and 11 (28%) reported using non-opioid analgesics prior to their ED visit. Prior to the interventions, patients reported an average pain severity rating of 7.5/10 (SD 1.7) and an average anxiety rating of 5.7/10 (SD 3.1). While in the ED, 14 patients (35%) received opioids, and of these patients, they received 19.6 MMEs on average (SD 11.1, range 4-38). Additionally, 36 patients (90%) received some type of non-opioid analgesic in the ED, including oral acetaminophen or NSAID, or topical NSAID or lidocaine. Patients were in the ED for a mean of 6.4 hours (median 5.4, SD 3.3, range 1.6-15.8), and three patients (8%) were subsequently admitted to the hospital. At discharge, 11 patients (38%) received a new opioid prescription, two (5%) continued taking the opioid prescription they were previously prescribed, and 29 (73%) received a prescription for a non-opioid analgesic.

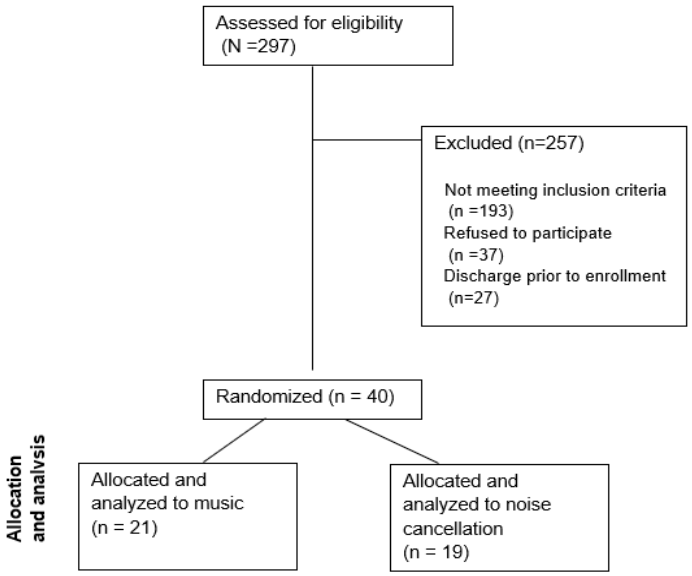

Figure 1. Study flow diagram for effect of music on musculoskeletal low back pain in the emergency department.

Group Differences in Baseline Characteristics

Twenty-one patients were randomized to the music group and 19 patients to the noise cancellation group. Patients randomized to the music group reported significantly higher baseline trait pain catastrophizing (PCS) compared to patients randomized to the noise cancellation group (mean ±SD: 28.4±12.6 vs 19.4±10.8, P = .02). There were no other significant differences between the two groups based on any other baseline psychosocial factors, demographic characteristics, or medication use prior to visiting the ED (Table 1). We also did not observe a significant difference in baseline pain severity or anxiety ratings between the music and noise cancellation groups (Table 1).

Group Differences in Post-Intervention Pain and Anxiety

While in the ED, there were no significant group differences in the proportion of patients who were prescribed opioid or non-opioid analgesics, nor in the amount of opioids (MMEs) prescribed. We conducted two ANCOVAs to examine whether post-intervention pain severity and anxiety significantly differed between the music and noise cancellation groups, while controlling for baseline trait PCS. There was a significant main effect of intervention on pain severity [F (1,37)= 4.69, P = 0.037, $\eta_p^{2=}$.11], such that patients in the music group reported significantly lower pain severity scores compared to patients in the noise cancellation group (estimated mean ± SE: 6.1 ± 0.4 vs 7.5 ± 0.4, P = 0.037) (Figure 2A). Similarly, there was a significant main effect of intervention on anxiety [F(1,36) = 6.40, P = 0.016, $\eta_p^{2=}$.15], with patients in the music group reporting significantly lower anxiety scores than patients in the noise cancellation group (3.0 ± 0.7 vs. 5.5 ± 0.7, P = 0.016) (Figure 2B).

Exploratory Analysis: Post-Intervention Anxiety as a Mediator of the Group Difference in Post-Intervention Pain Severity

A correlation analysis showed that greater post-intervention anxiety was significantly associated with greater post-intervention pain severity (r=0.54, P <0.001) (Figure 3). Since we found that music modulated post-intervention anxiety, we were interested in exploring whether lower levels of anxiety post-intervention among patients in the music group could partially explain, or mediate, the group difference in pain severity post-intervention. A mediation analysis was conducted with intervention group entered as the independent variable (x variable), post-intervention anxiety as a mediator (m variable), and post-intervention pain severity as the outcome variable (y variable), controlling for baseline PCS (Figure 4). The overall model predicting post-intervention pain severity was significant F(3,35) = 8.12, P < .001, R^2 = 0.41. Importantly, there was a significant indirect effect of intervention group on post-intervention pain severity through post-intervention anxiety (b = -0.60, 95% CI [-1.33, -0.09]). The direct effect of intervention group (b=-1.33, P=.04, 95% CI [-2.59, -0.06]) on post-intervention pain severity was no longer significant when post-intervention anxiety was included in the model (b = -0.72, P = .26, 95% CI [-2.01, 0.56]). This suggests that patients who listened to music reported lower post-intervention anxiety, and, in turn, lower post-intervention pain severity.

Post-Intervention Characteristics

We wanted to gain insight into patients' experience with music both prior to participating in our study, as well as their impressions of use of music in the ED during our study. Most patients reported that they had used music or a music app for relaxation in the past (63%), with 38% of patients reporting that they typically spend 30-60 minutes listening to music every day. Patients were asked how much they liked the music/noise cancellation, and those who listened to music reported that they liked the music significantly more than those who used noise cancellation headphones (5.0 ± 0.2 vs. 3.7 ± 1.3, P <.001). Of the 21 patients in the music group, 40% reported that they perceived improvement in their pain after the intervention and 60% reported no perceived change. Of the 19 in the noise cancellation group, 16% reported that they perceived improvement in their pain after the intervention, 74% reported no perceived change in their pain, and 10% reported that their pain worsened. Notably, there were no differences in the amount of opioid medications administered in the ED or prescribed at discharge between the groups (P-values>.05). The majority of patients also reported that they thought they could deal with their pain if they had music or noise cancellation in combination with taking non-opioid medications (54%) (ie, using music as an adjuvant analgesic).

DISCUSSION

Few non-pharmacologic analgesic options exist that can be easily, inexpensively, and flexibly deployed in the ED. Music,

Table 1. Patient characteristics.

	Music group (n=21) M±SD or n(%)	Noise cancellation group (n=19) M±SD or n(%)	P-value
Demographics			
Age	44.3±16.1	50.3±17.7	.27
Sex			.34
Male	5 (24%)	7 (37%)	
Female	16 (76%)	11 (58%)	
Non-binary/non-conforming	-	1 (5%)	
Race			.60
White	8 (38%)	9 (47%)	
Black	8 (38%)	3 (16%)	
Asian	1 (5%)	1 (5%)	
Native Hawaiian or Pacific Islander	-	1 (5%)	
More than one race	1 (5%)	1 (5%)	
Other	1 (5%)	3 (16%)	
Unknown/not reported	2 (10%)	1 (5%)	
Diagnosis of depression	1 (5%)	-	.34
Diagnosis of anxiety	1 (5%)	1 (5%)	.97
Baseline pain and psychosocial factors			
BPI pain intensity (range:0-10)	6.9±1.6	7.3±1.9	.41
BPI pain interference (range:0-100)	49.6±16.3	48.5±16.8	.84
PROMIS anxiety (range:7-35)	20.1±8.5	17.1±7.08	.24
PROMIS depression (range:7-35)	17.5±7.5	14.9±6.3	.24
PROMIS sleep (range:8-40)	27.8±8.0	28.0±5.4	.93
Perceived stress (PSS) (range:0-40)	18.1±8.4	16.3±6.6	.48
Trait pain catastrophizing (PCS) (range:0-52)	28.4±12.6	19.4±10.8	.02
Pre-intervention			
Pain rating	7.4±1.7	7.6±1.9	.73
Anxiety rating	5.2±3.4	6.3±2.7	.31
Medication use			
Prior to ED Visit			
Taking opioids	2 (9.5%)	3 (16%)	.55
Taking non-opioid analgesics	4 (19%)	7 (37%)	.21
While in the ED			
Prescribed opioids	9 (43%)	5 (26%)	.27
MMEs	18.5±11.2	21.6±11.9	.64
Prescribed non-opioid analgesics	20 (95%)	16 (84%)	.25
At discharge from ED			
Prescribed opioids	8 (38%)	5 (26%)	.44
MMEs	38.9±25.0	43.8±31.0	.76
Prescribed non-opioid analgesics	14 (67%)	15 (79%)	.39

BPI, Brief Pain Inventory; *PROMIS*, patient-reported outcome measurement information system; *ED,* emergency department; *MMEs,* morphine milligram equivalents.

given its unique trans-cultural applicability and potential targets in the biopsychosocial model of pain, is an enticing adjunctive intervention to address the experience of pain in the ED. The present investigation demonstrated that patients who listened to self-selected music experienced less pain and anxiety post-intervention than patients who used noise cancellation

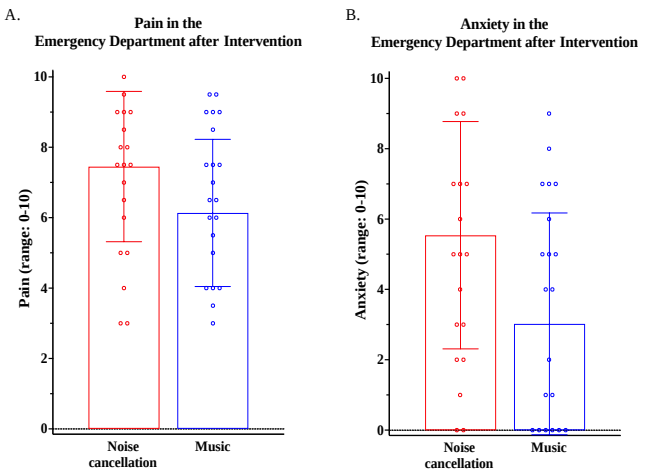

Figure 2. Differences in post-intervention (A) pain and (B) anxiety based on intervention group, controlling for baseline PCS. *PCS*, pain catastrophizing scores.

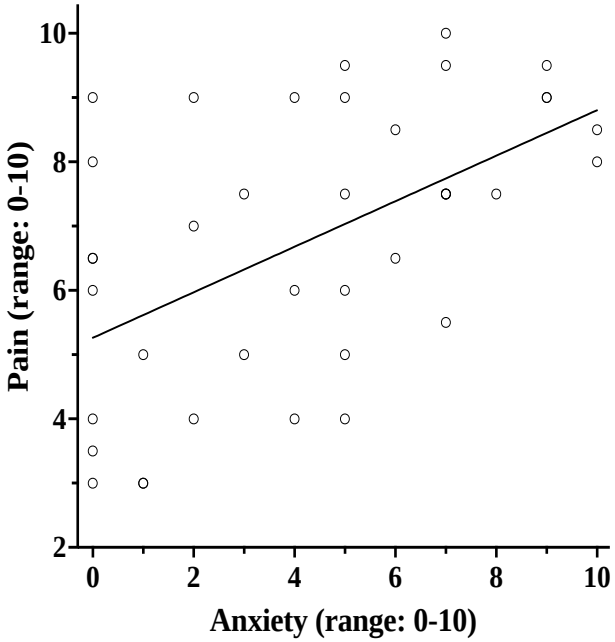

Figure 3. Greater post-intervention anxiety was correlated with greater post-intervention pain (r=0.54, P <0.001).

headphones alone. Furthermore, we found that patients who listened to self-selected music reported lower post-intervention anxiety, which partially contributed to why they reported lower post-intervention pain severity. These findings suggest that music may be a helpful adjunctive therapy in the ED to address pain by decreasing emotional distress.

Previous experimental studies demonstrated the effectiveness of listening to music to address acute painful conditions.[12,13,19,20] Within the clinical context, one randomized controlled trial (RCT) involving patients in the ED with simple lacerations demonstrated that listening to participant selected music from a pre-curated panel significantly reduced pain and anxiety associated with the procedure and resulted in an improved ED experience.[19,20] In another randomized study, listening to ambient music significantly decreased pain and anxiety in individuals with diverse chief complaints related to pain.[21] Similarly, our previous pilot study demonstrated that prescribed, brief sessions of a relaxing music app can decrease anxiety with regard to pain in the ED.[12] Taken together, these studies indicate that various types of music show efficacy in both experimental and clinical settings, including among patients in the ED, and are likely feasible to employ.

As all the clinical studies also included other analgesic use as per clinical practice, it seems likely that music may be best used as an adjunctive intervention to assist in managing pain and anxiety while in the ED. Similarly, the majority of our patients received multimodal analgesia including acetaminophen, NSAIDs, and lidocaine patches. In post-intervention surveys, about half of our participants (54%) endorsed that they thought they could manage their pain if they listened to music in combination with taking non-opioid medications, suggesting that music is an acceptable adjunctive strategy to help patients cope with their pain. Although we found no difference between the groups in opioid medication administration in the ED or prescribed at discharge, it is reasonable to consider using music as an adjunct for pain. Based on this data, clinicians may consider adding a brief music session in individuals with acute back pain, either as a protocol or on an individualized basis, among patients that demonstrate or report higher anxiety.

Our main analysis suggested a relatively significant impact of listening to music on anxiety itself (greater overall reduction than the reduction in pain scores), consistent with the idea that one mechanism of music's analgesic impact could be through anxiety reduction. Anxiety is a known positive modulator of pain severity in both acute and chronic pain settings.[22,23] Our exploratory analysis demonstrated that lower levels of post-intervention anxiety partially contributed to why patients who listened to their self-selected music reported lower post-intervention pain severity compared to those who used noise cancellation. From a clinical perspective, this may suggest that individuals who report higher degrees of anxiety surrounding back pain could derive greater benefit from music therapy. Reducing patients' anxiety may be especially beneficial for improving acute pain symptoms.

The acute environment of the ED, uncertainty about the initial diagnosis of musculoskeletal back pain, and fear surrounding disability and mobility likely contribute to increased anxiety surrounding pain in the ED compared to other clinical settings. Addressing these factors using a music intervention may indirectly impact the experience of pain, and thereby serve as an adjunctive strategy when pharmacologic

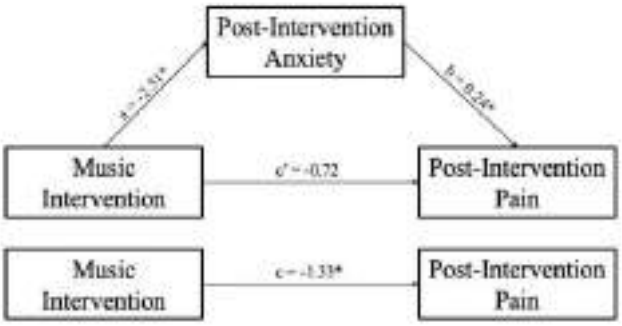

Figure 4. The mediating effect of post-intervention anxiety in the relationship between the music intervention and post-intervention pain, controlling for baseline Pain Catastrophizing Scale score
* $P < .05$.

options are exhausted or used in advance of certain maneuvers such as ultrasound-guided nerve blocks. Interestingly, despite the significant effect of music on anxiety and pain that we observed in this study, we did not observe group differences in the amount of opioid analgesics prescribed while in the ED or at discharge. This lack of effect on opioid administration may be due to changes in our practice surrounding opioid prescribing for musculoskeletal back pain at this academic site. Specifically, we have dramatically reduced the overall use and dose of opioids employed, compared to historical practices, which is likely why a similar proportion of patients in each group received opioid and non-opioid analgesics to manage their pain.

Given the promise of music as an adjunctive therapy for musculoskeletal back pain the ED, there are several future directions that should be investigated. The selection of type and method of music delivery remains heterogenous across studies. It is likely that each strategy of music (eg, researcher selected vs participant selected), type (vocals vs instrumental vs other sounds) and delivery method (participant generated vs listening to music) may result in different effects. Some of these modalities, like user-generated or group-based music therapy, are infeasible in the ED setting, but other strategies such as a pre-curated "relaxing" playlist compared to asking patients to select their own music may be strategies that can be integrated into ED operations. Self-selection may have some benefits over a pre-curated playlist due to the subjective nature of music preference. As people tend to have a good sense of the type of music they enjoy, it is unlikely that a patient would deliberately administer an ill-fitting kind of music.

It is possible that providing access to a streaming music service for patients in the ED may help address some acutely painful events, but given the significant role of music in modulating anxiety, it may also assist with the overall milieu of the ED. Additionally, there may be indirect benefits of providing music interventions in the ED related to patient experience and satisfaction. Further research that investigates both the type and delivery method of music interventions, the patients they most benefit, and their impact on ED experience are warranted. Perhaps most appealing, if future studies demonstrate efficacy of music interventions on certain painful experiences in the ED, the threshold to implement these options may be lower compared to other interventions. For example, an ED could stock headphones and a streaming music device that could be cleaned between use, or clinicians could guide patients to access guided music interventions on their own phones.

LIMITATIONS

This investigation had several limitations. First, we conducted our study at a single, tertiary, urban, academic teaching hospital where the majority of patients were evaluated by residents or physician assistants in conjunction with attending physicians. Practices and expectations surrounding analgesia for musculoskeletal back pain may vary across different sites with different practice models. Additionally, we did not collect information on the location of patients within the ED (eg, waiting room, private room, etc), which should be considered in future studies. Second, we opted to allow participants to select their own choice of music in this study. The degree to which these findings may generalize to use of standardized music interventions, chosen by the research team, is unknown. Similarly, the relative efficacy of different specific types of music (eg, instrumental or vocals, different genres of music) among individuals with pain in the ED was not specifically tested. It seems likely, based on previous studies,[24] and, based on the fact that our subjects did choose a variety of different music, that musical tastes vary, and allowing patient choice of music may be both the most pragmatic and efficacious route of music administration. Additionally, the intervention was brief, which may have limited the effect seen. Finally, we selected a relatively common condition where patients are likely to be discharged and the expected course of illness is relatively brief. The effect of music interventions on other painful conditions may, therefore, vary.

CONCLUSION

A brief, patient-selected music intervention resulted in significantly less pain and anxiety compared to the use of noise cancellation among individuals presenting to the ED with musculoskeletal back pain. Additionally, participants who listened to their self-selected music reported lower levels of anxiety post-intervention, which in turn, contributed to lower levels of pain. This data suggests that listening to music in the ED may be a low-threshold adjunctive tool in the armamentarium of non-pharmacologic interventions for musculoskeletal back pain.

Data Statement

The data that support the findings of this study are available from the corresponding author, CEG, upon reasonable request.

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A Missed Meal, A Missed Diagnosis: Why Emergency Departments Must Lead on Food Insecurity Screening

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To the Editor:

The recent recommendation by the US Preventive Services Task Force (USPSTF) concluding that there is "insufficient evidence" to assess the benefits and harms of food insecurity screening in the primary care setting may inadvertently stall momentum in addressing one of the most pressing social drivers of health: food insecurity,[1-4] which affected 12.8% of US households in 2022. It disproportionately impacts Black (22.4%) and Hispanic (20.8%) families, demonstrating profound associations with adverse health outcomes, including increased number of emergency department (ED) visits, hospitalizations, worse chronic disease management, and mental health comorbidities.[1-2,5-6] The ED serves as an entry point to healthcare for patients facing economic hardship[7] and often provides the main contact some families have with the healthcare system.[8-9]

Each year 155 million Americans visit the ED, representing about 47% of the population, and these patients are disproportionately underinsured.[10-11] Emergency physicians frequently observe the impacts of food insecurity when managing conditions such as uncontrolled diabetes or asthma exacerbations,[12] where food insecurity significantly contributes to poor outcomes by hindering effective management, often due to resource trade-offs between food and essential medications.[13-15]

Over the past three years, we have led feasibility studies and implemented screening across adult and pediatric EDs. We found that 21.8% of caregivers screened positive for food or housing insecurity in a pediatric ED.[16] In an adult ED, 16.9% of patients reported food insecurity.[17] Furthermore, findings from our adult ED study—in which the participants we followed showed improved food security scores after receiving resource information—support the plausibility of ED-based interventions helping to alleviate food insecurity.[17]

The ED serves high volumes of underinsured, unhoused, and high-acuity patients.[7,18] Preventive care gaps are the norm, and the ED often functions as the default site for both clinical and social triage.[8,19]

Emergency department-based screening tools can identify food insecurity among patients not captured through primary care screening; these include individuals without a primary care physician whose housing may be sporadic or who are living in resource deserts. The ED is far more than a safety net; it mirrors the state of community health, where upstream failures surface downstream with consequences of poorer health incomes and higher healthcare costs. In contrast, the evidence gap cited by the USPSTF reflects the known structural limitations in that setting: variable visit frequency; under-resourced clinics, and reimbursement models that do not support social screening.[1,20]

We call on healthcare leaders, policymakers, and emergency physicians to consider the ED not as a place where food insecurity screening is "optional," but where it is **essential**. Federal and state policy should incentivize ED-based screening workflows, fund navigator roles, and hospitals should integrate social determinants of health into the electronic health record. Medical education and residency training programs must prepare future clinicians to view food insecurity as an integral component of healthcare.

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Substance Use is Associated With Frequent Emergency Department Visits in Cardiac Patients

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Background/Objectives: Social and behavioral determinants of health (SBDoH) influence healthcare utilization and a variety of health outcomes, including among cardiovascular disease (CVD) patients. Currently, the majority of outpatient and emergency department (ED) patients are not adequately screened although their needs may be documented in the clinical notes. The use of artificial intelligence (AI) text processing algorithms to analyze vast amounts of data in the electronic health record (EHR) may provide a more comprehensive view of SBDoH needs across a patient population. AI, which is already used in EDs to provide initial machine read of electrocardiograms, best practice alerts, and detection of hemorrhage on stroke head CT readings, may also facilitate assessment of patient risk of high ED use. Our objective was to apply a novel natural language processing (NLP) approach that we developed to determine which SBDoH are associated with frequent ED use for patients with CVD.

Methods: We included patients 18-65 years with a history of atrial fibrillation, acute myocardial infarction, ischemic heart disease, or non-ischemic heart disease during a one-year period (9/1/2022-8/31/23) at a large metropolitan hospital in southeast Michigan. Patients over 65 years old were excluded to focus on younger and healthier patients whose visits may be more affected by SBDoH. We used a custom algorithm to combine ICD-10 codes, SDoH screening responses, and SBDoH detected from the clinical notes with NLP. SBDoH factors were compared between high- (≥ 5 visits/year) and non-high utilizers (< 5 visits/year). Logistic regression with backward selection was used to find significant associations between high ED use and demographics, chronic conditions and 17 different SBDoH factors.

Results: A total of 4,844 patients met inclusion criteria, with 526 (10.9%) having high ED use. Univariate analysis comparing high and low ED use showed significant differences in sex, race, payer mix, average number of chronic conditions, and average number of SBDoH factors (Table 1). Multivariable regression revealed female sex, African American race, financial strain, unreliable transportation, inadequate support system, uninsured/underinsured, medication affordability concerns, depression, alcohol, and opioid abuse were significantly associated with high ED utilization (Table 2). In particular, patients with documented opioid abuse (adjOR 3.25, 95% CI 2.60-4.07, p< .0001) and alcohol abuse (adjOR 2.22, 95% CI 1.75-2.84, p< .0001) had significantly increased odds of frequent ED use. Payer mix was not included in the regression analysis because of the high degree of correlation between Medicaid status and SBDoH factors.

Conclusions: Using our unique NLP approach, patients with CVD and specific SBDoH factors were associated with high ED use. Consistent with other studies, we found that alcohol and opioid abuse were associated with two- and three-fold higher rates of ED use, respectively. Importantly, substance abuse is not screened in the standard SDoH tools, which emphasizes the importance of aggregating these data from multiple sources within the EHR, including the clinical notes. Future work could consider whether strategically addressing SBDoH, particularly substance use disorder among CVD patients, could reduce high ED use.

Table 1. Characteristics of cardiovascular disease patients who frequently (≥5) visited the ED during a one year period at Corewell Health Royal Oak Hospital.

Variable	All	<5 ED visits	≥5 ED visits	p-value*
Sample, n (row %)	4844	4318 (89.1)	526 (10.9)	
Age, median (IQR)	56 (11)	56 (12)	54 (12.5)	< .0001
Female, n (col %)	2093 (43.2)	1807 (41.9)	286 (54.4)	< .0001
Race, n (col %)				
White	2737 (56.6)	2473 (57.4)	264 (50.2)	
Black/AA	1706 (35.3)	1464 (34.0)	242 (46.01)	
Asian	107 (2.2)	99 (2.3)	8 (1.5)	
Other	288 (6.0)	276 (6.4)	12 (2.28)	
Insurance class, n (col %)				< .0001
Commercial	2297 (47.4)	2180 (50.5)	117 (22.2)	
Medicaid	1314 (27.1)	1127 (26.1)	187 (35.6)	
Medicare	1178 (24.3)	957 (22.16)	221 (42.0)	
Other	55 (1.1)	54	1 (0.19)	
Number of SBDH, mean (SD)	1.51 (1.6)	1.36 (1.4)	2.75 (2.1)	< .0001
Chronic Conditions, mean, SD)	5.8 (2.8)	5.59 (2.7)	7.61 (2.9)	< .0001

* p-values were determined using Chi-Square or Fisher's Exact test for categorical variables and Wilcoxon rank sum test for continuous variables.
CVD, cardiovascular disease; *ED*, Emergency Department; *IQR*, interquartile range; *AA*, African American; *SBDH*, social and behavioral determinants of health; *SD*, standard deviation.

Table 2. Linear regression analysis of SBDoH associated with high ED use.

Category	Adj OR	95% CI	p-value
Opioid abuse (binary)	3.25	2.60-4.07	< .0001
Alcohol abuse (binary)	2.22	1.75-2.84	< .0001
Depression (binary)	1.88	1.53-2.31	< .0001
Race (Black compared to White)	1.66	1.35-2.04	< .0001
Sex (female compared to male)	1.54	1.26-1.90	< .0001
Financial strain (binary)	1.96	1.42-2.72	< .0001
Uninsured or Under-insured (binary)	2.71	1.58-4.64	< .0003
Unreliable transportation (binary)	2.24	1.39-3.61	< .0009
Inadequate support system (binary)	2.55	1.43-4.55	< .0015
Medication affordability concerns (binary)	2.95	1.39-6.30	< .005

SBDoH, social and behavioral determinants of health; *ED*, Emergency Department, *Adj OR*, adjusted odds ratio; *CI*, confidence interval.

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Patient Acceptance of Rapid HIV Testing During Targeted Screening in the Emergency Department

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Introduction: It is concerning that 12.8% of the 1.2 million individuals in the U.S. living with HIV are undiagnosed. It is important to identify these patients so those affected receive evidence-based treatment and prevent spread. The objective of this study is to estimate acceptance rates of free, point of care fingerstick HIV testing for a sample of targeted, at-risk individuals in the emergency department (ED). Additionally, we assess how test acceptance varies with demographics and categorize why patients decline HIV testing.

Methods: This is a single-center retrospective analysis of survey responses and documented HIV testing in a targeted sample of patients presenting to an urban academic ED in the Midwest from 2022-2023. The survey and testing were done by trained health promotion advocates, who perform targeted screening on a convenience sample of patients with social risk factors. We report the prevalence of testing acceptance and reasons for declining testing. Comparison of demographics between the overall ED population and those offered testing was done using a two sample T-test for age, and Chi-squared testing for all other variables. Logistic regression was done to find associations between test acceptance and demographic or risk factors.

Results: Over 24-months, 3,249 unique patients were offered point-of-care (POC) HIV tests and 1,680 (51.7%) accepted, per Table 1. African American patients and those identifying as males were offered testing at a greater frequency than their overall representation in the ED. African American patients were more likely to accept testing than white patients (54.3% vs. 47.8%, OR=1.28, p< 0.001), while increased age was associated with decreased test acceptance (OR=0.98 per year, p< 0.001), per Table 2. All patients who accepted belong to at least one population of interest including high-risk heterosexual behavior (40.4%), youth ages 13-29 (34.9%), and women of color (25.8%). The most common reasons cited by patients who declined testing were not wanting to be interviewed (24%) and having a prior negative test within the last 3 months (19.1%).

Conclusions: Over half of those offered POC testing for HIV in the ED accepted, with a significant percentage of those who declined reporting recent negative testing. Younger age and African American ethnicity were associated with a higher acceptance rate. Adopting an opt-out screening system and addressing common reasons for declining testing may provide opportunities for increasing HIV test uptake.

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Table 1. Characteristics of Emergency Department Patients and those offered rapid POC HIV testing, by acceptance

	ED Patients (n = 65,215)	Offered (n = 3,249)	Accepted (n = 1,680)	Declined (n = 1,569)
Demographics				
Age	42 (29-60)	35 (27-47)	34 (26-44)	37 (28-50)
Race				
Black/African American	25,836 (39.6)	1,655 (50.9)	899 (53.5)	756 (48.2)
White	31,196 (47.8)	1,413 (43.5)	676 (40.2)	737 (47.0)
Hispanic	5,184 (7.9)	79 (2.4)	49 (2.9)	30 (1.9)
American Indian/Alaska native	115 (0.2)	7 (0.2)	4 (0.2)	3 (0.2)
Asian/Pacific Islander	775 (1.2)	18 (0.6)	10 (0.6)	8 (0.5)
Biracial/Multicultural	633 (1.0)	42 (1.3)	25 (1.5)	17 (1.1)
Other/Unknown	1,476 (2.3)	35 (1.1)	17 (1.0)	18 (1.1)
Sex (at birth)				
Male	32,793 (50.3)	1,880 (57.9)	936 (55.7)	944 (60.2)
Female	32,377 (49.6)	1,369 (42.1)	744 (44.3)	625 (39.8)
Unknown	45 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
Gender Identity				
Male	32,685 (50.1)	1,872 (57.6)	931 (55.4)	941 (60.0)
Female	32,239 (49.4)	1,362 (41.9)	740 (44.0)	622 (39.6)
Transgender/Nonbinary	252 (0.4)	15 (0.5)	9 (0.5)	6 (0.4)
Unknown	39 (0.1)	0 (0.0)	0 (0.0)	0 (0.0)
Insurance Status				
None		368 (11.3)	206 (12.3)	162 (10.3)
Medicaid		2,141 (65.9)	1,117 (66.5)	1,024 (65.3)
Medicare		135 (4.2)	57 (3.4)	78 (5.0)
Dual Medicaid/Medicare		101 (3.1)	49 (2.9)	52 (3.3)
Private		278 (8.6)	149 (8.9)	129 (8.2)
Military/VA		6 (0.2)	3 (0.2)	3 (0.2)
Other/Unknown		220 (6.8)	99 (5.9)	121 (7.7)
Primary Care Status				
Has primary care		1,355 (41.7)	739 (44.0)	616 (39.3)
No primary care		1,233 (38.0)	736 (43.8)	497 (31.7)
Not Assessed/Unknown		661 (20.3)	205 (12.2)	456 (29.1)
Has primary care		1,355 (41.7)	739 (44.0)	616 (39.3)
No primary care		1,233 (38.0)	736 (43.8)	497 (31.7)
Not Assessed/Unknown		661 (20.3)	205 (12.2)	456 (29.1)

Age is reported as median (IQR), all other variables are n (%).
POC, point-of-care; *HIV, h*uman immunodeficiency virus; *VA,* Veterans Affairs.

Table 2. Logistic regression model for Emergency Department patients' acceptance of rapid POC HIV testing

	OR	95% CI	p-value
Demographics			
Age, per year	0.98	0.98-0.99	<0.001
Race			
White	*Reference		
Black/African American	1.28	1.17-1.53	<0.001
Hispanic	1.54	0.74-1.62	0.07
Other/Unknown	1.17	0.56-1.32	0.46
Sex (at birth)			
Male	*Reference		
Female	1.11	0.95-1.24	0.17
Insurance Status			
None	*Reference		
Medicaid	0.90	0.85-1.28	0.36
Medicare	0.73	0.53-1.16	0.13
Dual Medicaid/Medicare	0.92	0.60-1.38	0.73
Private	0.95	0.80-1.46	0.74
Other/Unknown	0.66	0.43-0.80	0.02

OR, odds ratio; *CI,* confidence interval.

Inter-Facility Emergency Department Transfers for Non-Contracted Insurance Status: Disproportionate Impact Upon Minority Patients

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Introduction: We examined inter-facility transfers due to non-contracted insurance status from the Emergency Department at a large tertiary care center in the Phoenix metropolitan area. This would go in results and conclusion, not introduction.

Transfers between Emergency Departments can have an important impact on patient care, with inter-hospital transfer associated with higher cost, longer overall length of stay, lower odds of discharge home, and higher risk of 3 and 30-day mortality for certain conditions.

Although such transfers are regulated by the Emergency Medical Treatment and Active Labor Act (EMTALA), transfers remain possible after patients have been stabilized, and evidence suggests that uninsured patients are more likely to experience inter-hospital transfer from the Emergency Department. We hypothesize that patients from minority populations will be disproportionately impacted by transfers for non-contracted insurance status from the Emergency Department.

Methods: Data were extracted from the hospital's electronic health record system, EPIC. The study period covered Emergency Department visits from January 1, 2021, to December 31, 2023, and records for all patients who presented to the ED during the study period were queried. Records were excluded if final disposition was not admission to an in-facility floor, the in-facility observations unit, or a facility transfer.

Records for patients who underwent facility transfer were reviewed to determine which transfers were due to insurance contracting status. Patients transferred to access care not provided at our institution were excluded.

The number of patients transferred for insurance incompatibility was compared with the number admitted either to observation or inpatient status at our facility for groups with socioeconomic minority status.

Results: We identified 336 transfers due to insurance incompatibility. Among patients transferred for non-contracted insurance status, the most common insurance type was Medicare Advantage plans, with 194 (53%) patients transferred.

We found significantly increased transfer rates due to insurance incompatibility for Hispanic patients (1.31% of all patients either admitted or transferred compared to 0.87% for non-Hispanic whites; Odds Ratio (OR) 1.52 give 95% confidence intervals for all odds ratios, p= .0036) and non-English speakers (2.06% compared to 0.90% for English speakers; OR 2.32 , p < .001). For the combined group of non-White, Hispanic, or non-English speaking, patients the rate of transfers due to insurance was 1.30% (compared to 0.84% for White, non-Hispanic English speakers; OR 1.55 p=.0001).

Conclusions: Our data suggest that hospital insurance contracting policies disproportionally affect minority groups, who may be more likely to hold non-contracted insurance classes. Further research is needed to determine the impact of limited provider networks associated with some health insurance plans. Hospital networks and health insurers alike must find solutions to address these systemic barriers to equitable care for minority and non-English speaking populations.

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Pilot Study: Impact of Primary Spoken Language as a Social Determinant of Health on CPR Education and Utilization

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Introduction: There are more than 350,000 out-of-hospital cardiac arrests every year in the United States. Neurologically intact survival is less than 10%. Recent literature shows that survival is even lower in communities of color and those that do not primarily speak English. Social determinants of health (SDOH), such as healthcare education access, language, and literacy, may serve as barriers to receiving cardiopulmonary resuscitation (CPR) education and using skills learned. Current literature is sparse on identifying which barriers may contribute to the lack of CPR education and utilization in non-English speaking communities. This study compared barriers to CPR education and utilization of CPR in English and Spanish-speaking learners. We hypothesized that language-specific barriers would be identified and may inform areas for further research. This study provides valuable insights into how CPR classes could be tailored to reduce disparities in CPR education and emergency access.

Methods: In this cross-sectional, survey-based study, participants were recruited using convenience sampling at community-based events. These included free, non-certification, public CPR and automated external defibrillator (AED) classes, taught in English and/or Spanish, as well as non-medical gatherings in association with community organizations. Respondents were asked 10 closed-ended questions assessing the knowledge, comfort, and perceived barriers to CPR education, performing bystander CPR, and activating the 911 system. Survey responses were directly compared between language groups using fisher tests within R, adjusting for various sociodemographic factors.

Results: A total of 307 surveys were collected, 179 in English and 128 in Spanish. Only 13% (n=16) of Spanish speakers stated they would have no concerns starting CPR, compared to 60% (n=107) in the English-speaking group. While the biggest barrier to initiating CPR in both groups was "fear of doing something wrong," this was a much more common concern among Spanish speakers (50% vs. 26%). The language barrier was indicated by 33 (26%) Spanish speakers as a reason they would not give bystander CPR, compared to 0% in the English group. 79% (n=141) of English-speaking participants indicated they would have no problem calling 911, compared to only 16% (n=20) of Spanish-speaking subjects. Spanish speakers expressed substantially higher rates of concern over immigration status (8% vs 0.6%), fear of doing something wrong (16.5% vs 6.9%), and the language barrier (34.7% vs 1.7%), with regard to calling 911. Among participants with no prior CPR education, when asked why, Spanish speakers were more likely to believe they were unqualified (24% vs 10%) and cite cost as a critical factor (12% vs 2%).

Conclusions: This study showed that Spanish speakers were less likely to know CPR or be comfortable initiating CPR than English speakers. While some barriers are common across language groups, Spanish speakers feel these more commonly. They are also burdened by barriers tied to SDOH, such as cost, language, and legal status. Having only 16% of a community being comfortable calling 911 is striking. These results suggest that marginalized communities will benefit from tailored educational models that address their unique challenges. Further research is necessary to better understand how SDOH serve as barriers to CPR education and CPR use.

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Content Analysis of Hospitals' Community Health Needs Assessments in the Most Violent Cities: 2023 Update

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Introduction: The Patient Protection and Affordable Care Act created a mandate for non-profit hospitals to conduct community health needs assessment (CHNAs) every three years. These allow researchers to conduct empirical analyses of hospitals' efforts to address issues of violence prevention. This study performs an analysis of CHNAs from hospitals within the twenty most violent U.S. cities and compares the content of CHNAs released after the ACA was implemented to hospitals' most recent CHNAs. Eight-seven CHNAs were analyzed for specific violence-related keywords and the designation of violence as an overall health need.

Methods: The selection criteria of hospitals and identification of trauma center status was previously described in Fischer et al.[1] The same cohort of hospitals were analyzed with their most recent CHNA from 2019-2023. CHNAs were collected between May and June of 2023. We investigated changes over time. This allows an analysis of temporal trends in the hospital identification of violence as a health issue.

To standardize the coding done by different individuals, we all coded for three of the same CHNAs and compared our results, which were the same. Each individual CHNA was coded based on the inclusion of the terms "violence", "violent", "assault", "murder", "homicide", or "intentional injury". Each was further characterized by the type of violence --community, domestic or sexual, child abuse, or terrorism. Moreover, statistics on the burden of violent injuries were reported, along with potential causes of the violence or if violence was recognized as a priority need by external stakeholders like non-hospital personnel or community members. Each CHNA was assessed for the presence or absence of violence listed as an overall community health need. We used a two-tailed Fisher's exact test to compare CHNAs from hospitals with and without trauma centers. Our primary outcome measure was to examine whether the same hospitals (trauma vs non-trauma centers) in the twenty most violent US cities have identified violence prevention as a major health need in their most updated CHNAs collected in 2023. Our secondary outcome was to compare in the specific ways the hospitals include violence-related terminology, the types of violence referenced, and how often external stakeholders raise the issue between the CHNAs gathered in 2015 vs 2023.

Results: 87 hospitals were identified and 19 of these hospital CHNAs did not meet the inclusion criteria, leaving a sample size of 68 hospital CHNAs.

Of the 68 hospitals, 58 (85%) CHNAs had violence-related terms mentioned with the most widely used terms used being "violence" 54 (93%) and "violent" 38 (66%). Forty-five (66%) CHNAs provided statistics about the burden of violence and 23 (34%) described potential causes of violence. External stakeholders identified violence as a community health issue in 43 (63%) CHNAs. Overall, violence was identified as a health need in 38 (56%) hospitals (Table 1).

When comparing the results from CHNAs collected from 2019-2023 to those from 2010-2016, violence-related terms were mentioned at a higher rate in the new data set, with 58 (85%) CHNAs mentioning them in the new paper versus 57 (74%) in the prior (Table 2). Of the terms used, only violence in reference to intimate partner/domestic/sexual violence (76% vs 42%) increased. Statistics about the burden of violence (66% vs 56%) increased. Additionally, violence identified as a community health need by external stakeholders (63% vs 38%) increased. Overall, the new data set also had an increase in violence

being identified as a health need (56% vs 32%) (Table 3). A limitation is that the presence of a term does not indicate the intensity to which violence was addressed nor does the absence exclude the possibility that hospitals are not participating in community outreach work.

Conclusions: These results demonstrated a significant increase from prior CHNAs for the identification of violence as a health need (56% vs 32%) and usage of violence-related terms (85% vs 74%). This study suggests that although there has been an increasing recognition of violence as a health issue, there is a need for additional education and programming for community responses to violence.

This represents an opportunity to improve the care for violently injured patients as well as programming. Overall, public health professionals must educate the public, health professionals, and policymakers on the importance of health-based strategies for violence prevention.

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Table 1. Results of CHNAs collected 2019-2023.

Content present in CHNAs	All (N=68)	Trauma Centers (N=46)	Non-trauma center (N=22)	p-value
Violence-related terminology utilized	85.3% (58)	87.0% (40)	81.8% (18)	0.72
Statistics on burden of violence provided	66.2% (45)	70.0% (32)	59.1% (13)	0.42
Underlying cause of violence discussed	33.8% (23)	32.6% (15)	36.4% (8)	0.79
External stakeholders perceive of violence as a need	63.2% (43)	65.2% (30)	59.1% (13)	0.79
Violence is designated as an overall priority need	55.9% (38)	60.1% (28)	45.5% (10)	0.30

CHNAs, community health needs assessment.

Table 2. Violence related terms in CHNAs collected in 2010-2016 v 2019-2023.

	Violence related terms	"Violence"	"Violent"	"Homicide"	"Murder"	"Assault"	"Intentional injury"
2010-2016 CHNAs	74.0% (57/77)	73.7% (42/57)	43.9% (25/27)	61.4% (35/57)	19.3% (11/57)	24.6% (14/57)	0% (0/57)
2019-2023 CHNAs	85.3% (58/68)	93.1% (54/58)	65.5% (38/58)	48.3% (28/58)	19.0% (11/58)	48.3% (28/58)	19.0% (11/58)

CHNAs, community health needs assessment.

Table 3. Results of CHNA collected in 2010-2016 vs 2019-2023.

	Violence in reference to community violence	Violence in reference to dating/ domestic/intimate partner or sexual violence	Violence in reference to child abuse	Statistics on burden of violence provided	Underlying causes of violence discussed	External stakeholders' perception of violence as a need	Violence is designated as an overall priority need
2010-2016 CHNAs	87.7% (50/57)	42.1% (24/57)	22.8% (13/57)	55.8% (43/77)	16.9% (13/77)	37.7% (29/77)	32.5% (25/77)
2019-2023 CHNAs	86.2% (50/58)	75.9% (44/58)	6.9% (4/58)	66.2% (45/68)	33.8% (23/68)	63.2% (43/68)	55.9% (38/68)

CHNAs, community health needs assessment.

Relationship Between Water Fluoridation Rates and Atraumatic Dental Visits to Emergency Departments in the U.S.: An Epidemiological Study

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Introduction: Dental health is a crucial aspect of overall well-being, and access to safe and effective measures for its maintenance is essential. Water fluoridation, as a public health intervention to prevent dental caries and promote oral health in communities across the United States, has been recognized as an effective strategy since 1945. Numerous studies have demonstrated the positive impact of fluoridation on reducing dental caries and the need for dental treatments; however, there has been ongoing debate about its safety and long-term effects. Although fluoridation is widely acknowledged as an effective public health measure, the connection between water fluoridation and atraumatic dental emergency room visits in the United States remains unknown.

The objective of this study was to compare the incidence of atraumatic dental visits in regions of the United States—Northeast, Midwest, South, and West—with adequate water fluoride content, to those below recommended fluoride thresholds.

Methods: This is an epidemiological nationwide study. Using the Nationwide Emergency Department Sample (NEDS), we cross-referenced water fluoridation areas in the United States with emergency department visits for atraumatic dental care during 2016-2019. We used the NEDS database and applied weights to extrapolate data to the entire U.S. population, limiting our evaluation to areas where the water fluoride content is available. The CDC State Fluoridation Report served as the database for water fluoridation rates in the Northeast, Midwest, South, and West regions of the U.S. These data were cross-referenced to extrapolate the average incidence of atraumatic dental visits per 100,000 over the noted years, divided by region.

Results: Analysis of NEDS and the CDC's State Fluoridation Reports revealed that the Northeast region, with 57.48% fluoridation, had an average incidence of 158.81 atraumatic dental visits per 100,000 from 2016 to 2019. The West, with 58.56% fluoridation, had an average incidence of 101.76 atraumatic dental visits per 100,000. The Southern region, with 79.48% fluoridation, averaged 192.71 visits per 100,000. Lastly, analysis revealed that the Midwest region, with 90.50% fluoridation, averaged 186.40 atraumatic dental visits per 100,000 during the same period. The coefficient of determination (R^2) for these results is 0.5774.

Conclusions: Using national data from NEDS and the CDC we were able to analyze incidence rates of atraumatic dental visits compared to fluoridation levels of water in the four regions of the U.S. Our results indicate that there is no clear correlation between water fluoridation and number of visits to the emergency department with atraumatic dental complaints. These findings suggest that while water fluoridation remains an important public health measure, further investigation is needed to understand the multifactorial influences on community dental health outcomes.

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Regional STEMI Program Historical Mortality Rates in Maine, USA

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Introduction: Without timely reperfusion therapy, 1-month mortality rates for ST-elevation myocardial infarction (STEMI) range from 10-25%. The addition of medical therapies has improved mortality rates to 1-8% (ISIS II, MORACS). This mortality rate is further reduced with percutaneous coronary intervention (Keeley). The chain of survival from patient recognition to proper and timely treatment requires ongoing assessment and monitoring. Given geographic constraints, patients presenting with STEMI in Maine are treated with both fibrinolysis and primary PCI depending on where they are first identified. The regional AMI-PERFUSE program represents an ongoing effort to provide optimal care for patients presenting with STEMI. Here we report historical mortality rates of patients presenting with STEMI based on treatment modality.

Methods: Utilizing historical databases of consecutive unselected patients treated for STEMI, we assessed and organized outcomes at the patient level. Each STEMI case was adjudicated to ensure proper classification. Treatment modalities included PCI, fibrinolysis with PCI, fibrinolysis alone, or no reperfusion therapy. Surgical revascularization was not specified within the database. Percentages and 2-tailed Z-test were used to analyze the data.

Results: From 2004-2017, 5,945 patients presented with STEMI and were analyzed (Table 1). There were 317 deaths (5.3%), with a 2017 aberration of 59 total deaths. 195 patients (3.2%) whose treatment was not classified were excluded from the analysis. Overall, in-hospital mortality rate following STEMI presentation was 5.3% for those receiving treatment. Between 2004-2016, mortality rates peaked at 7% for patients treated with primary PCI (n=3,243) and fibrinolysiswith PCI (n=2,230; see Figure 1). There was no significant difference in MaineHealth Maine Medical Center, Department, Portland, Maine overall mortality rates between the two populations (4.8% vs. 4.7%, p=0.84). Mortality rates between patients treated with PCI (54.5%, n= 3243) vs. fibrinolysis alone (0.9%, n=107) and between those treated with fibrinolysis with PCI (37.5%, n = 2230) vs. fibrinolysis alone (0.9%, n=107) were also not significantly different (p=0.06 and p=0.07, respectively). The in-hospital mortality rates for all three treatment modalities were significantly decreased from those who did not receive reperfusion therapy (23.5%, p< 0.01 for all comparisons, n=170).

Conclusions: Over 14 years of available historical data from a regional STEMI database, in-hospital mortality rates for patients varied along a narrow margin and did not differ based on treatment modality. Regardless of treatment, mortality was significantly lower compared with those who received no reperfusion therapy.

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Table 1. Comparison of mortality rates between STEMI treatment modalities and associated significance of outcomes.

Treatment	Mortality Rate	Z- Test Statistic	Significance in Over Mortality Rates
PCI vs. Lytics + PCI	4.78% vs. 4.66%	0.1983	P = 0.84
PCI v. Lytics + Observation	4.78% vs. 0.03%	1.857	P = 0.06
PCI vs. No reperfusion therapy	4.78% vs. 23.5%	-10.27	P < 0.001
Lytics + PCI vs. Lytics + Observation	4.78% vs. 0.03%	1.819	P = 0.07
Lytic + PCI vs. No reperfusion therapy	4.78% vs. 23.5%	-9.984	P < 0.001
Lytics + Observation + No reperfusion therapy	0.03% vs. 23.5%	-5.156	P < 0.001

STEMI, ST-elevation myocardial infarction, *PCI,* percutaneous coronary intervention, *Lytics,* thrombolytic therapy.

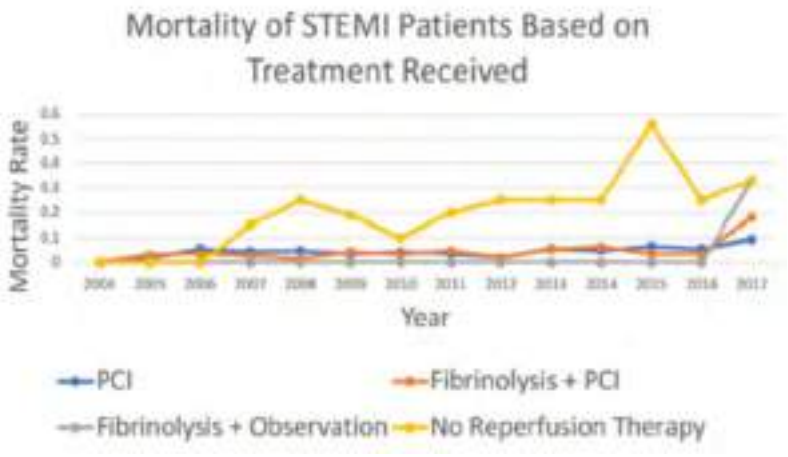

Figure 1. Longitudinal mortality rates of STEMI patients according to treatment modality received.

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