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Western Journal of *Emergency Medicine*:

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Official Journal of the California Chapter of the American College of Emergency Physicians, the America College of Osteopathic Emergency Physicians, and the California Chapter of the American Academy of Emergency Medicine

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JOURNAL FOCUS

Emergency medicine is a specialty which closely reflects societal challenges and consequences of public policy decisions. The emergency department specifically deals with social injustice, health and economic disparities, violence, substance abuse, and disaster preparedness and response. This journal focuses on how emergency care affects the health of the community and population, and conversely, how these societal challenges affect the composition of the patient population who seek care in the emergency department. The development of better systems to provide emergency care, including technology solutions, is critical to enhancing population health.

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VITAL STATISTICS

Western Journal of Emergency Medicine (*West*JEM): Integrating Emergency Care with Population Health (*West*JEM) is the premier open-access Medline-indexed EM journal in the world. As the official journal of the California Chapter of the American College of Emergency Physicians (ACEP), American College of Osteopathic Emergency Physicians (ACOEP), and the California chapter division of the American Academy of Emergency Medicine (AAEM), the journal focuses on how emergency care affects health and health disparities in communities and populations. Additionally, *West*JEM focuses on how social conditions impact the composition of patients seeking care in emergency departments worldwide. *West*JEM is distributed electronically to 19,000 emergency medicine scholars and 2,800 in print. This includes 83 academic department of emergency medicine subscribers and 8 AAEM State Chapters.

Western Journal of *Emergency Medicine*:

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Abstracts From The First Forum About The Future Of Emergency Medicine In Ecuador (September 5 & 6, 2019)

WestJEM is proud to support the scientific development of emergency medicine in Ecuador, through the publication of the following two abstracts presented at the Forum About the Future of Emergency Medicine in Ecuador. As the state of research in Ecuador develops, we feel it important to recognize the pioneers in research with abstract publication. These abstracts have not been peer-reviewed by WestJEM, and so readers should consider this prior to accepting the information as scientifically valid.

September 2019, Quito, Ecuador

In Ecuador, as in many other countries, emergency medicine (EM) is under development. EM was established as a specialty in Ecuador 26 years ago and has completed its first phase of development. The specialty has gained recognition in Quito, where the majority of EM specialists work; however, its expansion to the rest of the country has been slow and important challenges remain. In particular, the specialty faces difficulty gaining traction outside of Quito, and there are ongoing issues with respect to quality of care, postgraduate education, research, and leadership. The American College of Emergency Physicians (ACEP), through its Ambassador Program, and the Ecuadorian Society of Emergency and Disaster Medicine have established a goal of aligning Ecuadorian EM with the global and international objectives of the specialty. With this goal in mind, the First Forum About the Future of Emergency Medicine in Ecuador was held on September 5 and 6, 2019, in Quito. The forum was organized by the team of ACEP Ambassadors for Ecuador, with the support of the Universidad San Francisco de Quito, the Ecuadorian Society of Emergency and Disaster Medicine, and the Hospital de los Valles. The Forum had two main goals: 1) bring together Ecuadorian EM specialists to discuss current challenges and possible solutions with an emphasis on the vision and mission of the specialty, leadership, education and research; 2) expose Ecuadorian EM specialists to international EM leaders to promote the flow of ideas and transnational collaboration. One of the most engaging sessions at the Forum was the presentation before an international jury of scientific abstracts related to the practice of emergency medicine in Ecuador. We hope that activities of this type will stimulate the development of research within Ecuador and increase interest in research at universities involved in postgraduate EM training. Long-term research can inform the Ecuadorian government and other decision makers in order to improve the quality of emergency care and strengthen EM as a specialty. The scientific abstracts presented at the Forum are included below.

(Español)

En Ecuador, como en muchos otros países, la medicina de emergencias está en proceso de desarrollo. La Especialidad ha cumplido 26 años en el Ecuador y ha culminado la primera fase de su desarrollo. Actualmente la medicina de emergencias es reconocida como una especialidad y los servicios de emergencias de Quito, donde trabaja la mayoría de los emergenciólogos. Sin embargo, existen importantes desafíos con respecto al reconocimiento de la especialidad fuera de Quito, la calidad de la atención, los posgrados, la investigación y el liderazgo. El American College of Emergency Physicians, a través de su Programa de Embajadores, y la Sociedad Ecuatoriana de Medicina de Emergencias y Desastres se han planteado como meta alinear la medicina de emergencias ecuatoriana con los objetivos globales e internacionales de la especialidad. Con esta meta en mente, se llevó a cabo el Primer Foro Sobre el Futuro de la Medicina de Emergencias en Ecuador, el 5 y 6 de septiembre de 2019, en Quito. El foro fue organizado por el equipo de embajadores para el Ecuador del American College of Emergency Physicians, con el apoyo de la Universidad San Francisco de Quito, la Sociedad Ecuatoriana de Medicina de Emergencias y Desastres, y el Hospital de los Valles. El Foro tuvo dos metas principales: 1) Reunir a los emergenciólogos ecuatorianos para que discutieran los desafíos actuales de la especialidad en el país y posibles soluciones con énfasis en la visión y misión de la especialidad, el liderazgo, la educación y la investigación; 2) exponer a los emergenciólogos ecuatorianos a líderes internacionales de la especialidad para fomentar el flujo de ideas y la colaboración transnacional. Una de las sesiones más atractivas del Foro fue la presentación ante un jurado internacional de resúmenes científicos relacionados al ejercicio de la medicina de emergencias en el Ecuador. Esperamos que actividades de este tipo estimulen el desarrollo de la investigación en Ecuador, y aumenten el interés en la investigación de los programas universitarios de formación de especialistas. La investigación a largo plazo puede informar al gobierno ecuatoriano y otros tomadores de decisiones con el objetivo de mejorar la calidad de la especialidad de Medicina de Emergencia. A continuación, se incluyen los resúmenes científicos presentados del Foro.

Andrés Patiño, MD
ACEP Ambassador to Ecuador
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Augusto Maldonado, MD
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Alexis Kearney, MD, MPH
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Medical Student
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Katelyn Moretti, MD
Ecuadorian Emergency Medicine Forum's
Abstract Session Organizer
Brown University

Abstracts From The First Forum About The Future Of Emergency Medicine In Ecuador (September 5 & 6, 2019)

1 Management of Stroke with Pharmacological Fibrinolysis in an Emergency Department at a Level 2 Hospital in Central Ecuador

P López-Terán[1], M Jaramillo-Vintimilla[1] / [1]Hospital General Docente Ambato, Department of Emergency Medicine, Ambato, Ecuador

Introduction: A timely and organized response in the emergency department is crucial for the treatment of stroke with pharmacological fibrinolysis. Currently, few stroke patients have access to fibrinolytic treatment in Ecuador, as most hospitals lack a well-coordinated stroke response. This remains true at even the highest acuity (level 3) hospitals. In this study we report the initial results of the first code stroke and fibrinolysis pathway established in a level 2 public hospital in a small city (pop 300,000) in Ecuador.

Objective: To develop an organized and coordinated pathway within the hospital for the correct diagnosis and treatment of patients with clinical presentation of stroke, starting with early identification of signs/symptoms and the activation of a specific pathway, which in turn improves the prognosis and the quality of life of acute ischemic stroke patients.

Methods: This was a prospective, longitudinal, descriptive study of patients presenting with stroke symptoms, for whom a code stroke and red triage priority was applied in the emergency department of Hospital General Docente Ambato in the first three months of 2019. To be eligible for thrombolysis, patients had to arrive within 4.5 hours of symptom onset and not have any contraindications to thrombolysis.

Results: 30 patients arrived at the emergency department with stroke symptoms, and in each case a code stroke was activated upon arrival to the emergency department. The mean age of patients was 66.63 years, and 15 patients were male (50%). 19 patients (63%) arrived within 4.5 hours of symptom onset, of which 8 patients (42%) had no contraindication and received thrombolysis. The mean door-to-needle time was 66 minutes.

Conclusions: This study demonstrates that it is feasible to establish a code stroke and fibrinolysis treatment pathway in level 2 hospitals in Ecuador. Many other hospitals in the country could establish similar treatment protocols and improve their management of ischemic stroke patients.

1 *Manejo del Código Ictus con Fibrinólisis Farmacológica, en el Servicio de Emergencias en un Hospital Nivel 2 en el Centro de Ecuador*

P López-Terán[1], M Jaramillo-Vintimilla[1] / [1]Hospital General Docente Ambato, Department of Emergency Medicine, Ambato, Ecuador

Introducción: *La organización de los servicios de emergencias como respuesta al Evento Cerebro Vascular Isquémico tiene un rol fundamental en la fibrinólisis farmacológica. Actualmente, pocos pacientes con ictus tienen acceso al tratamiento con fibrinolíticos en el Ecuador, ya que muchos hospitales carecen de una respuesta bien coordinada para el manejo del ictus, inclusive en hospitales nivel 3 (de mas alta complejidad). En este estudio reportamos los resultados iniciales del primer código ictus y manejo con trombolíticos establecidos en un hospital nivel 2 en una ciudad pequeña (pob. 300,000), en Ecuador.*

Objetivo: *Desarrollar un proceso de atención organizado y coordinado a nivel hospitalario, para el adecuado diagnóstico y manejo de pacientes con signos y síntomas de ataque cerebral, el cual inicie con la identificación temprana de los pacientes y la activación hospitalaria de un código específico que acelere los procesos, mejorando el pronóstico y la calidad de vida de pacientes que han presentado un Evento Cerebro Vascular Isquémico en fase aguda.*

Métodos: *Se realizó un estudio prospectivo longitudinal descriptivo en pacientes en quienes se activó el código ictus con prioridad triaje roja en el servicio de emergencias del Hospital General Docente Ambato, los 3 primeros meses del 2019. Para ser elegibles para la trombólisis, los pacientes necesitaban llegar dentro de las primeras 4.5 horas del comienzo de síntomas y no tener contraindicaciones para la trombólisis.*

Resultados: *Se estudiaron 30 pacientes, que acudieron al servicio de emergencia con síntomas de ataque cerebral, en todos los casos se activó código ictus desde su llegada a emergencia, la media de edad de los pacientes fue de 66,63 años y 15 pacientes fueron de sexo masculino (50). 19 pacientes (63%) acudieron al hospital dentro de las 4.5 horas de iniciada su sintomatología, de los cuales 8 no presentaron contraindicación y recibieron trombólisis (42%). La media de tiempo puerta aguja fue de 66 minutos.*

Conclusiones: *Este estudio demuestra que es posible establecer un código ictus y tratamiento fibrinolítico en hospitales de nivel 2 en el Ecuador. Muchos otros hospitales en el país podrían establecer protocolos de tratamiento similares y mejorar el manejo de pacientes con ictus isquémico.*

2 Applicability of Winthrop Score for the Diagnosis of Influenza A in the Emergency Department of Hospital Pablo Arturo Suárez, January to March of 2018

R Salazar-Motesdeoca[1], L Yánez-Ortiz[1] / [1]Hospital Pablo Arturo Suárez, Department of Emergency Medicine, Quito, Ecuador

Introduction: In 2010, the Department of Infectious Diseases at Winthrop University Hospital designed a score system for the diagnosis of Legionella pneumonia. In this study, we applied the score to patients with acute respiratory symptoms suspected of having type A influenza. The identification of patients at medium to high risk of Influenza A allows for early initiation of treatment.

Objective: To study the applicability of the Winthrop score for the diagnosis of Influenza A.

Methodology: A prospective cohort study was performed in 2018 at Hospital Pablo Arturo Suárez, in Quito, Ecuador. Patients 0 to 100 years old presenting to the emergency department with influenza-like illness in January-March of 2018 were included in the study. Winthrop score results were then compared with the result of the reverse transcription polymerase chain reaction (RT-PCR) for influenza A, the gold standard for diagnosis. Sensitivity, specificity, positive and negative predictive values, and likelihood ratios were used to establish the diagnostic performance of this point system for influenza A within the sample at large and in subgroup analyses by age (<5 years, 5-65 years, and >65 years) and comorbidities.

Results: 149 patients were enrolled in the study period. The study population included 81 males (54.4%) and the majority of patients were less than 5 years of age (N=85, 57.0%). Furthermore, almost one-third of the patients were less than one year old (N=38, 25.5%). According to the Winthrop point system, 68.5% of the cases had a low probability of having influenza (n = 102), 8.7% of cases had a medium probability (n = 13) and 22.8 % of cases had a high probability (n = 34). The RT-PCR test for influenza was positive for 26.2% of patients (n = 39). The Winthrop point system had a sensitivity of 97.4%, specificity of 91.8%, positive predictive value of 80.8%, negative predictive value of 99.0%, positive likelihood ratio of 11.9, and negative likelihood ratio of 35.8 in the total study population. For children under 5 years, a sensitivity of 100%, specificity of 96.3%, positive predictive value of 77.7%, negative predictive value of 100%, positive likelihood ratio of 27, and negative likelihood ratio of 0. In patients older than 6 years, a sensitivity of 96.9%, specificity of 89%, positive predictive value of 84.21%, negative predictive value of 98%, positive likelihood ratio of 8.8, and negative likelihood ratio of 29.4. Testing in patients over 65 years had a sensitivity of 100%, specificity of 90%, positive predictive value of 87.5%, negative predictive value of 100%, positive likelihood ratio of 10 and negative likelihood ratio of 0. Finally, patients with comorbidities had a sensitivity of 90%, specificity of 88.24%, positive predictive value of 81.82%, negative predictive value of 93.75%, positive likelihood ratio of 7.65, and negative likelihood ratio of 8.82.

Conclusions: The Winthrop score performed well in predicting Influenza A in patients with acute respiratory symptoms. This score may be useful in settings were Influenza A PCR testing is unavailable.

2 *Aplicabilidad Del Sistema De Puntos de Winthrop Para el Diagnóstico de Influenza A en el Servicio de Emergencias del Hospital Pablo Arturo Suárez, Enero a Marzo de 2018*

R Salazar-Motesdeoca[1], L Yánez-Ortiz[1] / [1]Hospital Pablo Arturo Suárez, Department of Emergency Medicine, Quito, Ecuador

Introducción: *El departamento de Infectología del Hospital Universitario de Winthrop en el año 2010, diseñó un instrumento para el diagnóstico de neumonía por Legionella. En este estudio se implementó este instrumento en pacientes con síntomas respiratorios agudos con sospecha de influenza tipo A. La identificación de pacientes con mediana y alta sospecha de Influenza A puede optimizar el inicio precoz del tratamiento.*

Objetivo: *Estudiar la aplicabilidad del sistema de puntos de Winthrop para el diagnóstico de Influenza A.*

Metodología: *Un estudio prospectivo de cohorte se realizó en el Hospital Pablo Arturo Suárez en Quito, Ecuador. Pacientes de 0 a 100 años de edad, que fueron atendidos con enfermedad tipo influenza en el departamento de emergencias del hospital Pablo Arturo Suárez, en el primer trimestre del año 2018. A estos pacientes se les aplicó el sistema de puntos de Winthrop, que luego se comparó con el resultado de la RT-PCR para influenza, que es el patrón de oro para su diagnóstico. Se calculó la sensibilidad, especificidad, valor predictivo positivo, valor predictivo negativo, cociente de probabilidad positivo y cociente de probabilidad negativo, para establecer el rendimiento diagnóstico de este sistema de puntos para influenza A, tanto en la población total del estudio, así como en subgrupos por edad (<5 años, 5-65 años, and >65 años) y por comorbilidades.*

Resultados: *Se atendieron 149 casos en el periodo de estudio. La población del estudio incluyó 81 pacientes*

masculinos (54,4%). Así mismo casi un tercio de los pacientes fue menor de un año n=47 (31,5%). Según el sistema de puntos de Winthrop, el 68,5% de los casos tenía una probabilidad baja de tener influenza (n=102), para el 8,7% la probabilidad era media (n=13) y para el 22,8% era elevada (n=34). El examen de RT-PCR para influenza fue positivo para el 26,2% de los casos (n=39). Se obtuvo para el sistema de puntos de Winthrop una sensibilidad de 97,4%; especificidad de 91,8%, valor predictivo positivo de 80.8%, valor predictivo negativo de 99,0%, cociente de probabilidad positivo de 11.9 y cociente de probabilidad negativo de 35.8 en la población total del estudio. Para menores de 5 años una sensibilidad del 100%; especificidad de 96.3%, valor predictivo positivo de 77.7%, valor predictivo negativo de 100%, CPP de 27 y CPN de 0. En pacientes mayores de 6 años una sensibilidad del 96.9%; especificidad de 89%, valor predictivo positivo de 84.21%, valor predictivo negativo de 98%, cociente de probabilidad positivo de 8.8 y cociente de probabilidad negativo de 29.4. Lo que abarca pacientes mayores de 65 años una sensibilidad del 100%; especificidad de 90%, valor predictivo positivo de 87.5%, valor predictivo negativo de 100%, cociente de probabilidad positivo de 10 y cociente de probabilidad negativo de 0. Finalmente en pacientes con comorbilidades; una sensibilidad del 90%; especificidad de 88.24%, valor predictivo positivo de 81.82%, valor predictivo negativo de 93.75%, cociente de probabilidad positivo de 7.65 y cociente de probabilidad negativo de 8.82.

Conclusiones: *El sistema de puntos de Winthrop tuvo un buen rendimiento en la predicción de influenza A en pacientes con síntomas respiratorios agudos. Este sistema de puntos podría ser de utilidad en entornos donde no se cuente con pruebas de RT-PCR para influenza.*

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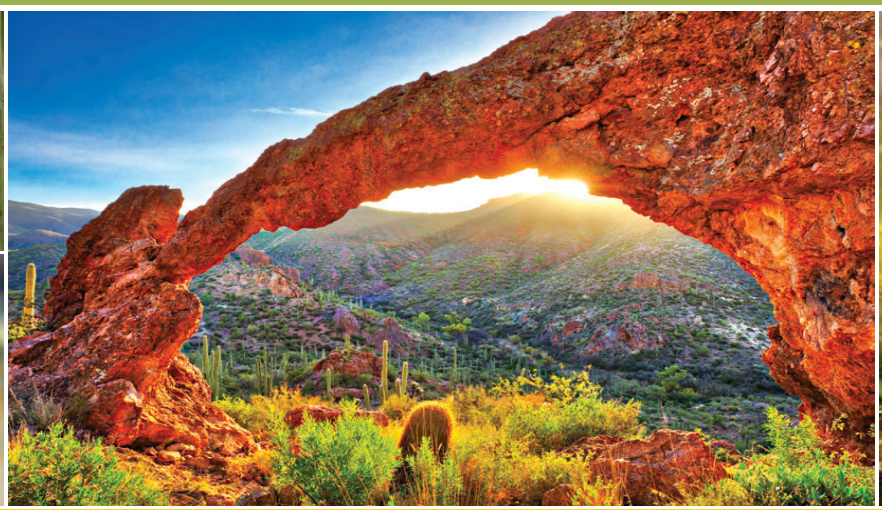

Come see the AAEM/RSA & *West*JEM Population Health Research Competition at AAEM's Scientific Assembly! This competition showcases medical student and resident research which affects the health of populations in and around the ED.

2019-nCoV: The Identify-Isolate-Inform (3I) Tool Applied to a Novel Emerging Coronavirus

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2019 Novel Coronavirus (2019-nCoV) is an emerging infectious disease closely related to MERS-CoV and SARS-CoV that was first reported in Wuhan City, Hubei Province, China in December 2019. As of January 2020, cases of 2019-nCoV are continuing to be reported in other Eastern Asian countries as well as in the United States, Europe, Australia, and numerous other countries. An unusually high volume of domestic and international travel corresponding to the beginning of the 2020 Chinese New Year complicated initial identification and containment of infected persons. Due to the rapidly rising number of cases and reported deaths, all countries should be considered at risk of imported 2019-nCoV. Therefore, it is essential for prehospital, clinic, and emergency department personnel to be able to rapidly assess 2019-nCoV risk and take immediate actions if indicated. The Identify-Isolate-Inform (3I) Tool, originally conceived for the initial detection and management of Ebola virus and later adjusted for other infectious agents, can be adapted for any emerging infectious disease. This paper reports a modification of the 3I Tool for use in the initial detection and management of patients under investigation for 2019-nCoV. After initial assessment for symptoms and epidemiological risk factors, including travel to affected areas and exposure to confirmed 2019-nCoV patients within 14 days, patients are classified in a risk-stratified system. Upon confirmation of a suspected 2019-nCoV case, affected persons must immediately be placed in airborne infection isolation and the appropriate public health agencies notified. This modified 3I Tool will assist emergency and primary care clinicians, as well as out-of-hospital providers, in effectively managing persons with suspected or confirmed 2019-nCoV. [West J Emerg Med. 2020;21(2)184-190.]

Disclaimer: Due to the rapidly evolving nature of this outbreak, and in the interests of rapid dissemination of reliable, actionable information, this paper went through expedited peer review. Additionally, information should be considered current only at the time of publication and may evolve as the science develops. On February 11, 2020, the World Health Organization renamed the virus COVID-19.

INTRODUCTION

2019 Novel Coronavirus (2019-nCoV) is a novel respiratory disease first reported in Wuhan, Hubei Province, China in December 2019.[1] Chinese health officials were originally investigating a sudden increase in cases of pneumonia which were later determined to be linked to 2019-nCoV. While most cases originated within mainland China, the disease spread to neighboring countries including Taiwan, Thailand, South Korea, and Japan, and later to the United States, Europe, and Australia. A near real-time updated tracking website for cases and locations worldwide, along with reported deaths is available.[2]

Chinese health authorities have sequenced 2019-nCoV and freely shared its genetic profile online.[3,4] Additionally, on January 28, 2020, an Australian laboratory reported growing the virus from a patient sample. As of January 30, 2020, there have been at least 9,776 persons infected and 213 verified deaths.[2] These numbers are likely underestimates due to the limited information available regarding incubation time, transmissibility, and virus origin. The

age distribution of these verified deaths is currently not available. One preliminary, small-scale study of 41 patients in Wuhan China, reported 6 deaths (15% mortality) with a median age of 49.0 years.[5] Additionally, transmission of the virus has reportedly occurred in healthcare facilities in Wuhan City, raising concerns of spread to healthcare workers, as was seen during prior outbreaks of the novel coronaviruses, Middle Eastern Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome (SARS). Due to the dynamic nature of the outbreak, exposure criteria may change depending on where new cases of 2019-nCoV are detected, the degree of transmissibility, and when additional information regarding the origin of the virus is discovered and reported.

On January 15, 2020, the Centers for Disease Control and Prevention (CDC) confirmed the first known imported case of 2019-nCoV in the US state of Washington. The patient had recently returned from Wuhan City, where he likely contracted the disease. Chicago health authorities reported a second US case on January 24, 2020. This was quickly followed by additional imported cases reported in Orange and Los Angeles Counties, California on January 26, 2020. Additional suspected cases continue to be evaluated. On January 30, 2020, the CDC reported the first local transmission in the US between members in a household. On the same day, the World Health Organization declared 2019-nCoV to be a Public Health Emergency of International Concern (PHEIC).[6] On January 31, 2020, the US Department of Health and Human Services declared coronavirus a public health emergency.[7]

Healthy individuals and those with mild illness may be asymptomatic, while others may have more pronounced symptoms of fever or lower respiratory illness. Upon identification of a suspected patient, that individual should immediately be isolated with airborne precautions. Further work-up and laboratory confirmation can then proceed. Emergency physicians (EPs), emergency medical services (EMS) personnel, and other healthcare workers who encounter patients with suspected 2019-nCoV infection must inform the appropriate authorities, including but not limited to hospital infection control and local or state public health agencies.

Healthcare workers must follow on-going developments related to the outbreak, especially new information concerning detection and management.[8,9] The 3I Tool outlined in this paper is consistent with current US CDC guidelines and can be applied in a variety of settings such as those in emergency departments, urgent-care clinics, physicians' offices, and prehospital settings. This paper will first briefly review 2019-nCoV and then present the novel 2019-nCoV 3I Tool as modified from its initial conception for Ebola virus disease [10,11] and later adapted for measles,[12] MERS,[13] mumps,[14] Zika virus disease,[15] hepatitis A,[16] pertussis,[17] and scabies.[18]

Population Health Research Capsule

What do we already know about this issue?
2019 Novel Coronavirus (2019-nCoV) is a rapidly spreading infectious disease closely related to severe acute respiratory syndrome (SARS)-CoV and Middle East respiratory syndrome (MERS)-CoV, first detected in late 2019 in Wuhan, China.

What was the research question?
Investigators adapted the "Identify, Isolate, Inform" (3I) Tool for use in suspected cases of 2019-nCoV.

What was the major finding of the study?
A novel 2019-nCoV 3I Tool is designed for frontline clinicians in the management of suspected patients.

How does this improve population health?
This 2019-nCoV 3I adaptation will aid healthcare providers most likely to encounter the disease in the containment and effective treatment of patients.

CLINICAL PRESENTATION

Signs and Symptoms

Coronavirus 2019-nCoV infection commonly presents with signs and symptoms of pneumonia or as a nonspecific lower respiratory illness, with coughing or difficulty breathing accompanied by fever.[5,19,20] Fever and cough constitute the most common presentations. However, patients may have other respiratory symptoms, sore throat, nasal congestion, malaise, myalgia, and headache. Bilateral infiltrates may be seen on chest X-ray. Severe cases may present with sepsis and even shock. Conversely, some patients may present as only mildly ill or asymptomatic altogether.[21] To date, patients with underlying medical conditions and the elderly are more likely to become severely ill, require hospitalization, and ultimately die.[22] Early predictions for incubation time are between 2 and 14 days, based on data from similar coronaviruses. The 14-day criterion for epidemiological risk assumes the longest estimated incubation time.[23] In addition, the World Health Organization (WHO) has created its own interim case definition.[24]

Disease Characteristics

By definition, the main features of a novel virus, for example, how it is transmitted, will not be immediately known. However, as with the development of any 3I Tool, it is essential to understand specific characteristics of the disease. In the case of a novel virus such as 2019-CoV, this is challenging since information is rapidly evolving and the science is not yet fully understood. It is possible that the virus will undergo mutations over time that could substantially change its

Table 1. Key disease features and implications.

Scenario	Special Considerations
Natural vs. human-generated (e.g., terrorism, industrial incident)	Law enforcement in addition to public health investigation; crime scene investigation
Contagion vs. contaminant/toxin vs. neither	Mode of transmission; PPE type
Transmissibility from person to person (i.e., R_0)	PPE requirements; need for declaration of PHEIC, need for surge capacity
Potential for mutations	Need for monitoring and updates on public health management guidance
Sensitivity and specificity of testing	Strategies for testing method and location (point-of-care, regional, national)
Contagious prior to symptom onset	Amenable to quarantine; types of public health interventions needed to prevent spread

PHEIC, Public Health Emergency of International Concern; *PPE*, personal protective equipment; R_0, Basic Reproduction Number: a mathematical prediction of disease contagiousness.

features. Nevertheless, an appreciation of the key concepts that drive evidence-based management is beneficial (Table 1). Management guidance will likely change over time.

With the initial discovery of a new potential public health threat, it will likely be unclear how patients become sick. For example, rather than a contagion, there could be a contaminant or a toxin responsible for signs and symptoms. In this case, the possibility of an environmental toxin in the Wuhan Market was a consideration early on when limited to no human-to-human transmission was reported. The mode of transmission has implications for the types of personal protective equipment (PPE) needed to protect healthcare providers in the prehospital, clinic, and hospital settings.[25] In addition, patients may need decontamination after exposure to certain toxins.[26]

Another important consideration for application of the 3I Tool is whether the disease is contagious prior to symptom onset (like measles) or only after symptoms develop (like Ebola). A January 30, 2020 letter to the *New England Journal of Medicine* describes a purported confirmed instance of transmission from an asymptomatic individual. Researchers state that, before symptom onset, the primary case infected two individuals, one of which infected two additional colleagues.[27] Subsequent investigation suggested that the source patient did have mild symptoms and had taken an antipyretic, calling this reported asymptomatic transmission into question.

While quarantine may not be feasible and can have unintended consequences,[28,29,30] it is a public health tool that can be considered in cases when disease is transmissible before symptom onset.[30] Conversely, if a disease is known not to be transmissible prior to symptom onset, asymptomatic exposed patients must be monitored, but do not require quarantine or isolation unless they develop symptoms.

Initially, it may be unclear whether an infectious agent occurred naturally or was deliberately or accidentally released. In this case, a BSL-4 laboratory studying coronaviruses was located approximately 32 kilometers away from the market where initial exposures were felt to occur.[31] Recall that in 2001, the anthrax letter attacks were initially thought to be naturally occurring. Once determined to be bioterrorism, management of the event was similar to that for a chemical exposure with a sudden impact, defined scene, and need for a rapid response and decontamination on site. This differed from the WHO's modeling predicting an aerosolized release that would result in an incubation period with 100,000 or more persons exposed rather than the 22 people who contracted anthrax in 2001.[32] By understanding the key features of a novel disease, healthcare workers can take evidence-based measures to protect themselves, optimize individual patient management, and prevent further disease spread.

Transmission

It is currently unclear how 2019-nCoV is spread, but it is suspected to be transmitted through contact with infected respiratory secretions, like other known coronaviruses. There are instances of sustained human-to-human transmission across generations of cases, especially near the epicenter in Wuhan City.[21] Current evidence suggests that close contact with an infected person is a major factor in disease transmission. CDC defines "close contact"[33] as being in or within two meters of an area with a confirmed patient or being directly exposed to infectious secretions without appropriate PPE. Healthcare facilities in China have reported spread from person to person. In addition, some mildly ill or potentially even asymptomatic patients may have a higher chance of spreading the disease to others as they may be less likely to seek medical care.[34] The possibility that patients may be infectious prior to symptom onset further compounds the difficulty of containing the virus and effectively preventing transmission.

The current majority of 2019-nCoV cases have been within China and its bordering countries.[2] Persons with recent travel (within 14 days) to Wuhan City or another region with widespread disease, or exposure to a patient under investigation, are considered to have an epidemiologic risk factor and should be assessed for signs and symptoms of a viral illness such as fever and respiratory symptoms. Coronavirus is a zoonotic virus

that is transmitted to humans via contact with infected animals. Preliminary reports suggest the disease may have originated in a seafood and live animal market in Wuhan City, but it is still unknown how or whether such transmission occurred.

Work-Up

Clinicians working with local public health departments must arrange to have specimens from patients under investigation (PUIs) sent to the CDC laboratory. At this time, the CDC has the only laboratory that can definitively test for 2019-nCoV, though laboratory testing capacity is being rapidly expanded. Polymerase chain reaction (PCR) assays conducted on samples from a patient's upper and lower respiratory tracts will be used to confirm potential cases. In addition, serum antibody titers can be analyzed for confirmation of infection or evidence of immunity. Up-to-date information about the needed specimens and handling requirements to test for 2019-nCoV are available on the CDC website.[35]

Differential Diagnosis

Like other related coronaviruses, patients with 2019-nCoV frequently present with non-specific symptoms resembling that of influenza. Physicians may consider differential diagnoses related to a wide variety of respiratory infections. In order to relate these symptoms to 2019-nCoV, it is imperative that the identification of a potential exposure event (epidemiologic risk factor) within 14 days of symptom onset is made so that a more focused work-up for 2019-nCoV can be completed. Although the likelihood of co-infection of 2019-nCoV and another respiratory virus is thought to be low, a positive finding of another respiratory pathogen does not exclude the diagnosis of 2019-nCoV. Many commercially available respiratory panels include "coronavirus" in the results, but neither a positive nor a negative finding on these panels should be used to include or exclude a diagnosis of 2019-nCoV.

Treatment

Supportive care with appropriate infection control is the mainstay of current CDC treatment guidelines for 2019-nCoV. There are not yet any approved antiviral treatments for 2019-nCoV. Emergency Use Authorizations (EUA) for compassionate use cases may be forthcoming from the US federal government for normally unapproved treatments. Supportive treatment predominantly includes respiratory support, hydration, and antipyretics. General treatment for severe cases should focus on the preservation of vital organ function. In the future, antiviral medications may be available. If a secondary bacterial infection such as pneumonia develops, targeted antibiotics are indicated.

Prevention

Prevention of 2019-nCoV transmission, like any other infectious agent, involves minimizing risk of exposure. Vaccines are under accelerated development and may be useful in the future for post-exposure prophylaxis. Healthcare personnel are at increased risk and should practice standard, droplet, and airborne precautions when encountering an infected person, a PUI, or any symptomatic close contacts. Healthcare workers handling specimens should also adhere to CDC guidelines and should not attempt to perform any virus isolation or characterization.

Fever screening has been implemented at numerous airports, including major international hubs within Asia and the US. The efficacy of this intervention is not well documented, however, as some infected persons may be afebrile and disease transmission might occur prior to symptom onset.[27] In addition, people can artificially lower their temperature readings, e.g., by applying ice to their foreheads.

Patient Disposition

As outlined above, admission criteria for 2019-nCoV are similar to that of other patients. If patients do not meet medical criteria for hospitalization, they may be discharged home with isolation precautions and continued observation. EPs must notify local public health authorities so appropriate monitoring and community protective measures can be instituted.

Identify-Isolate-Inform

The Identify-Isolate-Inform (3I) Tool was initially developed for Ebola virus disease [10,11] and later adapted for measles,[12] MERS,[13] mumps,[14] Zika virus disease,[15] hepatitis A,[16] pertussis,[17] and scabies.[18] This novel tool for suspected 2019-nCoV patients (Figure 1) provides frontline clinicians with a simple algorithm to manage an emerging disease. Identification of exposed patients with an epidemiologic risk factor within 14 days of symptom onset is a crucial first step. An automatic prompt in the electronic health record can be useful in assisting clinicians with early identification of patients at risk. Case definitions promulgated by the WHO[24] and CDC[33] provide useful comprehensive definitions that have been incorporated into the 3I Tool. The 2019-nCoV Tool provides an accurate, summarized algorithm to immediately, and effectively manage suspected patients until additional resources can be consulted.

Patients who do not have an exposure risk or any symptoms may be triaged normally. However, before making patient contact, providers must first apply the Vital Sign Zero concept.[36] Vital Sign Zero is a preliminary, non-contact assessment (i.e., performed prior to touching a patient to take traditional vital signs) to first determine whether specific PPE is indicated before the examination commences. By taking the additional time to complete this assessment, risk of exposure and further transmission can be minimized.

Following identification of patients with clinical features and an established epidemiologic risk, isolation should occur immediately. Patients should don a surgical mask before being placed in an airborne infection room, if available. Any healthcare staff entering the room should don a NIOSH-certified N95 respirator (or equivalent), eye protection, gloves, and a gown, as per CDC recommendations. Further patient contact and sample collection may then proceed. A list of all individuals (staff or other patients) who were in close contact with the individual

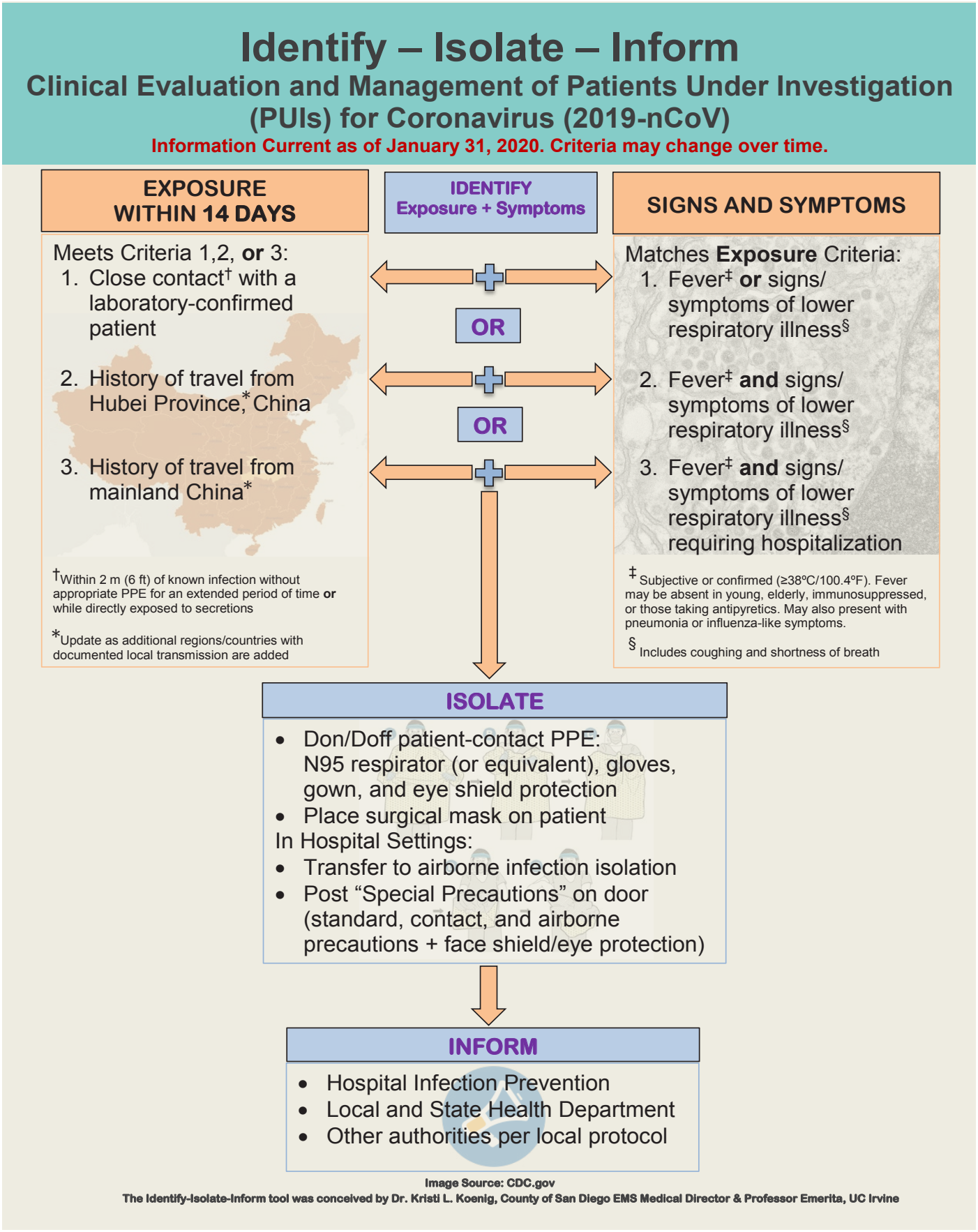

Figure 1. Koenig's Identify-Isolate-Inform Tool adapted for 2019-nCoV.

while in the treatment facility should be started and maintained to assist with the possibility of contact tracing.

Following isolation, physicians should immediately inform the appropriate authorities. Patients who do not meet medical criteria for admission can be isolated at home during the evaluation phase.[37] Health department officials can help prevent transmission in isolated patients by providing in-home monitoring and implementing appropriate exposure-control measures.

Prehospital EMS Management

Providers in the prehospital setting who have a high likelihood of encountering 2019-nCoV patients, such as those near international ports of entry, should adhere to established exposure control guidelines.[38] Along with appropriate PPE, providers should also carry thermometers to quantify any fever. In the US, providers should contact the appropriate CDC quarantine station upon isolation of infected or suspected patients, especially those from Wuhan, China or other regions with widespread disease, who report symptoms in the last 14 days. As for other infectious diseases, assessing travel history is essential. Dispatch protocols have been instituted to facilitate identification of callers to 911 or the country-equivalent emergency number prior to prehospital personnel arrival.[39] In addition, CDC has promulgated EMS guidelines for prehospital PPE, transportation of PUIs, vehicle decontamination, and 911 Public Safety Answering Points (PSAPs) for 2019-nCoV.[40]

CONCLUSION

2019-nCoV is an emerging infectious disease with rapidly evolving features, the full scope of which will be defined over time. Prior outbreaks of coronaviruses can help inform needed actions in the short term to assist with both treatment of individual patients and prevention of global disease spread. This adaptation of the Identify-Isolate-Inform Tool serves as a resource for healthcare workers who need to make clear, rapid assessments when confronted with potential patients. The concise nature of the 2019-nCoV 3I Tool allows for the rapid and effective management of a novel disease by healthcare providers.

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Scabies: Application of the Novel Identify-Isolate-Inform Tool for Detection and Management

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Scabies is a highly contagious, globally prevalent, parasitic skin infestation caused by *Sarcoptes scabiei* var. *hominis*, also known as the itch mite. There have been outbreaks not only in the developing world, but also in the developed world among refugees and asylum seekers. Once infested with scabies mites, symptomatic patients, as well as asymptomatic carriers, quickly spread the disease through direct skin-to-skin contact. Typically, symptoms of scabies are characterized by an erythematous, papular, pruritic rash associated with burrows. Treatment of scabies involves using topical or systemic scabicides and treating secondary bacterial infections, if present. Given the prevalence and contagiousness of scabies, measures to prevent its spread are essential. Through application of the novel Identify-Isolate-Inform (3I) Tool, emergency medical providers can readily identify risk factors for exposure and important symptoms of the disease, thus limiting its spread through prompt scabicide therapy; isolate the patient until after treatment; and inform local public health authorities and hospital infection prevention, when appropriate. Ultimately, these three actions can aid public health in controlling the transmission of scabies cases, thus ensuring the protection of the general public from this highly contagious skin infestation. [West J Emerg Med. 2020;21(2)191–198.]

INTRODUCTION

Human scabies is a highly contagious, globally prevalent, parasitic skin infestation caused by *Sarcoptes scabiei* var. *hominis*, also known as the itch mite. This parasite was identified in the 1687 by Bonomo and Cestoni using a light microscope; however, there is evidence of scabies as far back as 1200 BCE.[1] The most common symptoms of scabies, itching and a skin rash, are caused by a hypersensitivity reaction to the proteins and feces of the parasite about four to six weeks after infestation. Severe pruritus, especially at night, is the earliest and most common symptom of scabies. An erythematous, papular, pruritic rash with burrows on the hands, wrists, torso, and feet is also common.[1]

Scabies continues to be a common dermatological disease internationally. A systematic review estimated the prevalence of scabies in various countries to be 0.2% to 71%.[2] In the United Kingdom, a general practice database review for scabies estimated prevalence to be 2.2 and 2.8 per 1000 in men and women, respectively.[3] Studies from Greece and Spain conducted in dermatology clinics concluded that scabies is encountered in approximately 4% of visits, particularly among immigrants and patients with low socioeconomic status.[4,5] In developing countries the prevalence can be much higher,[6-9] ranging as high as 87% in one study in Thai orphanages.[10] Although prevalence of scabies is low in developed countries, public health authorities are challenged to identify and treat individuals with scabies promptly to avoid transmission amongst close-quartered populations, such as within the growing population of asylum seekers and refugees.[11,12]

Scabies remains a risk to public health, and it is essential

that frontline healthcare providers identify potential cases. Both under- and over-diagnosis are possible, and each is problematic. While missing the diagnosis can lead to both ongoing individual patient discomfort as well as rapid population spread, over-diagnosis can lead to inappropriate individual patient treatment and can create stress on healthcare systems with finite resources.

Emergency Department (ED) providers may encounter and treat these patients as the first point of contact. After an overview of the disease and critical information pertaining to transmission and treatment, this article adapts the 3I (Identify-Isolate-Inform) Tool to assist frontline providers in the identification and management of potential cases of scabies presenting to the ED (Figure 1). The 3I Tool was originally developed for Ebola virus disease and subsequently modified for use in measles, Middle East Respiratory Syndrome (MERS), mumps, Zika, hepatitis A, pertussis, and 2019 nCoV (COVID-19).[13-20]

Population Health Research Capsule

What do we already know about this issue?
Scabies is a highly contagious parasitic skin infestation with outbreaks in the developed world, as well as among at-risk populations in the developing world.

What was the research question?
Investigators modified the "Identify, Isolate, Inform" (3I) Tool for use in identifying and managing scabies.

What was the major finding of the study?
A novel Scabies 3I Tool is created for real-time application in emergency department (ED) patients.

How does this improve population health?
The Scabies 3I Tool aids ED providers who play an essential role in identifying and treating scabies effectively to avoid spread of the infestation.

CLINICAL PRESENTATION

Signs and symptoms of scabies differ depending on the time since exposure, degree of infestation, host immunocompetency, and coexistence of other skin pathologies. When people are first infested with scabies, they usually have no symptoms for 4-6 weeks. Classically, an intense nocturnal pruritic rash is the first symptom. The rash is typically characterized as erythematous with papules and associated burrows. Burrows are described as thin grey or brown lines that are approximately 5 mm long. Presence of burrows is a classic finding of scabies but uncommonly visualized due to skin excoriation or the presence of secondary infections. In adults and older children, the rash is most commonly found in the volar aspect of the wrists, interdigital web spaces, periumbilical area, anterior axillary folds, buttocks, and genitalia.[21] In infants and those who live in tropical areas, the rash can be generalized and may also involve the scalp, neck, face, palms, and soles.[22]

RISK FACTORS

Populations at highest risk for scabies include children, the elderly, the immunocompromised, and people in congregate living conditions, including refugee camps. Scabies is found worldwide and the risk of contracting infection is present regardless of gender, race, or socioeconomic status; however, higher prevalence of scabies has been correlated to tropical and subtropical climates, resource-poor countries, and areas with armed conflicts, homelessness, crowding, and shared use of clothes, beds, and blankets or pillows.[2,23-25]

DIAGNOSIS

A presumptive diagnosis of scabies can be made based on suggestive clinical features such as nocturnal pruritus, history of contact with scabies, and/or typical appearance and distribution of skin lesions with the presence of burrows. However, achieving a definitive diagnosis depends on identification of mites, eggs, or fecal material using light microscopy. Lesions should be scraped off using a scalpel. With the scalpel, the papule should be scraped multiple times to remove the top (Video Example: Scabies skin scraping technique). Adding a few drops of mineral oil to the skin prior to scraping may help the scraped material to adhere to the blade. Most hospital pathology laboratories will accept scrapings for microscopic evaluations. The pathology protocols for scabies skin scraping methods at two university hospitals are provided here for reference: University of Iowa and University of Michigan. The characteristic microscopic appearance is shown here. Even with ideal technique, however, failure to find mites, eggs, or fecal material is common and does not rule out the disease.[26,27] The sensitivity of this approach ranges from 40% to 90% and the specificity reaches 100%.[26]

Alternatively, the burrow ink test may be used. In this method, ink is absorbed by the burrows and will be visible as wavy lines (Figure 2).[24,25] This method requires a dark felt tip washable marker or a fountain pen over the affected area and an alcohol swab to clean the surface ink. Any remaining dark ink under the skin signifies presence of scabies burrows (Figure 2). The sensitivity and specificity for the burrow ink test is unable to be calculated based on a French dermatology study.[26] Nevertheless, for any case with concern for scabies in

Identify – Isolate – Inform

Guide to the Emergency Department Evaluation and Management of Patients Under Investigation (PUIs) for Scabies

Information Current as of September 22, 2019

EXPOSURE WITHIN 4–6 Weeks

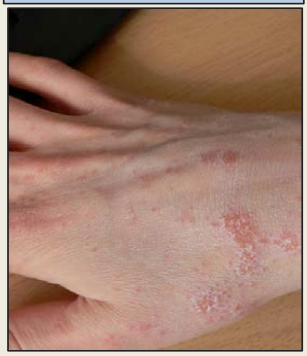
Direct skin contact
- Person-to-person contact
- Sexual contact

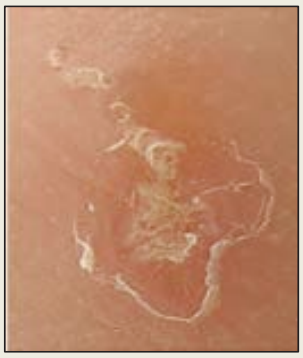
Contact with infested objects
- Furniture/Clothing
- Mites can only survive 3 days at room temperature

High-risk populations
- Children
- Elderly
- Immunocompromised

Transmission can occur prior to any symptoms

IDENTIFY Exposure OR Symptoms





SYMPTOMS

Rash characteristics
- Generalized
- Erythematous
- Papules
- Associated with burrows
- Predilection for
  - Volar aspect of wrists
  - Interdigital web spaces
  - Periumbilical areas
- Intense nocturnal pruritus

ISOLATE

- Implement contact precautions
- Avoid direct skin-to-skin contact until 8 hours after scabicide administration
- Wash clothing and items used in hot water
- Treat close contacts within the preceding month

INFORM

- Notify household and/or close contacts
- Encourage post-exposure prophylaxis
- For an outbreak,* report to local health department, if required
- Report Norwegian scabies (given high transmissibility) to hospital infection prevention

* Two or more consecutive cases among residents/staff within 4–6 weeks

The Identify-Isolate-Inform Tool was conceived by Dr. Kristi L. Koenig, County of San Diego EMS Medical Director & Professor Emerita, UC

Figure 1. The Identify, Isolate, Inform (3I) Tool for Scabies.

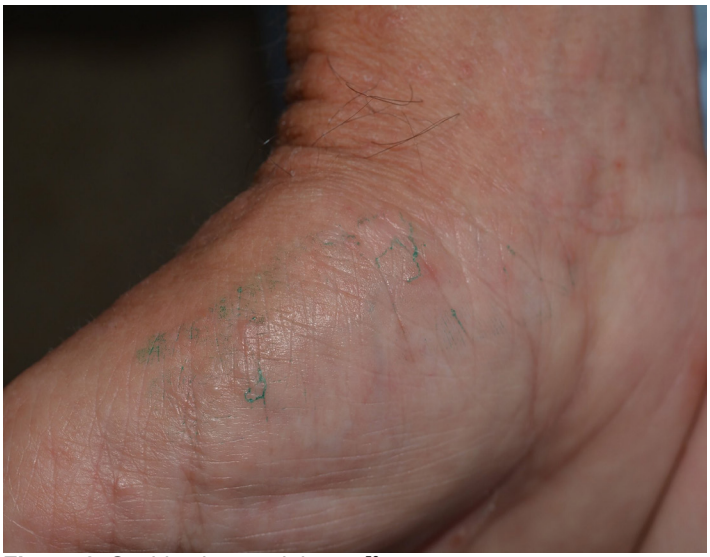


Figure 2. Scabies burrow ink test.[50]

the emergency department, this is a simple test that may help diagnose scabies.

A substitute for the burrow ink test is the tetracycline fluorescence test, where tetracycline is used instead of ink.[28,29] This method allows for colorless identification of the burrows. Similar to the ink, the topical tetracycline solution is applied over an affected area, and is wiped with alcohol to remove any excess solution on the surface. Then a Wood's lamp is used to visualize the tetracycline that tracked into the burrows.[28]

Other scabies diagnostic techniques unlikely to be used in the emergency department include video dermatoscopy, polymerase chain reaction (PCR) and enzyme-linked immunosorbent assays (ELISA), and IgE antibody testing. Video dermatoscopy is especially useful in cases with atypical distribution or appearance of the lesions.[30] Serological tests are emerging for both diagnosis and monitoring of treatment efficacy. One study showed that real-time PCR and ELISA tests are useful for monitoring treatment efficacy.[31] Another study reported a 100% sensitivity and a specificity of 93% using IgE antibody against *Sarcoptes scabiei*.[32]

COMPLICATIONS AND SPECIAL POPULATIONS

Secondary bacterial infections can develop in persons infested with scabies, particularly since the rash is typically intensely pruritic and scratching compromises the skin barrier and may introduce bacteria, particularly in patients with poor fingernail hygiene. Streptococcus or staphylococcus infections can cause impetigo, paronychia, cellulitis, or abscesses.[33] Sequelae of these bacterial infections include bacteremia leading to sepsis, acute post-streptococcal glomerulonephritis, and rheumatic heart disease.[22,33]

The most vulnerable populations to scabies infestations are young children, the elderly, and the immunocompromised. These populations are especially susceptible to secondary complications of infestation. Given transmission is favored in conditions of crowding and poor sanitation, outbreaks have been seen in refugee camps and asylum seeker shelters.[12]

Crusted scabies, also known as Norwegian scabies, is particularly serious with a high mortality rate from bacterial sepsis.[34] Caused by a hyperinfestation of the scabies mites, crusted scabies is characterized by development of a severe inflammatory response and hyperkeratosis (thickened skin crusts).[35] Any skin area might be affected, but commonly affected regions include the scalp, hands, and feet. Crusts are malodorous and nails are thickened and discolored. Most cases of the crusted variant are linked to immunocompromised hosts; however, cases of crusted scabies have occurred without identifiable risk factors.[35] From a public health perspective, patients with crusted scabies are highly infectious and, given they carry a significant number of mites, they can be the primary source of a community scabies outbreak. Furthermore, crusted scabies is difficult to manage, often requiring multiple treatments.[35]

TRANSMISSION AND PERSONAL PROTECTIVE EQUIPMENT

Human scabies is a parasitic skin infection caused by penetration of the ectoparasitic mite *Sarcoptes scabiei* var. *hominis* into the epidermis. The lifecycle begins with a female mite laying eggs in the skin burrows. These larvae hatch, create new burrows, and then mature, mate and repeat this cycle.[1] Once infested with scabies mites, symptomatic patients as well as asymptomatic carriers can easily spread the disease.[1,36]

Commonly, transmission occurs from person to person via direct skin contact, including by sexual contact. Because of the asymptomatic period following infestation, transmission can occur prior to symptom onset.[1] In addition, fomite transmission through infested objects such as furniture and clothing is possible, especially with the crusted variant of scabies.[1,36] Outside the human body and at room temperature with normal humidity, mites can only survive up to 3 days, whereas they are able to live up to 60 days inside human skin.[1,36] Lower temperatures and higher humidity prolong survival of the mite off the host.[23]

To prevent transmission within healthcare facilities, patients should be in contact isolation until 8 hours after treatment.[36] Personal protective equipment for healthcare workers treating patients with scabies includes the following: gowns, gloves, and shoe covers.[36] Proper use of infection control measures including handwashing and avoiding skin-to-skin contact should also be used when handling patients with potential scabies infestations.

DIFFERENTIAL DIAGNOSIS

The common manifestations of scaling and excoriation can impair skin visualization, making the differential diagnosis very broad. Clinicians should consider papular urticaria, secondary syphilis, folliculitis, contact dermatitis,

Table. Medication dosing and timing regimens for scabies with variation for Norwegian (crusted) scabies.

Medication	Dosing	Timing	Variation for Norwegian scabies
Permethrin cream 5%	Apply topically entire body	Wash off after 8-14 hours	Repeated daily for 7 days then twice weekly until discharge or cure* **Recommended combination therapy with ivermectin*
Ivermectin	200 mcg/kg/dose orally	2 doses 1 week apart	3, 5 or 7 doses depending on severity 3 dose regimen: days 1, 2, 8 5 dose regimen: days 1, 2, 8, 9, 15# 7 dose regimen: days 1, 2, 8, 9, 15, 22, 29 *#Recommended combination therapy with permethrin*
Sulfur ointment (5%-10%)	Apply topically entire body	Wash off after 24 hours Repeat for 3 doses	Not recommended

Mcg/kg/dose, micrograms per kilogram per dose.

atopic dermatitis, psoriasis, seborrhea, pityriasis rosea, lichen planus, and dermatitis herpetiformis as possible diagnoses.

TREATMENT

Treatment options depend on whether scabies lesions are classic or crusted on clinical presentation (Table). In general, medications consist of a scabicide that can be applied topically or taken orally. For classic scabies, topical permethrin or oral ivermectin are considered first-line treatments.[23] Dosing regimens are included in the table. Although high-quality trials comparing medications for the treatment of scabies are lacking, a Cochrane systematic review concluded that permethrin is more effective than ivermectin.[37] A more recent 2018 systematic review, however, concluded that both ivermectin and permethrin have similar efficacy.[38]

When used as directed, topical permethrin 5% has high cure rates, approaching 90% in randomized trials.[39] Permethrin is applied topically in patients older than 2 months of age from the neck to the soles of the feet and washed off after 8 to 14 hours. Considering that scabies can also affect the face, scalp and neck in infants and young children, topical application should be extended to these areas.[36,40] Repeating the topical permethrin treatment one or two weeks after the first treatment is necessary in severe cases.[36] Oral ivermectin is an alternate therapy that may be used if topical treatment fails; however, its safety in pregnant women and children weighing less than 15 kg has not been established.[34,46,37,41-43]

For crusted scabies, both an oral and a topical scabicide should be administered concurrently (Table).[15,19,37] Ivermectin use has also been described for scabies control in endemic areas or outbreaks where topical scabicide use may be difficult.[12] A randomized controlled trial examining mass administration of ivermectin for management of scabies concluded a reduction in prevalence from 32.1% to 1.9% in the ivermectin group compared to a reduction from 41.7% to 15.8% in permethrin-treated controls.[44]

Other topical agents such as sulfur, benzyl benzoate, crotamiton, and lindane are also options if first-line treatments fail. Topical sulfur is considered safe when used to treat infants younger than 2 months of age and pregnant women.[36,40,41] In addition to scabicides, treatment of secondary bacterial infections such as pyoderma or impetigo, if present, is indicated via administration of appropriate systemic antibiotics.[36] Advising patients and parents of young patients to keep fingernails short and clean can assist with preventing secondary infections.

Patients treated for scabies may have persistent pruritus for up to 4 weeks. Many patients return to the ED with concerns of treatment failure or reinfestation. These persistent symptoms do not necessarily indicate treatment failure. Symptomatic treatment and reassurance are often the only necessary management. Symptoms that persist or worsen beyond 2 to 4 weeks, especially if the rash worsens or new burrows appear, should trigger the physician to consider other causes such as incorrect diagnosis, treatment failure due to resistance or incorrect application, secondary infections, and/or reinfestation.[45]

PREVENTION

To eradicate and prevent reinfestation of the scabies mites, close contacts (within the previous 30 days) should be treated simultaneously. Additionally, items used by patients and close contacts in the preceding several days such as clothing and linens should be washed and dried at high temperatures (≥60°C), dry-cleaned, or placed in a plastic bag for at least 72 hours if unable to launder.[36,46] Another aspect of controlling this disease is avoidance of direct skin-to-skin contact with suspected or confirmed cases of scabies until 8 hours after treatment.[36] Treatment failures occur in some instances due to improper or inadequate application of the medications, reinfestation secondary to mishandling of clothes and bed linens, undertreatment of close contacts, and resistance to some medications, such as lindane.[34,35,37,41-43,47] Prevention and control of crusted (Norwegian) scabies is more complicated given that brief skin-to-skin contact can spread the infection. In these cases, numerous contacts may need treatment to prevent a large-scale outbreak.[35,41] In communities with a high prevalence of scabies, mass drug administration of scabicides

has been used for effective control. This may be a strategy for large outbreaks; however, local health authorities should be consulted prior to instituting this approach.[48]

DISPOSITION

Hospitalization is not recommended in patients with scabies unless they have other indications, such as crusted (Norwegian) scabies or severe secondary infections. Follow-up care 2-4 weeks after treatment should be arranged to assess for medication failure as well as reinfestation.[38] Based on suggested general guidelines by the Centers for Disease Control and Prevention, patients with scabies may return to work or school 1 day after starting treatment and prior to follow-up.[36] Healthcare providers with scabies who deliver direct hands-on care to patients and remain symptomatic after beginning treatment may return to work if they observe standard precautions, including the use of disposable gloves, until they are sure they are no longer infested.[36]

IDENTIFY-ISOLATE-INFORM (3I)

The Identify-Isolate-Inform (3I) Tool was conceived during the 2014 Ebola virus disease outbreak and later modified for application to the ED evaluation and management of patients with other communicable diseases.[14-20] The novel modification of this tool presented here can be applied for ED evaluation and management of a patient under investigation for scabies. The Scabies 3I Tool is an algorithm that begins with *identifying* suspected cases based on symptoms, exposure history, and testing as needed. History of exposure is important as patients can transmit scabies prior to symptom onset. Identification of close contacts is also an important step in controlling the spread of the infestation.

To prevent transmission within healthcare facilities, patients should be *isolated* in contact isolation until 8 hours after treatment.[36] Personal protective equipment for healthcare workers treating patients with scabies includes the following protective garments: gowns, gloves, and shoe covers.[36] Proper use of infection control measures including avoiding skin-to-skin contact and handwashing should be observed when handling patients with potential scabies infestations.[36]

Given the transmissibility of this disease and potential outbreaks that may threaten public health, ED staff should immediately *inform* the local health authority in cases of outbreak, defined as two or more consecutive cases of scabies among residents/staff within 4-6 weeks.[49] Timely notification of an outbreak is especially important in cases of scabies identified from healthcare facilities, shelters, or other communities where the disease could rapidly spread, including refugee and migrant shelters. In an online review of 20 hospital policies across the United States, no hospital required informing hospital infection control of scabies cases; however, individual hospital policies may vary both within the U.S. and internationally. Therefore, it is important to know and follow local hospital policies on scabies reporting. Additionally, cases of crusted (Norwegian) scabies should be isolated promptly and all close contacts should be informed and treated, given its high transmission rate.[35,41] Using this 3I Identify-Isolate-Inform Tool, healthcare providers can be more prepared to detect and manage potential scabies cases.

CONCLUSION

Prompt recognition of transmittable diseases, like scabies, by emergency healthcare workers is needed to mitigate spread. Scabies can be challenging to diagnose, and both under- and over-diagnosis of scabies have negative health and resource consequences. The novel Scabies Identify-Isolate-Inform (3I) Tool can aid ED staff in readily recognizing key risk factors for exposure and characteristic symptoms of the disease, thereby triggering implementation of appropriate isolation protocols, and notification of hospital and public health agencies, as appropriate.

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Using Tenecteplase for Acute Ischemic Stroke: What Is the Hold Up?

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Alteplase is the only Food and Drug Administration-approved intravenous (IV) thrombolytic medication for acute ischemic stroke. However, multiple recent studies comparing tenecteplase and alteplase suggest that tenecteplase is at least as efficacious as alteplase with regards to neurologic improvement. When given at 0.25 milligrams per kilogram (mg/kg), tenecteplase may have less bleeding complications than alteplase as well. This narrative review evaluates the literature and addresses the practical issues with regards to the use of tenecteplase versus alteplase for acute ischemic stroke, and it recommends that physicians consider tenecteplase rather than alteplase for thrombolysis of acute ischemic stroke. [West J Emerg Med. 2020;21(2)199-202.]

INTRODUCTION

Alteplase is currently the only FDA-approved medication for acute stroke. While alteplase has been shown to provide benefit to some patients who present with symptoms of acute stroke within 4.5 hours,[1] its administration increases the patient's risk of intracranial hemorrhage.[2] Moreover, the results of some recent studies have brought up some other concerns about alteplase. One such example was the PRISMS trial.[3] This study was terminated before reaching its enrollment goal, and was thus not definitive. However, it found that treatment with alteplase did not result in improved neurologic outcomes at 90 days as compared to aspirin for minor strokes.[3] Additionally, a small study by Wee et al found no benefit to administering alteplase to patients undergoing endovascular thrombectomy for acute stroke due to large vessel occlusion as compared to thrombectomy alone.[4]

While not FDA-approved for acute stroke, tenecteplase has theoretical advantages over alteplase as it has greater fibrin specificity and has a longer half-life than alteplase.[5] It is the preferred thrombolytic agent for ST-elevation myocardial infarction in the United States.[6]

Several recent studies have compared tenecteplase and alteplase with regards to their efficacy for the treatment of acute ischemic stroke. The purpose of this article is to review those studies as well as other practical matters with regards to the use of tenecteplase and alteplase. Based on these data, we make recommendations about the use of intravenous (IV) thrombolytic agents in acute ischemic stroke.

DISCUSSION

In comparing tenecteplase and alteplase for acute ischemic stroke, there are several issues to consider: Which medication is more effective with regards to neurologic improvement after an acute ischemic stroke? Which medication has less adverse effects? Which medication is easier to administer? Which medication costs less? Each of these issues will be addressed below.

Neurologic improvement after stroke

The results of five randomized controlled trials have been published that compare alteplase and tenecteplase for acute ischemic stroke.[7-11] The first was by Haley et al, published in 2010,[7] and it randomized patients with suspected acute ischemic stroke within 3 hours to tenecteplase 0.1 milligrams per kilogram (mg/kg), tenecteplase 0.25 mg/kg, tenecteplase 0.4 mg/kg, or standard dose alteplase (0.9 mg/kg). Patients in the tenecteplase 0.4 mg/kg group had the lowest rate of good neurologic outcomes at three months (defined as modified Rankin scale score of 0 or 1). There were no statistically significant differences among the other groups, but there was a trend towards higher percentages of patients having good neurologic outcomes in the tenecteplase 0.1 mg/kg and 0.25

mg/kg groups as compared to the alteplase group: tenecteplase 0.1 mg/kg 45.2%, tenecteplase 0.25 mg/kg 48.4%, and alteplase 41.9%

In 2012, Parsons et al published a study that randomized patients with suspected acute ischemic stroke with symptoms for 6 hours or less to tenecteplase 0.1 mg/kg, tenecteplase 0.25 mg/kg, or standard dose alteplase. A total of 25 patients were enrolled in each group. Those receiving tenecteplase had greater reperfusion on imaging studies and superior clinical neurologic outcomes at 24 hours. Those receiving tenecteplase 0.25 mg/kg had superior outcomes compared to those receiving alteplase for all efficacy outcomes, including serious disability at 90 days.[8]

Subsequently, in 2015, Huang et al published the results from a randomized trial that compared tenecteplase 0.25 mg/kg to alteplase for patients with suspected acute ischemic stroke within 4.5 hours of symptom onset. A total of 104 patients were enrolled, with 52 assigned to each group. There was no difference between groups with regards to the primary outcome of "percentage penumbra salvaged", 68% in each group. There were also no statistically significant differences in secondary outcomes between groups, but for the tenecteplase group, there were trends towards more early neurologic improvement at 24 hours (40% vs 24%) and a higher percentage of good neurologic outcome at 90 days (28% vs 20%).[9]

In 2017, Logallo et al published the results from a block-randomized study comparing tenecteplase 0.4 mg/kg and standard dose alteplase for patients with suspected acute ischemic stroke with 4.5 hours or less of symptoms or within 4.5 hours of awakening with symptoms. A total of 549 patients were randomized to the tenecteplase group and 551 were randomized to the alteplase group. There was no difference between groups in the primary outcome of good neurologic outcome at 90 days (64% tenecteplase vs 63% alteplase).[10]

Lastly, and perhaps of most interest, in 2018, Campbell et al published the results of a study comparing tenecteplase 0.25 mg/kg to standard dose alteplase for patients with symptoms of acute ischemic stroke for less than 4.5 hours prior to thrombectomy. There were 101 patients in each group. There was a statistically significant difference between groups with regards to the primary outcome of reperfusion of greater than 50% of the involved ischemic territory or an absence of retrievable thrombus at the time of the initial angiographic assessment. This primary outcome was found in 22% of patients in the tenecteplase group as compared to 10% of those with alteplase. Patients in the tenecteplase also had superior functional neurologic outcomes at 90 days as compared to the alteplase group.[11]

Four meta-analyses have been done using the clinical trials described above.[12-15] All of these meta-analyses reported no statistically significant differences with regards to neurologic recovery, and none of the meta-analyses found a difference between tenecteplase and alteplase with regards to mortality. However, the meta-analyses by Thelengana and Kheiri reported significantly improved early neurologic improvement with tenecteplase (relative risk 1.56 confidence interval [CI], 1.00-2.43; p=0.05),[13-14] and the meta-analysis by Kheiri reported significantly greater complete recanalization (odds ratio [OR] 2.01; 95% CI, 1.04-3.87; p=0.04).[14]

In summary, five randomized controlled trials have found tenecteplase to be at least as effective or more effective than alteplase for neurologic improvement after acute ischemic stroke. Using the results of those five randomized controlled trials, four separate meta-analyses have been performed, and none of those concluded that alteplase is superior to tenecteplase.

Adverse effects

All of the above clinical trials and meta-analyses measured the rates of symptomatic and total intracerebral hemorrhage.[7-15] Neither of the most recent meta-analyses found a statistically significant difference in the rates of intracerebral hemorrhage between tenecteplase and alteplase,[14-15] but there were trends toward less intracerebral hemorrhage with tenecteplase (OR; 0.81 95% CI, 0.56-1.17; p=0.26).[14] Notably, this value was calculated using all doses of tenecteplase grouped together while there is evidence that the 0.4 mg/kg dose of tenecteplase might lead to higher rates of intracerebral hemorrhage compared to the preferred 0.25 mg/kg dose.[7,14] Therefore, the trend towards less intracerebral hemorrhage would be more pronounced if patients who received tenecteplase at 0.4 mg/kg were excluded.

While stroke trials generally focus on intracerebral bleeding, it is worth considering the rates of other adverse bleeding events associated with the administration of alteplase and tenecteplase. There is an abundance of data from the cardiology literature comparing tenecteplase and alteplase with regards to adverse effects in patients with acute coronary syndrome. It is likely that the rates of adverse events other than intracerebral hemorrhage for tenecteplase and alteplase would be the same for patients with acute ischemic stroke as they would be for acute coronary syndrome. Thus, the relevant literature will be summarized below.

There are three randomized controlled trials that compared tenecteplase to alteplase for patients with acute coronary syndrome and reported the adverse effect of major bleeding (not just intracerebral hemorrhage).[16-18] The largest of those trials was ASSENT-2, which randomly assigned patients with acute myocardial infarction to alteplase or tenecteplase. It found that patients who received tenecteplase had reduced rates of non-cerebral bleeding complications (26.43 vs 28.95%, p=0.0003) and less need for blood transfusion (4.25 vs 5.49%, p=0.0002). A meta-analysis that included that trial and the two other studies referenced above[17-18] was completed, and included a total of 17,325 patients.[19] It found a statistically significant reduction in major bleeding with tenecteplase as compared with alteplase (RR 0.79; 95% CI, 0.69-0.90; p=

0.0002). Another 2017 meta-analysis compared tenecteplase and alteplase along with streptokinase and reteplase for ST-elevation myocardial infarction.[20] It similarly found that tenecteplase use was associated with a lower risk of bleeding than other thrombolytic regimens.

In summary, no statistically significant difference has been reported in the available literature in the rates of intracerebral hemorrhage for tenecteplase versus alteplase in acute ischemic stroke patients. Moreover, the use of tenecteplase is associated with lower rates of non-cerebral bleeding than alteplase.

Administration

As mentioned above, tenecteplase has greater fibrin specificity and a longer half-life than alteplase.[5] These pharmacologic differences allow tenecteplase to be administered as a bolus, rather than a bolus followed by a drip (as with alteplase). While our nursing colleagues are certainly capable of preparing and administering alteplase, the dosing regimen of 0.09 mg/kg bolus followed by 0.81 mg/kg as a drip over 60 minutes is a bit complicated. Perhaps this at least partially explains why there is data that pharmacist participation in acute ischemic stroke treatment is associated with decreased door-to-needle times.[21] While many tertiary care facilities involve clinical pharmacists in stroke protocols, this is not feasible in rural hospitals, leaving the somewhat cumbersome task of preparing and administering alteplase entirely to nursing staff.

Additionally, the administration of the alteplase drip requires an IV pump. Not all emergency medical technicians are qualified to manage IV pumps, which may, in certain circumstances, delay or complicate a patient's interfacility transfer. The use of tenecteplase, which does not require a pump or any specialized equipment, would simplify the administration of thrombolytics and remove one potential barrier to rapid interfacility transfer for those stroke patients who require it.

There is a great deal of emphasis on achieving rapid door-to-needle times for thrombolytics in acute ischemic stroke.[22] However, what probably actually matters is not the door to thrombolytic initiation time, which is what is generally tracked as a quality measure, but rather the door to thrombolytic *completion time*. A patient who is given tenecteplase will have a one hour faster door to thrombolytic completion time than if they were given alteplase.

Finally, when considering the administration of tenecteplase, it should be noted that the current evidence suggests that 0.25 mg/kg (maximum 25 mg) is the optimal dose. The 0.1 mg/kg dose did not fare as well as the 0.25 mg/kg dose in the study by Parsons et al,[8] and the 0.4 mg/kg dose may result in higher rates of intracerebral hemorrhage.[7]

Cost

Tenecteplase is consistently less expensive compared to alteplase nationally and internationally, with one study from Nepal stating that alteplase is twice as expensive as tenecteplase ($450 for tenecteplase versus $1000 for alteplase).[23] According to drugs.com, in the United States, a 50 mg vial of tenecteplase costs $6311.89, while a 100 mg vial of alteplase costs $9196.07.[24] Given the doses of 0.25 mg up to 25 mg for tenecteplase and 0.9 mg/kg up to 90 mg for alteplase, it is evident that tenecteplase costs much less. Moreover, hospital prices may be much higher than those listed on drugs.com. Thus, the switch from alteplase to tenecteplase has the potential to save hospitals and patients an enormous amount of money.

Conclusion

Tenecteplase is at least as effective as alteplase with regards to neurologic improvement after treatment of acute ischemic stroke. Additionally, tenecteplase is less expensive, easier to administer, and may have less bleeding complications than alteplase. Thus, physicians should consider using tenecteplase rather than alteplase for thrombolysis of acute ischemic stroke. If used, the preferred dose of tenecteplase is 0.25 mg/kg (maximum 25 mg).

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Human Papillomavirus Awareness, Vaccine Status, and Risk Factors in Female Emergency Patients

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Introduction: A vaccine targeting high-risk human papillomavirus (HPV) strains can effectively prevent HPV-associated cervical cancer risk. However, many girls and women do not receive the vaccine, more often those impacted by health disparities associated with race and/or socioeconomic status. This same disparate population has also been shown to be at higher risk for cervical cancer. Many of these women also rely on the emergency department (ED) as a safety net for their healthcare. This study sought to gather information pertaining to HPV and cervical cancer risk factors, awareness of HPV and the vaccine, as well as HPV vaccine uptake in female patients presenting to an ED.

Methods: We obtained 81 surveys completed by female ED patients. Demographics included age, race, income, insurance status, primary care provider status, and known cervical-cancer risk factors. Subsequent survey questions explored respondents' knowledge, familiarity, and attitudes regarding HPV, cervical cancer, and the HPV vaccine, including vaccination uptake rates. We analyzed data using descriptive statistics and Fisher's exact test.

Results: Approximately one in seven respondents (14.8%) had never previously heard of HPV and 32.1% were unaware of the existence of a HPV vaccine. Minority patients, including those who were Black and Hispanic patients, low income patients, and uninsured and publicly insured patients were less likely to be aware of HPV and the vaccine and likewise were less likely to be offered and receive the vaccine. More than 60% of all respondents (61.3%) had never previously been offered the vaccine, and only 24.7% of all respondents had completed the vaccine series.

Conclusion: Female ED patients may represent an at-risk cohort with relatively low HPV awareness and low HPV vaccine uptake. The ED could represent a novel opportunity to access and engage high-risk HPV populations. [West J Emerg Med. 2020;21(2)203-208.]

INTRODUCTION

Human papillomavirus (HPV) is the most common sexually transmitted infection and the most common cause of cervical cancer and cervical cancer-related deaths in the United States (US).[1-4] HPV infection and HPV-associated cervical cancer are preventable due to the advent of highly effective vaccines available since 2006. The Centers for Disease Control and Prevention (CDC), as well as the Advisory Committee on Immunization Practices, recommend the HPV vaccination series for girls aged 11 or 12 years of age, as well as females aged 13 to 26 not adequately vaccinated previously.[1,5] In response to these recommendations, HPV awareness and vaccination rates have increased, but overall vaccination uptake remains well below national goals.[6]

Most alarming, significant disparities in HPV vaccine knowledge and vaccine series completion exist among those with the highest rates of HPV infection, including racial minorities, the under- and uninsured, and the economically

disadvantaged.[7-11] Further, cervical cancer incidence and mortality are higher among Black and Hispanic women as compared to White women, and cervical cancer incidence has been shown to be nearly twice as high among those living in poverty.[12] For these reasons, it is a national priority to raise HPV awareness and vaccination among these disproportionately affected populations.

Due to challenges accessing primary care, disparate populations may benefit from engagement in HPV awareness and screening in alternative venues.[13] Emergency departments (ED) have previously been demonstrated to be high-yield and effective venues for raising awareness of similar silent, stigmatizing, and deadly conditions–specifically, human immunodeficiency virus (HIV) and hepatitis C virus (HCV).[14,15] Thus, it has been suggested that the ED be considered as an alternative setting for HPV education, screening, and vaccine administration in an effort to overcome barriers to HPV provision in all populations.[16]

We sought to measure and characterize HPV and cervical cancer awareness, risk factors, and HPV vaccination history among adult females presenting to an urban, academic ED. We hypothesized that female patients in the ED would demonstrate lower rates of HPV awareness and vaccination uptake than the general population.

Population Health Research Capsule

What do we already know about this issue?
Human papillomavirus (HPV) is the most common sexually transmitted infection in the US, responsible for over 90% of cervical cancer cases. HPV vaccine uptake is low.

What was the research question?
Evaluate and characterize HPV awareness and vaccine rates in female patients presenting to the emergency department (ED).

What was the major finding of the study?
The female ED population represents a unique, at-risk cohort in regard to HPV and cervical-cancer risk factors.

How does this improve population health?
This study challenges emergency physicians to consider an expanded role as HPV educator and vaccine advocate, particularly for "at-risk" patients.

METHODS

We performed a cross-sectional, survey-based study at the University of Alabama at Birmingham (UAB), an urban, academic ED in the Southeast US with an affiliated emergency medicine residency program and an annual volume of approximately 65,000, from June 1–August 31, 2016. The UAB Institutional Review Board approved the protocol. Adult female patients, aged 18-32, were recruited to participate in the survey during their ED visit. We selected the age of 32 as the upper age limit for survey engagement to align with the availability of the HPV vaccine and vaccine administration guidelines beginning in 2006.[17] Trained female research assistants (RA) recruited applicable patients and administered the survey Monday through Friday, 9 AM to 4 PM (a convenience sample).

We collected 81 completed surveys in this pilot study to demonstrate feasibility. Exclusion criteria included the following: individuals who did not speak English or for whom communication barriers were present (eg, altered mental status, dementia); were medically or psychiatrically unstable; or who were undergoing active emergent evaluation or treatment; and individuals presenting for sexual assault. Subjects were recruited and administered the surveys in private rooms, and written informed consent was provided. RAs verbally delivered the survey questions in a casual interview style.

The 21-item survey instrument was developed by the study authors with the intent to be expansive, capturing general HPV awareness as well as HPV vaccine uptake information, in addition to demographic factors to include pre-existing cervical-cancer risk factors. While created de novo, the survey was influenced by previously published HPV awareness and attitude survey studies.[12,16,18,19] The final survey (Appendix A) contained the following: demographic information; HPV infection and vaccine awareness; HPV vaccination history; HPV infection and cervical cancer risk factors. Survey questions met a SMOG (Simple Measure of Gobbledygook) reading index of 7th grade and a Gunning Fog score of 8.6, designating it "fairly easy to read."[20,21] The RA was allowed to clarify for the respondent any real-time questions regarding definitions and/or survey question verbiage as needed.

We selected a $20,000 annual household income threshold to reflect the 2016 Federal Poverty Line (FPL), the minimum amount of gross income that a family needs for food, clothing, transportation, shelter, and other necessities, as determined by the Department of Health and Human Services.[23] In 2016, the FPL for a two-person household was $16,020 and for a three-person household was $20,160. To effectively capture the majority of respondents and understand the effect of socioeconomic status, we selected a delineation of $20,000 for the purpose of this study.

We collected the project data in a secure REDCap database.[22] We determined the proportion of participants acknowledging HPV awareness and prior vaccination stratified by age, gender, race, access to primary care, income, and medical insurance status, assessing non-random differences of association using Fisher's exact test (STATA/IC, 15.1, College Station, Texas).

RESULTS

A total of 81 surveys were completed. Participant demographics are displayed in Table 1. Insurance status information was unavailable for one respondent (0.05%); likewise, income information was unavailable for five respondents (6.2%), and primary care provider status was unavailable for one respondent (1.2%). Three respondents (3.7%) identified more than one locale where they routinely sought primary care services.

Selected survey question responses with demographic delineation are displayed in Table 2. Survey response data regarding HPV vaccination rates was available for 80 survey respondents. One respondent who had previously received the HPV vaccine and four who had not received the vaccine did not disclose or were unaware of their annual household income.

HPV awareness was significantly higher among White respondents (96.4%, $p = .016$) and those with higher annual income (96.9%, $p = .020$). Among respondents with awareness of HPV, however, additional understanding of its designation as a common sexually transmitted infection and its association with cervical cancer was generally mixed. White patients were more likely to be aware of the HPV-cervical cancer association (). HPV vaccine awareness was higher among patients with an established primary care provider (84.6%, p = .003) and lower among those publicly insured or uninsured (42.2%, $p = .034$) and those with lower annual household income (40.9%, $p = .048$).

Only 38.8% respondents reported ever being offered the HPV vaccine and 24.7% previously completed the vaccination series. Of those vaccinated for HPV, 78% reported receiving the vaccine at their primary care physician's office. Notably, 12.5% of respondents reported declining a prior HPV vaccination.

Table 1. Demographics of participants who completed a survey on human papillomavirus awareness.

Race	n = 81
Black or African American	50 (61.7%)
White or Caucasian	28 (34.6%)
Hispanic or Latina	3 (3.7%)
Insurance Status	n = 80
Private	36 (45.0%)
Publicly insured or uninsured	44 (55.0%)
Income	n = 76
<$20,000/year	44 (57.9%)
>$20,000/year	32 (42.1%)
Primary Care Provider Status	n = 80
Established primary care	42 (52.5%)
Federally funded or "free" clinic	20 (25.0%)
Emergency department or urgent care	17 (21.25%)
None/other	5 (6.25%)

Of those age-eligible (n = 43) for HPV vaccination, 76% reported they would be comfortable initiating and receiving HPV vaccination in the ED.

A number of known cervical-cancer risk factors were also identified among respondents: inconsistent use of barrier contraceptive during sexual activity (59.5%); tobacco use (27.2%); pregnancy prior to age 17 (12.3%); and a family history of cervical cancer (7.6%) (Appendix C).

DISCUSSION

In general, our survey respondents demonstrated a population with low HPV awareness and low HPV vaccination rates along with significant risk factors for HPV exposure and cervical cancer. The HPV vaccine series completion rate reported in this unique ED population was far below national vaccination rates. In 2017, 49% of US teens had completed the HPV vaccine series as compared to less than a quarter of our survey respondents.[24] Racial and social inequities that have previously been associated with decreased vaccination rates in the primary care setting were echoed and, in some cases, amplified in this ED venue.[7-11]

In addition, it is alarming to note the number of vaccine-eligible women who reported they had never been counselled about nor offered the HPV vaccine, potentially because they did not have a primary care physician or the resources to see one regularly. Equally concerning was the nearly 13% refusal rate by those who had been offered the vaccine. Reasons given for declination were variable but predominantly included "I feel the illness is not severe or 'bad enough' to warrant vaccination," and "The preservatives in the vaccines are dangerous." This may represent lack of an established or primary care relationship to offer sufficient education regarding HPV, HPV's direct association with cervical cancer, and vaccines in general.[25]

The study population also demonstrated a low awareness of HPV's direct correlation with cervical cancer along with a significant risk profile for cervical cancer. Thirty-five percent were unaware of the HPV-cervical cancer connection, with even higher percentages noted among Black patients (44.9%) and the uninsured (57.1%). This has been demonstrated previously and may represent the influence of socioeconomic determinants of health, which can affect primary care access and utilization of preventive health services.[11,12,19] Likewise, prevalence of several cervical-cancer risk factors among respondents was noted to be high as compared to the general population including smoking tobacco (27.2% among respondents compared to 15.5% nationwide) and full-term pregnancy before age 17 (12.3% of respondents compared to 19 births per 1000 in the US in 2017, or nearly seven times the national rate).[26,27] The over-representation of cervical-cancer risk factors in this population underscores a vulnerable, at-risk subset.

The survey results highlight several potential engagement opportunites for emergency physicians (EP) to consider, including HPV awareness campaigns and ED-initiated HPV

Table 2. HPV* and HPV vaccine awareness and uptake.

	Yes n (%)	No n (%)	p-value
Have you heard of HPV?	69 (85.2)	12 (14.8)	
Race			
Black or African American	41 (82.0)	9 (18.0)	
White or Caucasian	27 (96.4)	1 (3.6)	
Hispanic or Latina	1 (33.3%)	2 (66.7%)	.016
Insurance Status			
Private insurance	34 (94.4)	2 (5.6)	
Publicly Insured or Uninsured	35 (77.8)	10 (22.2)	.057
Income			
<$20,000/year	34 (77.3)	10 (22.7)	
>$20,000/year	31 (96.9)	1 (3.1)	.020
Primary Care Provider Status			
Established PCP	37 (94.9)	2 (5.1)	
Federally funded or “free” clinic	14 (73.7)	5 (26.3)	
ED or Urgent Care	12 (80.0)	3 (20.0)	
None or “Other”	4 (80.0)	1 (20.0)	0.072
Respondents who have received partial or complete HPV vaccination	23 (28.75)	57 (71.25)	
Race	23 (28.75)	57 (71.25)	
Black or African American	13 (26.0)	37 (74.0)	
White or Causcasian	10 (37.0)	17 (63.0)	
Hispanic or Latina	0 (0)	3 (100)	.437
Insurance Status			
Private insurance	13 (36.1)	23 (63.9)	
Publicly insured or uninsured	10 (22.7)	34 (77.3)	.221
Income			
<$20,000/year	9 (20.9)	34 (79.1)	
>$20,000/year	13 (40.6)	19 (59.3)	.077
Primary Care Provider Status			
Established PCP	15 (35.7)	27 (64.3)	
Federally funded or “free” clinic	2 (10.0)	18 (90.0)	
ED or Urgent care	5 (29.4)	12 (70.6)	
None or “Other”	1 (14.3)	6 (85.7)	.150

**HPV*, human papillomavirus; *PCP*, primary care provider; *ED*, emergency department.

vaccine administration. Physician recommendation has been shown to be the most effective indicator of HPV uptake among vaccine-eligible women and may be equally effective in an ED setting.[28-31] However, as Hill and Okugo demonstrated when assessing EP attitudes toward proposed HPV vaccine initiation in the ED, perceived barriers to HPV education and vaccine initiation in the ED setting do exist, including concerns regarding time requirements and reimbursement.[32] Likewise, it is anticipated that some EPs may not embrace a preventative medicine role, a wheelhouse that traditionally has belonged to primary care physicians.

EPs, however, as demonstrated by our survey responses, may represent the only healthcare encounters many women ever have. EDs, as part of the national public health safety net, frequently encounter subsets of the general population who often have minimal interaction with or limited access to the traditional primary care-based healthcare system.[13,33] Considering an expanded role for the EP, incorporating social determinants of health and their influence on our patients, beyond immediate stabilization and acuity, will be paramount to our patients’ health as well as general public health.

Initiating a conversation with EPs and primary care partners

and/or community resources may be an important consideration as the healthcare system attempts to address HPV from a public health perspective.[34] Certainly it is interesting to note that the majority of survey respondents were amenable to HPV vaccine initiation in the ED.

The ED setting has more recently been used as a venue for universal screening of other sexually transmitted viral infections, including HIV and HCV. Well established, opt-out screening programs of this type have resulted in the successful linkage of care of previously undiagnosed and untreated HIV- and/or HCV-positive patients, many of whom may have had no other access to testing or definitive care.[14,15] Initiating a similar ED-based HPV vaccine awareness and initiation with a linkage to care program may be a way to bridge the existing HPV gaps in the US, particularly among racial and socioeconomic groups suffering from healthcare disparities.

Future, more expansive studies, considering additional evaluation of the adolescent age range as well as male patients, would be useful to further characterize the at-risk population presenting routinely to the ED setting.

LIMITATIONS

This is a single-center study, and as such, results may not be universally applicable to all ED settings. In addition, the results represent a convenience sample collected as a pilot study and may not reflect overall ED demographics. In certain instances (eg, Hispanic respondents), small response numbers may limit data interpretation. Likewise, demographic data on excluded patients, as well as those who refused participation, was not collected in this feasibility study, which may also limit its general applicability. Exclusion of population subsets, particularly non-English speaking individuals, may result in skewed data; however, the majority of non-English speaking patients presenting to our ED represent underserved minorities who face similar healthcare inequities to other minority groups, including decreased rates of HPV vaccination. Thus, we suspect that inclusion of their responses and data would likely contribute to disparities noted in the discussion above. Because survey answers were self-reported by respondents, there was a potential for recall bias and/or social desirability bias, which could have contributed to over- or under-inflation of personal medical history and/or risk factor reporting in particular. Finally, pediatric patients, an important patient subset, were excluded from our study. A nearby children's hospital caters to the majority of local pediatric emergency patients, limiting pediatric patient exposure in the study ED.

CONCLUSION

HPV awareness and vaccination rates in this female ED population were low while cervical-cancer risk factor rates were high, identifying a particularly vulnerable population. EDs may be a high-yield venue for HPV and cervical cancer prevention including education, screening, and vaccine initiation.

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Changes in Emergency Department Care Intensity from 2007-16: Analysis of the National Hospital Ambulatory Medical Care Survey

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Introduction: Emergency departments (ED) in the United States (US) have increasingly taken the central role for the expedited diagnosis and treatment of acute episodic illnesses and exacerbations of chronic diseases, allowing outpatient management to be possible for many conditions that traditionally required hospitalization and inpatient care. The goal of this analysis was to examine the changes in ED care intensity in this context through the changes in ED patient population and ED care provided.

Methods: We analyzed the National Hospital Ambulatory Medical Care Survey (NHAMCS) from 2007-2016. Incorporating survey design and weight, we calculated the changes in ED patient characteristics and ED care provided between 2007 and 2016. We also calculated changes in the proportion of visits with low-severity illnesses that may be safely managed at alternative settings. Lastly, we compared ED care received and final ED dispositions by calculating adjusted relative risk (aRR) comparing ED visits in 2007 to 2016, using survey weighted multivariable logistic regression.

Results: NHAMCS included 35,490 visits in 2007 and 19,467 visits in 2016, representing 117 million and 146 million ED visits, respectively. Between 2007 and 2016, there was an increase in the proportion of ED patients aged 45-64 (21.0% to 23.6%) and 65-74 (5.9% to 7.5%), while visits with low-severity illnesses decreased from 37.3% to 30.4%. There was a substantial increase in the proportion of Medicaid patients (22.2% to 34.0%) with corresponding decline in the privately insured (36.2% to 28.3%) and the uninsured (15.4% to 8.6%) patients. After adjusting for patient and visit characteristics, there was an increase in the utilization of advanced imaging (aRR 1.29; 95% confidence interval [CI], 1.17-1.41), blood tests (aRR 1.16; 95% CI, 1.10-1.22), urinalysis (aRR 1.22; 95% CI, 1.13-1.31), and visits where the patient received four or more medications (aRR 2.17; 95% CI, 1.88-2.46). Lastly, adjusted hospitalization rates declined (aRR 0.74; 95% CI, 0.64-0.84) while adjusted discharge rates increased (aRR 1.06; 95%CI 1.03-1.08).

Conclusion: From 2007 to 2016, ED care intensity appears to have increased modestly, including aging of patient population, increased illness severity, and increased resources utilization. The role of increased care intensity in the decline of ED hospitalization rate requires further study. [West J Emerg Med. 2020;21(2)209-216.]

INTRODUCTION

Emergency departments (ED) have become the center for acute, episodic care in the United States (US) over the past two decades. The growth in visit volumes to EDs across the nation has exceeded population growth,[1,2] despite concurrent ED closures.[3] A rising proportion of hospital admissions are originating from the ED.[4,5] These changes have propelled EDs to significantly expand its diagnostic and treatment

capabilities, most notably the availability of advanced imaging and observation unit care.[6,7] These changes allowed EDs to take a larger role in acute care delivery and increased the intensity of care delivered in EDs over time. Evidence from the early 2000s showed a rapid rise in advanced imaging use as well as an increase in laboratory testing and treatment utilization.[6,8,9] However, these studies coincided with the proliferation of advanced imaging technology and outpatient care pathways.[6,10] Whether these trends of rising care intensity and utilization continued beyond the initial expansion is unclear.

While the demand for emergency care and ED capabilities continues to expand, the rising healthcare expenditure has led policymakers and clinical leaders to implement cost reduction policies, aiming to decrease low-value care and avoidable hospitalizations. On the one hand, efforts to decrease low-value care, such as the formation of Choosing Wisely guidelines by the American College of Emergency Physicians, may lower care intensity through decreased avoidable testing and treatment use. On the other hand, to reduce avoidable hospitalizations, ED care intensity may increase so that EDs may facilitate lower-cost outpatient management or ED-based observation care for conditions that conventionally have required hospitalized care.[10] Therefore, the net change in emergency care intensity as a result of efforts in low-value care reduction and the shift toward outpatient care remains unknown and warrants an updated evaluation.

The goal of this study was to use a nationally representative dataset to assess the changes in the intensity of the care provided in US EDs over the past decade. We examined the changes in the complexity of the ED patient population and the services provided in US EDs between 2007 and 2016.

Population Health Research Capsule

What do we already know about this issue?
Emergency departments (ED) occupy a more central role in acute, unscheduled care by providing an increasing proportion of acute care. EDs are also a rising source of hospital admission.

What was the research question?
Is emergency care rising in intensity, as defined by increased patient complexity, testing, and treatment?

What was the major finding of the study?
From 2007-2016, ED patients have become more complex. Diagnostic and treatment use continued to rise, but admission rates have declined.

How does this improve population health?
Future research should examine whether increased ED care intensity has directly improved the value of care, which will inform future delivery and payment system reform for emergency care.

METHODS

Dataset

We analyzed the 2007–2016 public-use datasets of the National Hospital Ambulatory Medical Care Survey (NHAMCS) ED sample. NHAMCS is an annual survey conducted by the Ambulatory and Hospital Care Statistics Branch of the National Center for Health Statistics (NCHS). The NHAMCS consists of multistage, probability samples of visits to hospital-based EDs in the US. Each encounter was assigned a weight and corresponding design variables to generate nationally representative estimates and standard errors. Detailed sampling and survey methodologies are available on the NCHS website.[11] This study was exempt from review by the institutional review boards of the authors' institutions.

Patient Characteristics

We first examined demographic characteristics of ED patients, including age groups, gender, race/ethnicity, and insurance status, to explore the change in patient complexity as a contributor of changing ED care intensity. Of note, NCHS imputed approximately 20-25% of visits where race (Black, White, and other groups), ethnicity (Hispanic and non-Hispanic), or both were missing in each survey year. We used the two variables to categorize patients into four racial/ethnic groups: non-Hispanic White, non-Hispanic Black, Hispanic, and others. For insurance status, we used the variable *paytyper,* which categorized patients into a hierarchy by the primary insurance that is providing the patient coverage, including private insurance, Medicare, Medicaid, other insurance, and uninsured. We accounted for the changes in the hierarchy used to construct this variable in year 2007 where Medicare and Medicaid dual-eligible patients were categorized as Medicaid, whereas they were categorized as Medicare in the remainder of the survey years included in this study.[8]

We included other visits characteristics including region (Northeast, Midwest, South, and West) and whether the care team included any physician assistants, nurse practitioners, or residents. We also included time of visit, categorizing visits into weekday (8 AM to 5 PM Monday through Friday), weeknights (5 PM to 8 AM starting on Monday through Thursday), and weekends (not weekdays or weeknights). To further assess the complexity of ED visits, we adopted a previously published definition to categorize ED visits as low-severity (Appendix Table A).[12]

We considered including triage severity and initial visit vitals as an additional measure of patient complexity; however, there was a significant proportion of missing values to both (approximately 20-30% and 10-15%, respectively, across survey years), which substantially limited their interpretability and validity. Therefore, we did not include triage severity or visit vitals.

Emergency Care Delivered

We next examined the care and services delivered as a measure of ED care intensity, including advanced imaging, radiographs, blood and urine testing, electrocardiograms (ECG), and bedside procedures. Advanced imaging included a patient getting any computer tomography (CT) and magnetic resonance imaging (MRI). We also included patients who received ultrasound, since ultrasound, like CT or MRI, is often not readily available in the outpatient care setting. We categorized blood testing into routine—including complete blood counts, chemistry panels, liver function tests, coagulation studies, cardiac enzymes, alcohol level—and special testing, including blood cultures, human immunodeficiency virus testing, toxicological screening, and arterial blood gas.

We categorized bedside procedures into urgent care procedures—including orthopedic care (cast/splint), wound care (such as laceration repair and incision and drainage), urinary catheter placement, and critical care procedures—including cardiopulmonary resuscitation, and endotracheal intubation. This categorization scheme was made as patients receiving these procedures are clinically distinct although all warranting direct time from clinicians. The selection of these procedures was limited by the availability of procedural indicators throughout the study period. For example, an indicator for non-invasive positive pressure ventilation was not available until 2012.

To explore the connection of care intensity with the changes in downstream outcomes, we also examined final disposition of ED visits. We considered admission to inpatient or observation units as hospitalizations for several reasons. For two-thirds of US hospitals, observation care is delivered through inpatient floors and structured similarly to inpatient admissions.[13,14] Recent evidence further suggests that observation care may be replacing traditional inpatient hospitalizations or readmissions.[15, 16] Lastly, from the patient's perspective, observation stay is likely a similar experience to hospitalized care on inpatient units.

Statistical Analyses

We first calculated proportions of ED visits for each patient characteristic and care received, comparing 2007 to 2016 survey years. Specifically, for each patient characteristic, we calculated weighted national visit counts as well as proportions of all ED visits to illustrate both absolute change in the number of ED visit and relative changes in proportion of ED visits. We also calculated the weighted total number of annual ED patient visits for all years between 2007 and 2016 that were discharged, hospitalized (including both inpatient and observation), received advanced imaging, blood test, or four or more medications.

For ED care delivered, we calculated the unadjusted proportions of ED visits receiving each category of ED care. We further calculated the unadjusted and adjusted relative risk of receiving care in each category comparing 2016 to 2007, using survey-weighted logistic regression and *margins* post-estimation command,[17] accounting for differences in patient characteristics, including age, gender, race, insurance status, ambulance use, region, time of visit, presence of physician assistant, nurse practitioner, or resident. We calculated 95% CI for all relative risks; however, hypothesis testing was considered significant at alpha of 0.01 for two-tailed test, in accordance to NCHS guidelines for NHAMCS 2015 and 2016.[18]

We performed all analyses and calculations of national estimates using *svy* package in Stata 15.0 (StataCorp, College Station, TX), which allowed us to incorporate the corresponding survey weights and account for complex survey design in the estimation for standard error.

RESULTS

Visit Patient Characteristics

From 2007 to 2016, NHAMCS sampled a total of 289,188 ED visits, with 35,490 visits in 2007 and 19,467 visits in 2016, representing 117 million ED visits in 2007 and nearly 146 million ED visits in 2016. Table 1 shows the visit patient characteristics in 2007 and 2016. Visits across all age groups increased in the total number of visits. The proportion of ED patients aged 45-64 and 65-74 slightly increased without substantial overall changes in the distribution of ED patients by age groups between 2007 and 2016.

Compared to 2007, in 2016 Medicaid visits significantly increased from 22.2% to 34.0% while there were decreases in the proportion of ED visits by uninsured (15.4% to 8.6%) and privately insured patients (36.2% to 28.3% (Table 1). Lastly, although the proportion of visits arrived by ambulance were similar, compared to 2007, the proportion of ED visits with low-severity diagnoses decreased from 37.3% to 30.4%. Notably, the weighted total number of low-severity visits increased only slightly (41.0 million visits to 41.6 million visits).

Emergency Care Services Delivered

Table 2 shows the proportion of ED visits receiving each testing or treatment and the unadjusted and adjusted relative risk of receiving the care comparing 2016 to 2007. The proportion of ED visits that received diagnostic testing have increased slightly, including CT/ MRI (aRR 1.25; 95% CI, 1.14-1.36), basic blood tests (aRR 1.11; 95% CI, 1.05-1.17), urine tests (aRR 1.17; 95% CI, 1.09-1.26), and ECGs (aRR 1.18; 95% CI, 1.08-1.28). The proportion of ED visits receiving four or more medications during ED care increased

Table 1. Patient and emergency department visit characteristics in National Hospital Ambulatory Care Survey, 2007 and 2016.

	2007		2016				
	Weighted Visit Count	Weighted % of total visit	Weighted Visit Count	Weighted % of total visit	Change in Weighted Visit	Change in Weighted %	
Total ED visit	116,802,066		145,591,209		28,789,143		
Patient Characteristics							
Age (in years)							
<15	22,309,924	19.1%	27,435,668	18.8%	5,125,744	-0.3%	
15-24	18,978,889	16.3%	20,674,299	14.2%	1,695,410	-2.1%	*
25-44	33,482,347	28.7%	40,013,993	27.5%	6,531,646	-1.2%	
45-64	24,493,735	21.0%	34,359,290	23.6%	9,865,555	2.6%	#
65-74	6,911,506	5.9%	10,984,887	7.6%	4,073,381	1.6%	*
75 or older	10,625,665	9.1%	12,123,071	8.3%	1,497,406	-0.8%	
Female	63,192,896	54.1%	79,594,987	54.7%	16,402,091	0.6%	
Race							
Non-Hispanic White	71,776,208	61.5%	87,940,570	60.4%	16,164,362	-1.1%	
Non-Hispanic Black	26,195,544	22.4%	30,704,146	21.1%	4,508,602	-1.3%	
Hispanic	15,803,866	13.5%	22,422,154	15.4%	6,618,288	1.9%	
Other	3,026,448	2.6%	4,524,339	3.1%	1,497,891	0.5%	
Insurance							
Private/WC/Other	42,240,378	36.2%	41,191,152	28.3%	-1,049,226	-7.9%	*
Medicare	20,130,178	17.2%	25,915,772	17.8%	5,785,594	0.6%	
Medicaid	25,920,279	22.2%	49,425,546	34.0%	23,505,267	11.8%	*
No insurance	18,026,918	15.4%	12,474,774	8.6%	-5,552,144	-6.9%	*
Unknown	10,484,313	9.0%	16,583,965	11.4%	6,099,652	2.4%	
Ambulance	18,076,808	15.5%	22,936,057	15.8%	4,859,249	0.3%	
Low-Severity Illness[1]	41,035,868	37.3%	41,593,226	30.4%	557,358	-6.9%	*
Visit characteristics							
Visit time							
Weekday	40,337,211	34.5%	52,865,496	36.3%	12,528,285	1.8%	#
Weeknight[2]	35,064,025	30.0%	41,736,017	28.7%	6,671,992	-1.4%	^
Weekend[3]	41,400,830	35.5%	50,989,695	35.0%	9,588,865	-0.4%	
Resident	9,289,073	8.0%	11,930,651	8.2%	2,641,578	0.2%	
PA/NP	15,179,703	13.0%	40,771,144	28.0%	25,591,441	15.0%	*
Region							
Northeast	20,484,250	17.5%	24,513,937	16.8%	4,029,687	-0.7%	
Midwest	25,062,048	21.5%	31,428,233	21.6%	6,366,185	0.1%	
South	48,712,961	41.7%	53,484,530	36.7%	4,771,569	-5.0%	
West	22,542,807	19.3%	36,164,508	24.8%	13,621,701	5.5%	

PA, physician's assistant; *NP*, nurse practitioner; *WC*, Workers' Compensation.
[1]Compared 2007 to 2015. Unable to compare due to a change to ICD-10 coding of diagnoses without a validated crosswalk for NHAMCS, which only codes the first 4 characters of ICD-10 diagnoses.
[2]Weeknights - Mon-Thursday after 5 through 8 AM the next day.
[3]Weekend - Friday after 5 PM to Monday 8 AM.
*p<0.001.
#p<0.01.
^p<0.05.

Table 2. Emergency department care provided, comparing 2007 and 2016 National Hospital Ambulatory Medical Care Survey.

	2007 (%)	2016 (%)	Unadjusted Relative Risk (95% CI)		Adjusted Relative Risk[1] (95% CI)	
Advanced imaging						
CT/MRI	14.2	17.8	1.25	(1.13-1.38)	1.29	(1.17-1.41)
Ultrasound	3.0	5.2	1.73	(1.37-2.09)	1.78	(1.45-2.11)
Blood test						
Basic[2]	39.3	44.3	1.13	(1.06-1.20)	1.16	(1.10-1.22)
Special[3]	7.7	9.2	1.20	(0.94-1.47)	1.21	(0.99-1.43)
Urinalysis	22.5	26.6	1.19	(1.09-1.28)	1.22	(1.13-1.31)
Electrocardiogram	16.6	20.3	1.22	(1.09-1.35)	1.24	(1.14, 1.33)
Any radiograph	33.8	33.7	1.00	(0.94-1.06)	1.01	(0.96-1.06)
Procedures						
Urgent	14.6	10.0	0.69	(0.61-0.77)	0.67	(0.60-0.75)
Critical	0.26	0.27	1.06	(0.52-1.59)	1.06	(0.55-1.57)
Medications given in ED						
1 to 3	47.7	46.4	0.97	(0.91-1.03)	0.99	(0.93-1.05)
4 or more	6.9	15.3	2.20	(1.87-2.52)	2.17	(1.88-2.46)
Disposition						
Hospitalized	16.0	12.3	0.77	(0.64-0.90)	0.74	(0.64-0.84)
Observation	2.1	2.0	0.97	(0.49, 1.45)	0.88	(0.53-1.23)
Inpatient	13.9	10.3	0.74	(0.63-0.85)	0.72	(0.63-0.80)
Discharged	80.2	84.8	1.06	(1.03-1.09)	1.06	(1.03-1.08)

CT, computed tomography; *MRI*, magnetic resonance imaging; *ED*, emergency department; *CI*, confidence interval.
[1]Adjusted relative risk is calculated using survey weighted multivariable logistic regression and margins post-estimation command. The model adjusted for age, sex, race, insurance status, region, ambulance use, triaged as urgent or emergent, presence of physician assistant, nurse practitioner, or resident, visit timing.
[2]Include complete blood count, basic metabolic panel, liver function tests, coagulation, cardiac enzymes, blood alcohol level
[3]Include human immunodeficiency virus testing, blood cultures, arterial blood gas, toxicology screening.

more than two-fold (aRR 2.13; 95% CI, 1.84-2.42). In contrast, the proportion of ED visits receiving urgent care procedures decreased (aRR 0.72; 95% CI, 0.63-0.80), as well as the proportion of ED visits that led to hospitalization (aRR 0.73; 95% CI, 0.62-0.83).

When examined by total visit counts, the number of ED visits that led to hospitalizations remained relatively unchanged, while the increase in discharged visits parallels the upward trend in total ED visit volume (Figure 1).

DISCUSSION

From 2007 to 2016, the total visit volume to US EDs has continued to rise while the complexity of ED patients and the intensity of emergency care delivered has grown modestly. We found that the patient population has aged slightly but the proportion of ED patients with low-severity illnesses has declined. There is also a modest increase in the utilization of testing and medication treatments. However, there was a notable decrease in the proportion of ED visits leading to hospitalizations, which appears largely driven by the increase in the number of discharged visits while the estimated number of ED hospitalizations remains largely unchanged.

Although the growth in discharged visits may suggest that the overall acuity of the ED population decreased, we instead observed that there is a modest increase in overall patient age and a decline in the proportion of ED visits with low-severity illnesses, suggesting a rise in the complexity of the ED patient population. These findings correlate with a decline in the proportion of visits receiving urgent care procedures, such as abscess drainage and orthopedic care, which are more commonly low-severity visits. Indeed, recent claims data analysis of the Nationwide Emergency Department Sample that found ED patient population is growing older with higher burdens of comorbid conditions.[19] Likely as a result of the recent Medicaid expansion under the Affordable Care Act, we also observed a large increase in Medicaid beneficiaries and a decline in uninsured patients. As many uninsured gain coverage under Medicaid expansion and begin seeking care, previously undiscovered and untreated conditions may also contribute to the increasing complexity of the ED patient population.[20] Taken together, US EDs are seeing an increasingly complex patient population without increasing the number of patients hospitalized.

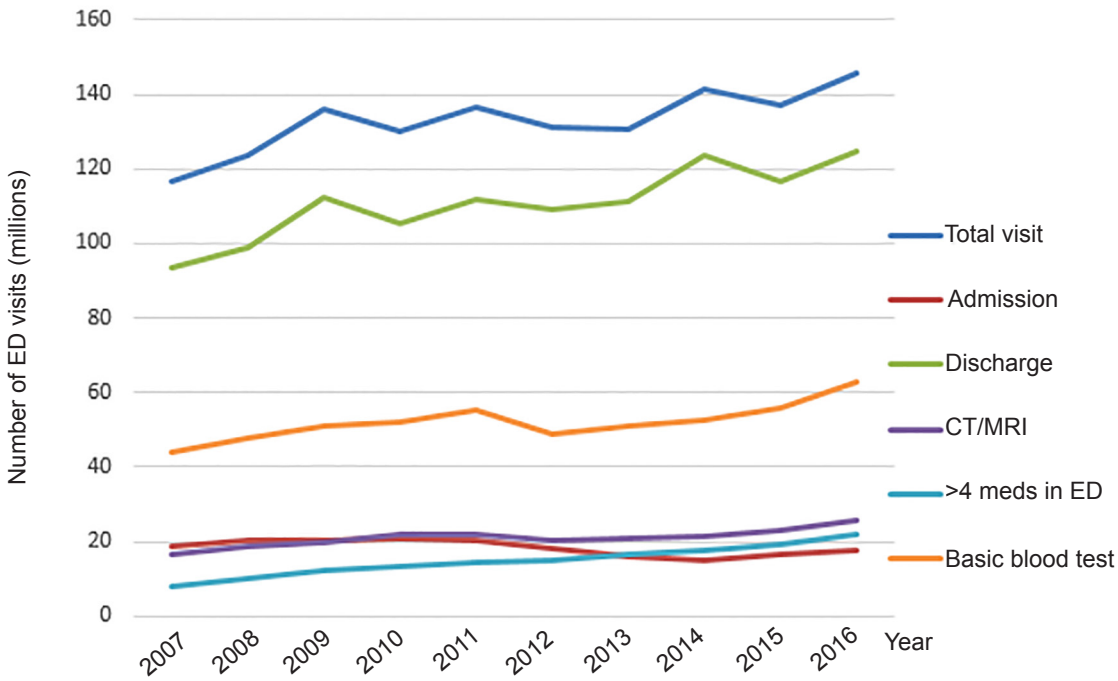

Figure 1. Weighted total number of emergency department (ED) visits, by care provided and disposition, National Hospital Ambulatory Medical Care survey 2007-2016.
CT, computed tomography; *MRI*, magnetic resonance imaging.

The opposing trends of decreasing ED hospitalization but rising ED patient complexity suggest that a proportion of patients who would have likely been admitted in the past are now managed in the outpatient setting from the ED. These concurrent trends may, in part, explain the continued rise in the utilization of diagnostic testing and treatment intensity that we observed. As policymakers sought to reduce short-stay hospitalizations through policies such as the Recovery Audit Contractors program,[21] EDs have become the center for expedited diagnosis, risk-stratification, and treatment for many conditions that traditionally warranted hospitalized care, such as chest pain, cellulitis, syncope, and transient ischemic attack. To fulfill these roles, EDs have adopted critical care pathways, which likely contributed to a rise in care intensity but reduced hospitalizations.[10] Future studies are needed to shed light on the effect of condition-specific care pathways on care intensity and resource utilization in the ED.

The continued increase in advanced imaging use warrants attention. The rapid rise in advanced imaging in the early 2000s has led policymakers and clinical leaders to be concerned with overuse and emphasize reduction of low-value advanced imaging use.[6,8,9] Although we observed no decrease in advanced imaging use, compared to prior studies, the increase in ED advanced imaging rates during our study period was relatively modest. A possible explanation may be that the rapidity with which advanced imaging use rose was largely due to the initial proliferation of imaging technology. As imaging technology has become ubiquitous in US EDs,[22] the increase in advanced imaging rate has slowed down.

While the continued increase in advanced imaging use may have helped facilitate the downward trend in hospital admissions, this observation may also suggest that low-value advanced imaging remains prevalent. Examination of low-value advanced imaging among headache and syncope ED visits have shown that imaging rates increased rapidly prior to 2007.[23] From 2007 and on, while the trend in low-value imaging use plateaued, the rate of use remained high.[23] Future research will be needed to examine how increased advanced imaging use has influenced ED hospitalization practices.

Our results contribute to the growing literature that has documented the shifting practice of emergency care. There has been significant interest in examining the changes in ED care that may explain rising emergency care expenditures. While the volume of ED visits has grown at a pace exceeding population growth,[24] costs per ED visit have also grown substantially.[25] The latter likely resulted from a combination of increased cost for ED visits at the same levels of complexity and the rising proportion of visits billed at higher levels of complexity.[26] Although, as we demonstrated, services provided during an ED visit have grown in intensity, it only partially accounts for the changes in higher complexity visit billing.[27]

Furthermore, we found that intensity has increased even after controlling for patient and visit characteristics. Together, these shifts likely result in the rising costs of emergency care; however, whether the increase per ED visit in cost reflects a corresponding

increase in the value of emergency care is not known. In our study period, we found a concurrent decline in inpatient hospitalization from the ED, which leads us to hypothesize that more intense emergency care services have increased ED visit value by reducing inpatient hospitalizations. Future studies are needed to more rigorously demonstrate the association between changes in care intensity and patient outcomes and downstream resource utilization in order to assess the changes in the value of emergency care.

LIMITATIONS

Our study is bound by the limitations of a national survey, including its cross-sectional nature as well as the potential for misclassification in patient visit characteristics, ED care provided, and diagnoses. The dataset also provided limited ability to assess the complexity of ED patients due to a significant proportion of missing data such as triage categories and presenting vital signs. As the survey changed over the years, we only selected variables such as a subset of procedures or blood tests that were present throughout the study period. NHAMCS also does not differentiate between admissions to ED observation vs observation status on an inpatient service. With the increasing prevalence of ED-based observation units, we expect there has been an increasing shift away from observation status on inpatient services.[7]

A key aspect of intensity not measured in our study was the change in physician workforce over time. Estimates from prior studies showed that the number of emergency medicine-trained physicians increased from 26,826 in 2008 to 35,856 in 2014, while physicians who were not trained in emergency medicine decreased from 12,235 to 8,397.[28,29] Physician assistants and nurse practitioners are increasingly prevalent among all ED clinicians, up to 14,360 in 2014.[29] To accurately measure changes in work intensity, patient volume, patient complexity, and care intensity these changes should be benchmarked by changes in total clinician hours in the ED in future studies.

CONCLUSION

Using survey data from a nationally representative sample of ED visits from 2007 to 2016, we found that the overall ED care intensity increased modestly as patients aged slightly, and that despite an increase in visit volume, ED visits were less likely to have low-severity illnesses. We also found that utilization of diagnostic testing, including advanced imaging, increased modestly. Furthermore, we also observed a decline in ED hospitalization rate. Future studies are needed to assess the relationship between changes in ED care intensity and the declining hospitalization rate, as well as the value of increased resource use in the ED.

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Safety and Efficacy of Hospital Utilization of Tranexamic Acid in Civilian Adult Trauma Resuscitation

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Introduction: Patients with trauma-induced coagulopathies may benefit from the use of antifibrinolytic agents, such as tranexamic acid (TXA). This study evaluated the safety and efficacy of TXA in civilian adults hospitalized with traumatic hemorrhagic shock.

Methods: Patients who sustained blunt or penetrating trauma with signs of hemorrhagic shock from June 2014 through July 2018 were considered for TXA treatment. A retrospective control group was formed from patients seen in the same past five years who were not administered TXA and matched based on age, gender, Injury Severity Score (ISS), and mechanism of injury (blunt vs penetrating trauma). The primary outcome of this study was mortality measured at 24 hours, 48 hours, and 28 days. Secondary outcomes included total blood products transfused, hospital length of stay (LOS), intensive care unit LOS, and adverse events. We conducted three pre-specified subgroup analyses to assess outcomes of patients, including (1) those who were severely injured (ISS >15), (2) those who sustained significant blood loss (≥10 units of total blood products transfused), and (3) those who sustained blunt vs penetrating trauma.

Results: Propensity matching yielded two cohorts: the hospital TXA group (n = 280) and a control group (n = 280). The hospital TXA group had statistically lower mortality at 28 days (1.1% vs 5%, odds ratio [OR] [0.21], (95% confidence interval [CI], 0.06, 0.72)) and used fewer units of blood products (median = 4 units, interquartile range (IQR) = [1, 10] vs median=7 units, IQR = [2, 12.5] for the hospital TXA and control groups, respectively, (95% CI for the difference in median, -3 to -1). There were no statistically significant differences between groups with regard to 24-hour mortality (1.1% vs 1.1%, OR = 1, 95% CI, 0.20, 5.00), 48-hour mortality (1.1% vs 1.4%, OR [0.74], 95% CI, 0.17, 3.37), hospital LOS (median= 9 days, IQR = (5, 16) vs median =12 days IQR = (6, 22.5) for the hospital TXA and control groups, respectively, 95% CI for the difference in median = (-5 to 0)), and incidence of thromboembolic events (eg, deep vein thrombosis, pulmonary embolism) during hospital stay (0.7% vs 0.7% for the hospital TXA and control group, respectively, OR [1], 95% CI, 0.14 to 7.15). We conducted subgroup analyses on patients with ISS>15, patients transfused with ≥10 units of blood products, and blunt vs penetrating trauma. The results indicated lower 28-day mortality for ISS>15 (1.8% vs 7.1%, OR [0.23], 95% CI, 0.06 to 0.81) and blunt trauma (0.6% vs 6.3%, OR [0.09], 95% CI, 0.01 to 0.75); fewer units of blood products for penetrating trauma (median = 2 units, IQR = (1, 8) vs median = 8 units, IQR = (5, 15) for the hospital TXA and control groups, respectively, 95% CI for the difference in median = (-6 to -3)), and ISS>15 (median = 7 units, IQR = (2, 14) vs median = 8.5 units, IQR = (4, 16) for the hospital TXA and control groups, respectively, 95% CI for the difference in median, -3 to 0).

Conclusion: The current study demonstrates a statistically significant reduction in mortality after TXA administration at 28 days, but not at 24 and 48 hours, in patients with traumatic hemorrhagic shock. [West J Emerg Med. 2020;21(2)217-225.]

INTRODUCTION

Trauma is the leading cause of death in individuals between the ages of one and 44 years in the United States and accounts for more than 5.8 million deaths worldwide.[1] It is estimated that by 2020 more than one in 10 people will die from trauma-related injuries.[1] A subset of traumatic injury deaths are a result of hemorrhagic shock that is refractory to optimal resuscitation efforts.[2] Trauma-induced coagulopathy is present in up to 35% of patients with severe injury on arrival to the emergency department (ED).[3] Patients with an uncorrected coagulopathy such as hyperfibrinolysis are at the greatest risk of death.[4]

Trauma-induced depletion of coagulation factors and dysregulation of the coagulation system may lead to hemodynamic instability, resulting in cardiovascular collapse. Trauma-induced coagulopathies have been associated with a significant increase in the risk of trauma-induced mortality.[3,5-8] Although scant evidence indicates that tranexamic acid (TXA) may increase mortality in cases of fibrinolysis shutdown, patients with trauma-induced coagulopathies may benefit from the use of antifibrinolytic agents. TXA, for example, is a synthetic derivative of the amino acid lysine that exerts its antifibrinolytic effect through the reversible blockade of lysine-binding sites on plasminogen molecules.[9]

TXA administration has been studied in both the prehospital and hospital settings. Wafausade et al reported a decreased mortality after TXA administration in a prehospital setting in Germany.[10] Similar conclusions were reported about the benefit of TXA administration in a prehospital setting.[11] The 2010 Clinical Randomization of an Antifibrinolytic in Significant Hemorrhage 2 (CRASH-2) study was the first to report the use of TXA in the management of civilian traumatic hemorrhage in a hospital setting. CRASH-2 described a 1.5% reduction in all-cause mortality at 28 days for patients who received TXA for trauma-related injuries.[12]

Subgroup analyses of CRASH-2 in subsequent years demonstrated that the administration of TXA within three hours of injury resulted in a 2.4% decrease in death due to bleeding.[13] The efficacy of TXA to reduce mortality was further supported by the Military Application of Tranexamic Acid in Trauma Emergency Resuscitation (MATTERS) study, a retrospective, observational study that analyzed TXA administration at a military hospital in Afghanistan.[14] Additionally, Cole et al suggested TXA administration provided survival benefit for severely injured patients.[15] However, Boutonnet et al studied TXA in a civilian hospital setting and reported no reduction in hospital mortality associated with TXA alone.[16]

There has been some discrepancy in current literature regarding the potential side effects of TXA, such as venous thromboembolic events (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE). While some studies have not identified an increase in incidence of VTE associated with TXA, others have found TXA to be an independent risk factor for increased incidence of VTE.[11,12,14,17-19] Thus, there is a need to continue to further evaluate the safety of TXA use within the hospital trauma setting.

Population Health Research Capsule

What do we already know about this issue?
Prior studies assessing tranexamic acid (TXA) use in civilian and military trauma resuscitation demonstrate a promising effect on mortality reduction and a limited side-effect profile.

What was the research question?
We aimed to assess the safety and efficacy of TXA in civilian adults hospitalized with traumatic hemorrhagic shock.

What was the major finding of the study?
The current study demonstrates a statistically significant reduction in mortality after TXA administration at 28 days, but not at 24 and 48 hours, in patients with traumatic hemorrhagic shock.

How does this improve population health?
Traumatic injury is a major cause of death in both developed and developing nations. TXA use represents a feasible measure toward reducing loss of life due to traumatic exsanguinating injury.

To date, there is limited evidence on the optimal timing and use of TXA in cases of traumatic hemorrhagic shock in the civilian hospital setting.[12,14-16] Our goal was to evaluate the safety and efficacy of early TXA use in a civilian hospital setting for cases of traumatic hemorrhagic shock within a developed North American trauma system. We hypothesized that administration of TXA upon arrival to the trauma center would be associated with reduced mortality in cases of traumatic hemorrhagic shock. The primary outcome of this study was mortality measured at 24 hours, 48 hours, and 28 days. Secondary outcomes included the following: total blood products transfused during resuscitation efforts and during the hospital stay; the hospital and intensive care unit (ICU) lengths of stay (LOS); and the incidence of known adverse events associated with TXA administration including thromboembolic events (eg, DVT, PE), myocardial infarction, and neurological events (eg, stroke, seizure).

METHODS

This civilian hospital-based study is a prospective, observational cohort study with a retrospective comparison. The current study was initiated in June 2014 at two trauma centers in Southern California: Arrowhead Regional Medical Center (Level 2 trauma center), and Loma Linda University Medical Center (Level 1 trauma center). Data collection at both trauma centers

concluded in July 2018. The hospital TXA study, including administration protocols, was approved by the institutional review boards of each receiving trauma center. At each institution, TXA was approved for use in traumatic hemorrhagic shock injury within the emergency department (ED) as well as incorporated into the massive transfusion protocol and administered uniformly between centers based on the study protocol.

Data Collection, Protocols, Outcomes

All patients ≥18-years-old who sustained blunt or penetrating trauma with signs and symptoms of hemorrhagic shock were considered for TXA treatment upon meeting inclusion criteria (Table 1). The original design of Cal-PAT (California Prehospital Antifibrinolytic Therapy) included a prehospital arm and a hospital arm.[11] The investigators followed the same protocol to ensure consistency of inclusion/exclusion criteria. Patient selection in the hospital setting was determined by inclusion criteria upon patient arrival to the trauma center. Trauma and ED team members underwent a standardized training session on the inclusion and exclusion criteria for the study, guidelines for TXA candidate identification, protocols for TXA administration, and the medication's side-effect profile. The choice of 120 beats per minute for heart rate (HR) for the prehospital arm was added by an agreement with the State of California EMS Agency Authority at the time of the approval of the original protocol.

TXA was delivered in two doses as per the protocol used in the CRASH-2 trial.[20] The first dose was one gram of TXA in 100 milliliters (mL) of 0.9% normal saline infused as a bolus over 10 minutes via intravenous (IV) or intraosseous access. This first dose was administered by registered nurses as soon as feasible after the patient's initial assessment and screening by the trauma team. Identification of study patients receiving TXA was achieved through a wristband labeled "TXA" and/or verbal communication at patient hand-off by team members. Following the completion of the first dose infusion, a second dose of TXA infusion at one gram in 100 mL of 0.9% normal saline, was administered via IV over eight hours.

A control group was formed from patients evaluated at each respective trauma center within five years prior to the conclusion of data collection for this report. The control group patients met the same study criteria (Figure 1) and were matched to the "Hospital TXA" group patients through the use of propensity scoring based upon age, gender, injury severity score (ISS), and mechanism of injury. The biostatistician in charge of the matching process was blinded to patient outcomes to avoid bias in the matching process. There were no institutional changes in transfusion and ICU policy within the past five years in either trauma center that would have affected our outcomes. In addition, the same protocol were followed regardless of the change in trauma team members.

We abstracted data for selected subjects from the electronic health record (EHR) for each patient within each hospital. Follow-up to determine mortality outcomes after hospital discharge were abstracted from the EHR and trauma registry. In select cases, we conducted direct chart review and, in cases of missing data, study investigators contacted the patient(s) and/or the families directly to confirm survival outcomes. All patients included in this study were accounted for via hospital follow-up or direct communication.

Statistical Analysis

We conducted all statistical analyses using SAS software for Windows, version 9.3 (SAS Institute, Cary, North Carolina). Descriptive statistics were presented as means and standard deviation or median and interquartile range (IQR) for continuous variables, along with frequencies and proportions for categorical variables. We used propensity score matching based on age, gender, ISS, and mechanism of injury to form the hospital TXA and control groups. Matching of each patient for the hospital TXA and control groups were performed within the trauma registry of each respective center involved. We conducted chi-square analyses to identify whether there were differences in mortality at 24 hours, 48 hours, and 28 days between the hospital TXA and control groups.

Table 1. Patients Inclusion and exclusion criteria provided to clinicians at receiving trauma centers.

Inclusion criteria	Exclusion criteria
The hospital use of TXA should be considered for all trauma patients that meet any of the following criteria: • Blunt or penetrating trauma with signs and symptoms of hemorrhagic shock within three hours of injury. o Systolic blood pressure of less than 90 mmHg upon arrival to designated trauma centers. o Heart rate >120. o Estimated blood loss of 500 milliliters o Bleeding not controlled by direct pressure or tourniquet. • Major amputation of any extremity above the wrists and above the ankles.	• Any patient <18 years of age. • Any patient more than three hours post-injury. • Any patient with an active thromboembolic event (within the last 24 hours) – ie, active stroke, myocardial infarction or pulmonary embolism. • Any patient with a hypersensitivity or anaphylactic reaction to TXA. • Any patient that received prehospital TXA. • Traumatic arrest with more than five minutes of cardiopulmonary resuscitation without return of vital signs. • Penetrating cranial injury. • Traumatic brain injury with brain matter exposed. • Isolated drowning or hanging victims. • Documented cervical cord injury with motor deficits.

TXA, tranexamic acid, *mmHG,* millimeters of mercury.

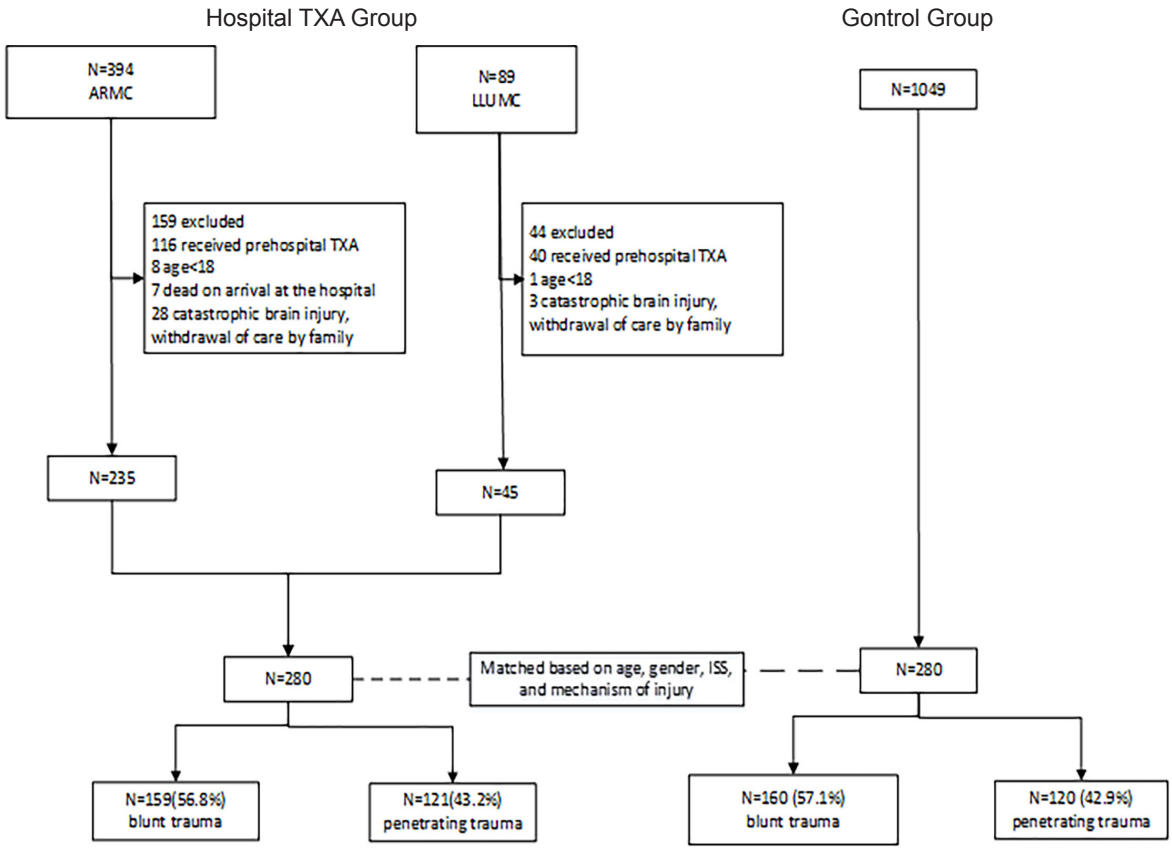

Figure 1. Patient flow chart for the hospital tranexamic acid (TXA) and control groups.
ISS, Injury Severity Score; *LLUMC,* Loma Linda University Medical Center; *ARMC*, Arrowhead Regional Medical Center.

Independent t-tests were conducted to identify whether there were differences of continuous variables (eg, age) between the hospital TXA and control groups. We conducted Wilcoxon rank sum tests to identify whether the median of some continuous variables (eg, hospital LOS) was different between the hospital TXA and control groups. Based on the original study design, three pre-specified subgroup analyses were conducted to assess outcomes of patients, including (1) those who were severely injured (ISS >15), (2) those who sustained significant blood loss (≥10 units of total blood products transfused), and (3) those who sustained blunt vs penetrating trauma. All statistical analyses were two-sided. P-value<0.05 was considered to be statistically significant.

RESULTS

A total of 280 patients were included in the hospital TXA group. A propensity matching process selected 280 patients from a control group (n = 1049). Thus, a total of 560 patients were included in the final analysis. Table 2 presents the overall analysis results. The hospital TXA group had statistically lower mortality at the 28-day mark (1.1% vs 5%, odds ratio [OR] [0.21], 95% confidence interval (CI), 0.06 to 0.72) and used fewer units of blood products (median =4 units, IQR = [1, 10] vs median = 7 units, IQR = [2, 12.5] for the hospital TXA and control groups, respectively, 95% CI for the difference in median = (-3 to -1)). There were no statistically significant differences between groups in regard to 24-hour mortality (1.1% vs 1.1%, OR = 1, 95% CI, 0.20, 5.00; 48-hour mortality (1.1% vs 1.4%, OR [0.74], 95% CI, 0.17, 3.37); hospital LOS (median = 9 days, IQR = (5, 16) vs median = 12 days, IQR = (6, 22.5) for the hospital TXA and control groups, respectively, 95% CI for the difference in median = (-5 to 0)), and the incidence of thromboembolic events (eg, DVT, PE) during hospital stay (0.7% vs 0.7% for the hospital TXA and control groups, respectively, OR [1], 95% CI, 0.14 to 7.15). The average time of TXA administration from injury was 100 minutes for ground transportation and 166 minutes for air transportation.

A first subgroup analysis was conducted among patients with ISS>15 (Table 3). The hospital TXA group had statistically lower mortality at 28 days (1.8% vs 7.1%, OR [0.23], 95% CI, 0.06 to 0.81). Moreover, the hospital TXA group used fewer units of blood products (median = 7 units, IQR = (2, 14) vs median = 8.5 units, IQR = (4, 16) for the hospital TXA and control groups, respectively, 95% CI for the difference in median = (-3 to 0)). We found no statistically significant differences in the 24-hour and 48-hour mortality, as well as in other secondary outcomes (Table 3).

We conducted a second subgroup analysis among patients who were transfused ≥10 units of total blood product (Table 4). There were no statistically significant differences in 24-hour, 48-

hour, and 28-day mortality, and all secondary outcomes (Table 4). A final subgroup analysis was conducted based on blunt vs penetrating trauma (Table 5). Among patients who sustained blunt trauma, the hospital TXA group had statistically lower mortality at 28 days (0.6% vs 6.3%, OR [0.09], 95% CI, 0.01 to 0.75). There was no statistically significant difference in the 24-hour and 48-hour mortality, and secondary outcomes (Table 5).

Among patients who sustained penetrating trauma, the hospital TXA group used fewer units of blood products (median = 2 units, IQR = (1, 8) vs median = 8 units, IQR = (5, 15) for the hospital TXA and control groups, respectively, 95% CI for the difference in median = (-6 to -3)), and had a shorter hospital LOS (median = 6 days, IQR = (2.5, 14.5) vs median = 11 days, IQR = (7, 21.5) for the hospital TXA and control groups, respectively, 95% CI for the difference in median = (-7 to -1)). There was no statistically significant difference in the 24-hour, 48-hour, and 28-day mortality, and other secondary outcomes (Table 5).

DISCUSSION

This study completed in July 2018, marks one of the first large-scale prospective studies assessing the effects of TXA administration when used for traumatic hemorrhagic shock in a civilian hospital setting within a developed North American trauma system. Hospital TXA administration was associated with a statistically lower 28-day mortality. Secondary outcomes in this study also demonstrated a statistically significant decrease in hospital LOS.

The current study suggests that TXA may be more effective in patients who are more severely injured and require more units of blood products. The benefit of TXA particularly among the most severely injured trauma patients was consistent with multiple other studies including CRASH-2 and MATTERS.[12,14] Despite the fact that the TXA groups were more severely injured, both studies identified a decrease in mortality.[12,14] Additionally, patients requiring a massive blood transfusion benefited more from the TXA administration.[14] Both benefits were identified despite the inability to quantify the degree of fibrinolysis prior to TXA treatment.

TXA has been hypothesized to exert its beneficial effect on trauma patients via its antifibrinolytic properties. Specifically,

Table 2. Comparison of outcomes and factors between hospital tranexamic acid (TXA) and control groups.

	Hospital TXA group (n = 280)	Control group (n = 280)	Statistic with 95% CI
Outcomes			
Mortality at 24 hours	3 (1.1%)	3 (1.1%)	1 (0.20, 5.00)†
Mortality at 48 hours	3 (1.1%)	4 (1.4%)	0.74 (0.17, 3.37)†
Mortality at 28 days	3 (1.1%)	14 (5%)	0.21 (0.06, 0.72)†
Total blood product, units, median (Q1, Q3)	4 (1, 10)	7 (2, 12.5)	-2 (-3, -1)‡
Hospital LOS, days, median (Q1, Q3)	9 (5, 16)	12 (6, 22.5)	-2 (-5, 0)‡
ICU LOS, days, median (Q1, Q3)	4 (3, 8)	4 (2, 10)	0 (-1, 1)‡
Adverse event during hospital stay			1 (0.14, 7.15)†
VTE	2 (0.7%)	2 (0.7%)	
None	278 (99.3%)	278 (99.3%)	
Factors			
Blunt trauma percentage	159 (56.8%)	160 (57.1%)	0.99 (0.71, 1.38)†
Male percentage	236 (84.3%)	241 (86.1%)	0.87 (0.54, 1.38)†
Age, years, mean ± SD	38.89 ± 15.98	37.91 ± 18.15	0.98 (-1.86, 3.82)*
SBP, mmHg, mean ± SD	99.32 ± 17.84	102.32 ± 23.27	-3.00 (-6.51, 0.50)*
Discharge ISS, median (Q1, Q3)	17 (10, 26)	17 (12, 26)	0 (0, 2)‡
GCS, median (Q1, Q3)	15 (11, 15)	15 (14, 15)	0 (0,0)‡

†Values were presented as the odds ratio (use the control group as the reference) and the corresponding 95% confidence interval. Chi-square tests were conducted to assess the statistical significance. If the 95% confidence interval contains 1, then there was not statistically significant difference between the two groups.

‡Values were presented as the median and IQR for the difference between the two groups (defined as the hospital TXA group less the control group). Wilcoxon rank sum tests were conducted to assess the statistical significance. If the 95% confidence interval contains 0, then there was not statistically significant difference between the two groups.

*Values were presented as the means and 95% corresponding confidence interval for the difference between the two groups (defined as the hospital TXA group less the control group). An independent t-tests were conducted to assess the statistical significance. If the 95% confidence interval contains 0, then there was not statistically significant difference between the two groups.

TXA, tranexamic acid; *CI;* confidence interval; *LOS,* length of stay; *ICU,* intensive care unit; *ISS,* Injury Severity Score; *Q1,* 25th percentile; *Q3,* 75th percentile; *SBP,* systolic blood pressure; *SD,* standard deviation; *GCS*, Glasgow Coma Scale; *VTE*, venous thromboembolic events.

Table 3. Subgroup analysis: comparison of outcomes and factors between hospital tranexamic acid (TXA) and control groups among patients with Injury Severity Score >15.

	ISS>15 (n = 337)		
	Hospital TXA group (n=167)	Control group (n=170)	Statistic with 95% CI
Outcomes			
Mortality at 24 hours	3 (1.8%)	3 (1.8%)	1.01(0.20, 5.12)†
Mortality at 48 hours	3 (1.8%)	4 (2.4%)	0.76 (0.17, 3.44)†
Mortality at 28 days	3 (1.8%)	12 (7.1%)	0.23 (0.06, 0.81)†
Total Blood Product, units, median (Q1, Q3)	7 (2, 14)	8.5 (4, 16)	-2 (-3, 0)‡
Hospital LOS, days, median (Q1, Q3)	13 (7, 17)	14 (7, 27)	-2 (-6, 2)‡
ICU LOS, days, median (Q1, Q3)	5 (3, 10)	5 (3, 13)	0 (-1, 1)‡
Factors			
Blunt trauma percentage	116 (69.5%)	98 (57.7%)	1.67 (1.07, 2.62)†
Male percentage	132 (79%)	146 (85.9%)	0.62 (0.35, 1.10)†
Age, years, mean ± SD	39.23 ± 16.44	35.79 ± 16.84	3.43 (-0.13, 7.00)*
SBP, mmHg, mean ± SD	98.66 ± 17.8	101.26 ± 23.77	-2.60 (-7.18, 1.99)*
Discharge ISS, median (Q1, Q3)	24 (17, 29)	24 (17, 29)	0 (-1, 1) ‡
GCS, median (Q1, Q3)	14 (8, 15)	15 (14, 15)	0 (0, 0) ‡

Table 4. Subgroup analysis: comparison of outcomes and factors between hospital tranexamic acid (TXA) and control groups among patients who were transfused ≥10 units of blood product.

	Blood product ≥ 10 Units (n=176)		
	Hospital TXA group (n=76)	Control group (n=100)	Statistic with 95% CI
Outcomes			
Mortality at 24 hours	3 (4%)	3 (3%)	1.33 (0.26, 6.77)†
Mortality at 48 hours	3 (4%)	4 (4%)	0.99 (0.21, 4.54)†
Mortality at 28 days	3 (4%)	11 (11%)	0.34 (0.09, 1.24)†
Total Blood Product, units, median (Q1, Q3)	15.5 (12, 23.5)	16 (12, 25)	-1 (-3, 1)‡
Hospital LOS, days, median (Q1, Q3)	16 (8, 23)	16 (7, 28.5)	-1 (-8, 6)‡
ICU LOS, days, median (Q1, Q3)	6 (3, 13)	6 (4, 13)	0 (-2, 2)‡
Factors			
Blunt trauma percentage	50 (65.8%)	54 (54%)	1.64 (0.88, 3.03)†
Male percentage	58 (76.3%)	88 (88%)	0.44 (0.20, 0.98)†
Age, years, mean ± SD	41.04 ± 15.78	35.41 ± 16.61	5.63 (0.75, 10.51)*
SBP, mmHg, mean ± SD	98.24 ± 16.94	107.21 ± 23.39	-8.98 (-15.35, -2.60)*
Discharge ISS, median (Q1, Q3)	22 (17, 29)	22 (16, 29)	0 (-2, 4)‡
GCS, median (Q1, Q3)	14 (7, 15)	14 (13, 15)	0 (-1, 0)‡

†Values were presented as the odds ratio (use the control group as the reference) and the corresponding 95% confidence interval. Chi-square tests were conducted to assess the statistical significance. If the 95% confidence interval contains 1, then there was not statistically significant difference between the two groups.

‡ Values were presented as the median and IQR for the difference between the two groups (defined as the hospital TXA group less the control group). Wilcoxon rank sum tests were conducted to assess the statistical significance. If the 95% confidence interval contains 0, then there was not statistically significant difference between the two groups.

*Values were presented as the means and 95% corresponding confidence interval for the difference between the two groups (defined as the hospital TXA group less the control group). An independent t-tests were conducted to assess the statistical significance. If the 95% confidence interval contains 0, then there was not statistically significant difference between the two groups.

TXA, tranexamic acid; *CI;* confidence interval; *LOS*, length of stay; *ICU*, intensive care unit; *Q1*, 25th percentile; *Q3,* 75th percentile; *SBP*, systolic blood pressure; *mmHg,* millimeters of mercury; *SD*, standard deviation; *GCS*, Glasgow Coma Scale; *ISS*, Injury Severity Score.

TXA has been thought to reduce mortality by preventing exsanguination on the day of injury.[21] After significant trauma, coagulopathies may begin almost immediately and can rapidly progress to life-threatening scenarios.[6-8] These coagulopathies have been postulated to be driven in part by excessive activation of the thrombomodulin-protein C pathway.[22] Following tissue hypoperfusion in the setting of traumatic injury, protein C is activated.[3] This subsequent rise in activated protein C leads to proteolytic cleavage and inactivation of procoagulant factors V and VIII.

In addition, activated protein C neutralizes plasminogen activator inhibitor-1 causing increased concentrations of tissue plasminogen activator and further progression of fibrinolysis.[23] These mechanisms combine and can lead to acute traumatic coagulopathies.[22] Research has demonstrated that high levels of activated protein C on admission in trauma patients have been associated with increased mortality, longer hospital stay, and increased transfusion requirements.[22] Although not specifically measured in our study, the role of activated protein C in coagulopathies may show why TXA's ability to inhibit the excess plasminogen is crucial in preventing mortality.

We observed a statistically significant decrease in 28-day mortality, suggesting that TXA may exert an effect beyond the limitation of blood loss and treatment of hyperfibrinolysis. This may be due to the long-term effects of limiting profound hypoperfusion in the setting of trauma and the long-term benefits in controlling bleeding with TXA therapy. The conversion of plasminogen to plasmin in the clotting pathway exacerbates and leads to overactivation of the inflammatory response.[24] Plasmin has been shown to have a direct effect on macrophages,

Table 5. Subgroup analysis: comparison of outcomes and factors between hospital tranexamic acid (TXA) and control groups for blunt vs penetrating trauma.

	Blunt trauma (n = 319)			Penetrating trauma (n=241)		
	Hospital TXA group (n = 159)	Control group (n = 160)	Statistic with 95% CI**	Hospital TXA group (n = 121)	Control group (n = 120)	Statistic with 95% CI
Outcomes						
Mortality at 24 hours	1 (0.6%)	1 (0.6%)	1.00 (0.06, 16.2)†	2 (1.7%)	2 (1.7%)	0.99 (0.14, 7.16)†
Mortality at 48 hours	1 (0.6%)	2 (1.3%)	0.5 (0.04, 5.57)†	2 (1.7%)	2 (1.7%)	0.99 (0.14, 7.16)†
Mortality at 28 days	1 (0.6%)	10 (6.3%)	0.09 (0.01, 0.75)†	2 (1.7%)	4 (3.3%)	0.49 (0.09, 2.71)†
Total Blood Product, units, median (Q1, Q3)	5 (2, 11)	5 (2, 11)	0 (-1, 1)‡	2 (1, 8)	8 (5, 15)	-5 (-6, -3)‡
Hospital LOS, days, median (Q1, Q3)	13 (7, 16)	14 (5, 23)	0 (-6, 4)‡	6 (2.5, 14.5)	11 (7, 21.5)	-4 (-7, -1)‡
ICU LOS, days, median (Q1, Q3)	5 (3, 10)	5 (2, 10)	1 (0, 2)‡	3 (1, 5)	4 (2, 9)	-1 (-2, 0)‡
Factors						
Male percentage	122 (76.7%)	126 (78.8%)	0.89 (0.52, 1.51)†	114 (94.2%)	115 (95.8%)	0.71 (0.22, 2.30)†
Age, years, mean ± SD	42.55 ± 17.34	44.34 ± 19.09	-1.80 (-5.81, 2.22)*	34.08 ± 12.53	29.33 ± 12.46	4.76 (1.59, 7.93)*
SBP, mmHg, mean ± SD	99.25 ± 17.06	100.23 ± 21.4	-0.98 (-5.28, 3.33)*	99.4 ± 18.9	105.46 ± 25.61	-6.06 (-11.94, -0.17)*
Discharge ISS, median (Q1, Q3)	22 (14, 27)	17 (12, 26)	1 (0, 4)‡	14 (9, 19)	17 (11, 25)	3 (1,5)‡
GCS, median (Q1, Q3)	15 (10, 15)	14.5 (13.5, 15)	0 (0, 0)‡	15 (13, 15)	15 (14, 15)	0 (0,0)‡

†Values were presented as the odds ratio (use the control group as the reference) and the corresponding 95% confidence interval. Chi-square tests were conducted to assess the statistical significance. If the 95% confidence interval contains 1, then there was not statistically significant difference between the two groups.

‡Values were presented as the median and IQR for the difference between the two groups (defined as the hospital TXA group less the control group). Wilcoxon rank sum tests were conducted to assess the statistical significance. If the 95% confidence interval contains 0, then there was not statistically significant difference between the two groups.

*Values were presented as the means and 95% corresponding confidence interval for the difference between the two groups (defined as the hospital TXA group less the control group). An independent t-tests were conducted to assess the statistical significance. If the 95% confidence interval contains 0, then there was not statistically significant difference between the two groups.

TXA, tranexamic acid; *CI;* confidence interval; *LOS*, length of stay; *ICU*, intensive care unit; *Q1*, 25th percentile; *Q3,* 75th percentile; *SBP*, systolic blood pressure; *mmHg,* millimeters of mercury; *SD*, standard deviation; *GCS*, Glasgow Coma Scale; *ISS*, Injury Severity Score.

leading to the transcription of the proinflammatory cytokines tumor necrosis factor-alpha and interleukin-6.[25] Excess plasmin can cause detachment of endothelial cells leading to apoptosis and release of radical oxygen species.[24] Aside from the proinflammatory effects, plasmin has also been known to cause platelet hypofunction.[24] TXA's inhibitory effect on the conversion of plasminogen to plasmin may contribute to its anti-inflammatory properties leading to the extended benefits observed in our study. The exact mechanism is likely multi-factorial and needs to be more clearly elucidated.

The efficacy of TXA when used during fibrinolysis and hyperfibrinolysis is controversial. Recent studies demonstrate that TXA may be associated with an increased risk of fibrinolytic shutdown when monitored via thromboelastography (TEG).[26] In another study within a civilian hospital setting, patients receiving TXA required more total blood products and had a statistically significant increase in mortality.[27] However, this study has limitations, given that it is a retrospective study and includes older patients with higher injury severity and hypotension compared to patients in other studies.[12,27]

The incidence of VTE associated with TXA administration in a trauma setting has also been controversial. Johnston et al conducted a retrospective, follow-up study to MATTERs to re-examine TXA use within the military hospital setting.[17] They reported a higher incidence of VTE in patients receiving TXA and found that use of TXA was an independent risk factor for VTE with an overall rate of 15.6% VTE.[17] The prevention of clot dissolution via TXA inhibition of plasmin may heighten risks of VTE by promoting thrombus.[18] A civilian study performed by Myers et al reported a 7.4% and 15.5% incidence rate of VTE for the control and TXA groups, respectively.[19] However, the reported incidence rate of VTE by Myers and Johnston was much higher than other reported VTE incidence rates ranging from 0.36% to 1.8%.[11,20,28]

The current study suggests an incidence rate of 0.7% for VTE among patients who received TXA, which is within range of previously reported incidence rates.[11,20,28] The two studies that reported TXA administration as an independent risk factor for VTE had several significant limitations including the following: retrospective data collection; possible patient selection bias; small sample size; population differences between control groups and TXA groups; VTE surveillance bias; and variation in trauma settings.[17,18] Future prospective research is warranted to examine the incidence of VTE among adult trauma patients.

LIMITATIONS

First, this study was limited by design. The prospective, non-randomized cohort design did not allow TXA to be administered in a blinded fashion. Providers and physicians were aware of TXA administration, which may have affected the level of care provided and assessments of outcome. However, given that the primary outcome was mortality, this impact was likely minimal. Second, we acknowledge an inability to account for certain potential confounding factors. This includes the variability of total transport time to the ED, which contributed to variability of initial TXA administration time. Additionally, despite following the same study protocol, patients were included from two trauma centers in the same geographic area that may follow slightly different institutional policy and procedure. To reduce the impact of these differences on patient outcomes, control patients were matched by trauma center. These factors in addition to minimal inherent differences between the TXA and control groups may limit the generalizability of these results.

Lastly, we did not integrate the use of TEG into this study; thus, we were unable to assess the combined role of TEG and TXA regarding patient outcomes. Debate continues regarding whether TEG can accurately predict the need and use of TXA.[21,29] TEG is not routinely available in many trauma centers; however, those centers have continued including TXA administration in their current trauma resuscitation standards. Further investigation into the combined use of both TXA administration and TEG is warranted.[14]

CONCLUSION

The current study demonstrates a statistically significant reduction in mortality after TXA administration at 28 days, but not at 24 and 48 hours, in patients with traumatic hemorrhagic shock. Future prospective research is warranted to further evaluate the benefits and side effects of TXA use among adult civilian trauma patients on a larger scale.

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Screening for QT Prolongation in the Emergency Department: Is There a Better "Rule of Thumb?"

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Introduction: Identification of QT prolongation in the emergency department (ED) is critical for appropriate monitoring, disposition, and treatment of patients at risk for torsades de pointes (TdP). Unfortunately, identifying prolonged QT is not straightforward. Computer algorithms are unreliable in identifying prolonged QT. Manual QT-interval assessment methods, including QT correction formulas and the QT nomogram, are time-consuming and are not ideal screening tools in the ED. Many emergency clinicians rely on the "rule of thumb" or "Half the RR" rule (Half-RR) as an initial screening method, but prior studies have shown that the Half-RR rule performs poorly as compared to other QT assessment methods. We sought to characterize the problems associated with the Half-RR rule and find a modified screening tool to more safely assess the QT interval of ED patients for prolonged QT.

Methods: We created graphs comparing the prediction of the Half-RR rule to other common QT assessment methods for a spectrum of QT and heart rate pairs. We then proposed various modifications to the Half-RR rule and assessed these modifications to find an improved "rule of thumb."

Results: When compared to other methods of QT correction, the Half-RR rule appears to be more conservative at normal and elevated heart rates, making it a safe initial screening tool. However, in bradycardia, the Half-RR rule is not sufficiently sensitive in identifying prolonged QT. Adding a fixed QT cutoff of 485 milliseconds (ms) increases the sensitivity of the rule in bradycardia, creating a safer initial screening tool.

Conclusion: For a rapid and more sensitive screening evaluation of the QT interval on electrocardiograms in the ED, we propose combining use of the Half-RR rule at normal and elevated heart rates with a fixed uncorrected QT cutoff of 485 ms in bradycardia. [West J Emerg Med. 2020;21(2)226-232.]

INTRODUCTION

In the emergency department (ED), emergency providers encounter patients with prolonged QT for many reasons, including drug overdose, hypokalemia, hypomagnesemia, and therapeutic use of QT-prolonging medications. QT prolongation is a known risk factor for torsades de pointes (TdP). While TdP often self-terminates, it can be associated with hemodynamic instability and collapse and may degenerate into ventricular fibrillation and resultant cardiac death. Identifying ED patients with prolonged QT and risk of TdP is crucial to allow for appropriate monitoring, interventions, and disposition.

Unfortunately, computer electrocardiogram (ECG) algorithms are unreliable in identifying prolonged QT. Prior studies have shown that computer ECG algorithms are often inaccurate in measuring QT interval, particularly in abnormal or poor-quality ECGs.[1] Additionally, when these algorithms do identify prolonged QT, they often fail to report the findings in the computer-generated diagnostic statement.[1,2] For this reason, clinicians should not rely on computer algorithms; they should have an independent method of assessing the QT interval so as

not to miss this critical diagnosis.

The "rule of thumb" or "Half the RR" (Half-RR) rule is one such option. It estimates the QT segment to be prolonged if it occupies greater than one-half the respiratory rate interval, and is a favored clinician screening tool due to its ease of use. Other options for clinician-driven QT interval assessment are more laborious. QT correction formulas require the user to measure the raw QT interval, then calculate a "corrected" QT (QTc) to determine QT prolongation. QTc formulas have their own associated errors, and no QTc formula is clearly superior.[3–7] The Chan QT nomogram offers an outcome-oriented assessment of the QT interval but requires the user to plot the raw QT interval against heart rate to determine whether the patient is at risk of TdP.[8] This clinically-oriented approach is promising but has not been prospectively validated and requires additional analysis on the part of the clinician, which limits its widespread use.

In prior studies, the Half-RR rule has performed poorly when compared to various QTc formulas and the QT nomogram.[9] However, without a simple screening tool like the Half-RR rule, clinicians are likely to rely more heavily on computer measurements that are unreliable and inaccurate. Rather than discard the Half-RR rule entirely, we aimed to assess the reliability of the commonly used Half-RR rule and find a modified, easy-to-use screening tool to more safely assess the QT interval in ED patients for prolonged QT.

Population Health Research Capsule

What do we already know about this issue?
The "Half the RR" (Half-RR) rule is a popular screening tool for prolonged QT, but it performs poorly compared to other QT assessment methods.

What was the research question?
To identify the pitfalls of the Half-RR rule and find a modified screening tool that safely assesses for prolonged QT.

What was the major finding of the study?
Adding a fixed QT cutoff of 485 milliseconds in bradycardia increases the sensitivity of the Half-RR rule, creating a safer screening tool.

How does this improve population health?
Using this modified rule will enhance screening for prolonged QT and improve the identification of patients at acute risk of torsades de pointes and sudden cardiac death.

METHODS

Graph Development and Initial Comparison

We used R software (open source, version 3.4.4) to create graphs comparing the prediction of the Half-RR rule to various common QT assessment methods, including the Chan QT nomogram and the Bazett, Fridericia, Framingham, and Hodges QTc formulas. These graphs considered all possible QT-heart rate pairs, with QT intervals ranging from 300 milliseconds (ms) to 1000 ms and heart rates ranging from 40 beats per minute (bpm) to 150 bpm. The prediction of the given QT correction method (ie, prolonged vs not prolonged QT interval) for each QT-heart rate pair was calculated and is reflected on the graph. For the QT correction formulas, a QTc of 485 ms and higher was considered prolonged. We chose this value recognizing that the upper limit of normal for QTc varies by gender and formula used. While no perfect cutoff has been established, prior studies suggest that a QTc of 485 ms is beyond the upper limit of normal in both genders and in all formulas used in this study.[4,7]

We then created a series of agreement graphs to better identify occasions that prediction of the Half-RR rule differed from the other methods. All possible QT-heart rate pairs were plotted and identified as "prolonged" or "not prolonged" according to the correction method used in that graph. We then compared the Half-RR graph to each of the various other QT assessment methods to highlight areas of agreement and disagreement between the Half-RR rule and that particular method.

Development of New Screening Rules

After understanding the problem areas for the Half-RR rule, we then considered various modifications to improve the rule of thumb as a screening tool for clinicians. We created several new screening rules in an attempt to improve the sensitivity of the rule of thumb in bradycardia without compromising the specificity at higher heart rates.

Data analysis

We analyzed the test characteristics of the new screening rules using standard diagnostic statistics and calculated using R statistical computing software, version 3.4.4.

RESULTS

The performances of the various QT assessment methods over a range of QT interval and heart rate pairs is depicted in Figure 1.

The Half-RR rule is notably different from the other graphs, but most closely mimics the other QT correction methods between heart rates of 60-100 bpm. At heart rates below 60 bpm, the Half-RR rule labels too many QT intervals as normal, thus producing more false negatives. In tachycardia, the Half-RR tends to label too many QT intervals as prolonged, and thus has more false positives.

Figures 2 and 3 highlight the areas of agreement and disagreement between the Half-RR rule and other QT

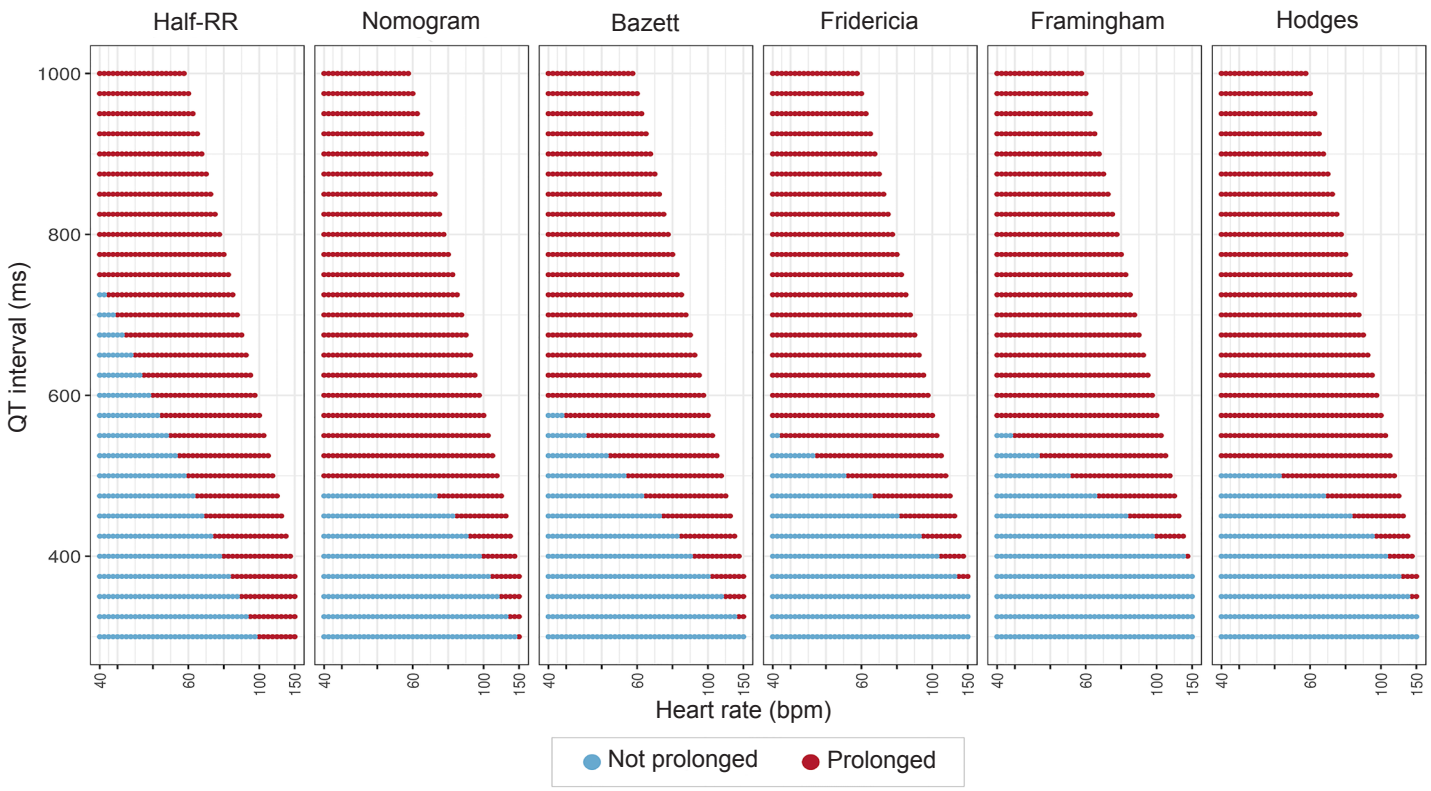

Figure 1. Prediction of various QT correction methods. This graph shows the predictions of each QT correction method (ie, prolonged vs not prolonged QT interval) for various QT-heart rate pairs. The Half-RR rule differs significantly from the remainder of the methods. In bradycardia, the Half-RR rule labels fewer QT intervals as "prolonged" as compared to the other methods. In tachycardia, the Half-RR rule labels more QT intervals as "prolonged."
ms, milliseconds; *RR*, respiratory rate; *bpm*, beats per minute.

assessment methods and also support this assessment. At heart rates between 60-66 bpm, the Half-RR rule is accurate as compared to the other methods. Below 60 bpm, the Half-RR rule often failed to note prolonged QT as indicated by all other methods. By contrast, above 66 bpm,the Half-RR rule was overly conservative. At 96 bpm, all four formulas consider a QT stretching 60% of the RR interval to be not prolonged, indicating that at high heart rates, the Half-RR rule produces many false positives.

In Figure 4**,** we considered whether changing the percentage from 50% of the RR interval to a higher or lower percentage would result in a better rule of thumb. Lowering the percentage to 40% of the RR interval produces far too many false positives at higher heart rates. Raising the percentage to 60% of the RR interval produces far too many false negatives at lower heart rates.

Keeping in mind our goal of creating a screening rule for clinicians to use to routinely assess QTc prolongation by mental math, we developed several new rules of thumb aimed at improving the sensitivity of the rule in bradycardia without sacrificing specificity at higher heart rates. The proposed rules (Table 1) focus on percentages and fixed cutoffs so that they would be easy to calculate and remember.

The proposed screening rules were compared to the QT nomogram given its promising data and clinically-oriented focus. Figure 5 demonstrates how the increasingly complex rules successively fill in the additional area where the traditional half-RR rule of thumb disagrees with the nomogram.

The "fixed" rule, a combination of the Half-RR rule with a fixed cut-off of 485 ms in bradycardia, most closely mimics the QT nomogram. The sensitivity of the unmodified Half-RR rule for detecting QTc prolongation, using the nomogram as a reference standard, is 84.2% (95% confidence interval [CI], 81.5-86.9%). The addition of the fixed cutoff of 485 ms in bradycardia raises the sensitivity to 100% (99.5-100.0%). The single and multiple proportional rules have 96.1% (94.7-97.5%) and 95.3% (93.7-96.8%) sensitivity. The specificity of these rules ranges from 75.4% to 80.3%. Table 2 presents the full test characteristics of each rule.

DISCUSSION

Our analysis shows consistently poor test characteristics of the Half-RR rule as compared to other methods of QT interval assessment. In bradycardia, the Half-RR rule consistently misses cases of prolonged QT as identified by all other QT

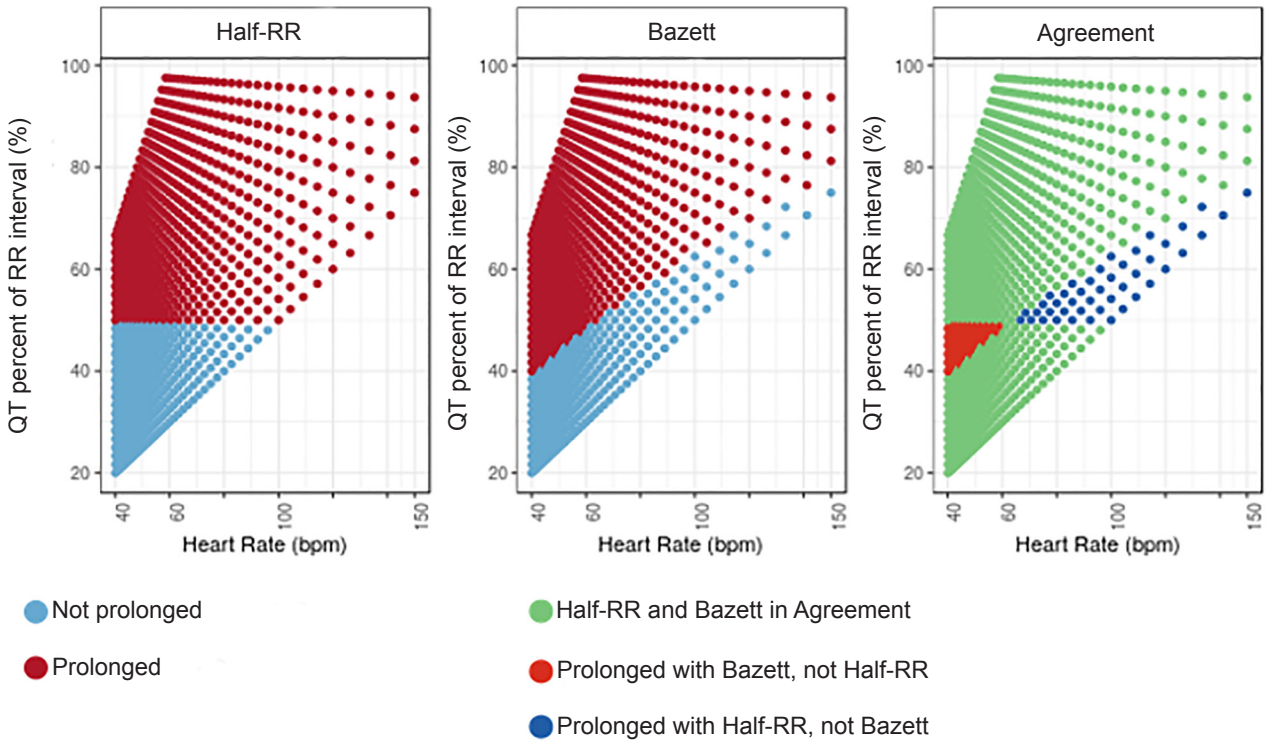

Figure 2. Agreement Between the Half-RR and Bazett's Formula.
The left and center graphs show the prediction of the Half-RR rule and the Bazett correction method for various QT-heart rate pairs, showing the QT interval as a percent of the RR interval on the y-axis. The right graph shows the areas of agreement and disagreement between the Half-RR rule and Bazett correction method, showing that the Half-RR rule is less conservative than Bazett in bradycardia, but more conservative at higher heart rates.
bpm, beats per minute.

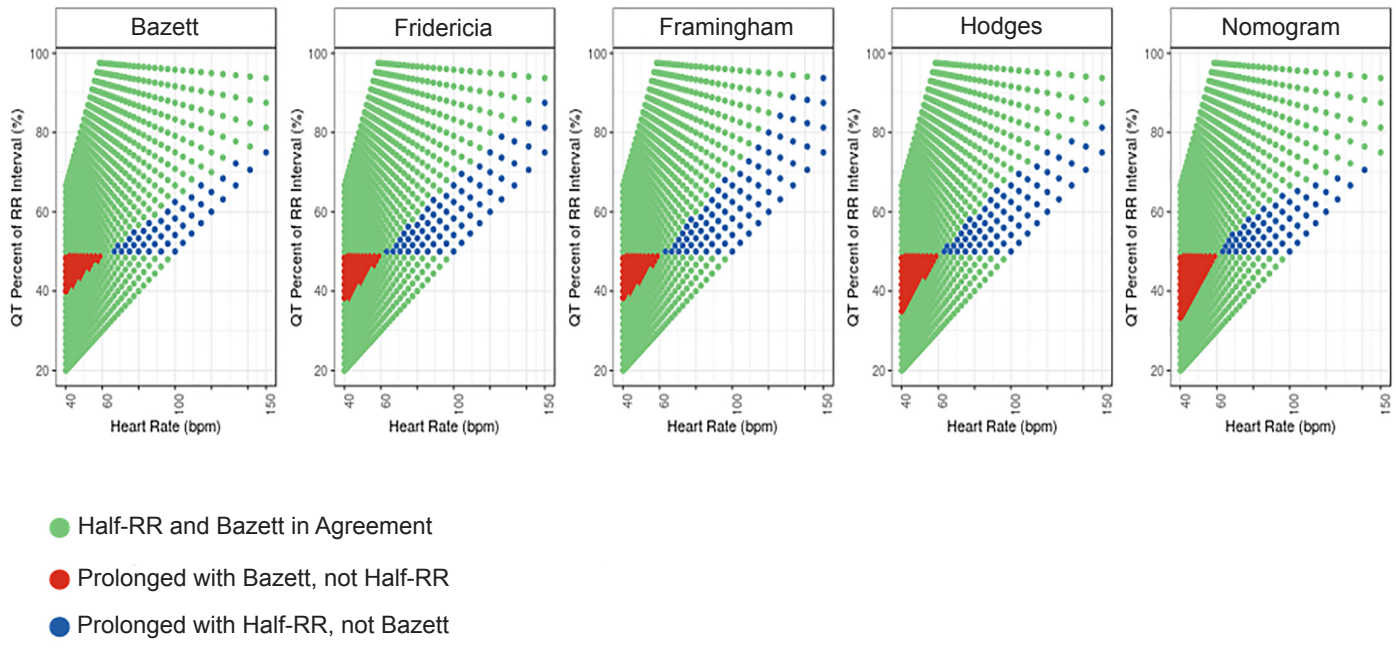

Figure 3. Areas of agreement and disagreement among the Half-RR rule and the remaining QT correction methods. Red areas represent occasions when the Half-RR rule is less conservative than the listed QT correction method. These instances only occur in bradycardia.
RR, respiratory rate; *bpm*, beats per minute.

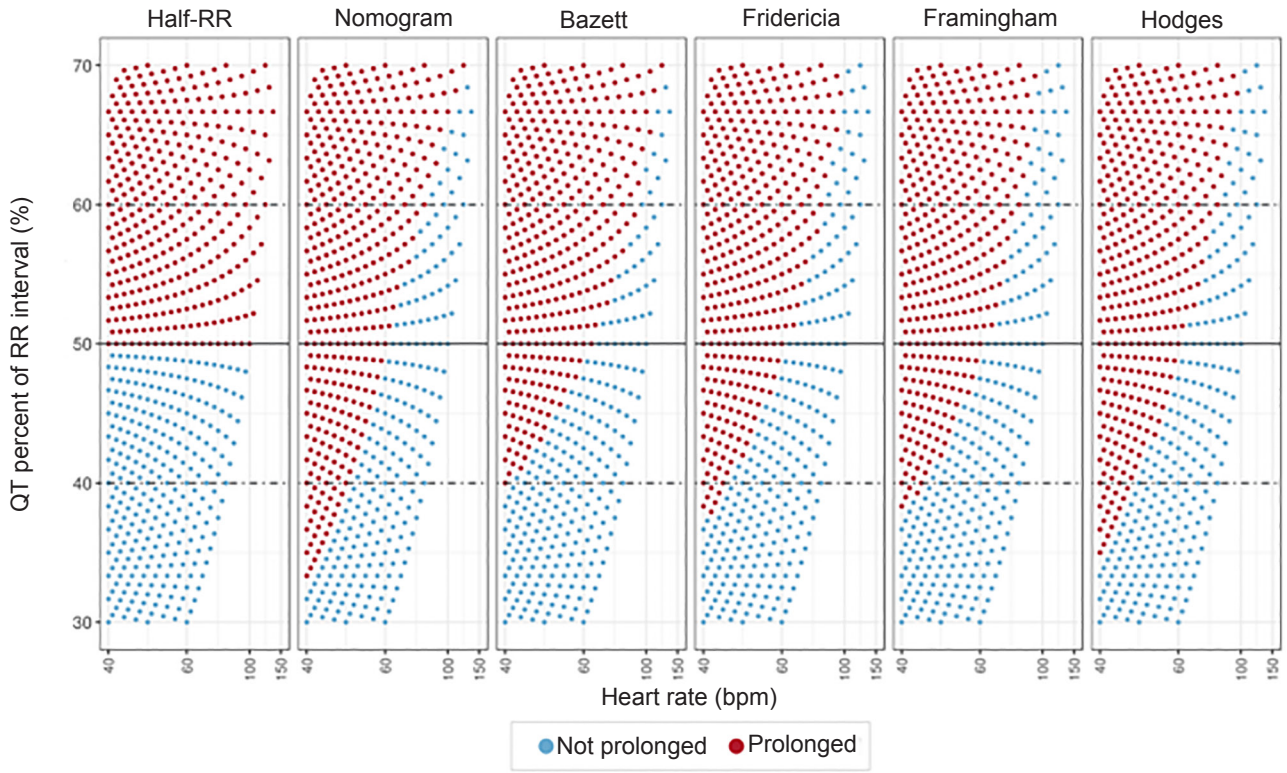

Figure 4. A perfect formula "rule of thumb" based on percentage is impossible. Changing the percentage in the rule of thumb to 60% (ie, raising the horizontal line of demarcation) increases the specificity at higher heart rates but increases the false negatives at low and normal heart rates. Lowering the percentage to 40% (ie, lowering the line of demarcation) would make the screening tool more sensitive in bradycardia but would result in many more false positives at normal and high heart rates.
RR, respiratory rate; *bpm*, beats per minute.

Table 1. Proposed new "rules of thumb."

Fixed	Half-RR rule above 60 beats per minute (bpm), fixed cutoff of 485 below 60 bpm
Single Proportional	Half-RR rule above 60 bpm, 40% RR below 60 bpm
Multiple Proportional	60% RR above 90 bpm, Half-RR rule above 60 bpm, 45% RR below 60 bpm, 40% RR below 50 bpm

correction methods. At normal and elevated heart rates, the Half-RR rule produces many more false positives as compared to other QT correction methods. This is consistent with prior research, which has shown the Half-RR rule to have a poor sensitivity at heart rates below 60 bpm, but 100% sensitivity and approximately 50% specificity with heart rates above 60 bpm.[9]

The Half-RR rule is used primarily as a screening tool; thus, a low sensitivity in any clinical context is problematic. The poor sensitivity in bradycardia is of particularly serious concern given that patients are most clinically at-risk of TdP when they are bradycardic due to the pause-dependent TdP phenomenon. Lowering the percentage used in the rule of thumb was not an acceptable solution to this problem, as doing so negatively impacted the specificity of the rule. Of the newly considered modified rules of thumb, the "fixed" rule adds a simple modification to the Half-RR rule to resolve the poor sensitivity in bradycardia. For heart rates below 60 bpm, the raw QT is declared prolonged when above 485 ms, achieving excellent sensitivity (100%, CI, 99.5-100.0%) without unduly decreasing specificity.

At normal and elevated heart rates, our analysis shows that the Half-RR rule is more conservative than other QT assessment methods and produces many more apparent false positives. The new "fixed" RR rule does not address this issue. Thus, if the "fixed" RR rule deems a QT interval "prolonged" at any heart rate above 66 bpm, the clinician should proceed with formal measurement and risk assessment based on the QT nomogram or one of the correction formulas.

The proposed "fixed" RR rule is simple to use and remember. It is a safe and realistic initial screening tool for QT prolongation for emergency clinicians. Using this screening tool should improve recognition of prolonged QT in bradycardia in the ED and assist clinicians in safely "ruling-out" prolonged QT at normal and elevated heart rates.

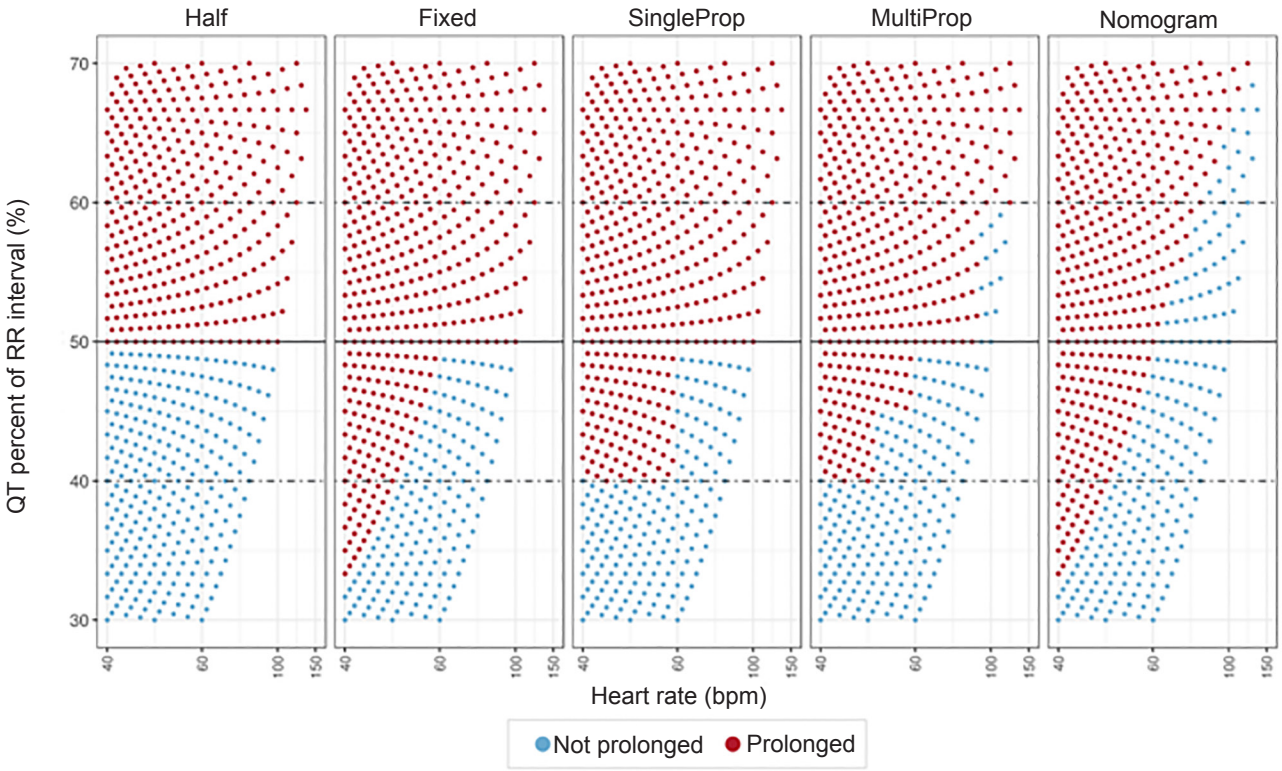

Figure 5. Comparison of the performance of various, newly proposed "rules of thumb." The proposed "fixed" rule most closely mimics the QT nomogram and improves the sensitivity of the Half-RR rule in bradycardia.

Table 2. Diagnostic test characteristics of the proposed rules of thumb compared to the Chan nomogram.

	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)	Positive likelihood ratio	Negative likelihood ratio
Half-RR	84.2	80.3	91.1	67.8	4.3	0.2
Fixed	100	80.3	92.4	100	5.1	0
SingleProp	96.1	75.4	90.1	90.0	3.9	0.1
MultiProp	95.3	84.1	93.5	88.0	6.0	0.1

LIMITATIONS

There are several limitations to this discussion. First, the Half-RR rule ideally would be evaluated by comparing it to a gold-standard formula or nomogram that has been carefully calibrated against a large database with mortality as the outcome. Such a gold standard does not exist. The existing QT correction rules were not derived with mortality outcomes in separate validation samples, although the Bazett correction has been used to correlate long QTc with long-term, but not short-term, outcomes.[9] Instead, we compared the Half-RR method to each of the four formulas and the QT nomogram, effectively substituting usual care for the unattainable gold standard.

Second, these measures depend on the population values. While sensitivity and specificity do not vary with population prevalence in theory, in practice they seem to do so.[10] Since we have arbitrarily generated a population of values, these values may change slightly if we knew that particular ratios of RR intervals to QT intervals were more common. Still, in the absence of data on prevalence of RR and QT pairs in the ED, it is difficult to improve upon this strategy of comparing to the existing – and more complicated – rules.

Finally, the above discussion implies that the variation of QT interval across heart rates is alike in all individuals. However, a substantial body of research shows that there is

great interindividual variability and even intrasubject variability.[3,11,12] The most accurate way to know a patient's true corrected QT at a given heart rate is to measure and plot the individual patient's QT interval over a range of heart rates. Of course, this task is not realistic in the ED setting. The discussion and strategies offered above provide a reasonable and more realistic approach to QT interval assessment without highly personalized patient data.

CONCLUSION

Recognizing and addressing prolonged QT intervals is critical in the ED. Accurately identifying patients with dangerously prolonged QT intervals allows emergency clinicians to intervene on patients who are at acute risk of TdP and to avoid discharging patients at risk of sudden death. There are many complexities in measuring and correcting the QT interval, and, unfortunately, computer algorithms cannot be relied upon for accurate QT measurement and correction. When the heart rate is above 60 bpm, the Half-RR rule is a conservative screening tool and may be safely used. In bradycardia, the Half-RR rule is prone to false negatives and should not be used. Instead, a fixed cutoff of 485 ms is likely a better measure, but further validation is required.

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Bridging the Gap in Emergency Medicine in Pakistan

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To the Editor:

Pakistan has an increasing need for a strong emergency care system as emergency conditions – acute cardiovascular disease, road injuries, and stroke – form the top 10 leading causes of death.[1] However, until 2019 the country had only seven officially-recognized emergency medicine (EM) residency programs, on average five years long, leading to an insufficient number of EM specialists, and a large gap in quality emergency care provision. This, in addition to the high turnover rate of the existing emergency doctors, results in a gap that will take approximately 30 years to bridge.[2] Hence, in the interim, a training module is needed, comprising of a well-developed, shorter EM curriculum to efficiently train the current emergency department (ED) workforce: predominantly medical officers with no formal EM training.

Thus, the year-long Certification Program in Emergency Medicine (CPEM) was developed by EM specialists from The Indus Hospital (TIH), Karachi, Pakistan, and Brigham & Women's Hospital – a teaching affiliate of Harvard Medical School, Boston, USA - and launched at TIH in July 2018.

The objectives of this program are to ensure that participants become familiar with fundamental concepts in EM, understand ED processes and patient flows, seek formal specialisation in EM, represent and advocate for EM over various platforms, and, overall provide better patient care.

The teaching site is a 300-bed tertiary care facility, with a 25-bed ED, six-bed intensive care unit, six-bed coronary care unit, and five operating rooms, serving a low-income catchment population and approximately 300,000 patients monthly. The CPEM is aimed towards training EM physicians in proper emergency care, improving ED employee retention, and fostering support for EM throughout Pakistan. The program curriculum is based on the College of Physicians & Surgeons Pakistan (CPSP), the American College of Emergency Physicians (ACEP) and African Federation of Emergency Medicine (AFEM) guidelines, with input from EM specialists experienced in providing and managing EM training in both first-world and lower-and-middle-income country (LMIC) contexts. The curriculum is divided into 12 month-long topic blocks, each based around a specialty or organ system (eg, cardiovascular, trauma, psychiatry) (Table 1).

CPEM offers both didactic and practical learning to full-time physicians from TIH and from five other institutes across Karachi, with instruction and mentorship from local and international faculty. Participants are divided into two groups: CPEM-Clinical (CPEM-C), comprised of doctors from the teaching site, and CPEM-Didactic (CPEM-D) (ie, doctors from the other hospitals). Participants are assessed through regular examinations and formative and summative evaluations. Other competencies, such as participants' attitude, professionalism, documentation, cognitive processes, etc., are also assessed for quality improvement purposes using guidelines developed by the Accreditation Council for Graduate Medical Education (ACGME) in the USA. Special innovations within CPEM include point-of-care ultrasound practice, flipped classroom sessions, practical workshops (eg, intubation, splinting and reduction, laceration repair), weekly case-based discussions over a messaging application, and use of low-cost improvised models to hone procedural skills (eg, thoracostomy, lateral canthotomy, incision and drainage, central venous catheter placement). CPEM-C participants receive clinical mentorship in the ED from the Visiting Faculty. Additionally, participants are also given exposure to various types of imaging and technology (e.g., computed tomography, ultrasound, and radiograph; magnetic resonance imaging is not available at the teaching site).

Another innovative aspect is the proactive role of the participants. Their feedback is used in program decision-making and curriculum revision, and the institutional diversity they bring allows for a healthy exchange of ideas, practices and policies, all of which contribute towards a dynamic and efficient learning experience. This will eventually lead to improved quality of care, and stronger inter-ED synergy in the future.

Block	Topic	Key skills and procedures
1	Cardiovascular	Advanced Cardiac Life Support (light), echocardiogram, electrocardiogram (ECG), pericardiocentesis, central venous catheter placement, ultrasound-guided intravenous line placement, ankle-brachial indices, pulsus paradoxus
2	Pulmonary	Intubation, mechanical ventilation, non-invasive positive pressure ventilation, arterial blood gas, chest tube/needle decompression, thoracentesis, lung ultrasound
3	Trauma	Advanced Trauma Life Support (light), FAST/e-FAST
4	Orthopedics, Immunology/ Rheumatology, Dermatology	Arthrocentesis, laceration repair, wound care, incision and drainage, procedural sedation, nerve blocks, splinting, joint radiograph interpretation
5	Renal, Genitourinary, Gynecology	Foley placement, renal/bladder/pelvic ultrasound, lab interpretation (electrolytes)
6	Pediatrics	Pediatric Advanced Life Support (light), intraosseous line placement, pediatric lumbar puncture, pediatric intravenous access, pediatric ultrasound, pediatric radiograph interpretation
7	Obstetrics/Gastrointestinal	ALSO (light), emergency delivery, obstetrical ultrasound, nasogastric tube placement, paracentesis, abdominal ultrasound
8	Neurology	NIHSS, lumbar puncture
9	Ophthalmology and HEENT	Slit lamp exam, foreign body removal, peritonsillar abscess drainage, nasal packing, lateral canthotomy, dental block, eye ultrasound
10	Hematology, Oncology, Endocrinology	Lab interpretation (hematology and coagulation studies, endocrinology studies)
11	Psychiatry and Toxicology	Chemical and physical restraints, ECG interpretation
12	Infectious Diseases	Antibiotic use, review of ultrasound and procedures

Table 1. Certification Program in Emergency Medicine Block Overview.
ECG, electrocardiogram; *FAST*, focused assessment with sonography in trauma; *e-FAST*, extended focused assessment with sonography in trauma; *ALSO*, Advanced Life Support in Obstetrics; *NIHSS*, National Institutes of Health Stroke Scale; *HEENT*, head, eyes, ears, nose, and throat.

Throughout the first academic year, from July 2018 to June 2019, participants had received nearly 300 hours of instruction, and covered over 70 simulated cases, with CPEM-C trainees additionally logging several hundred cases and supervised procedures. In its first year, CPEM graduated 25 out of 32 originally enrolled physicians, with about 20 participants certain about seeking additional training in EM. In its new academic year, CPEM has 29 enrollees, from eight different hospitals, with some excelling graduates from the first batch returning to assist as instructors.

Ultimately, as this model embodies a modular, flexible learning approach, with a concentration on adaptation vs adoption, it has the potential to be replicated in other settings with a high burden of emergency conditions and rudimentary emergency care systems. It is hoped that the CPEM model can be expanded to other hospitals and will foster increased inter-ED collaboration, and continued interest in EM will contribute towards significantly advancing the quality and accessibility of emergency care in Pakistan. Especially in LMICs, where EM is still emerging, it will take decades to achieve a sufficient capacity of formally trained providers. However, the CPEM model can serve as a feasible mechanism in bridging this gap and helping to improve the overall state of emergency care in low-resource settings.

For more information on CPEM, please visit: http://www.cpem.com.pk/.

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Penalties for Emergency Medical Treatment and Labor Act Violations Involving Obstetrical Emergencies

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Introduction: The Emergency Medical Treatment and Labor Act (EMTALA) was intended to prevent inadequate, delayed, or denied treatment of emergent conditions by emergency departments (ED). While controversies exist regarding the scope of the law, there is no question that EMTALA applies to active labor, a key tenet of the statute and the only medical condition – labor – specifically included in the title of the law. In light of rising maternal mortality rates in the United States, further exploration into the state of emergency obstetrical (OB) care is warranted. Understanding civil monetary penalty settlements levied by the Office of the Inspector General (OIG) related to EMTALA violations involving labor and other OB emergencies will help to inform the current state of access to and quality of OB emergency care.

Methods: We reviewed descriptions of all EMTALA-related OIG civil monetary penalty settlements from 2002-2018. OB-related cases were identified using keywords in settlement descriptions. We described characteristics of settlements including the nature of the allegation and compared them with non-OB settlements.

Results: Of 232 EMTALA-related OIG settlements during the study period, 39 (17%) involved active labor and other OB emergencies. Between 2002 and 2018 the proportion of settlements involving OB emergencies increased from 17% to 40%. Seven (18%) of these settlements involved a pregnant minor. Most OB cases involved failure to provide screening exam (82%) and/or stabilizing treatment (51%). Failure to arrange appropriate transfer was more common for OB (36%) compared with non-OB settlements (21%) ($p = 0.041$). Fifteen (38%) involved a provider specifically directing a pregnant woman to proceed to another hospital, typically by private vehicle.

Conclusion: Despite inclusion of the term "labor" in the law's title, one in six settlements related to EMTALA violations involved OB emergencies. One in five settlements involved a pregnant minor, indicating that providers may benefit from education regarding obligations to evaluate and stabilize minors absent parental consent. Failure to arrange appropriate transfer was more common among OB settlements. Findings suggesting need for providers to understand EMTALA-specific requirements for appropriate transfer and for EDs at hospitals without dedicated OB services to implement policies for evaluation of active labor and protocols for transfer when indicated. [West J Emerg Med. 2020;21(2)235-243.]

INTRODUCTION

The Emergency Medical Treatment and Labor Act (EMTALA) was enacted in 1986, in response to highly publicized incidents of inadequate, delayed, or denied treatment of uninsured patients including pregnant women by emergency departments (ED).[1-4] While controversies exist regarding the scope of EMTALA,[5] there is no question that the law applies to active labor, a key tenet of the statute and the only condition specifically included in the title of the law. EMTALA is actively enforced with more than a quarter of hospitals in the United States having received citations for EMTALA violations between 2005-2014.[6]

More than three decades after passage of EMTALA, hospitals continue to be cited for EMTALA cases related to labor and other obstetrical (OB) emergencies. Between 2005-2014, 198 (9%) of 2118 citations for EMTALA violations were related to labor and 97 (5%) to other OB emergencies.[6] Prior systematic studies have described general patterns of EMTALA enforcement,[6] resulting fines,[7-10] impact of the law on on-call coverage,[11] and patterns of EMTALA transfers for surgical subspecialty care.[12-17] Despite the fact that labor is the only medical condition named in the title of the law, EMTALA violations related to labor and other OB emergencies have not previously been systematically described in the peer-reviewed medical literature.

EMTALA requires that all patients presenting to a dedicated ED have 1) a timely medical screening, 2) stabilization of emergency medical conditions, and 3) transfer of care if services required for stabilization are not available at the facility.[18] Hospitals have a duty to accept transfer of patients requiring specialty care if the facility has an on-call specialist and capacity to treat the patient.[18] All hospitals with Medicare provider agreements are subject to EMTALA, and enforcement is conducted by the Centers for Medicare and Medicaid Services (CMS). The Office of the Inspector General (OIG) of the Department of Health and Human Services has power to assign civil monetary penalties to facilities and individual physicians that violate EMTALA.[19] An estimated 7.9% of EMTALA violations result in a civil monetary penalty.[9] The historic maximum civil monetary penalty of $50,000[18] for an EMTALA violation increased to $103,139 in 2016.[20]

While general characteristics of OIG civil monetary penalties have been previously described for hospitals[7,9,10] and individual physicians,[8] characteristics of civil monetary penalties related to EMTALA violations involving active labor and other OB emergencies specifically have not previously been described. In light of rising maternal mortality rates in the US[21] that now far exceed those of other developed countries, further exploration into the state of emergency OB care is warranted. Understanding civil monetary penalty settlements levied by the OIG related to EMTALA violations involving labor and other OB emergencies will help to inform the current state of access to and quality of emergency care for patients with labor and other OB emergencies. The purpose of this study is to describe characteristics of civil monetary penalties imposed by the OIG related to EMTALA violations involving active labor and other OB emergencies.

Population Health Research Capsule

What do we already know about this issue?
While labor is the only condition named in the law's title, EMTALA violations related to labor and other obstetrical (OB) emergencies have not previously been described.

What was the research question?
To describe characteristics of civil monetary penalties related to EMTALA violations involving labor and other OB emergencies.

What was the major finding of the study?
One in six settlements involved OB cases (one in five were pregnant minors). OB settlements more often involved failure to arrange transfer.

How does this improve population health?
Providers may benefit from education regarding EMTALA requirements to evaluate, stabilize and, when necessary, arrange appropriate transfer of patients with OB emergencies.

METHODS

Study Design and Data Sources

We obtained case descriptions of all civil monetary penalty settlements issued between 2002-2018 from the OIG.[22] Using methodology established in prior work,[7,8] we identified civil monetary penalty settlements related to EMTALA violations by inclusion of the terms "EMTALA" or "patient dumping" in the title or text of the settlement description, and settlements unrelated to EMTALA (eg, kickback allegations, fraudulent Medicare claims) were excluded from analysis. Case descriptions included settlement amount, location, and brief description of the involved patient's condition and for some cases, clinical course, although the level of detail provided varied between entries. We additionally categorized locations by CMS region, the level at which EMTALA is enforced. Appendix A includes a map depicting each of the 10 CMS regions.

Identification of Cases Involving Obstetrical Emergencies

We identified settlements related to OB conditions by searching text of case settlement descriptions for key words: pregnant, pregnancy, birth, and labor. We excluded cases where the term "labor" was included in the description as part of the EMTALA acronym without relevance to an OB context. Each

case description was reviewed and coded by two authors (EB, ST), and kappa statistics were calculated to evaluate for inter-rater reliability for identification of OB cases.[23]

Recording of Case Features

We recorded the date, location, and settlement amount for each case, as well as whether the settlement involved a hospital or individual physician. When available, the age of involved patient and location of the incident within the hospital were recorded as well (ED vs labor and delivery triage). Settlement descriptions were reviewed to determine if they described 1) failure to provide appropriate medical screening exam, 2) failure to provide stabilizing treatment, 3) failure to arrange appropriate transfer, 4) failure to accept appropriate transfer, or 5) failure of an on-call doctor to respond, consistent with prior work in this field.[7] These categories correspond to EMTALA deficiency tags involving clinical aspects of care, and a list of tags and descriptions is included in Appendix B.

Of note, for settlement descriptions describing EMTALA deficiencies for both an OB patient and a non-OB patient, only those deficiencies involving the OB patient were included in analysis. For example, in one case a Florida hospital system agreed to pay $85,000 for allegedly violating the Patient Anti-Dumping Statute on three separate occasions when they did the following: 1) inappropriately transferred a 27-year old female in active labor; 2) did not accept a patient referred to one of its facilities under the Baker Act; and 3) failed to provide an appropriate medical screening examination for a patient who arrived at its ED. For the present analysis, only the first instance, the inappropriate transfer of the patient in active labor, would have been recorded as the failure to accept and failure to provide a medical screening exam pertained to non-OB patients. Settlement descriptions involving labor and OB emergencies were systematically reviewed for 1) reference to a provider directing a pregnant patient to proceed to another facility, 2) whether they were directed to the facility where their obstetrician practiced, and 3) whether the transport was by private vehicle.

Data Analysis

We compared characteristics of cases resulting in OIG settlements between those involving and those not involving OB emergencies with t-tests, chi-squared and Fisher's exact tests, as indicated. We performed statistical analyses using Stata/MP13 (StataCorp, College Station, TX). This study was approved by the Health Sciences Institutional Review Board at the University of Southern California, Los Angeles.

Illustrative Case Study

To provide a richer understanding of EMTALA violations, enforcement and settlement process, we conducted an in-depth study of an illustrative case. A recent OIG settlement related to an EMTALA violation involving an OB emergency was identified. Reports and proceedings from the EMTALA investigation including the facility's proposed corrective actions were obtained from CMS via a Freedom of Information Act request. Individual patient-level identifiers were redacted in documents provided. We examined contextual information about the hospital cited for this EMTALA violation to provide understanding of the circumstances and conditions in which the hospital operates. The clinical case that led to the EMTALA investigation was described in detail. We summarized EMTALA investigation findings and facility corrective actions from this case to provide a deeper example of the EMTALA enforcement process and hospital response to EMTALA citation for cases involving labor and OB emergencies.

RESULTS

Characteristics of Civil Monetary Penalties Related to Obstetrical Emergencies

Between 2002-2018, there were 232 civil monetary penalty settlements related to EMTALA in the US. Among these, eight (3%) were levied against individual physicians and 224 (97%) were levied against facilities. Of all civil monetary penalty settlements related to EMTALA, 39 (17%) involved OB emergencies, including three against individual physicians. The kappa inter-rater reliability for identification of OB cases was 0.985. (The sole case with disagreement upon preliminary review was determined by consensus to be related to an OB condition). While the number of overall annual EMTALA-related settlements declined by 58% during the study period from 24 in 2002 to 10 in 2018, settlements related to labor and other OB emergencies occurred relatively consistently (Figure 1), with four settlements in the first and last years of the study period. The proportion of all settlements related to labor and other OB emergencies increased from 17% in the first year to 40% in the final year of the study period.

Most cases resulting in settlements involving OB emergencies centered on a failure to provide medical screening exam (82%) and/or stabilizing treatment (51%). Failure to arrange appropriate transfer was more common for OB-related settlements (36%) compared with non-OB settlements (21%) ($p = 0.041$). Failure to accept an appropriate transfer (5%) and failure of an on-call doctor to respond (3%) were less common in OB cases. Characteristics of OIG settlements related to EMTALA violations involving OB emergencies are shown in Table 1.

Although location of incident was not uniformly recorded, 21 (54%) cases were specifically noted to have occurred in an ED compared with five (13%) in labor and delivery areas. Additionally, six (15%) of the settlements involving OB issues included descriptions of EMTALA deficiencies related to separate patients with non-OB complaints. (See Appendix C for example). Fifteen (38%) OB settlements were noted to involve a provider specifically directing a pregnant woman to proceed to another hospital, with seven (47%) of these women directed specifically to hospitals where their obstetrician practiced. Nine (60%) of these patients were specifically noted to proceed to the other hospital by private vehicles. In one case a patient was escorted to their personal vehicle and directed to call 911. While ages of

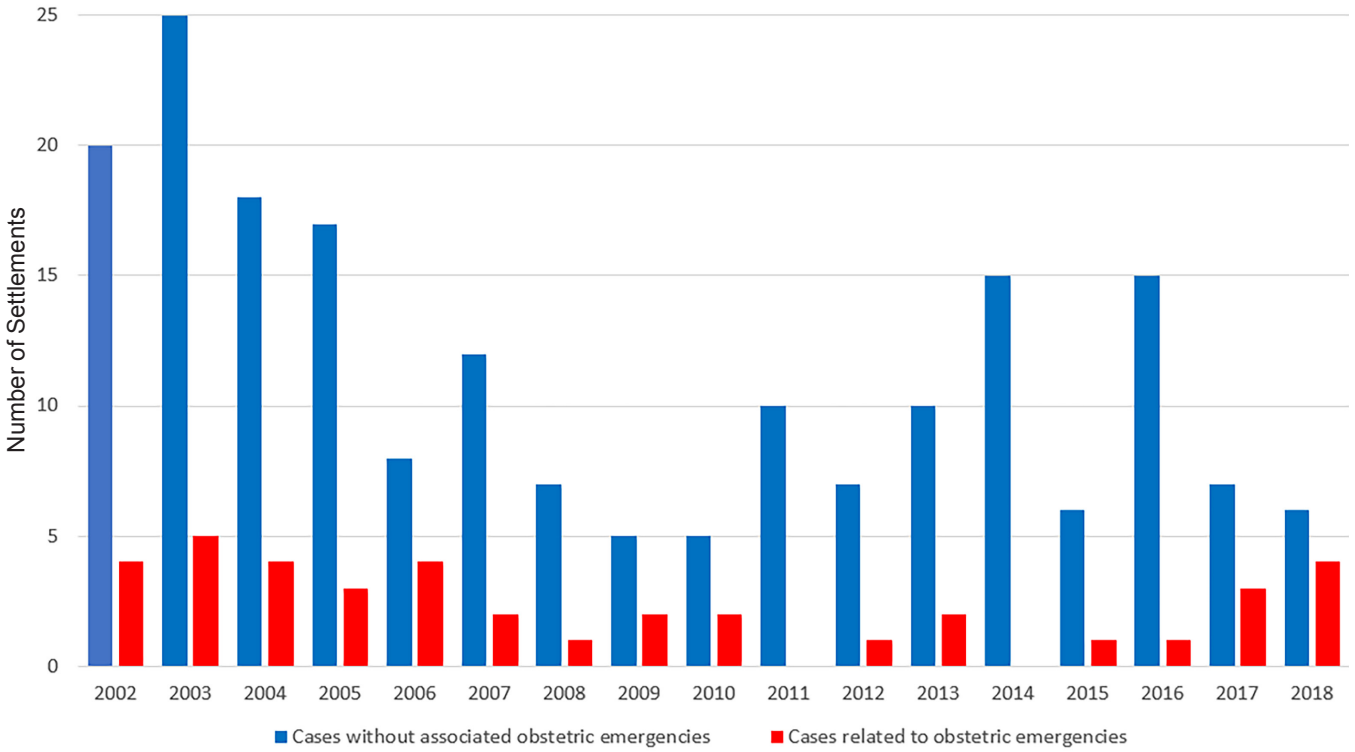

Figure 1. Civil monetary penalty settlements related to violation of the Emergency Medical Treatment and Labor Act Involving obstetrical emergencies by year (number).

patients involved in cases resulting in civil monetary penalties are not systematically reported, seven (18%) settlements related to OB emergencies were specifically noted to involve a pregnant minor. Settlement summaries for those cases noted to involve a pregnant minor are included in Appendix C.

Of the 39 civil monetary penalties related to OB emergencies, 15 (38%) occurred in CMS Region IV, including eight (53%) in Florida and five (20%) in North Carolina. CMS Region VI accounted for eight (21%) settlements related to OB emergencies with five (63%) of these in Texas, and three (37%) in Louisiana. Average settlements related to OB emergencies by year are depicted in Figure 2. For the majority of the study period, the maximum OIG civil monetary penalty for an EMTALA violation was set at $50,000, which approximately doubled in 2016 with plans for future inflation adjustments.[20] Four settlements exceed the maximum penalty amount, including for $80,000 in 2005, $85,000 in 2008, $90,000 in 2012, and $200,000 in 2018, indicating that the OIG has been stacking penalties for multiple deficiencies identified during a single citation event.

Case Study

To provide a richer description of the EMTALA enforcement process and hospital response to EMTALA citations, we included findings and facility corrective actions from the EMTALA investigation related to a recent OIG settlement involving an OB emergency in Figure 3.

DISCUSSION

Maternal mortality rates in the US are rising, and now exceed those of other developed countries,[21] indicating significant room for improvement in OB care. More than three decades after EMTALA was passed and despite inclusion of the term "labor" in the law's title, hospitals continue to be cited and fined for EMTALA cases related to labor and other OB emergencies. Since 2002, the OIG has reached 39 civil monetary penalty settlements related to EMTALA violations involving labor and other OB emergencies, including three against individual physicians. While the number of annual settlements for EMTALA cases declined by more than 50% over the study period, cases related to OB emergencies remained consistent.

The proportion of settlements involving OB emergencies increased from 17% to 40% between 2002-2018. Generally, civil monetary penalties for EMTALA violations related to OB emergencies tended to involve failure to provide medical screening exam and stabilization and to concentrate in a few CMS regions. OB settlements were significantly more likely than non-OB settlements to involve failure to arrange an appropriate transfer. Nearly one in five OB cases involved a pregnant minor. Study findings highlight a number of key points important for hospital administrators, emergency physicians, and OB providers to be aware of.

Among civil monetary penalty settlements involving labor and OB emergencies, failure to provide appropriate screening exam was the most commonly cited cause for EMTALA

citation, identified in 87% of cases. Under EMTALA, any patient presenting to the ED must be screened for evidence of an emergent condition or active labor. According to CMS, labor is defined to mean the process of childbirth beginning with the latent or early phase of labor and continuing through delivery of the placenta.[27] CMS further clarifies that a woman experiencing contractions is considered to be in true labor, unless after a reasonable observation period, a qualified medical provider certifies that the woman is in false labor.[27] The medical provider (a physician, certified nurse-midwife, or other qualified medical personnel acting within his or her scope of practice as defined in hospital staff bylaws and state law) must also complete a reasonable observation period.

We found that 13% of settlements were specifically noted to involve labor and delivery triage areas. While it is commonly understood that EMTALA applies to patients presenting to medical EDs, it is important for providers to understand that many labor and delivery evaluation areas that evaluate patients for emergent conditions on an unscheduled basis qualify as dedicated EDs and are required to comply with screening, stabilization, and transfer requirements of EMTALA, if located within a hospital with a Medicare provider agreement.[28]

The importance of providing appropriate care to pregnant minors should be highlighted. Nearly one in five of the OB settlements involved a pregnant minor, and 86% of these cases centered failure to provide appropriate medical screening exam for the pregnant minor (Appendix C). CMS has clarified that under EMTALA, a minor can request an examination or treatment for an emergency medical condition, and that a hospital is required by law to conduct the exam to determine whether an emergency medical condition exists.[27] Medical screening exams or treatment of an emergent condition should not be delayed by waiting for parental consent.

Failure to provide appropriate stabilizing treatment was the second most commonly cited cause for EMTALA citation leading to OIG settlements among patients with OB emergencies, identified in more than half of cases. An individual is considered stabilized if the treating provider has determined with reasonable clinical confidence, that the emergency medical condition has been resolved.[27] In the case of active labor, medically stabilization is achieved when a woman has delivered the child and the placenta.[27] According to CMS for patients requiring transfer, stabilized is defined as "no material deterioration of the condition is likely, within reasonable medical probability, to result from or occur during the transfer of the individual from a facility." EDs at hospitals without dedicated OB services must still provide

Table 1. Characteristics of EMTALA-related civil monetary penalty settlements involving obstetrical emergencies.

	Obstetrical		Non-obstetrical		P-value	Test type
Total number	39		193			
Settlement (mean US dollars)	$36,269.23		$43,677.87		0.6386	Student's t-test
	n	%	n	%		
Settlement against physican	3	8%	5	3%	0.134	Fischer's exact test
Minor involved	7	18%	24	12%	0.356	Pearson Chi squared
Failure to MSE	32	82%	142	74%	0.265	Pearson Chi squared
Failure to stabilize	20	51%	105	54%	0.721	Pearson Chi squared
Failure to arrange transfer	14	36%	40	21%	0.041	Pearson Chi squared
Failure to accept transfer	2	5%	29	15%	0.123	Fischer's exact test
On call failed to respond	1	3%	13	7%	0.475	Fischer's exact test
CMS region					0.052	Fischer's exact test
1	2	5%	5	3%		
2	0	0%	8	4%		
3	3	8%	1	1%		
4	15	38%	81	42%		
5	4	10%	20	10%		
6	8	21%	20	10%		
7	2	5%	25	13%		
8	0	0%	6	3%		
9	5	13%	27	14%		
10	0	0%	0	0%		

EMTALA, Emergency Medical Treatment and Labor Act; *OIG*, Office of the Inspector General; *MSE,* medical screening exam; *CMS*, Centers for Medicare and Medicaid Services.

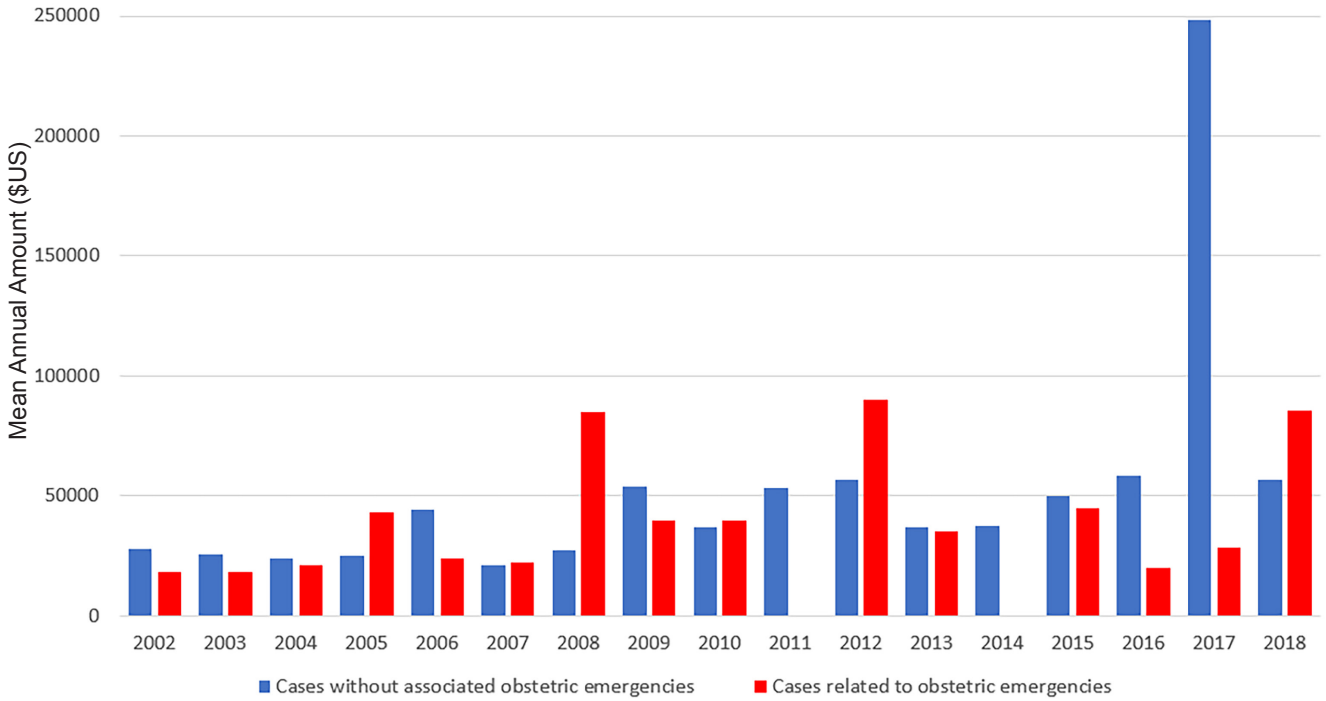

Figure 2. Civil monetary penalty settlements related to violations of the Emergency Medical Treatment and Labor Act Involving Obstetrical Emergencies, mean annual amount ($US).

stabilizing treatments to laboring women under EMTALA and should implement policies for evaluation and stabilization of pregnant patients.

More than a third of OIG settlements in this study were cited for failure to arrange appropriate transfer compared with only a fifth of non-OB settlements. According to CMS, if a woman is in labor the hospital must deliver the baby and the placenta or transfer appropriately.[27] Study findings and the illustrative case highlight the need for EDs to follow EMTALA requirements for appropriate transfer of patients in active labor even if dedicated OB services are unavailable at the hospital. This is particularly important as 45% of rural counties in the US had no OB services between 2004-2014, and an additional 9% of rural counties lost OB services during that period, leaving more than half of US rural counties without hospital OB services.[29] In the illustrative case described, an ED nurse informed the patient that OB services were not available at the hospital and offered for the pregnant woman to proceed via private vehicle to the facility where her obstetrician practiced, even calling to inform the intended receiving hospital to expect the patient.

The offer, suggestion, or demand by hospital staff for pregnant patients to proceed via private vehicle to another facility, typically the hospital where their obstetrician practiced, was a common theme noted among settlements involving OB emergencies. EMTALA requires any patient presenting to a dedicated ED to be entered into a log, have a documented screening exam, stabilization, and when indicated appropriate transfer for specialty care even if the most logical and reasonable course of action might seem to be for a patient to be transported via private vehicle to a facility that has the specialty services that they require. The transferring hospital must provide treatment within its on-site capability that minimizes the risks of the woman and the unborn child, obtain permission from the receiving hospital for transfer, and send medical records with the patient.[27] The sending hospital is responsible for ensuring that the transfer is effected through qualified personnel and transportation equipment including the use of medically appropriate life support measures during transfer.[27]

Additionally, CMS has specified that a pregnant patient in labor may not be transferred unless she, or a legally responsible person acting on her behalf, requests a transfer and a physician or other qualified medical personnel, in consultation with a physician, certifies that the benefits to the woman and/or the unborn child outweigh the risks associated with transfer.[27] Had the provider in the illustrative case logged the visit and provided a medical screening exam, they would have had sufficient information to either provide stabilizing services and arrange appropriate transfer, or to adequately and appropriately inform the patient of the risks and benefits of leaving the hospital if the patient were to decline stabilizing services at the original facility.

Failure to accept an appropriate transfer (5%) and failure of an on-call doctor to respond (3%) were relatively rare in the current study. While hospitals with on-call obstetricians without a dedicated ED may not be obligated to adhere to certain aspects of EMTALA (eg, providing medical screening exams, stabilizing treatment), it is worth noting that they are required to accept appropriate transfer of patients from another dedicated ED with emergent OB conditions requiring specialized treatment if the

hospital has a Medicare provider agreement.

OIG settlements related to OB conditions concentrate in two of the 10 CMS regions (IV and VI), with a third of cases occurring in Florida and Texas. This is consistent with prior published work showing both high rates of EMTALA-related OIG settlements in the same regions.[6] Both Florida and Texas have maternal mortality ratios far above the national average[30] suggesting that the quality of OB care may be contributory. Further work is needed to determine whether the high rates of civil monetary penalty settlements reflect suboptimal OB emergency care or enhanced enforcement in CMS regions IV and VI.

LIMITATIONS

Although this study provides the most comprehensive assessment to date of OIG penalties resulting from EMTALA citations related to OB emergencies, there are a number of potential limitations. First, as reported findings rely upon administrative data provided by the OIG, data may be limited by variability in reporting and enforcement of EMTALA cases related to OB emergencies across regions or over time. However, the case descriptions analyzed represent the best available data to study OIG penalties. While it would be ideal to report overall trends in EMTALA enforcement for OB emergencies, available data for EMTALA citations not resulting in fines reported by CMS does not provide granular details about cases included in settlement descriptions.

While additional documentation related to EMTALA settlements involving OB emergencies were requested via the Freedom of Information Act for a more in-depth qualitative review, only a limited number of documents were available at the time of submission and were included in the illustrative case study. While it would have been ideal to separately analyze settlements related to labor and other OB emergencies, many of the case descriptions were sufficiently vague such that it was impossible to determine whether a pregnant patient was in labor or not at the time of the alleged incident; thus, all OB cases were grouped. Second, available data is limited to EMTALA cases resulting in civil monetary penalty settlement agreements.

Finally, published settlement descriptions varied markedly in detail and some descriptions were sufficiently vague such that settlements related to OB emergencies may not have been identified (eg, "The OIG alleged that the hospital failed to provide appropriate medical screening examinations and stabilizing treatment to two patients.") However, in the vast majority of OIG settlement descriptions, the nature of the condition was indicated, and the proportion of settlements related to OB emergencies (17%) was similar to the proportion of overall EMTALA citations involving labor and OB emergencies identified previously (14%).[6]

On April 22, 2016, based upon allegations of noncompliance with the requirements of EMTALA, the Ohio Department of Health launched an investigation of a small hospital in rural, northwest Ohio.[24] The facility is a 25-bed critical access hospital run by the county government, reporting 217 annual discharges and 1396 inpatient days.[25] The incident triggering the EMTALA investigation by CMS occurred on April 16, 2016, when a 33-week pregnant woman presented to the hospital's ED with complaints of pelvic pain, vomiting, and leakage of fluids.[26]

In the ED, the patient was reportedly told by a nurse that the hospital did not have an OB unit, and that the patient could either choose to begin treatment at the hospital and then be transferred, or elect to be driven by the patient's male companion via private vehicle to an outside hospital where the patient's OB practiced. The patient elected to go to the other hospital 30 minutes away and was escorted to her car by the nurse. The nurse reportedly called the hospital where the patient was heading and informed them of the patient's pending arrival, and again called several hours later to make sure the patient had safely arrived. The patient was not registered in the hospital's ED log and did not receive medical assessment or stabilizing treatment. Upon arrival at the outside hospital, the patient underwent an emergent C-section and delivered a stillborn infant. The infant died despite resuscitation efforts.

Following an on-site investigation and review by state investigators, CMS determined that the hospital was in violation of multiple EMTALA requirements including failure to screen, failure to treat, and failure to appropriately transfer a patient.[24] Based on the results of the investigation, CMS notified the hospital of plans to terminate the facility's participation in the Medicare program effective within 90 days unless CMS was provided with evidence of correction of the deficiencies identified.[24]

In response to EMTALA citations and threat of termination of Medicare participation, the hospital submitted a plan for corrective actions, including how the hospital intended to rectify the deficiencies, how the plan would prevent recurrence, and expected completion dates.[26] The hospital's plan for correction included 1) immediate termination of the offending nurse, 2) institution of mandatory immediate and 3) subsequent annual training regarding EMTALA requirements, as well as 4) launching a quality assessment of the patients presenting to the ED. Additionally, the hospital held a mandatory in-service on management of the pregnant and laboring patient for ED personnel. The hospital's plan of corrective action was accepted by CMS on August 10, and all deficiencies were confirmed to have been corrected by the Ohio Department of Public Health on August 18, 2016. On March 3, 2018, the hospital entered into a $50,000 settlement with the OIG related to the case described.[22]

Figure 3. Illustrative case study.
EMTALA, Emergency Medical Treatment and Labor Act; *OIG,* Office of the Inspector General; *CMS,* Centers for Medicare and Medicaid Services.

CONCLUSION

Despite inclusion of the term "labor" in the title of the law, approximately one in six civil monetary penalty settlements related to EMTALA violations involve OB emergencies. While the overall number of annual settlements declined during the study period, settlements related to OB emergencies occurred consistently throughout, accounting for 17% of settlements in 2002 and 40% in 2018. Our study found that failure to arrange appropriate transfer was more common among OB settlements and that settlements related to OB conditions concentrate in two of the 10 CMS regions. One in five cases was specifically noted to involve a pregnant minor, indicating that emergency physicians and obstetricians may benefit from education regarding obligations to evaluate, stabilize, and when necessary arrange for appropriate transfer of pregnant minors with active labor or other OB emergencies, even absent parental consent. Recent cases highlight the need for hospital administrators, emergency physicians, and obstetricians to evaluate and strengthen policies and procedures related to both screening exams and stabilizing care of patients with labor and OB emergencies, even if the hospital does not provide dedicated OB care.

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The EMTALA Loophole in Psychiatric Care

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Overhead page: "Code Gray in bed 32." You find an agitated, combative, and clearly frightened woman in her thirties. After attempting to calm her down and de-escalate the situation, you're left with no choice but to emergently sedate her to ensure the safety of the patient and your staff. Five security guards hold her down and restrain her to the bed and she's given intramuscular antipsychotics. When the dust clears, you review her chart and discover she's been there for 105 hours with diagnoses of schizophrenia with grave disability. This person's name is Julia and her children and friends visit her regularly. Despite our hopes, the emergency department (ED) is not a place where she can begin to heal. She has been rejected from inpatient hospitalization by 13 psychiatric hospitals in Sacramento and surrounding counties. Julia desperately needs access to psychiatrists and inpatient psychiatric care, and our system is failing her.

Every morning, emergency physicians throughout the state are responsible for reassessing psychiatric patients who are awaiting placement in an acute psychiatric hospital (APH). We're often greeted by familiar faces, people we've met with for three, four, maybe five days in a row. Although these patients have been evaluated and are medically stable for transport, they remain in a persistent state of psychiatric crisis and are stuck in treatment limbo until they receive intensive psychiatric care. As emergency physicians, we are proud to provide an essential service to this highly stigmatized and often marginalized segment of our population, but many of us can't help but feel an ongoing sense of futility and hopelessness for them. While we were trained in providing the care needed for initial stabilization, we don't have the skills to meaningfully treat their underlying psychiatric illness. Unfortunately, these patients are trapped in an under-resourced mental healthcare system that is rife with barriers to the intensive treatment they need and deserve.

In an effort to improve access to mental health care, emergency physician and California State Assembly Member Joaquin Arambula, in collaboration with Assembly Member Miguel Santiago, introduced Assembly Bill (AB) 451 in February 2019. The bill would expand the Emergency Medical Treatment and Active Labor Act (EMTALA) to apply to APHs across California, thus subjecting psychiatric care to the same rules and regulations as all other medical specialties that provide coverage for patients in EDs. The hope is that patients with psychiatric disease would be afforded the same access to care as patients with any other disease and we would effectively close "the EMTALA loophole" in psychiatric care. AB 451 seems like a simple, straightforward solution; however, a glance at history and a dive into the current system of care will instill a healthy dose of caution and skepticism.

Mental healthcare in the United States is a patchwork of well-intentioned policies with often wayward results. In 1980, President Jimmy Carter signed into law the Mental Health Systems Act, which aimed to restructure psychiatric care from large, institutionalized asylums with hundreds of beds to a smaller-scale community model. The goal was to make psychiatric care more humane and to safely facilitate reintegration of patients into their communities. In the 1980s, President Ronald Regan ushered through legislation including the Omnibus Budget Reconciliation Act that repealed large portions of the Mental Health Systems Act and slashed federal funding for mental health. These two waves of legislation resulted in the closure of large asylums throughout the country, and then defunded the outpatient mental health treatment network and social safety net that was designed to facilitate a safe and healthy transition for these patients.

There are a few other key regulatory vestiges that shape mental healthcare today. 1988 amendments to the Institution for Mental Diseases (IMD) Exclusion Act barred Medicare from paying for treatment in mental health facilities with more than 16 beds. Put another way, APHs get reimbursed for only 16 patients under their care at any given time and take a financial loss when treating any additional patients. APHs are therefore financially disincentivized to expand the supply of psychiatric care despite our communities' ever-growing need. An additional rule caps Medicare coverage at 190 total lifetime days of treatment. This is meant to prevent patients from interminably being placed in inpatient psychiatric facilities; however, it serves to arbitrarily limit the potential treatment for patients with the most debilitating psychiatric illnesses. After the 190-day cap is reached, patients are functionally uninsured for the rest of their lives. This is particularly onerous for patients with severe, persistent

psychiatric disease who exhaust this paucity of coverage early in life. The IMD exclusion act disincentivizes and stunts expansion of mental healthcare despite immense need.

In 1986, EMTALA was enacted and EDs became the de facto safety net for many patients with mental illness. EMTALA was designed to counteract the growing problem of "patient dumping," the practice of hospitals refusing to treat people with medical emergencies because of their inability to pay. EMTALA ensured that psychiatric patients had access to physicians; however, it did not ensure timely access to the specialists optimally trained to provide the definitive care needed to treat their illness. While emergency physicians are well versed in preventing self-harm and managing acute psychosis, we are not trained in the behavioral therapy and medication management that can help patients recover from their underlying psychiatric illness.

In 1989, EMTALA was amended to require that hospitals with the specialists needed to stabilize emergency medical conditions accept patients from hospitals without the required specialists. For example, if a patient presents to a small rural critical access hospital with a subdural hematoma, the nearest hospital with an on-call neurosurgeon and open bed is required to accept the patient in transfer. While EMTALA is enforceable by potentially large financial penalties, it is sparingly applied to mental health transfers. In 2012 the California Department of Public Health issued an all-facilities notice that "APHs must provide the care and treatment necessary to relieve or eliminate a psychiatric emergency medical condition within the capability of the facility, including, as necessary, admission or transfer to a psychiatric unit."[1] Moreover, the July 2019 Centers for Medicare and Medicaid Services (CMS) State Operations Manual for EMTALA, which contains the regulations and interpretive guidelines states "In the case of psychiatric emergencies, if an individual expressing suicidal or homicidal thoughts or gestures, if determined dangerous to self or others, would be considered to have an emergency medical condition (EMC). Psychiatric patients are considered stable when they are protected and prevented from injuring or harming him/herself or others."[7] Unfortunately, public statements from regulatory agencies have largely been ignored. While EMTALA violations related to psychiatric care are vastly under-reported, nearly 20% of all EMTALA fines involve mistreatment of patients with psychiatric emergencies.[2]

The Great Recession of the late 2000s led to additional defunding of mental health systems on the county and state level. In Sacramento, the number of beds at the county mental health facility were halved from approximately 100 to 50 in 2009. This resulted in placement times increasing and patients languishing in local EDs awaiting access to psychiatric care. Health conglomerates such as Sutter, Mercy, and Kaiser responded by reserving beds at APHs in order to move patients with psychiatric needs out of their EDs and free up ED beds for financially profitable medical patients. A tragedy of the commons scenario was created as APHs are paid to reserve beds, but the beds often go unoccupied. The APHs didn't expand their capacity beyond 16 beds due to the IMD exclusion act, and an already insufficient number of beds became further reduced to protect the monetary interest of large health systems. The bed shortage particularly affects our uninsured and underinsured patients.

The practice of preferentially holding beds for large, private payer groups rather than the patients in most need is morally bankrupt yet ubiquitous. The mechanism APHs use to screen patients before accepting them in transfer is a clear violation of EMTALA standards – every patient being considered for transfer undergoes a "wallet biopsy" as Sacramento APHs require the referring hospital to transmit a face sheet that includes the patient's insurance status. APHs often deny uninsured, underinsured Medi-Cal patients, or Medicare patients who have exhausted their 190 reimbursement limit based off this information. Patients treated in an ED for an acute mental health condition are particularly vulnerable as 45% of are enrolled in Medi-Cal, 19% have Medicare, 7% are uninsured, and only 25% have private insurance.[3] This leads to a two-tiered system in which patients with acute, complex psychiatric needs typically board in EDs for days or weeks, while better-funded and less debilitated patients are often placed within hours.

ED boarding is a health risk that disproportionately affects patients with mental health needs. There is a 2.5% mortality rate for patients admitted in less than two hours compared to a rate of 4.5% for patients boarding more than 12 hours.[4] Prolonged boarding is also associated with delays to pain medication and diagnostic studies, and lower patient satisfaction.[4] In our ED, the vast majority of patients boarding for more than 12 hours, and nearly all of the patients waiting more than 24 hours, are in psychiatric crisis. This is not an isolated trend. A 2012 study found that psychiatric patients remain in EDs 3.2 times longer than non-psychiatric patients.[5]

Decreased access to psychiatric care is not just an inconvenience. It harms all of our patients, and we applaud Assembly Members Arambula and Santiago for their efforts. Moreover, we would be remiss not to mention the hard work by the California Chapter of the American College of Emergency Physicians for their outstanding advocacy work on this important issue.

We believe that AB 451 will make real change for our patients, but it will take more work to cure our broken system. AB 451 will eliminate the ability of large payer groups to monopolize beds, expand and hasten access to mental healthcare, reduce preferential placement based off payer status, and help ensure that patients in psychiatric crisis get the care they need when they need it. That said, generations of myopic legislation have created a system in which the supply of mental health beds will continue to be outstripped by demand unless we increase funding and build capacity. EDs are the release valve for a mental health system that can't treat all its patients and the patients boarding in our EDs can be conceptualized as overflow for a system that doesn't have the capacity to handle

the volume of need that exists. We will continue to see patients like Julia flowing into EDs throughout the state until there are more psychiatric providers and psychiatric beds. Patients like Julia need and deserve a well-funded mental healthcare system that can serve every patient with psychiatric needs. It is our responsibility to our patients to continue undoing decades of self-sabotaging policy by increasing funding for mental healthcare, and collaborating with our psychiatry colleagues to grow the capacity of the mental healthcare system so that our patients can get access to the care that they need and deserve.

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Public Performance Metrics: Driving Physician Motivation and Performance

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Introduction: As providers transition from "fee-for-service" to "pay-for-performance" models, focus has shifted to improving performance. This trend extends to the emergency department (ED) where visits continue to increase across the United States. Our objective was to determine whether displaying public performance metrics of physician triage data could drive intangible motivators and improve triage performance in the ED.

Methods: This is a single institution, time-series performance study on a physician-in-triage system. Individual physician baseline metrics—number of patients triaged and dispositioned per shift—were obtained and prominently displayed with identifiable labels during each quarterly physician group meeting. Physicians were informed that metrics would be collected and displayed quarterly and that there would be no bonuses, punishments, or required training; physicians were essentially free to do as they wished. It was made explicit that the goal was to increase the number triaged, and while the number dispositioned would also be displayed, it would not be a focus, thereby acting as this study's control. At the end of one year, we analyzed metrics.

Results: The group's average number of patients triaged per shift were as follows: Q1-29.2; Q2-31.9; Q3-34.4; Q4-36.5 (Q1 vs Q4, $p < 0.00001$). The average numbers of patients dispositioned per shift were Q1-16.4; Q2-17.8; Q3-16.9; Q4-15.3 (Q1 vs Q4, $p = 0.14$). The top 25% of Q1 performers increased their average numbers triaged from Q1-36.5 to Q4-40.3 (ie, a statistically insignificant increase of 3.8 patients per shift [$p = 0.07$]). The bottom 25% of Q1 performers, on the other hand, increased their averages from Q1-22.4 to Q4-34.5 (ie, a statistically significant increase of 12.2 patients per shift [$p = 0.0013$]).

Conclusion: Public performance metrics can drive intangible motivators (eg, purpose, mastery, and peer pressure), which can be an effective, low-cost strategy to improve individual performance, achieve institutional goals, and thrive in the pay-for-performance era. [West J Emerg Med. 2020;21(2)247–251.]

INTRODUCTION

As healthcare reimbursement shifts from "fee-for-service" to "pay-for-performance," strategies designed to incentivize improved physician performance must evolve in tandem. Across industries, financial incentives and disciplinary threats are frequently used; however, prior studies have demonstrated that these so-called extrinsic motivators lead to worsened performance for any task requiring even rudimentary cognitive ability.[1] In contrast, prior studies have also shown that intrinsic motivation—personal motivators based on a

sense of pride, accomplishment, and mastery rather than a desire for money or fear of reprisal—is much more effective at driving performance outcomes for highly cognitive tasks. In fact, as open disclosure of healthcare performance outcomes becomes more common as a health policy tool,[2] advocates cite that public disclosure of poor individual physician performance directly drives positive physician behaviors that result in improved performance and patient outcomes.[3]

Existing evidence on the impacts of publicly reporting individual performance outcomes offers varied results. One study describing Los Angeles schoolteacher performance concludes that openly disclosing performance outcomes to one's peers and the public drove improvement by appealing to the teachers' desire to protect their reputations and allowing them to benchmark their individual effectiveness vs their peers.'[4] However, the study also found deleterious effects in one subgroup that experienced feelings of anger and embarrassment, which ultimately hampered intrinsic motivation.

To our knowledge, there are no studies to date that examine the outcomes of reporting individual performance outcomes of physicians. This study aimed to determine whether open reporting of a select set of performance metrics at the individual physician level could influence individual behavior and drive future improvements in those measured metrics. Specifically, we examined performance within an emergency department (ED) physician-in-triage (PIT) system. In our study, PIT physicians' only tasks are to sort patients, based on a history and physical exam, into two groups—those that require further evaluation and stabilization vs those who require minimal to no further evaluation—and discharge patients in the latter group. PIT performance was subsequently openly published to all PIT physicians.

Population Health Research Capsule

What do we already know about this issue?
Evidence on public reporting to drive improvements has been mixed. This is the first study to analyze whether publicizing individual metrics affects emergency department (ED) triage performance.

What was the research question?
Does publicly displaying physician performance metrics influence the individual physician's future triage performance?

What was the major finding of the study?
Displaying public performance metrics correlated with a statistically significant increase in the average patients triaged per hour.

How does this improve population health?
Improved triage performance has been shown to lead to improvements in door-to-physician time, length of stay, and left without being seen visits, despite increasing ED volume.

METHODS

This was a retrospective review of individual emergency physicians' (EP) triage-system performance data from a single-site, academic tertiary-care center's ED over a 12-month period from September 1, 2015, through August 31, 2016. During this period, total ED census was 50,140 patients. The ED triage system consisted of three patient evaluation spaces and was staffed with one of 24 board-certified or board-eligible emergency medicine (EM) attending physicians and two to three EM nurses with 14 total hours of physician coverage per day from 10 AM to midnight. Each physician's "triage shift" consisted of seven hours patient evaluation and one hour of charting. On average, EM attending physicians worked 25% of their scheduled shifts as PITs.

The EPs were informed that the triage system would have two goals: 1) Based on a limited history and exam, rapidly identify and sort (ie, "triage" patients into either a moderate-to-high acuity group that required moderate-to-extensive evaluation and management or into a low-acuity group that required little to no management); and 2) disposition (which was primarily quantified as discharges from the ED but also included "direct" admits to the main hospital) of all patients in the low-acuity group, as appropriate. Patients sorted into the moderate-to-high acuity group were subsequently assigned to another EP for further care. For patients designated as moderate-to-high acuity, the EP would document a 1-3 sentence note describing the initial impression and order labs, imaging, and or medications via computerized order entry (COE) system. For patients who could be rapidly dispositioned, the EP would chart the full ED note and order all studies, medications, and prescriptions via COE. Based on these goals, we tracked the two performance measures for each individual physician: 1) mean number of patients triaged per shift; and 2) mean number of patients dispositioned per shift.

Before data collection for this study began, the PIT system had been in place for three months to allow for any learning curve with this change to physician practice. We extracted these metrics for individual PIT physicians from the electronic medical record system without patient identifiers. Performance metrics for all 24 PIT physicians were reported on a quarterly basis openly to the PIT physician group; the average and standard deviation for each metric was also reported to the group. Performance metrics were not linked to any material or financial incentive or disincentive. While goals were reiterated quarterly and physicians were encouraged to practice as they deemed safe and appropriate, no specific

guidance or remediation strategies were created, administered, or required for any physician at any point before, during, or after the study period; physicians were free to apply or disregard the data as they wished.

After the study period, we examined the group's average quarterly performance for all four quarters and trended the comparison over time. Using Student's t-test, we compared the group's average performance in the first quarter of the study vs the final quarter. Given the possibility that particular subgroups' performance would evolve in different ways, we also compared the performance of the top and bottom quartile of performers.

RESULTS

During the first quarter, the average number of patients triaged and dispositioned over seven-hour shifts by all physicians were 29.1 (±5.5) and 16.4 (±4.3), respectively. For the second quarter, the average number of patients triaged and dispositioned were 31.9 (±6.1) and 17.8 (± 5.0), while for the third quarter, the average number of patients triaged and dispositioned were 34.3 (± 5.2) and 16.9 (±4.5), respectively. In the final quarter of the study period, the average number of patients triaged was 36.5 (±5.3), and the average number of patients dispositioned was 15.3 (±5.0). Results are summarized graphically in Figure 1.

After Q1, the top and bottom 25% quartile groups by number of patients triaged were identified. These groups were determined a priori before analysis in order to avoid Type I error. The top 25% of Q1 performers increased their average numbers triaged from Q1-36.5 to Q4-40.3 (ie, a statistically insignificant increase of 3.8 patients per shift [p = 0.007; Table 2]). The bottom 25% of Q1 performers, on the other hand, increased their averages from Q1-22.4 to Q4-34.5 (ie, a statistically significant increase of 12.2 patients per shift [p = 0.0013; Table 2]). The number of patients dispositioned in Q1 vs Q4 was determined not to be statistically significant (a decrease of 1.1 patients per shift; p = 0.142; Table 1).

DISCUSSION

Measuring physician performance is a difficult task as many variables are involved to performing the job of a physician. Physicians have historically been reluctant to have their efficiency of patient throughput objectively measured, given the many confounders that affect their daily decision-making.[13] These variables include,the following: input; lengthy or inefficient admission processes; patient disease characteristics; and system-level factors (eg, ED staffing, difficulty getting timely consultations, a lack of available inpatient beds, timeliness of labs or radiology interpretations).[14] Furthermore, many contend that elements involved in patient care, such as compassion and communication, are difficult for objective data capture yet contribute meaningfully to outcomes of morbidity and mortality.[15]

Increasing ED visits and concomitantly ED crowding represent a major challenge for healthcare systems across the

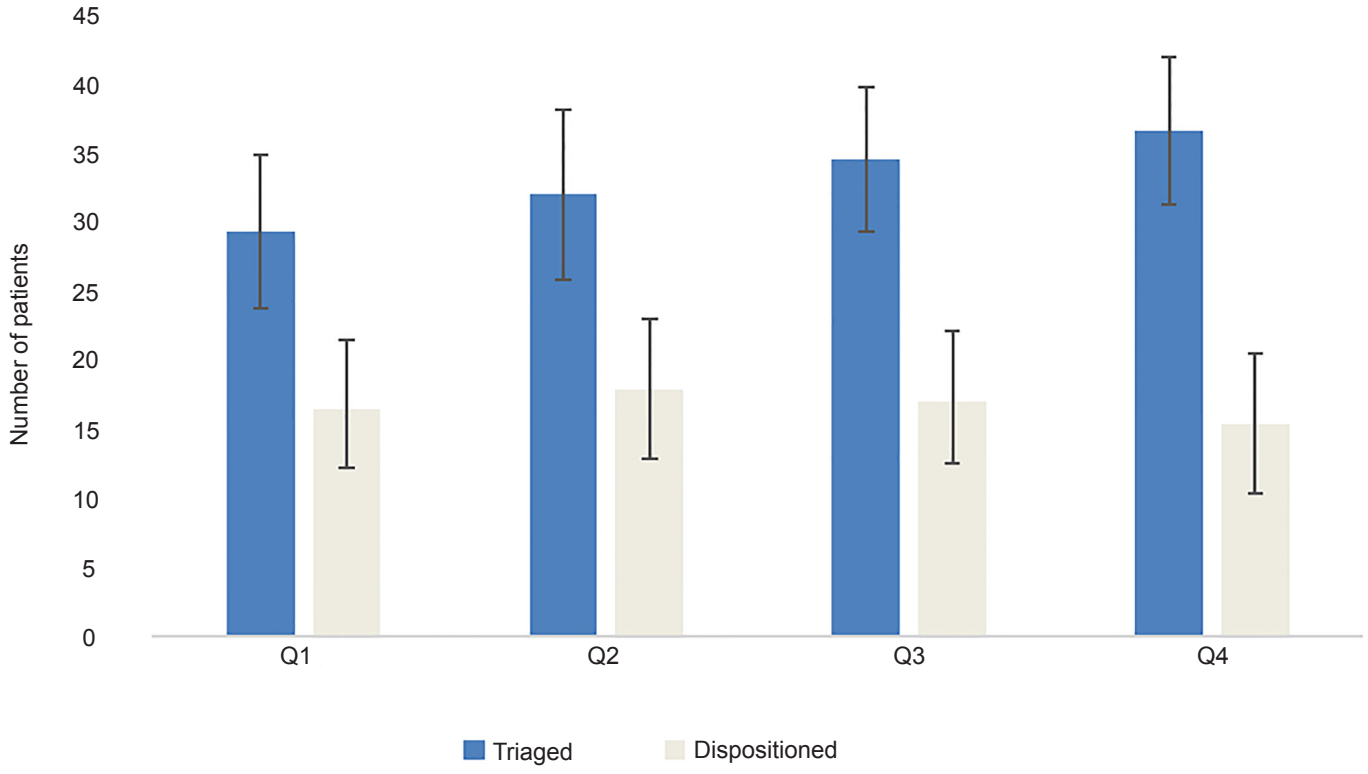

Figure 1. Average number of patients triaged vs dispositioned by yearly quarter for all providers ± standard deviation.

Table 1. Overall triage and disposition performance Q4 vs Q1.

	Q1	Q4	95% Confidence interval (CI) for difference Q4 vs Q1	P-value
Number of patients dispositioned per shift	16.4	15.3	↓ 1.1 patient /shift; CI: -3.8 to 1.7	0.1424
Number of patients triaged per shift	29.2	36.5	↑ 7.3 patients/shift; CI: 4.18 to 10.5	<0.05

Table 2. Triage and disposition performance by top and bottom quartile performers Q4 vs Q1.

	Q1	Q4	Difference and confidence interval (CI) for Q4 vs Q1	P-value
Number of patients patients triaged per shift by top 25% performers	36.5	40.3	↑ 3.8 patients/shift; CI: 0.05 to 7.5	<0.05
Number of patients triaged per shift by bottom 25% performers	22.4	34.5	↑ 12.2 patients/shift; CI: 8.4 to 15.9	<0.05

country.[16] The increase in wait times before patients are seen by a physician has led many facilities to adopt a PIT system as a strategy to alleviate ED crowding by improving throughput. PIT systems target and reduce initial long wait times for patients by ensuring rapid evaluation by a physician upon arrival to the ED. Orders are expedited with critically ill patients immediately identified and sent back to the main ED and low- acuity patients rapidly discharged. PIT programs have been proven to provide sustainable improvements in ED performance metrics such as including door-to-physician time, length of stay, and left without being seen visits, despite increasing ED volume.[17]

The results of this study demonstrate that simply displaying attending physician performance metrics at quarterly meetings led to an increase in patients triaged per hour. Furthermore, the increase was most notable and statistically significant for the bottom 25th percentile of attending physicians, a cohort that improved their number of patients triaged per hour by 12.2 patients, or 54% quarter-over-quarter. Although not statistically significant, there were still improvements in patients triaged per hour in the top 25th percentile performers of attending physicians, a cohort that was already outperforming its peers. This cohort increased the average patients triaged per hour by 3.8, a 10.3% quarter-over-quarter increase.

An increase in the number of patients triaged per hour has been shown to reduce waiting times and length of stay in the ED.[17] While the significant investment required for designing, implementing, and evaluating the development of a PIT system must be considered, the long-term gains in various ED metrics may offset the upfront cost. Furthermore, once a triage system is established, publicly publishing triage performance metrics does not require any increase in resources, resulting in arguably only upside potential.

Our results align with much of the current literature regarding workplace motivation, finding that workers are rewarded for measurable performance improvement. While the logic behind extrinsic motivators (eg, more money for better performance) is intuitive, other studies[18] concerning workers who perform higher level cognitive tasks, such as physicians, have shown that the best use of money is to pay workers just enough to take the issue of money off the table. Once this is done, there appear to be three factors, so-called intrinsic motivators, that lead to better performance when performing tasks that require higher-level of thinking: 1) autonomy, the ability to self-direct; 2) mastery, the desire to be the best at our artform or tasks; and 3) purpose, the idea that what we do is important and connected to our inner belief system. Publishing performance metrics while simultaneously allowing physicians to maintain their autonomy (physicians were allowed to practice how they desired), achieve mastery (bottom-performing physicians, known to all as laggards in the cohort, dramatically improved their ability and performance relative to their peers), and purpose (physicians were informed that this was an important group goal), is a simple yet powerful solution to improve motivation and performance.

Within healthcare, prior studies have only examined the effects of reporting performance at the institutional level with highly variable outcome measures and mixed results[5,6,7,8] Interestingly, several studies demonstrated that public performance reporting had a greater effect on quality improvement than traditional performance evaluation alone and suggest that public performance reporting stimulates additional quality improvement activity,[9,10,11] which then correlated with increased patient satisfaction and care outcomes.[12]

LIMITATIONS

There were some limitations to this study. First is the question of whether performance increased solely due to the psychologically motivating effect of the published performance data or physicians improved simply due to practice. We believe that this effect was mitigated by the fact that the PIT system had already been operational for several months prior to the start of the study, which should have been

adequate to adjust to any learning curve. Second, this study was performed at a single-center, academic tertiary care center and not a community ED where other factors may affect how physicians perform. There were a small number of attending physicians in this study, a total of 24. We did not control or analyze for volume of patients presenting during a given shift to the triage physician. It is possible, although unlikely, that arrival volume could affect triage per hour numbers in a systematic way.

Additionally, we did not collect or analyze outcome data for patients triaged by the group or individuals. Speed could conceivably have a negative effect on quality or cost. Finally, institutional culture plays a role in terms of how such a study is received among their physician staff. Like most real-world processes, the University of California, Irvine ED triage system constantly evolved in real-time. It would be beneficial to determine whether this study's findings could be duplicated in EDs with differing triage systems or for other ED performance indicators such as computed tomography utilization rates, length of stay, or patients per hour.

CONCLUSION

Most business organizations now look for a transcendent purpose within an organization to help foster a sense of contribution from their workforce. This study shows that public performance metrics had a correlation with increased performance among physicians. Public performance metrics can encourage mastery within one's profession by demonstrating what was possible within the top 25% of performers. By reinforcing autonomy and allowing physicians to practice the way they prefer to, we increase engagement within the work force. This study also challenged the traditional belief that financial incentives are tied to increase in production. The lack of a financial incentive within this study did not deter improvement in performance. This study demonstrates it is possible to increase and improve performance without increasing departmental operational cost.

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#MeToo in EM: A Multicenter Survey of Academic Emergency Medicine Faculty on Their Experiences with Gender Discrimination and Sexual Harassment

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Introduction: Gender-based discrimination and sexual harassment of female physicians are well documented. The #MeToo movement has brought renewed attention to these problems. This study examined academic emergency physicians' experiences with workplace gender discrimination and sexual harassment.

Methods: We conducted a cross-sectional survey of a convenience sample of emergency medicine (EM) faculty across six programs. Survey items included the following: the Overt Gender Discrimination at Work (OGDW) Scale; the frequency and source of experienced and observed discrimination; and whether subjects had encountered unwanted sexual behaviors by a work superior or colleague in their careers. For the latter question, we asked subjects to characterize the behaviors and whether those experiences had a negative effect on their self-confidence and career advancement. We made group comparisons using t-tests or chi-square analyses, and evaluated relationships between gender and physicians' experiences using correlation analyses.

Results: A total of 141 out of 352 (40.1%) subjects completed at least a portion of the survey. Women reported higher mean OGDW scores than men (15.4 vs 10.2; 95% confidence interval [CI], 3.6–6.8). Female faculty were also more likely to report having experienced gender-based discriminatory treatment than male faculty (62.7% vs 12.5%; 95% CI, 35.1%-65.4%), although male and female faculty were equally likely to report having observed gender-based discriminatory treatment of another physician (64.7% vs 56.3%; 95% CI, 8.6%-25.5%). The three most frequent sources of experienced or observed gender-based discriminatory treatment were patients, consulting or admitting physicians, and nursing staff. The majority of women reported having encountered unwanted sexual behaviors in their careers, with a significantly greater proportion of women reporting them compared to men (52.9% vs 26.2%, 95% CI, 9.9%-43.4%). The majority of unwanted behaviors were sexist remarks and sexual advances. Of those respondents who encountered these unwanted behaviors, 22.9% and 12.5% reported at least somewhat negative effects on their self-confidence and career advancement.

Conclusion: Female EM faculty perceived more gender-based discrimination in their workplaces than their male counterparts. The majority of female and approximately a quarter of male EM faculty encountered unwanted sexual behaviors in their careers. [West J Emerg Med. 2020;21(2)252-260.]

INTRODUCTION

Women represented 49.5% of United States (US) medical students in 2018-2019.[1] Despite near parity in the number of men and women now entering medicine, female physicians continue to experience disparities in salary,[2,3] leadership,[4,5] and career advancement.[6-8] For example, while 80% of the overall medical workforce is comprised of women, women hold only 13% of the healthcare industry's executive positions.[9] Data suggest inequity and harassment are intertwined, and harassment is often fostered in workplace environments that perpetuate these gender disparities.[10] For instance, discrimination and harassment by gender are more prevalent in industries in which women make up a majority of the workforce but hold a minority of the positions of power.[11] Many studies have documented gender discrimination and sexual harassment of female medical students and physicians.[5,12-19] The recently released National Academies of Science, Engineering, and Medicine report on sexual harassment of women in medicine revealed similarly troubling results. In that report 50% of female medical students and 30% of female physicians described having been sexually harassed on the job.[20] Inappropriate encounters were consistently reported, ranging from sexist comments and sexual innuendo to inappropriate touching and solicitation.[2]

Sexual harassment can be complex to study and measure because it has several varying legal definitions. The American Medical Association and the United Kingdom General Medical Council define sexual harassment as unwelcome attention or behavior that a person finds offensive and that makes them feel unsafe or uncomfortable.[21,22] One of the more comprehensive definitions comes from the US Equal Employment Opportunities Commission (EEOC), which states that "unwelcome sexual advances, request for sexual favors, and other verbal or physical harassment of a sexual nature constitutes sexual harassment when this conduct explicitly or implicitly affects an individual's employment, unreasonably interferes with an individual's work performance, or creates an intimidating, hostile, or offensive work environment."[23] Such harassment may include unwelcome verbal, visual, non-verbal, or physical conduct that is of a sexual nature or based on someone's gender.

There is currently little data examining gender discrimination and sexual harassment in academic emergency medicine (EM).[17,24,25] The objective of this study was to explore the perceptions of and experiences with gender-based discrimination and sexual harassment among academic EM faculty. We hypothesized that female emergency physicians would have greater perceptions of and more experiences with gender-based discrimination and sexual harassment compared to their male colleagues.

Population Health Research Capsule

What do we already know about this issue?
Female physicians experience disparities in salary, leadership, and career advancement. Prior studies have documented gender discrimination and sexual harassment of female physicians.

What was the research question?
What are the perceptions of and experiences with gender discrimination and sexual harassment among academic emergency medicine faculty?

What was the major finding of the study?
Female faculty reported more gender discrimination than male faculty, and half had encountered sexual harassment in their careers.

How does this improve population health?
There is cultural momentum to confront gender discrimination and sexual harassment across many industries. Ensuring a safe and equitable workplace is vital for the healthcare workforce.

METHODS

Study Design

This study was a cross-sectional survey of a convenience sample of EM faculty on their perceptions of and experiences with gender discrimination and sexual harassment in the workplace.

Study Setting and Population

All EM faculty at six urban, academic training programs were eligible for this study with the exception of the study authors. Study sites were departments of EM located in the following regions: New England (one); the Southeast (two); the South (one); the Midwest (one); the West (one). The survey was administered over February and March 2019.

Study Protocol

An anonymous electronic survey was emailed to all eligible subjects. The invitation stated that the purpose of the study was to examine subjects' experiences with gender discrimination and sexual harassment in their medical careers. Subjects consented to the voluntary study by completing the survey on an online, secure platform. Three reminder emails were sent to non-responders. The study was either approved or deemed exempt from review by each site's institutional review board.

Measurements

No single, well-validated instrument could be found that satisfactorily measured the multiple aspects of workplace gender discrimination and sexual harassment that were of interest. Based on a review of the current literature, we created a 31-item survey consisting of questions adapted from surveys used in similar work among populations of physicians from

multiple specialties (Appendix). The survey was pre-tested by EM faculty at five of the six participating institutions to ensure respondent comprehension. These individuals were subsequently excluded from the study.

We measured subjects' perceptions of discrimination using five questions adapted from the Overt Gender Discrimination at Work (OGDW) scale, an instrument that assesses the perception of gender biases in the workplace.[26,27] The scale asks, "How strongly do you agree with the following statements about your current place of work:" (1) I have been treated unfairly at work because of my gender; (2) The people I work with sometimes make sexist statements and/or decisions; (3) I feel that some of the policies and practices of this organization are sexist; (4) At work, I sometimes feel that my gender is a limitation; and (5) At work, I do not get enough recognition because of my gender. Responses are based on a 1-5 Likert scale, with 1 = strongly disagree; 3 = neutral; and 5 = strongly agree. Scores range from 5-25, with higher scores indicating higher perceptions of discrimination.

Evidence supporting the reliability and validity of the OGDW when used with healthcare and other professional workers has been previously described[26] with a Cronbach's alpha of 0.97 and a strong, positive correlation between scores on the OGDW and another established measure of everyday gender discrimination experiences at work ($r = 0.79$; $p<0.0001$; $n= 240$).[26] In addition, a recent study among anesthesiology trainees reported significant gender-based differences in median OGDW scores as well as in scores on the Career Barriers Inventory that reflect sexual harassment, providing further support for the construct validity for the OGDW.[27]

Using questions adapted from prior work,[14] we also asked subjects to report the frequency with which they have *experienced* discriminatory treatment based on their gender as well as the frequency with which they have *observed* discriminatory treatment of another physician based on gender. Responses included the following: weekly, monthly, annually, rarely, and never. Those respondents who reported weekly, monthly, or annually to either experiencing discriminatory treatment or having observed discriminatory treatment were subsequently asked to identify the source of the gender-based discrimination. Potential sources included university, medical school or hospital administration, consulting or admitting physician, EM attending physician, resident physician, medical student, nursing staff, clerical staff, emergency medical services personnel, patient, and other. Subjects were asked to report the frequency with which they had experienced or had observed discriminatory treatment from each source (weekly, monthly, annually, rarely, and never). Developed by Bruce and colleagues,[14] these items were designed to categorize the scope, type, and source of gender-based discrimination in medicine. Items were piloted with female general surgery residents and then studied in a sample of 334 female healthcare practitioners who practiced or intended to practice in general surgery. Responses to these items were consistent with qualitative responses from the same participants analyzed using a grounded theory approach. Taken together, these findings provide early evidence supporting the construct validity of the items.[14]

Lastly, we asked subjects whether in their professional career, they had encountered unwanted sexual comments, attention or advances by a work superior or colleague based on the 1980 EEOC definition of sexual harassment.[2,5,23] For respondents who answered yes, we asked them to indicate "yes" or "no" for each of the following behaviors they may have encountered ordered by level of severity[28]: (1) sexist remarks / behavior; (2) unwanted sexual advances; (3) subtle bribery to engage in sexual behavior; (4) threats to engage in sexual behavior; (5) coercive advances; and other (we included text space to allow respondents to specify). We asked respondents who answered yes to having encountered unwanted sexual behaviors to indicate the extent to which those experiences had a negative effect on their self-confidence as a professional and on their career advancement. Both of these questions were adapted from prior work[2,5] and answered via a 1-5 Likert scale, with 1 = not at all and 5 = greatly. Carr and colleagues[5] previously showed that female medical school faculty who reported sexual harassment experiences using these items were more likely to also report gender-based bias in the academic environment, providing evidence to support the validity of these items.

We collected limited demographic information (Table 1) to prevent easy identification of otherwise anonymous responses and to encourage honest reporting. We did not obtain information linking subjects by study site.

Data Analysis

We collected data electronically using Qualtrics (Qualtrics, Provo, UT) survey software and exported into SPSS for Windows v.25.0 (SPSS, Inc., Chicago, IL) for analysis. Continuous variables (eg, age, OGDW scores) were examined for normality using visual inspection of histograms, P-P plots, and Pearson's skewness statistic. We used the *t*-test for independent samples to compare group means for continuous variables. In addition, we used Pearson's chi-square analysis to compare proportions across categorical variables. In some cases, for example, in categorizing respondents as having experienced or observed gender-based discrimination, response categories were collapsed into dichotomous categories a priori to aid in result interpretation ("never" and "rarely" vs "weekly," "monthly," and "annually"). To assess the strength and direction of relationships between variables, we used Pearson's correlation coefficient or Spearman's rho as appropriate for the data. Partial correlations were also used to evaluate relationships between variables, while controlling for the effect of a covariate (gender). Data are presented as frequencies, proportions, means, and 95% confidence intervals (CI) around differences between means. All *p*-values are two-tailed, and we accepted an alpha of less than 0.05 as statistically significant.

Table 1. Characteristics of participants in survey of gender bias and sexual harassment

Characteristics	Participants (N=141) n (%)
Age years)	
<39	52 (47.3)
40-49	41 (37.3)
50-59	16 (14.5)
≥60	1 (0.9)
Years out of training	
1-5	33 (25.2)
6-10	40 (30.5)
11-15	26 (19.8)
16-20	15 (11.5)
≥21	17 (13.0)
Gender	
Male	80 (61.1)
Female	51 (38.9)
Race/ethnicity	
White	104 (79.4)
Black/African American	6 (4.6)
Hispanic/Latino	5 (3.8)
Asian/Pacific Islander	12 (9.2)
American Indian/Alaska Native	2 (1.5)
Other	2 (1.5)

RESULTS

A total of 141 out of 352 (40.1%) subjects completed at least a portion of the survey. Respondents were mostly male (n = 80, 61.1%) and White (n = 104, 79.4%) (Table 1). The mean age reported by participants was 41.3 years (range 30-64 years) with the majority of respondents (n = 73, 55.7%) having completed residency training within 10 years.

In our sample, Cronbach's alpha for the five items of the OGDW scale was 0.70, suggesting an acceptable level of internal consistency. The mean OGDW score for all respondents was 12.5 (standard deviation 4.9, 95% CI, 11.6–13.3), with women reporting significantly higher mean OGDW scores than men (15.4 vs 10.2, respectively; t = 6.450, df = 82.143, p < 0.001, equal variances not assumed; mean difference 5.2, 95% CI, 3.6–6.8). Female EM faculty were also significantly more likely to report having experienced workplace discriminatory treatment based on gender than their male counterparts (62.7% vs 12.5%, respectively; p < 0.001) (Figure 1). Having experienced discriminatory treatment based on gender was significantly associated with higher OGDW scores (mean OGDW 17.6 vs 9.8, t = -13.318, df = 87.293, p < 0.001; equal variances not assumed; mean difference -7.8, 95% CI, -9.0 – -6.6).

Although women were more likely than men to report having experienced gender-based discriminatory treatment, male and female EM faculty were equally likely to report having observed discriminatory treatment of another physician based on gender (64.7% vs 56.3%, respectively; p = 0.090) (Figure 1). Having observed discriminatory treatment of another physician based on gender was also significantly associated with higher OGDW scores (mean OGDW 14.3 vs 9.7, t = -6.212, df = 131.8, p < 0.001, equal variances not assumed; mean difference -4.5, 95% CI, -5.9 – -3.1). Respondent age and years in practice were not significantly correlated with OGDW scores, experience with or observations of gender-based discriminatory treatment.

For those respondents who had experienced or observed gender-based discriminatory treatment, at least annually, the three most frequent sources of the discriminatory treatment were patients, consulting or admitting physicians, and nursing staff (Figure 2).

The majority of women (52.9%) reported having encountered unwanted sexual comments, attention, or advanced by a work superior or colleague in their professional career (Table 2). A significantly greater proportion of women reported encountering these unwanted behaviors as compared to men (52.9% vs 26.2%, ^{2} = 9.559, df = 1, p = 0.002). The majority of unwanted behaviors were sexist remarks and unwanted sexual advances (Table 3). Of those respondents who encountered these unwanted behaviors, 22.9% (11/48) and 12.5% (6/48) reported negative effects on their self-confidence and on their career advancement at least somewhat (Table 3). Controlling for gender, those respondents who were older (r = 0.243, p = 0.011) and had been practicing longer (r = 0.211, p = 0.016) were also significantly more likely to report having encountered these unwanted behaviors. Respondents who reported having experienced these unwanted behaviors had OGDW scores that were significantly higher than those of their counterparts without such experiences (14.7 vs. 10.9, t = -4.516, df = 91.662, p < 0.001, equal variances not assumed; mean difference = -3.8, 95% CI, -5.4 – -2.1).

DISCUSSION

Although gender discrimination and sexual harassment in medicine are well documented,[5,12-20] the extent of these problems within academic EM had not been previously examined. In our study, men and women differed significantly in their perceptions of and experiences with workplace gender discrimination and sexual harassment. Our data showed that the majority of female EM faculty have encountered unwanted sexual comments, attention, or advances in the workplace. This is consistent with prior work among US medical school faculty wherein 52% of women reported harassment during their careers.[5] A significant number of male EM faculty also reported these unwanted sexual behaviors in our study, similar to a recent study among surgery residents.[29]

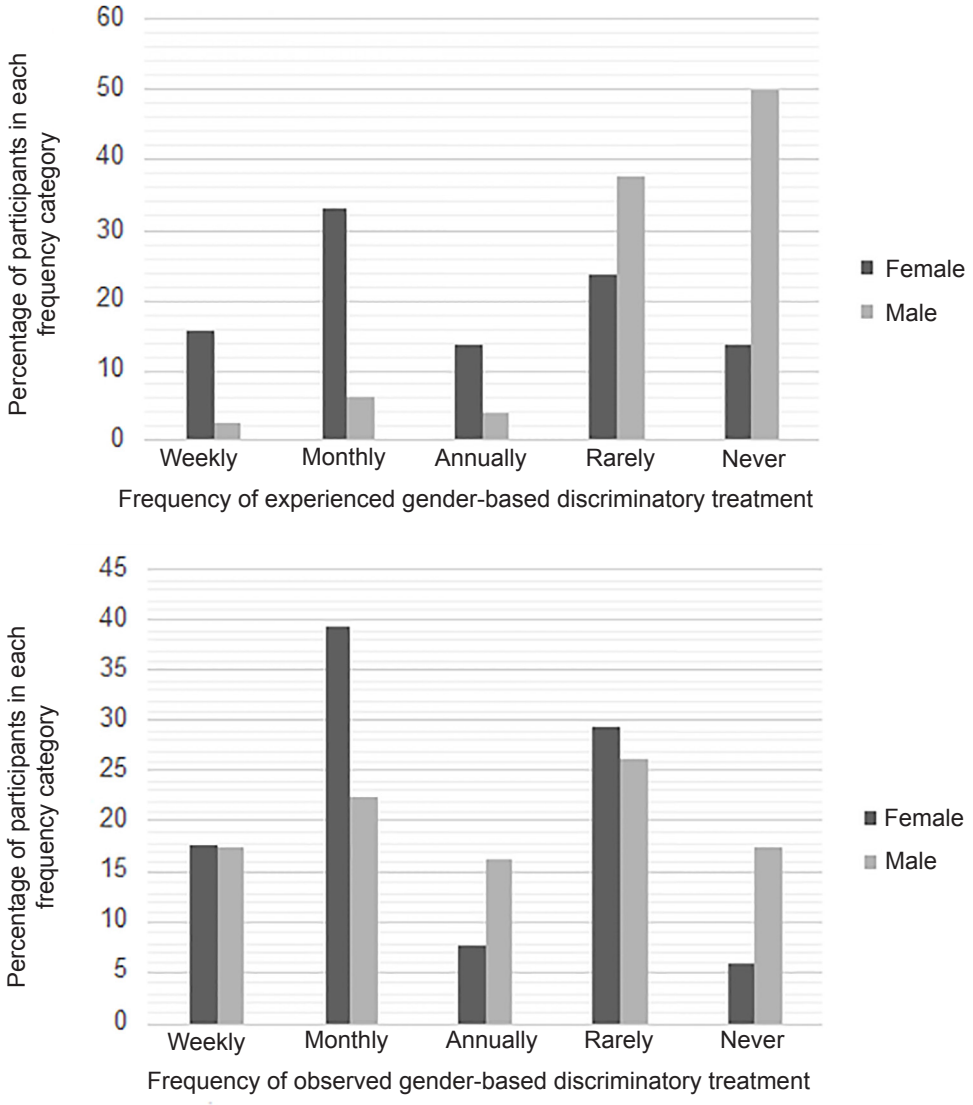

Figure 1. Percentage of participants who experienced or observed gender-based discriminatory treatment by gender and frequency.

It is important to note that these results spanned respondents' professional careers, which encompass time from medical school and residency or fellowship training to their current practice as EM faculty. We did not ask respondents to identify the source of each case of unwanted sexual behavior. We therefore do not know what proportion stemmed from a work superior (eg, department chair or medical director for when respondents were faculty, or medical faculty or senior resident for when respondents were trainees) vs a work colleague (eg, peer faculty or trainee or nursing staff). Older respondents and those who have been in practice for a longer period of time were more likely to report having encountered these unwanted sexual behaviors. This is in contrast to a prior study that reported higher rates of sexual harassment among younger physicians.[16]

It is unclear in our study whether older respondents have had more time in the medical profession to encounter these behaviors, whether such behaviors were more common in the past, or whether they felt more empowered to report these instances since they may be more established in the field and have less fear of reporting. In recent work among clinician-researchers who had received career development awards from the National Institutes of Health between 2006-2009, 30% of women reported having experienced sexual harassment compared with 52% of women in the aforementioned study of medical school faculty study in 1995.[2,5] While the proportion of women reporting sexual harassment appears to have decreased from 1995 to 2009, definitive conclusions cannot be drawn due to differences in study populations and the higher percentages of women enrolled in medical school in the intervening years.

Similar to other studies, the majority of unwanted sexual behaviors in our study were sexist remarks and unwanted sexual advances.[29,30] Although these behaviors are detrimental and should not be tolerated, they may be less threatening than

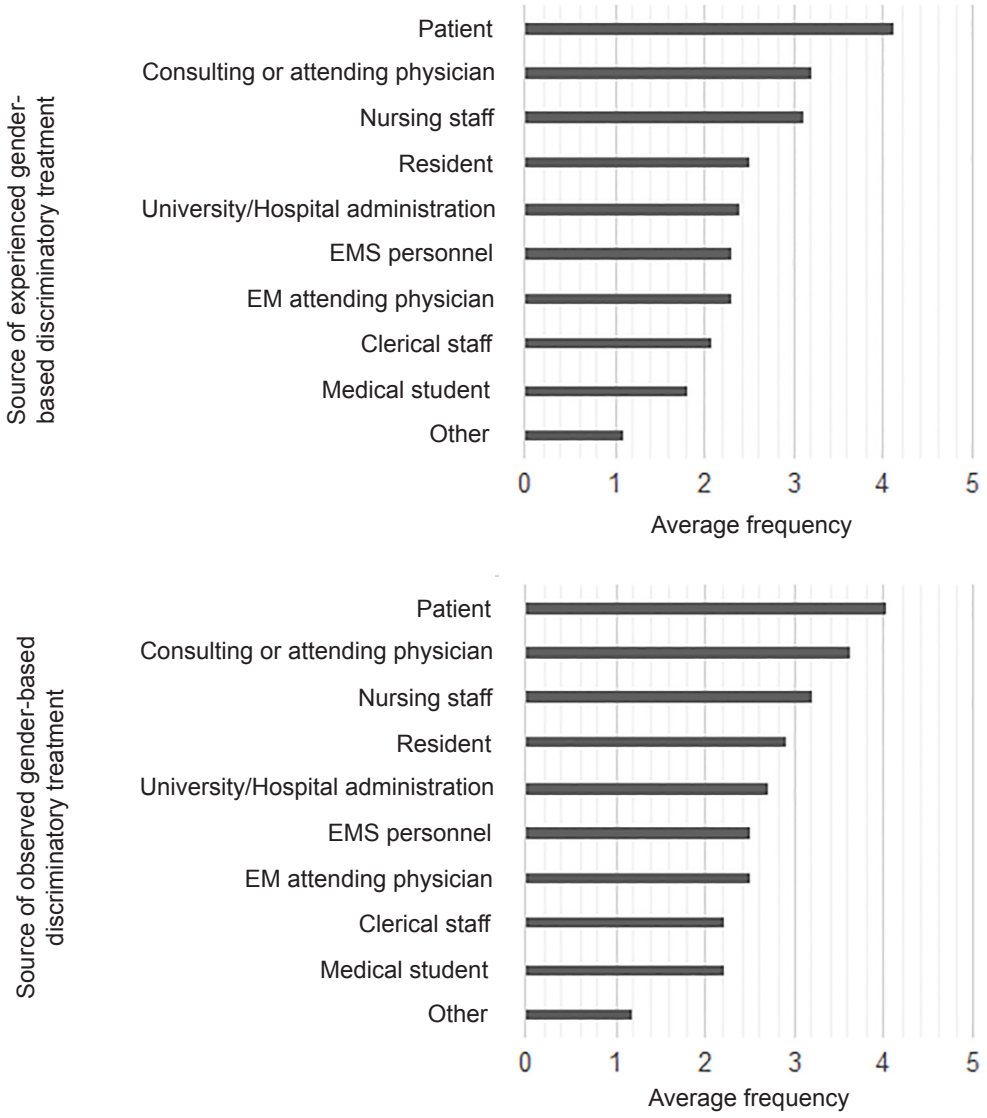

Figure 2. Sources of experienced or observed gender-based discriminatory treatment by average frequency. Frequency categories: 1 = never; 2 = rarely; 3 = annually; 4 = monthly; 5 = weekly.

the other examples of unwanted sexual behavior included in the study survey. This may explain why a majority of respondents who described having encountered these behaviors reported that they had little to no negative impact on their self-confidence or career advancement. Our results are consistent with work among female surgeons wherein a majority similarly reported that they could overcome career barriers stemming from gender discrimination.[31] It is important to note, however, that we do not know the cumulative impact of these less aggressive but more frequent forms of unwanted sexual behavior on individuals over the course of their professional lives. Prior research among female physicians suggested that while there were no significant differences in the effects of sexual harassment on professional confidence or career advancement, women who reported experiencing negative gender bias had lower career satisfaction.[5] Qualitative studies of female EM faculty may be able to shed light on this important issue.

A smaller but significant number of respondents reported more alarming instances of unwanted sexual behavior, including coercive advances, bribery to engage in sexual quid pro quos, and threats to engage in sexual behavior. We did not query how respondents dealt with these unwanted behaviors, including whether they had reported them to institutional authorities or confided in mentors, colleagues, or others. Studies among surgeons found that only a minority of respondents who experienced workplace gender discrimination or sexual harassment reported it to colleagues or supervisors.[14,29] The two most common reasons for non-reporting were believing that the action was harmless and that reporting would be a waste of time.[29] Of those who reported such discrimination, a majority

Table 2. Number of participants by gender who reported having encountered unwanted sexual comments, attention, or advances.

Response	Female n (%)	Male n (%)	Total n (%)
No	24 (47.1%)	59 (73.8%)	83 (63.4%)
Yes	27 (52.9%)	21 (26.2%)	48 (36.6%)

Table 3. Type and impact of unwanted sexual comments, attention, or advances.

Action type	Total n (%)
Sexist remarks/behavior	45 (48.4)
Unwanted sexual advances	36 (38.7)
Coercive advances	8 (8.6)
Subtle bribery to engage in sexual behavior	3 (3.2)
Threats to engage in sexual behavior	1 (1.1)
Extent these behaviors had a negative effect on your confidence in yourself as a professional	
Greatly	4 (8.3)
Moderately	1 (2.1)
Somewhat	6 (12.5)
A little	3 (6.3)
None at all	34 (70.8)
Extent these behaviors negatively affected your career advancement	
Greatly	1 (2.1)
Moderately	2 (4.2)
Somewhat	3 (6.2)
A little	7 (14.6)
None at all	35 (72.9)

described a lack of action as the result.[14]

A study of internal medicine residents similarly revealed that female residents did not report harassment because they were not confident they would be helped.[18] Among EM residents specifically, only about 3% filed a formal complaint regarding abuse or harassment.[17] Those EM residents who did not file complaints reported a variety of reasons for not doing so, including the following: feeling that the episode was insignificant; feeling that it would not help; fear of reprisal; feeling that reporting would not stop the behavior; feeling that they had no mechanism to file; and describing that they were discouraged to report by others.[17]

Our data showed OGDW scores were significantly higher for female EM faculty than male EM faculty. Our finding was consistent with prior studies, including one among anesthesiology trainees that demonstrated a significant gender disparity in OGDW scores.[27] In a different study, female medical school faculty were more than 2.5 times more likely than male faculty to perceive gender-based discrimination in the academic environment.[5] Similar investigations among early-career surgery faculty and senior general surgery residents revealed that female surgeons perceived they were treated differently based on their gender and these differences in treatment were a barrier to their academic career development.[31] As expected, our data revealed that having encountered unwanted sexual behaviors and having more experiences with and observations of gender-based discriminatory treatment correlated with higher OGDW scores.

Female EM faculty were significantly more likely to report experiencing discriminatory treatment based on their gender than their male colleagues in our study. Interestingly, male and female EM faculty were equally likely to report observing discriminatory treatment of another physician based on gender. So although someone may not have direct experience with gender discrimination, he or she can identify and recognize it when it occurs with another physician. We did not query respondents as to whether they acted or intervened in any way when they saw these instances of discrimination of another physician. Nor did we ask respondents who reported having experienced discrimination or harassment whether others intervened on their behalf when there were witnesses. Institutional policies and guidance illustrating how witnesses should report and intervene in instances of gender discrimination or sexual harassment may be helpful.

EM faculty reported that patients were the most common source of both experienced and observed gender-based discriminatory treatment. This may stem from underlying sexist beliefs that exist within our culture and society. Prior qualitative work revealed that despite the power physicians hold in the relationship with their patients, it did not preclude female physicians from being the target of unwanted sexual harassment and sexual advances.[32] In these circumstances, female physicians were viewed as women first and physicians second, leaving them susceptible to sexual harassment, particularly by male patients. Physicians described sexual harassment from patients most commonly in the form of suggestive looks or gestures and sexual remarks.[19]

Among EM residents, women were more likely to report unwanted sexual advances and discomfort from sexual humor, and that patients or patients' family members were the most frequent source of abuse or harassment.[17,25] To be clear, in our study we only asked respondents about discriminatory behavior, not harassment, from patients. Nonetheless, significant overlap exists between the two types of behavior and there is evidence to suggest that progress has been limited. In a recent study of female medical students, all participants reported numerous workplace interactions with male patients involving flirting or sexual innuendo, with many describing that they were "too used to it."[12]

The second and third most common sources of experienced and observed gender-based discriminatory

treatment were consulting or admitting physicians and nursing staff. This is consistent with prior work among surgery residents, where among all hospital staff, nurses were the most common perpetrators of harassment, followed by attending physicians.[29] Sexism within the medical profession is well documented, starting from undergraduate medical education, through residency and fellowship training, and continuing through clinical practice as attendings.[14] In a recent study investigating the prevalence of sexual harassment in academic medicine, the presence of a strong institutional hierarchy was associated with sexual harassment in both genders, highlighting the important role of organizational culture.[30]

While issues related to gender discrimination and sexual harassment in medicine have long been documented, there is currently significant societal and cultural momentum to confront these pervasive problems. Prominent attention to sexual harassment and assault has been raised through the #MeToo movement, which aims to shed light on the prevalence of sexually inappropriate behaviors. The #MeToo movement subsequently spurred the TIME'S UP organization that coordinates responses and develops solutions to address gender discrimination and harassment. TIME'S UP Healthcare was recently established to unify national efforts to bring safety, equity, and dignity to the healthcare workplace.[33]

There are many ways gender-based discrimination and sexual harassment can be addressed. For example, leaders in medicine can commit to ending gender-based inequities by changing workplace standards and culture. Medical educators can better prepare students, residents, and fellows for dealing with gender-based discrimination and sexual harassment in their present role as trainees and future role as physicians. Physicians should also take advantage of their inherent leadership roles in healthcare and advocate for each other as well as other healthcare providers who may not feel empowered to speak up. Future research examining and describing successful strategies (eg, staff education, clear anti-harassment policies, reliable reporting mechanisms, strict accountability, changes to academic promotion processes, and faculty recruitment and retention) to address gender inequities and sexual harassment in the healthcare workplace is necessary.[29]

LIMITATIONS

Our study population was a convenience sample of EM faculty at six urban academic sites and our results may not be generalizable to practicing emergency physicians in non-urban and non-academic settings. Approximately 40% of eligible subjects responded to the survey and response bias may have played a role in our results. We were unable to compare characteristics of respondents with those of non-respondents due to the anonymous nature of our survey methodology. Therefore, we do not know whether more men or women chose to participate in the study and whether their experiences with gender discrimination or sexual harassment played a role in their study participation.

Although our questions measuring self-reported experiences and observations of gender discrimination and unwanted sexual behavior were modeled after prior work, have face validity as well as internal consistency reliability ($\alpha = 0.70$) in this sample, other aspects of reliability and criterion and construct validity have not been previously established

Finally, we were unable to corroborate respondents' self-reported experiences with and observations of gender discrimination or sexual harassment. Prior work demonstrated that the majority of medical students developed progressive desensitization to discrimination and learned to systematically tolerate or minimize discrimination or harassment as a part of their future career.[12] Thus, we do not know whether respondents' accounts of experienced or observed gender discrimination and sexual harassment represent over- or under-reporting of what may be considered objective definitions of discrimination or harassment.

CONCLUSION

Female EM faculty perceived more gender-based discrimination in their workplace than their male counterparts, with higher perceptions of discrimination associated with greater reports of experience with and observations of discriminatory treatment. Although female EM faculty were more likely to experience gender discrimination than their male colleagues, both groups were similar in their observations of discriminatory treatment of another physician based on gender. The majority of female and approximately a quarter of male EM faculty encountered unwanted sexual comments, attention, or advances by a work superior or colleague during their professional careers. Future work to examine the prevalence and characteristics of gender discrimination and sexual harassment in a larger and more diverse sample of emergency physicians is necessary.

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Emergency Department Clinicians' Attitudes Toward Opioid Use Disorder and Emergency Department-initiated Buprenorphine Treatment: A Mixed-Methods Study

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Introduction: Emergency department (ED) visits related to opioid use disorder (OUD) have increased nearly twofold over the last decade. Treatment with buprenorphine has been demonstrated to decrease opioid-related overdose deaths. In this study, we aimed to better understand ED clinicians' attitudes toward the initiation of buprenorphine treatment in the ED.

Methods: We performed a mixed-methods study consisting of a survey of 174 ED clinicians (attending physicians, residents, and physician assistants) and semi-structured interviews with 17 attending emergency physicians at a tertiary-care academic hospital.

Results: A total of 93 ED clinicians (53% of those contacted) completed the survey. While 80% of respondents agreed that buprenorphine should be administered in the ED for patients requesting treatment, only 44% felt that they were prepared to discuss medication for addiction treatment. Compared to clinicians with fewer than five years of practice, those with greater experience were less likely to approve of ED-initiated buprenorphine. In our qualitative analysis, physicians had differing perspectives on the role that the ED should play in treating OUD. Most physicians felt that a buprenorphine-based intervention in the ED would be feasible with institutional support, including training opportunities, protocol support within the electronic health record, counseling and support staff, and a robust referral system for outpatient follow-up.

Conclusion: ED clinicians' perception of buprenorphine varied by years of practice and training level. Most ED clinicians did not feel prepared to initiate buprenorphine in the ED. Qualitative interviews identified several addressable barriers to ED-initiated buprenorphine. [West J Emerg Med. 2020;21(2)261-271.]

INTRODUCTION

Background

Emergency department (ED) visits related to opioid use disorder (OUD) have increased nearly twofold over the last decade.[1] As a critical access point for patients with OUD, the ED is well positioned to provide and link patients to OUD treatment.[2] However, current practice in United States EDs for patients seeking treatment for OUD is referral to addiction

treatment services, which often consist of abstinence-based programs or psychosocial interventions.[3]

Buprenorphine is a first-line medication for addiction treatment (MAT) of OUD.[4] Treatment with buprenorphine decreases non-medical opioid use and opioid-related overdose deaths while improving retention in treatment compared to patients receiving abstinence-based treatment or psychosocial intervention.[5-8] A recent randomized controlled study demonstrated that when buprenorphine treatment was initiated in the ED, patients were more likely to remain engaged in treatment compared to brief intervention and referral for treatment.[9] ED-initiated buprenorphine was also found to be cost-effective compared with referral to community-based treatment or combined brief intervention and referral.[10]

Importance

Several EDs have launched ED-initiated treatment programs with buprenorphine.[2,11-14] Legislative changes are also underway to incorporate initiation of buprenorphine into ED management of patients of OUD. For example, a new State of Massachusetts law requires acute care hospitals that provide emergency services to have the capacity to initiate opioid agonist therapy to patients after an opioid-related overdose, and to directly connect the patients to continuing treatment prior to discharge.[15] Despite the growing national momentum toward offering buprenorphine in the ED, little is known about ED clinicians' attitudes related to this practice.[16,17] To work toward the goal of improving care for patients with OUD in the ED, it will be important to better understand clinicians' diverse views on and perceived barriers to the practice of initiating buprenorphine in the ED.

Goals of This Investigation

The objective of this study was to better understand ED clinicians' perceptions of OUD and ED-initiated buprenorphine treatment. This was a mixed-methods study consisting of a survey and in-depth qualitative interviews of ED clinicians. The survey phase aimed to understand ED clinicians' perceptions of ED-initiated buprenorphine treatment, in addition to their attitudes, clinical practice, and self-perceived preparedness related to caring for patients with OUD. The goal of the qualitative interview phase was to explore emergency physicians' perceptions about their current management options for OUD, characterize their opinions about ED-initiated buprenorphine, and identify addressable barriers to prescribing buprenorphine in the ED. While the survey phase focused on measuring how many ED clinicians have certain perceptions, the purposive, in-depth qualitative interviews were designed to uncover a range of opinions and to identify new ideas and concepts, embedded in real-life experiences that frame OUD treatment for emergency physicians.

Population Health Research Capsule

What do we already know about this issue?
Treatment of opioid use disorder (OUD) with buprenorphine has been shown to decrease opioid-related overdose deaths while improving retention in treatment.

What was the research question?
How do emergency department (ED) clinicians perceive opioid use disorder and ED-initiated buprenorphine?

What was the major finding of the study?
Most ED clinicians supported ED-initiation of buprenorphine, which would be feasible with robust institutional support.

How does this improve population health?
This study provides potential solutions to facilitate the initiation of buprenorphine in the ED and transform the delivery of emergency care for OUD patients.

METHODS

We conducted a cross-sectional survey of ED clinicians (attending physicians, resident physicians, and physician assistants) and individual semi-structured interviews with emergency medicine (EM) attending physicians working in an ED at a tertiary-care academic hospital with an annual volume of 65,000 patients. The study was approved by the study site's institutional review board.

Survey

The sampling frame for the survey phase consisted of attending physicians, residents, and physician assistants (n = 174) from December 2017 to February 2018. A request to participate along with a link to the de-identified survey was emailed to ED clinicians. The survey was administered via Qualtrics (Qualtrics, Provo, Utah). ED clinicians received an initial request and two reminder emails and an incentive of a $10 gift card for survey completion. As an exploratory study, a sample size calculation was not performed a priori, but rather investigators aimed for a response rate of >50% with a goal of recruiting approximately 100 participants.

A previously studied survey instrument designed for internal medicine physicians was adapted to assess ED clinicians' attitudes, exposure, clinical practice, and preparedness related to caring for patients with OUD on an 11-point Likert scale.[18] Two questions were specific to

understanding perceptions of buprenorphine treatment and whether it should be initiated in the ED. Participants' role and their total years of practice in EM after graduation from medical or physician assistant school were also recorded.

We selected our outcomes a priori and performed the Kruskal-Wallis with Bonferroni adjusted pairwise Mann-Whitney tests to determine the differences in the responses based on years of practice and roles. Seven participants with missing responses were removed from data analysis. We used Stata version 13.1 (Stata Corporation, College Station, TX) for all statistical analyses.

Qualitative Interview

For the interview phase of the study, we contacted all ED attending physicians (n = 72 by email), informed them of the study, and invited them to be interviewed on a voluntary basis in February-March, 2018. Participants were offered a $50 gift card. Study participants were recruited until thematic saturation was reached, which is the point at which no new themes emerged. We recruited 17 attending physicians to interviews, in line with typical sample size employed to achieve thematic saturation in qualitative studies.[19]

Qualitative, semi-structured interviews were conducted individually in person by a research assistant (H.V.) trained in in-depth interviewing by an expert in qualitative methodology (A.C.). Informed consent was verbally obtained before each interview. Interview questions focused on emergency physicians' experiences treating patients with OUD as well as attitudes towards buprenorphine initiation in the ED (Table 1). Basic demographic information was collected about each participant's number of years of practice, average number of shifts worked per month, and fellowship training.

All interviews were recorded, de-identified and professionally transcribed. Investigators developed a codebook based on preliminary review of six transcripts. Subsequently, individual interviews were coded independently by four investigators (D.I., A.C., L.V., and L.C.), with NVivo version 12 (QSR International, Melbourne, Australia). D.I., A.C., and H.V. serially reviewed coded transcripts and discussed discrepancies until reaching consensus. Themes were identified using a modified grounded theory approach, and thematic saturation was determined by team consensus.

RESULTS

Survey Results

Of the 100 survey respondents, 93 had complete responses (57% response rate, 53% completion rate) and were included for analysis. Table 2 summarizes the characteristics of survey respondents. Of the respondents surveyed, 88% agreed that buprenorphine should be administered in the ED for patients requesting treatment for OUD. However, only 44% of ED clinicians reported that they felt prepared to discuss MAT options with patients. Table 3 summarizes ED clinicians' attitudes related to OUD and buprenorphine by years of practice and roles in the ED. Compared to clinicians with more than five years of practice, those with fewer years of practice were (1) more likely to believe that OUD is like other chronic diseases; (2) more likely to approve of ED-initiated buprenorphine; and (3) less likely to believe that buprenorphine replaces one addiction with another ($p<0.01$ for each). Compared to attending physicians, residents were less likely to believe that OUD is different from other chronic diseases ($p<0.03$).

Attending physicians and residents viewed ED-initiated buprenorphine more favorably than physician assistants

Table 1. Interview guide domains and sample questions.

Domains	Sample questions
Perceptions of current ED-based practices to manage patients seeking treatment for OUD	• Can you tell me about your experiences working with OUD patients? • How do you feel about your current personal practice when treating patients with OUD?
Perceptions of ED-initiated buprenorphine to treat OUD	• What are your thoughts on ED clinicians prescribing buprenorphine in the ED? • How do you think your colleagues might feel about an ED-based buprenorphine intervention?
Perceived barriers to initiating buprenorphine treatment in the ED	• Do you think it would be practical to initiate buprenorphine in the ED? Why or why not? • Tell me about your comfort level with initiating buprenorphine in the ED.
Potential solutions to the identified barriers	• What would help facilitate you incorporating buprenorphine into your ED practice.

OUD, opioid use disorder.

Table 2. Demographics of survey respondents.

	n	%
Gender		
Male	48	51.6%
Female	45	48.4%
Role		
Attending	26	28.0%
Resident	41	44.0%
Physician Assistant	26	28.0%
Years of Practice		
0-5 years	55	59.1%
6-10 years	18	19.4%
>10 years	20	21.5%

($p<0.01$). Compared to physician assistants, residents were also less likely to view buprenorphine as replacing one addiction with another ($p<0.01$). Compared to clinicians with fewer than five years of practice, those with more years of practice were more likely to feel prepared to discuss overdose prevention and naloxone with patients ($p<0.03$) (Table 4). Attending physicians were more likely to feel prepared to discuss harm reduction with patients than residents ($p=0.01$).

Qualitative Interview Results

Table 5 summarizes the characteristics of the 17 interviewees. Several themes emerged regarding the following: (1) emergency physicians' views of current ED practices to manage OUD; (2) perceptions of ED induction of buprenorphine for OUD treatment; (3) clinician-level barriers and solutions to initiating buprenorphine in the ED; and (4) systems-level barriers and solutions to initiating buprenorphine in the ED.

Current ED-based Approaches to Manage Patients Seeking Treatment for OUD

The majority of the emergency physicians (EPs) described current practices as consulting social work (if available) and providing a list of detoxification facilities to patients. As one participant observed, "My practice has been pretty much what emergency physicians have largely done, which is I give them the badly photocopied list of treatment options and let them walk out the door."

EPs expressed frustration, anger, helplessness, sadness, and dissatisfaction when describing their current practices to manage patients seeking treatment for OUD in the ED setting. Their emotions stemmed from the inadequate and limited nature of the current management options. One emergency physician summarized: "It's really frustrating, and I feel kind of helpless sometimes – where we're doing the bare minimum to get them discharged, and that's kind of the best we can do, and the rest of it's on them." Many of the participants associated their dissatisfaction with the sentiment of "temporizing things without feeling like we're actually making a meaningful difference" in patients' lives.

Emergency Physicians' Views of ED-initiated Buprenorphine Treatment

EPs expressed their view of buprenorphine as an effective treatment option for OUD. As one participant elaborated, "I've heard that when well managed and when well coordinated, that it has a whole lot better efficacy than some of the other things that we have seen, certainly compared to the non-medication-assisted therapies."

Despite favorable views of buprenorphine in general, only a minority of the interviewees were in favor of ED-initiated buprenorphine. Those who supported ED-initiated buprenorphine often cited the duty of EM as a medical specialty to improve public health. One EP described EM as an all-encompassing specialty, with the ED serving as a point of capture for underserved populations: "When [patients] are [in the ED] for whatever issue, whether it be an overdose or some other medical process, it'd be a great way to capture them and put them into some sort of system at least to get [the treatment] started."

Reluctance to support ED-based buprenorphine treatment stemmed from three major concerns. First, interviewees viewed prescribing buprenorphine as not within the scope of EM practice. One participant described the current ED practice of deferring long-term management of chronic illnesses to outpatient clinicians, and applied this to using buprenorphine to treat OUD: "My impression is that it's not necessarily a great thing for emergency physicians to be primarily involved with those patients because – just like I don't manage people's diabetes long term and I don't manage their blood pressure long term, I don't see long-term management of the buprenorphine as within our wheelhouse."

A second concern about prescribing buprenorphine related to patients' potential misuse of the medication. Interview participants expressed belief that buprenorphine is a highly diverted medication, which would encourage patients to either abuse or sell ED-prescribed buprenorphine. One physician stated, "What I do fear is that there is a potential for emergency medicine to be seen as like a way to potentiate kind of bad habits if people know like 'oh, if I go and I ask for buprenorphine, I'll get a script for it and I can somehow misuse that.' That's one of my concerns. I know buprenorphine has some kind of misuse prevention kind of built into the way it's formulated, but I still think it's sold on the street and has a street value and is – it could be misused. I just want to be careful that I'm not adding to the problem and that I really am alleviating the problem by me participating in this way."

Table 3. Attitudes towards opioid use disorder (OUD) and buprenorphine treatment by years of practice and roles. Eleven discrete, graded responses were possible for each question, with a score of 10 indicating strongly agree and 0 indicating strongly disagree.

	Median Response (IQR)							
		Years of Practice			Roles			
Perception of OUD	All clinicians	< 5 years	≥ 5 years	P value	Attg EP	Resident EP	PA	P value
Opioid use disorder (OUD) is different from other chronic diseases (e.g., diabetes, hypertension) because people who use drugs like heroin or illicit opioids are making a choice.	3 (2-6)	2.5 (1-5)	4 (2-7)	<0.01	5 (3-7)	3 (1-4)	2.5 (1-5)	<0.03[α]
Opioid use disorder is a treatable disease.	8 (7-10)	8 (7-10)	8 (6-10)	0.66	8 (6-10)	8 (7-10)	8 (7-10)	0.85
I find caring for patients with opioid use disorder as satisfying as my other clinical activities.	3 (2-5)	3.5 (2-5)	3 (2-5)	0.84	3 (1-5)	4 (2-5)	3 (2-7)	0.59
Treating opioid use disorders reduces associated health and social costs by more than the cost of the treatment itself.	8 (7-10)	8 (7-10)	9 (7-10)	0.98	9 (7-10)	8 (8-10)	8 (7-10)	0.59
Patients with opioid use disorder are more challenging to take care of than the average patient.	7 (7-0)	7 (7-9)	8 (7-10)	0.01	8 (7-10)	7 (7-9)	8 (7-10)	0.21
Someone who uses drugs is committing a crime and deserves to be punished.	1 (0-3)	1 (0-3)	1 (0-3)	0.63	1 (0-3)	1 (0-3)	1 (0-2)	0.55
Perception of Buprenorphine Treatment								
I think buprenorphine should be administered in the ED for patients requesting treatment for OUD (with referral for outpatient long-term buprenorphine management)?	7 (5-9)	8 (6-10)	6 (3-9)	<0.01	7 (4-9)	9 (7-10)	5 (2-6)	<0.01[βΔ]
Using medications like methadone and buprenorphine for opioid use disorder is simply replacing one addiction with another.	1 (1-4)	1 (0-3)	3 (1-6)	<0.01	2 (1-4)	1 (0-3)	3 (1-6)	<0.01[Δ]

[α]statistically significant difference between attending EP and resident EP.
[β]statistically significant difference between attending EP and PA.
[Δ]statistically significant difference between resident EP and PA.
IQR, interquartile range; *Attg,* attending; *EP,* emergency physician; *PA,* physician assistant.

Third, physicians vocalized their concerns about inadvertently harming patients with buprenorphine. They expressed reluctance to start prescribing a new medication that could result in overdose or co-ingestion with other sedatives, such as benzodiazepines. Another physician offered, "If they take higher than normal doses to get an effect and you end up causing a death or an inadvertent overdose because of the way it's done and the mechanism of action and somebody wants to, you end up doing more harm."

Clinician-level Barriers and Solutions to Provision of MAT in the ED

EPs also identified three major clinician-level addressable barriers potential and solutions. First, EPs commonly cited

Table 4. Summary response of current practice (A) and preparedness to care for patients with opioid use disorder (OUD) (B) by years of practice and roles. Eleven discrete, graded responses were possible for each question, with a score of 10 indicating very frequently/very prepared and 0 indicating very infrequently/very unprepared.

	Median Response (IQR)							
		Years of Practice			Roles			
	All clinicians	< 5 years	≥ 5 years	P value	Attg EP	Resident EP	PA	P value
Current Practice								
See a patient who asks for help with OUD	5 (3-8)	5.5 (2-8)	5 (3-8)	0.87	5.5 (3-7)	5 (5-7)	6 (2-8)	0.70
Refer a patient to OUD treatment	5 (2-6)	3.5 (1-6)	5 (2-7)	0.22	5 (2-7)	4 (2-6)	5 (2-7)	0.44
Prescribe naloxone	2 (1-6)	2.5 (1-6)	2 (1-7)	0.86	3 (0-7)	3 (1-6)	2 (2-7)	0.99
Preparedness								
Screen for OUD	7 (5-8)	6 (5-8)	7 (5-9)	0.10	8 (4-9)	6 (5-8)	7 (5-9)	0.41
Diagnose OUD	7 (6-8)	7 (6-8)	7 (5-8)	0.82	8 (6-8)	7 (6-8)	6 (5-8)	0.50
Provide brief intervention	6 (3-8)	5 (3-7)	7 (4-8)	0.06	5 (4-8)	5 (3-7)	7 (5-8)	<0.01[Δ]
Refer to OUD treatment	6 (3-8)	7 (4-8)	6 (3-8)	0.48	5 (2-7)	7 (4-8)	7 (3-8)	0.15
Discuss behavioral therapy	3 (2-6)	3 (2-6)	4 (2-6)	0.29	3.5 (2-7)	3 (1-5)	4 (3-6)	0.10
Discuss medication OUD treatment	4 (2-6)	5 (2-6)	3 (2-6)	0.25	4 (2-6)	4 (2-6)	3 (2-6)	0.90
Discuss overdose prevention and naloxone	8 (6-9)	7 (6-9)	8 (7-10)	<0.03	8 (6-10)	7 (5-9)	9 (8-10)	<0.01[Δ]
Discuss harm reduction	7 (5-8)	7 (5-8)	7 (5-9)	0.12	7.5 (5-9)	6 (5-7)	7.5 (5-9)	<0.02[α]

[α]statistically significant difference between attending EP and resident EP.
[β]statistically significant difference between attending EP and PA.
[Δ]statistically significant difference between resident EP and PA.
OUD, opioid use disorder; *IQR,* interquartile range; *Attg,* attending; *EP,* emergency physician; *PA,* physician assistant.

that the current length of the waiver training is burdensome. Under the Drug Addiction Treatment Act of 2000 (DATA 2000), physicians are required to complete an eight-hour training to qualify for a waiver to prescribe and dispense buprenorphine.[20] As a potential solution, participants suggested providing financial or academic incentives for completing the waiver training. In addition to the waiver training required for potential prescribers, an institution-wide educational campaign was recommended for other stakeholders in the ED, including nurses, non-physician clinicians, administrative staff, and other support staff. As one participant stated, "I just think there would have to be an emergency department-wide educational process. The nurses need to be on board. The whole team needs to be on board."

A second barrier noted was the time-consuming nature of building therapeutic relationships in order to identify ideal candidates for buprenorphine treatment and to engage these patients for buprenorphine induction in the ED. As one EP expressed, "It's unrealistic for the ER doc to do that because it takes time." Another commented about resource utilization: "The reality is it's time away from other patients." One participant made an analogy to providing medical forensic care to victims of sexual assault or abuse, stating that it is a skillset she has acquired in her training, but has not used frequently enough to feel confident in her ability to conduct an exam efficiently, effectively, and safely. She advocated that just as specialized practitioners, such as a sexual assault nurse examiner, are better equipped with training, practice, and time to conduct an exam for forensic evidence collection, EDs should employ dedicated, specialized staff (social worker, advocate, or addiction specialist) to identify patients ideal for ED-initiation of buprenorphine, to discuss instructions on how to start buprenorphine, and to ensure outpatient follow-up.

A third clinician-level barrier identified was a reported lack of motivation to start patients on buprenorphine in the ED because of delayed clinical gratification. Participants expressed frustration with the inability to see the impact of engaging patients to start MAT in the ED on long-term opiate use. One potential solution offered was to create a mechanism that tracks patients' engagement in outpatient MAT after ED discharge and reports it back to ED prescribers. As one participant stated, "[it] would be really key to be able to show

Table 5. Demographics of interviewees.

	n	%
Gender		
Male	11	64.7%
Female	6	35.3%
Fellowship Training		
Completed	8	47.1%
Not completed	9	52.9%
Current Practice Setting		
Academic ED only	8	47.1%
Academic ED and community ED	9	52.9%
Years of Practice		
0-5 years	4	23.5%
6-10 years	2	11.8%
>10 years	11	64.7%
Median 12 (IQR 9-20)		

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

that this was having positive outcomes for people and I think that kind of positive feedback would be really helpful." See Table 6 for additional supporting quotes.

System-level Barriers and Solutions to Provision of MAT in the ED

Interviewees described three major systems-level barriers and solutions to offering buprenorphine in the ED and their potential solutions. First, EPs expressed discomfort with prescribing buprenorphine in the ED without the ability to ensure outpatient follow-up. In describing the need for establishing a long-term plan for patients being considered for buprenorphine, interviewees identified the anticipated gaps in the outpatient follow-up system. One EP questioned, "Like, what if the person can't [see] the PCP for 20 days? Then, all of a sudden, you're the one prescribing 20 days of [buprenorphine/naloxone], which – I don't know – I might feel uncomfortable doing that with that patient population. So, I think it would have to be some sort of strict process of like, we'll give you two doses or something like that, and then [connect them to] a good follow-up system to go to somebody who's going to do it long term. Because I think that's the issue with a lot of ED clinicians is we're not going to be the ones following them."

As a potential solution, EPs looked to the system-level approach of using electronic health record (EHR) integration for providing cohesive addiction treatment. EHR integration can enhance the ability to place electronic orders for referrals and to track patients using mechanisms such as a prescription drug monitoring program. Individualized care plans, which many EHRs have integrated for complex care patients, were also recommended to guide ED management of patients with OUD.

Participants raised a second systems-level barrier of possible financial barriers for patients to continue on buprenorphine after ED-induction. Interviewees suggested that variability in insurance coverage may prohibit patients from continuing on buprenorphine after induction in the ED. In addition to having dedicated ED staff helping patients navigate the healthcare system and ensuring follow-up, physicians suggested providing ready-to-go buprenorphine in supply kits (3-7 days) or in a depot form. Physicians suggested this would ensure that patients would have the needed supply until they can be seen by an outpatient clinician and potentially minimize diversion risks.

A third system-level barrier was the anticipated increase in ED volume related to patients requesting OUD treatment. Some physicians expressed concerns about MAT workload being shifted to EPs from outpatient clinicians. While some participants worried about the potential strain on the ED, others were optimistic about an eventual decrease in the number of ED visits related to overdoses and injuries associated with OUD. Physicians suggested a potential solution for reducing the burden on EPs was to institutionalize clear clinical protocols for initiating buprenorphine in the ED. Clinical protocols similar to those that exist for risk stratifying and managing patients with chest pain could be developed for initiation of buprenorphine in the ED for patients with OUD. Additional quotes regarding these themes are available in Table 7.

DISCUSSION

Our mixed-methods approach allowed a nuanced analysis of ED clinicians' attitudes toward OUD and ED-initiation of buprenorphine for OUD treatment. Recent evidence suggests that ED attending physicians and residents view patients with substance use disorders differently than those with other medical conditions.[17] Similarly, our data showed that some ED clinicians viewed OUD as different from other chronic disease, but this group represented only a minority of our surveyed ED clinicians (34% of surveyed attending physicians, residents, and physician assistants). Interestingly, our in-depth qualitative interviews with attending physicians revealed nuances in the negative emotions such as helplessness, sadness, and frustration associated with OUD and the currently limited ED-based treatment options for OUD. These feelings were directed at clinicians' own inability to effectively help patients with OUD, and did not seem to be directed at the patient population itself. Unlike other studies that have shown health professionals' general negative attitudes toward patients with OUD, we differentiate clinicians' frustrations at the status quo from their negative feelings toward working with this patient population.[16,17,22,23] These data can inform development of future initiatives to redesign care for patients requesting treatment for OUD.

Our analysis of the survey results captured another nuance in ED clinicians' attitudes toward OUD and buprenorphine:

Table 6. Clinician-level barriers to emergency department-initiated buprenorphine and potential solutions with supporting quotes.

	Barriers	Solutions
Clinician-level	1. Length of training to prescribe buprenorphine "That's a little bit ludicrous. I mean, I have much more dangerous drugs that I don't get 10 hours of training on that I can read about, I can go to a lecture, I can learn about probably – and again, I could be wrong. This could be a very complicated drug, although I don't think it is. Why are they putting barriers in front of the care providers? You know, be safe. Don't just say, here, give this medication. People should know about it. But eight hours for one medicine that treats one disorder? That's a little bit harsh."	1. Providing training incentives and streamlining process for training, which includes all members of ED team "I think if this is a hospital or institution-wide initiative, I think getting compensated for the time I spend getting the additional training to be able to write for the script, as well as any kind of licensing costs paid for by the hospital would be I think a nice sign or it's a signal from the hospital of the importance of this issue and the support that they're willing to give for this."
	2. Time-consuming nature of building therapeutic relationships and initiating buprenorphine "What's that like? How long does it take? Is it like a mental health office visit where you sit down and counsel them for 45 minutes? If that's what's involved with this stuff, then I can imagine that nobody's got time for that."	2. Dedicating staff for identifying patients and initiating buprenorphine in the ED "If you could do all of that, you have like a dedicated – like a SWAT team that came down, like an addiction team, identify this patient, do all that, figure out, is this an appropriate patient to prescribe buprenorphine?"
	3. Lack of immediate impact on patients "... to take time [initiating buprenorphine in the ED]... then the outcome is not immediate. And then my gratification for it is prolonged. That's why I may not feel as that – it's not – so, that's the downside of doing something like this in the emergency department. You don't see the immediate outcome. And then you're like, oh, why do I have to do this?"	3. Creating a rapid feedback system to highlight the impact of ED-initiated buprenorphine treatment on patients "People like me, if you ask me to do something and it's all really evidence based and it's the great thing to do for the patient but if I don't get the personal feedback on what I did actually made a difference for that patient, it's less likely for me to continue doing it even though I know in research papers it's been efficacious."

the minority of ED clinicians who negatively viewed OUD and ED-initiated buprenorphine had a disproportionate representation of clinicians with more experience. Similar patterns existed in the attitudes toward buprenorphine and its administration in the ED among survey respondents. The difference in the attitudes toward OUD and buprenorphine by years of practice may reflect changing attitudes toward OUD and a higher number of negative experiences associated with providing treatment for patients with OUD over time. We also attribute this difference to the increased education about OUD for more recently trained ED clinicians with the increased public awareness of the opioid epidemic, particularly regarding the second and third waves of rapid rise in overdose deaths in 2010 and 2013, involving heroin and synthetic opioids, respectively.[24,25]

We also found a difference in the attitudes toward ED-initiated buprenorphine between EPs (attendings and residents) and physician assistants. Institution-wide initiatives for ED-initiation of buprenorphine must take into account the important roles that non-physician clinicians can play, with physician assistants and nurse practitioners also qualified to prescribe buprenorphine after obtaining a waiver. Notably, the Comprehensive Addiction and Recovery Act signed into law in 2016 requires qualifying non-physician clinicians to complete 24 hours of training to be eligible for a waiver, compared to eight hours for physicians.[26]

While 80% of our survey respondents supported ED-initiation of buprenorphine, less than half expressed comfort even with discussing MAT options with patients, let alone initiating MAT in the ED. Our findings regarding clinicians' preparedness are similar to the results of a recent survey study: a minority of EPs felt prepared to connect patients with OUD to outpatient care or to initiate buprenorphine.[27] Our qualitative interviews further elucidated why ED clinicians feel underprepared and reluctant to treat patients with buprenorphine in the ED. Our interviews confirmed that EPs were reluctant to initiate buprenorphine despite their understanding of the scientific evidence behind the effectiveness of buprenorphine. Their reluctance originated from presumed unintended consequences, including diversion, abuse, and accidental overdoses. These concerns represent a double standard applied to buprenorphine, compared to other dangerous medications commonly prescribed by EPs without any special training or waivers. To dispel these concerns, we recommend describing the required Drug Enforcement Administration waiver course as

Table 7. System-level barriers to emergency department-initiated buprenorphine and potential solutions with supporting quotes.

	Barriers	Solutions
System-level	1. Lack of follow-up mechanism or warm hand-off. "I mean, for what the resources are, I feel like it's fine. But it's definitely not sufficient. When we have somebody who's diabetic and comes in with high blood sugar, either they need to go back to see their PCP or we even have a program where we can get them seen in the endocrine clinic within the next 48 hours. Like, we really – we have things in place to not let those kinds of patients fall through the cracks. But with opioid and substance abuse disorders, there's all sorts of falling through the cracks."	1. Ensuring electronic health record integration that include ordering referrals, checking past prescriptions, and sharing individualized care plans. "Like a medical record that we could tap in or [see] patterns of use, not just opiate use but of healthcare system use – if I could see all that, I would feel better, I think. Then I get a better sense of how the patient's used the healthcare system and how accessible it is to them and how tight the safety net is with them." "We do have treatment plans for chronic plan that are really effective. We have patient populations, like for example, sickle cell patients with vaso-occlusive crisis. So it could be very much like that [for patients on buprenorphine] – an individualized plan."
	2. Affordability of buprenorphine and pitfalls in payment models. "Is there an insurance issue? [Patients] could be the ideal candidate, but [if] they don't have insurance or their insurance doesn't cover it, [they will be] paying out-of-pocket. Or then they can't get to the clinic or they can't get follow-up. Yeah, the healthcare system is tough to navigate sometimes."	2. Providing ready-to-go buprenorphine supply or in a depot form. "But if we had ready-made, one-week supplies or three-day supplies, I think that would increase the likelihood that patients actually were able to access it and take it appropriately." "If there was a longer term and non-divertible, like a depo shot for example or something like that, I think that would be ideal just because it – you know that they're going to receive it. They're not going to divert it."
	3. Likely increase in patient volume. "I fear if that word gets out, then we see a 15 percent rise in ED visits for, please give me buprenorphine, which I don't think we want. I think what we really would like to see is that this becomes a more ubiquitous treatment as an outpatient so we actually see fewer of these patients in overdose in the ED. I worry about the buprenorphine-prescribing workload being shifted to emergency physicians."	3. Institutionalizing clear protocols for ED-initiation of buprenorphine. "We have pathways for atrial fibrillation, starting blood thinners, and that's like really well thought out, and most people have no problem with that. I think it would be a similar thing with buprenorphine. But, I think people just need assurance that it's not unsafe for the patient and for themselves, like medically and legally."

PCP, primary care physician; ED, emergency department.

a tool that empowers EPs with new knowledge and skillsets to transform addiction care—akin to mastering techniques for nerve blocks and difficulty airways.

Our preliminary study identified a mix of barriers to ED-initiated buprenorphine at the clinician and system levels, but all the suggested solutions were beyond what one clinician could do, highlighting the need for institutional support. EPs supported integrated healthcare delivery systems that seamlessly coordinate care between the ED and outpatient providers with central databases that allow creation and visualization of complex care plans and prior prescriptions. As managed care becomes increasingly pervasive in healthcare for both privately and publicly insured individuals, we anticipate more healthcare organizations will be incentivized to implement initiatives that coordinate care for chronic, complex conditions such as OUD. Managed care organizations aligning payment incentives with performance goals present opportunities for EM as a specialty to advocate for integrating care to support ED-initiated buprenorphine programs. Building on this preliminary study results, future research can include a larger sample from EDs across the spectrum (academic, community, urban, and rural) to gather more generalizable results. Future directions also include implementation of our suggested clinician- and systems-level solutions and analysis of the impact of the interventions on initiating buprenorphine in the ED.

LIMITATIONS

Our study is limited by the small sample size, which may influence the generalizability of the results. Second,

our survey study had a low response rate (53% completion rate), which may have contributed to sampling bias. Those who responded to survey and interview invitations may have chosen to participate due to interests in OUD not present in the general population of participating physicians. Third, our study took place in Massachusetts, which is one of the states most affected by the opioid epidemic.[21] Clinicians in this practice setting have significant exposure to MAT strategies, and acceptability of buprenorphine may reflect regional emphasis on this issue. At the time of the study, another hospital in our health system initiated a program to encourage ED attending physicians to become waivered to prescribe buprenorphine. Our study participants' exposure to this program within the same health system may have affected the external validity of our findings. The geographic limits may also impact the generalizability of the results.

Fourth, our study relied on clinicians whose primary appointment is at an ED at a tertiary-care academic hospital, which is more likely to be equipped with addictions counseling resources and to be associated with more outpatient buprenorphine prescribers compared to the community ED setting. While all of the residents and physician assistants surveyed also work in surrounding community EDs, just half of the attending physicians interviewed reported that they also have additional appointments in addition to the academic ED where the study took place. This may have biased our study participants in their views on feasibility of initiating treatment with buprenorphine, thus limiting the generalizability of the study results. The survey results may not be representative of the perception of general EPs due to the inclusion of residents, whose external clinical exposure is largely defined by the residency program leadership and the training site. In addition, our reliance on interview-based accounts of practice may result in social acceptability bias, which may have limited participants' honest description of their perceptions of OUD and buprenorphine.

CONCLUSION

Our quantitative and qualitative data showed that the majority of ED clinicians neither blame patients with OUD for the difficulty of managing this complex, chronic disease nor consider OUD in and of itself different from other medical conditions. Although they understand the scientific evidence supporting buprenorphine as a long-term treatment option for OUD, they overwhelmingly feel that they do not have adequate training or resources to initiate buprenorphine in the ED. Our qualitative interviews identified a need for institutional response and support, as well as better facilitation of training for waivers and coordination of follow-up after ED-initiation of buprenorphine.

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Ketamine Safety and Use in the Emergency Department for Pain and Agitation/Delirium: A Health System Experience

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Introduction: Two protocols were developed to guide the use of subdissociative dose ketamine (SDDK) for analgesia and dissociative sedation ketamine for severe agitation/excited delirium in the emergency department (ED). We sought to evaluate the safety of these protocols implemented in 18 EDs within a large health system.

Methods: We conducted a retrospective chart review to evaluate all adult patients who received intravenous (IV) SDDK for analgesia and intramuscular (IM) dissociative sedation ketamine for severe agitation/excited delirium in 12 hospital-based and six freestanding EDs over a one-year period from the protocol implementation. We developed a standardized data collection form and used it to record patient information regarding ketamine use, concomitant medication use, and any comorbidities that could have impacted the incidence of adverse events.

Results: Approximately 570,000 ED visits occurred during the study period. SDDK was used in 210 ED encounters, while dissociative sedation ketamine for severe agitation/excited delirium was used in 37 ED encounters. SDDK was used in 83% (15/18) of sites while dissociative sedation ketamine was used in 50% (9/18) of sites. Endotracheal intubation, non-rebreather mask, and nasal cannula ≥ four liters per minute were identified in one, five, and three patients, respectively. Neuropsychiatric adverse events were identified in 4% (9/210) of patients who received SDDK.

Conclusion: Patients experienced limited neuropsychiatric adverse events from SDDK. Additionally, dissociative sedation ketamine for severe agitation/excited delirium led to less endotracheal intubation than reported in the prehospital literature. The favorable safety profile of ketamine use in the ED may prompt further increases in usage. [West J Emerg Med. 2020;21(2)272-281.]

INTRODUCTION

Ketamine is an *N*-methyl-D-aspartate receptor antagonist that exhibits dissociative sedation and analgesic properties and is commonly used in procedural sedation and induction settings.[1-3] Additionally, ketamine has been explored as novel therapy for analgesia and severe agitation/excited delirium. Multiple studies have described the efficacy and safety of subdissociative-dose ketamine (SDDK) for analgesia in the emergency department (ED), typically with dosing regimens of 0.1-0.3 milligrams per kilogram (mg/kg) administered intravenously (IV).[4-9] Dissociative sedation ketamine, typically defined as 3-5 mg/kg given intramuscularly (IM),[10-12] has been

studied for severe agitation/excited delirium in the prehospital setting.[12-14] Ketamine use for this indication has also been studied in a limited number of patients in single-center EDs.[15,16] Adequate sedation is necessary to prevent severe agitation/excited delirium complications such as metabolic abnormalities, cardiac arrest, and death.[11]

However, ketamine administration may contribute to serious respiratory, cardiovascular, and neuropsychiatric adverse events.[8,10,12] Cole et al. reported intubation rates of 39% for severely agitated patients who received ketamine 5 mg/kg IM vs 4% for those who received haloperidol 10 mg IM in the prehospital setting.[13] These authors also reported intubation rates of 57% in profoundly agitated patients who received ketamine in the prehospital setting.[14] SDDK use may also lead to neuropsychiatric adverse events such as mood changes, dysphoria, confusion, and hallucinations.[4-6, 16] To assist emergency medicine (EM) prescribers in safely using ketamine, our emergency services attending physicians and pharmacists developed two ED ketamine protocols for these two indications.

Previous single-center studies have described the benefits and risks of SDDK for analgesia and dissociative sedation ketamine for severe agitation/excited delirium, but the optimal dosing range and administration method of SDDK to minimize adverse effects is unclear.[8-9, 17-18] Additionally, limited, single- center studies have assessed the safety of IM ketamine for severe agitation/excited delirium in the prehospital setting and ED.[12-16] We designed this multicenter study to provide further insight into the safety of ketamine use in the ED for these two novel indications across a broad spectrum of EDs in a variety of settings.

Our goal was to evaluate the safety of SDDK for analgesia and dissociative sedation ketamine for severe agitation/excited delirium in patients at 18 EDs of a large, integrated health system. The primary objective of this study was to describe the incidence of serious respiratory and cardiovascular adverse events requiring intervention within two hours after ketamine administration. Secondary objectives included describing the incidence of neuropsychiatric adverse events after SDDK administration during the ED encounter; determining the percentage of ketamine orders in the ED for analgesia or severe agitation/excited delirium that were adherent to the approved protocols; and evaluating real-world ketamine use in a large, integrated health system with a diverse group of providers.

Population Health Research Capsule

What do we already know about this issue?
The use of subdissociative dose ketamine (SDDK) and dissociative sedation ketamine may lead to serious respiratory, cardiovascular, and neuropsychiatric adverse events.

What was the research question?
To describe the incidence of severe adverse events after ketamine use in the ED and adherence to ketamine dosing protocols.

What was the major finding of the study?
Dissociative sedation ketamine led to less intubation than reported in pre-hospital studies and SDDK led to limited toxicities.

How does this improve population health?
Ketamine used for analgesia or severe agitation/excited delirium leads to limited adverse events and is a viable option when dosed based on our health system's ketamine protocols.

Materials and Methods

This study was a multicenter, retrospective, electronic medical chart review that evaluated the safety of SDDK for analgesia and dissociative sedation ketamine for agitation/excited delirium in ED settings. The authors of this study have no conflict of interest, and our institutional review board approved this study. The study sites included 12 hospital-based EDs and six freestanding EDs with a combined annual census of over half a million ED visits. The hospital-based EDs include a quaternary care, academic medical center, a Level 1 trauma center, and 10 community hospitals, including two Level 2 trauma centers, in both suburban and urban locations. Medical care at the study sites was provided by emergency physicians, medical residents, advanced practice registered nurses, and physician assistants. The health system uses a comprehensive, integrated electronic health record (EHR) (EPIC, Verona, WI) at all hospital-based and freestanding EDs.

In 2017 two ketamine protocols were developed to provide guidance for the use of SDDK for acute pain and IM ketamine for dissociative sedation for severe agitation/excited delirium at all EDs across the enterprise. The protocols included indications for therapy as well as recommended dosage regimens and monitoring parameters. See Table 1 for treatment protocol details and treatment indication definitions. The ketamine protocol recommendations were developed by our institution's emergency physicians, pharmacists, midlevel providers, and nurses based on currently available literature for ketamine use for these two indications and ketamine's pharmacokinetic and pharmacodynamics profile.

Emergency providers and nursing were educated via email communication and staff meetings regarding the data supporting the new ketamine protocols and the operational changes

Table 1. Ketamine treatment protocols.

	Subdissociative-dose ketamine (SDDK) for analgesia	Ketamine for severe agitation/excited delirium
Indications	First-line analgesic therapy for management of severe pain in the following scenarios: • Acute pain secondary to traumatic injury • Acute pain in patients with documented allergy/intolerance to parenteral opioid therapy • Chronic pain in patients who are not candidates for opioid or NSAID therapy Adjunct analgesic therapy for the management of severe pain in ED patients who failed to achieve therapeutic response with parenteral opioid therapy	First-line pharmacologic monotherapy for adult patients with severe agitation, excited delirium, and violent/self-destructive behavior who meet the following criteria: • Patient poses an immediate threat to patient and healthcare provider safety (RASS score of +4) • Failure and/or futility of alternative non-pharmacologic de-escalation strategies • Absence of IV access • Not a candidate for intramuscular antipsychotics and/or benzodiazepines due to unacceptably protracted onset of action
Contraindications	Unstable vital signs • Systolic blood pressure > 180 mmHg • Heart rate > 150 beats per minute • Respiratory rate < 10 or > 30 Suspected acute coronary syndrome Acute decompensated heart failure Unstable dysrhythmia Acute head or ocular trauma Suspected elevated intracranial pressure History of schizophrenia or other psychosis Active psychosis	None
Dosing regimen and administration	0.2 – 0.3 mg/kg (up to a max dose of 25 mg) Administered as slow IV push over 5 minutes Dose may be repeated once in 30 minutes	4 mg/kg IM up to max single dose of 500 mg Dosing weight can be estimated if actual weight unavailable Immediate availability of advanced airway equipment
Patient monitoring	Vital signs (including pain assessment) at baseline, 15 minutes, and 30 minutes after each dose followed by routine nursing care per department protocol Continuous pulse oximetry for at least 30 minutes after dose administration Telemetry for at least 30 minutes after dose administration Immediate availability of ED attending physician for at least 30 minutes	Continuous direct patient observation for minimum of 15 minutes Continuous pulse oximetry, cardiac monitor, and end-tidal CO2 monitoring (if available) Removal of physical restraints Supine patient positioning with elevation of head of bed at 30°

ED, emergency department; *NSAID,* Nonsteroidal anti-inflammatory drugs; *RASS,* Richmond Agitation-Sedation Scale; *IV,* intravenous; *mmHg,* millimeters of mercury; *mg/kg,* milligrams per kilogram; CO_2, carbon dioxide.

associated with them. Afterward, the ketamine protocols were implemented on May 9, 2017. SDDK ketamine would be dosed 0.2-0.3 mg/kg, maximum dose 25 mg, as a slow IV push over five minutes with a potential repeated dose in 30 minutes. Ketamine for severe agitation/delirium would be dosed 4 mg/kg IM once, with a maximum dose of 500 mg. Providers were reminded monthly of the new protocol doses and indications through emails, especially with consideration of the opioid crisis and the desire to use alternative, non-opioid analgesics.

Adult patients, at least 18 years old, who received IV SDDK for analgesia and/or IM dissociative sedation ketamine for severe agitation/excited delirium at any study ED from May 9, 2017–May 9, 2018, were included in the study. Exclusion criteria included the following: age <18 years old; administration of ketamine for indications other than analgesia or severe agitation/excited delirium (e.g., rapid sequence intubation, procedural sedation, etc.); or administration of ketamine via route other than IV or IM. Four of the ED sites (one hospital-based ED and three freestanding EDs) were not using the integrated health record until September 29, 2017; therefore, patients were eligible for study inclusion only between September 29, 2017–May 9, 2018, at these four study

EDs. An ED agitation protocol order set was built into our EHR that enabled the EM provider to select severe agitation/excited delirium as the indication, which would provide a calculated dose of ketamine 4 mg/kg IM if this drug were selected. A specific order set was not created for ketamine used for analgesia.

We conducted a query of our EHR to identify all patients who received either IV bolus or IM ketamine at a study ED within the study period. A standardized electronic data collection form was developed within Research Electronic Data Capture (REDCap, Nashville, TN), a secure data collection tool. A single investigator, H.M., a clinical pharmacy resident, manually conducted chart review within the EHR to collect data points such as ketamine regimen details; vital sign data; psychiatric comorbidities; concomitant medications (benzodiazepines, antipsychotics, opioids, and antihistamines) administered within one hour before and two hours after ketamine use; predefined ketamine-related adverse events; and additional relevant points for all eligible patients. Adverse event data was identified through review of physician and allied health documentation during the ED visit, as well as review of the medication administration record and respiratory documentation flowsheets within the EHR. Data collected in the respiratory documentation flowsheets included the patient's respiratory status (eg, endotracheal intubation [ETI], bag valve mask, bilevel positive airway pressure [BiPAP], non-rebreather mask, nasal cannula [NC], or room air), and the timing of respiratory intervention, if applicable. A single investigator collected and reviewed all data to ensure consistency in data interpretation.

The primary outcome was to describe the incidence of severe respiratory and cardiovascular adverse events after ketamine administration. We defined severe respiratory adverse events as use of an advanced airway such as ETI, non-invasive positive pressure ventilation (bag valve mask, BiPAP, continuous positive airway pressure), non-rebreather mask, and/or escalation from baseline oxygen requirements to at least four liters (L) or more per minute via NC within two hours following administration of ketamine dose. Severe cardiovascular adverse events were defined as elevated blood pressure requiring IV antihypertensive medication(s) or new dysrhythmia requiring electrical cardioversion or pharmacological rate and/or rhythm control within two hours following administration of a ketamine dose.

Secondary outcomes included describing the incidence of neuropsychiatric adverse events after SDDK for analgesia administration and determining the percentage of ketamine orders for both indications in the ED that were adherent to the approved protocols. We defined neuropsychiatric adverse events as hallucinations, dysphoria, delusions, and/or any other mood change documented at any time during the ED visit following administration of a ketamine dose. Protocol adherence was defined as administering ketamine without protocol contraindications and using dosing regimens within the approved dose ranges and frequencies. There were no contraindications listed for using ketamine for severe agitation/excited delirium since acute interventions for this emergent condition are time sensitive, and an accurate medical history is often difficult to obtain. We analyzed all data descriptively.

RESULTS

During the study period, we identified 762 ED encounters with ketamine administration; 515 did not meet study inclusion criteria. A total of 247 ED encounters (210 SDDK and 37 dissociative sedation ketamine) were included in the study. There were 170 unique patient encounters as 13 patients within the SDDK group had repeated ED visits. These 13 patients accounted for 53/210 (25.2%) of all SDDK ED encounters. All patient characteristics reported were calculated based on unique patient encounters. The median age was 43 years of age (interquartile range [IQR]: 30-54) in the SDDK group and 39 (IQR: 31-48) in the dissociative sedation group. Median baseline blood pressure was 130/81 millimeters of mercury (mmHg) (IQR: 118-149.5/71-90.5 mmHg) prior to ketamine administration in the SDDK group. The most frequently used concomitant medications for the SDDK group were opioids (30%), while benzodiazepines (54.1%) were more commonly used in the dissociative sedation ketamine group. Table 2 summarizes patient demographics for each ketamine group.

In the SDDK group, the median ketamine dose was 20 mg (IQR: 16.1-25) IV with a median weight-based dose of 0.26 mg/kg (IQR: 0.2-0.3) IV. In the severe agitation/excited delirium group, the median ketamine dose was 242.4 mg (IQR: 124.7–319.4) IM with a median weight-based dose of 3.2 mg/kg (IQR: 1.89-4.0) IM. Fifteen out of 18 (83%) ED sites used SDDK for analgesia while 9/18 (50%) used dissociative sedation ketamine for severe agitation/delirium (Table 3). The distribution of ketamine use by type of ED is also described in Table 3.

For the primary outcome, serious respiratory adverse events were identified in 1% (2/210) of patients in the SDDK group and 16.2% (6/37) of patients in the dissociative sedation group. Additionally, serious cardiovascular adverse events were identified in 0.5% (1/210) of patients in the SDDK group. Examples from the SDDK group included three different patients who either received NC oxygen ≥ 4 L/minute (min), required a non-rebreather mask, or were given IV antihypertensive therapy for elevated blood pressures. Examples from the dissociative sedation group included one patient who received ETI, three patients who received a non-rebreather mask, and two patients who received NC oxygen ≥ 4 L/min. The patient who received ETI initially came in with seizures and had no history of substance abuse or psychosis documented.

In the SDDK group 4.3% (9/210) of patients experienced neuropsychiatric adverse events. Patients described these neuropsychiatric adverse events as feeling "out of it,"

Table 2. Baseline patient demographics.

Patient characteristics	SDDK IV for analgesia (n=210)	Ketamine IM for agitation/delirium (n=37)
No. of ED encounters	210	37
Age, median (IQR), years	43 (IQR: 30-54)	39 (IQR: 31-48)
Sex, male (%)	39	70
Weight, median (IQR), kg	79.9 (65.8-90.7)	77.1 (IQR: 68-99.8)
History of psychosis (%)	11.9	40.5
History of illicit drug use or alcohol abuse (%)	22.4	59.5
Systolic blood pressure, median (IQR), mmHg*	130 (118-149.5)	N/A
Diastolic blood pressure, median (IQR), mmHg*	81 (71-90.5)	N/A
Pulse rate, median (IQR), beats/min*	83 (IQR: 70-98)	N/A
O_2 saturation, median (IQR), %*	98 (IQR: 97-100)	N/A
Concomitant medications† (%)		
Antihistamines	10.0	24.3
Antipsychotics	3.3	35.1
Benzodiazepines	12.4	54.1
Opioids	30.0	5.4

*Baseline vitals prior to ketamine administration
†One hour before or two hours after ketamine administration
SDDK, subdissociative-dose ketamine; *IV,* intravenous; *IM,* intramuscular; *ED,* emergency department; *IQR,* interquartile range; *kg,* kilogram; *mmHG,* millimeters of mercury; O_2, oxygen.

"uncontrolled," confused, and anxious. One patient experienced hallucinations. The same patient who experienced the serious cardiovascular adverse event also experienced an emergence reaction and neuropsychiatric adverse event. No neuropsychiatric adverse events required intervention. Adverse events are summarized in Tables 4-6.

For the secondary outcome of protocol adherence, 80% of patients (167/210) in the SDDK group and 32% (12/37) in the dissociative sedation group met adherence criteria (administering SDDK without protocol contraindications or ketamine for either indications within the approved dose ranges and frequencies). Eight patients who received SDDK had a systolic blood pressure greater than 180 and one patient presented with head trauma, both of which are protocol contraindications for SDDK. A total of 11.4% of patients (24/210) in the SDDK group and 54.1% (20/37) in the dissociative sedation ketamine group received doses below the recommended range. The recommended dose is 0.2-0.3 mg/kg IV for SDDK, maximum dose 25 mg, and can be repeated once in 30 minutes, and 4 mg/kg IM once for severe agitation/excited delirium. Additionally, 3.8% of patients (8/210) in the SDDK group received ketamine above 0.3 mg/kg IV or higher than the maximum recommended single dose of 25 mg IV. Five of 37 patients (13.2%) received dissociative sedation ketamine doses greater than 4 mg/kg IM. A summary of ketamine protocol adherence is described in Table 7.

LIMITATIONS

This study was retrospective and relied on accurate documentation of adverse events. Variable documentation may have impacted the results identified. However, this limitation was minimized by using objective outcome measures such as specific respiratory and medication interventions to define adverse events. Neuropsychiatric adverse events may also have been under-reported considering that ED nursing, respiratory therapy, and/or physician documentation was the primary source for identification. The descriptiveness of these side effects reported were also limited by chart documentation. However, none of the identified neuropsychiatric adverse events required intervention, suggesting that the adverse effects observed were mild and self-limiting. Additional limitations include the data review by a single abstractor, who potentially may have not captured all adverse events. Furthermore, there was no control group to calculate a confidence interval and determine whether these adverse events identified were statistically significant. Last, data was not available to further characterize patients who met exclusion criteria.

DISCUSSION

In this multicenter pragmatic study, the use of SDDK for analgesia and dissociative sedation dosing for severe agitation/excited delirium resulted in a lower incidence of serious respiratory adverse events than previously reported. In patients receiving dissociative sedation ketamine for severe

Table 3. Ketamine utilization.

Ketamine	SDDK IV for analgesia	Ketamine IM for agitation/delirium
Dose in mg, median (IQR)	20 (IQR: 16.1-25)	242.4 (IQR 124.7-319.4)
Dose in mg/kg, median (IQR)	0.26 (0.2-0.3)	3.2 (1.89-4)
Unique ED encounters	170	37
No. patients with repeated ED encounters	13, accounting for 40 ED encounters	0
No. ED locations using ketamine (%)	15 out of 18 (83)	9 out of 18 (50)
ED Type		
Hospital-based ketamine patients	196	37
Freestanding ketamine patients	14	0

SDDK, subdissociative-dose ketamine; *IV,* intravenous; *IM,* intramuscular; *ED,* emergency department; *IQR,* interquartile range; *mg,* milligram; *kg,* kilogram; *no.*, number.

agitation/excited delirium, 16.2% of patients experienced serious respiratory adverse events. However, only one of these patients required ETI yielding an intubation rate of only 2.7% within this treatment group. In contrast, Cole et al.'s single-center studies reported that intubation rates were 39% in severely agitated patients and 57% in profoundly agitated patients who received ketamine 5 mg/kg IM in the prehospital setting.[13-14] These studies raised concern about the safety of ketamine use. The differences in intubation rates between our study and Cole et al.'s studies may be attributed to a number of factors. Ketamine administration in the prehospital setting for severe agitation/excited delirium results in the arrival of a fully dissociated patient at the time of ED presentation, which may contribute to a higher probability of a respiratory intervention provided by the receiving emergency physician.

In our study, patients were evaluated by an emergency physician prior to the institution of dissociative sedation, which may have allowed for more appropriate selection of patients and closer monitoring of patients' respiratory status following administration of ketamine. The patients in our study also received a lower median dose of 3.2 mg/kg IM (IQR: 1.9-4.0 mg/kg), compared to an average of 5 mg/kg in the Cole et al. studies. The lower ketamine doses also may have led to a decreased incidence of respiratory depression requiring ETI. Furthermore, the use of concomitant medications with sedative potential in the prehospital setting may have also led to an increased number of respiratory adverse events. Cole et al. reported that patients in their study had positive urine drug screen results for opioids (21%), diphenhydramine (12%), antipsychotics (15%), and benzodiazepines (18%).[13] The amount, frequency, and timing of these administrations is unknown.

Although our study did not evaluate the use of prehospital medications, only 5.4% of our patients received opioids one hour before or two hours after ketamine use in the ED. Of note, controversy does exist as to whether intubation itself is

Table 4. Adverse events.

	SDDK IV for analgesia (n=210)	Ketamine IM for agitation/ delirium (n=37)
Respiratory	2 (1.0%)	6 (16.2%)
Endotracheal intubation	0	1† (2.7%)
Bag valve mask	0	0
BiPAP	0	0
Non-rebreather mask	1 (0.5%)	4† (10.8%)
Nasal cannula O_2 ≥ 4 L/min	1 (0.5%)	2 (5.4%)
Cardiovascular	1* (0.5%)	0
Neuropsychiatric	9* (4.3%)	0

†Indicates one patient required both non-rebreather mask use and endotracheal intubation
*Indicates one patient experienced a cardiovascular and neuropsychiatric adverse event
SDDK, subdissociative-dose ketamine; *IV,* intravenous; *IM,* intramuscular; *BiPAP,* bilevel positive airway pressure.

Table 5. Respiratory and cardiovascular adverse event patient cases: dissociative sedation ketamine.

	Patient 1*	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Age, years	42	34	54	54	30	31
Gender	Male	Male	Female	Female	Male	Male
Weight, kg	79.4	86.2	55.8	68	162	113.4
History of psychosis	No	No	Yes	Yes	No	Yes
Illicit drug/ alcohol abuse	No	Yes	Yes	Yes	Yes	No
Number of ketamine doses during ED visit	3	1	1	1	1	2
Ketamine dose, mg	238.2 IV, 158.8 IV, and 317.6 IM	300 IM	223.2 IM	300 IM	150 IM	113.4 IM x2
Ketamine dose, mg/kg	2 IV, 3 IV, and 4 IM	3.48 IM	4 IM	4.4 IM	0.92 IM	1 IM x2
Baseline supplemental oxygen	No	No	No	No	No	No
Concomitant medications 1 hour before or 2 hours after ketamine use	Lorazepam IV 1 mg x1 and 2mg x2 Haloperidol IM 5 mg x1	None	Lorazepam IM 2 mg x1 Diphenhydramine IV 50 mg x1	Lorazepam IV 1 mg x2	None	Lorazepam IM 2 mg x1
AE identified	Non-rebreather mask and endotracheal intubation	Non-rebreather mask	Non-rebreather mask	Non-rebreather mask	NC O_2 ≥ 4 L/min	NC O_2 ≥ 4 L/min
Time (min) between AE and ketamine use	4 min after first ketamine IV dose and 120 min after IM ketamine dose	12	104	44	41	42 min after second ketamine dose

*Required endotracheal intubation
Kg, kilogram; *ED,* emergency department; *mg,* milligram; *IV,* intravenous; *IM,* intramuscular; *AE,* adverse event; *NC,* nasal cannula; *O_2,* oxygen; *L,* liters; *min,* minute.

considered an adverse event given that these patients were severely agitated and at high risk of harm to self or others where the only alternative was to intubate and sedate to ensure patient safety. Finally, the increased publicity around ketamine usage in the ED literature may have led to more familiarity with its pharmaceutical properties and concomitant risks. Our protocol required that once sedation occurred, a full complement of monitoring be deployed including cardiac monitoring, pulse oximetry, and presence of nursing at bedside, similarly to procedural sedation practices.

SDDK use led to few serious respiratory adverse events requiring intervention. One patient required NC ≥ 4 L/min and a second patient required the use of a non-rebreather mask; none of the patients required ETI. Both of these patients received just one dose of ketamine and met all protocol adherence criteria. However, both patients also received one dose of fentanyl IV 50 micrograms and morphine IV 4 mg, respectively. Additionally, one of these patients had a history of drug and/or alcohol abuse, which may have impacted the occurrence of adverse events. Although the use of opioids and having a history of drug and/or alcohol abuse may have contributed to the need for respiratory intervention, these findings suggest that close patient monitoring of respiratory status with SDDK may be warranted.

One patient in the SDDK group (0.5%) also experienced elevated blood pressures following ketamine administration, which required IV antihypertensive therapy despite the absence of any protocol contraindications. This patient's blood pressure went from a baseline of 161/86 mmHg to 205/164 mmHg after ketamine administration. The potential for ketamine to contribute to elevated blood pressure and heart rate has been well established. Review of vital signs prior to dose administration to determine the absence of hemodynamic instability and monitoring vital signs after dose

Table 6. Respiratory and cardiovascular AE patient cases: subdissociative ketamine.

	Patient 1	Patient 2	Patient 3
Age, years	70	28	66
Gender	Male	Male	Female
Weight, kg	69.4	149.7	53.1
Psychosis	No	No	No
Illicit drug/ alcohol abuse	No	Yes	No
Number of ketamine doses	1	1	1
Ketamine dose, mg	20.82 IV	25 IV	15 IV
Ketamine dose, mg/kg	0.3 IV	0.17 IV	0.28
Baseline supplemental oxygen	No	No	No
Concomitant medications 1 hour before or 2 hours after ketamine use	Fentanyl IV 50 mcg x1	Morphine IV 4 mg x1	Morphine IV 5 mg x1
AE identified	Non-rebreather mask	NC O_2 ≥ 4 L/min	Elevated BP receiving IV labetalol 10 mg x1 (BP increased to 205/164 from 161/86 mmHg)
Time (min) between AE and ketamine use	32	9	76

Kg, kilogram; *mg,* milligram; *IV,* intravenous; *mcg,* microgram; *AE,* adverse effect; *NC,* nasal cannula; *L,* liter; *min,* minute; *BP,* blood pressure.

administration is indicated.

SDDK use also led to limited and non-severe neuropsychiatric adverse events in 4.3% of patients. However, Motov et al. reported higher rates of mood changes (13%) and disorientation (29%) in patients who received 0.3 mg/kg (mean 21.8 mg, standard deviation 4.9 mg) of ketamine IV push over 3-5 minutes.[8] In contrast, Sin et al. reported neuropsychiatric adverse advents in 3% of patients who received ketamine IV 0.3 mg/kg IV piggyback over 15 minutes.[16] Neither study included patients with a past medical history of psychiatric illness or substance abuse or described concomitant medications used outside of the protocol.[8,16] Concomitant medications and comorbidities may lead to an increase in adverse events.

Due to the retrospective design of our study, the lower incidence of neuropsychiatric adverse events reported may have been attributed to incomplete documentation of adverse events in the EHR. The lower rates of neuropsychiatric adverse events in our study may also have been due to our ketamine single-dose cap of 25 mg and the requirement of a slow IV push administration over at least five minutes. Our multicenter study results support that SDDK use led to minor neuropsychiatric adverse events that did not require intervention, which aligns with previously published, single-center studies.[5,8]

Despite frequent reminders, the protocols were not used at all of the ED sites in our enterprise. This probably reflects the reality of knowledge translation and willingness of more experienced physicians to try new medications with which they are less familiar or their comfort with more conventional therapy for analgesia such as opioids or benzodiazepines and haloperidol for agitation. While ketamine usage has been increasingly touted in Free Open Access Medication Education (FOAMed) and other social media, the vocal users may be in more academic settings or accustomed to trying novel therapies. The strength of our study lies in its real-world experience across a diverse group of providers and ED sites. This study should help alleviate some concerns of those providers that the therapy is safe and effective even in small EDs.

The protocol adherence for SDDK was 80%, while dissociative sedation ketamine was 32%. The decreased protocol adherence was attributed primarily to patients receiving ketamine below the recommended doses. This can paradoxically be harmful as partially dissociated patients have more neuropsychiatric effects, which may increase agitation. This is perhaps due to the ED prescribers not being as comfortable with ordering higher doses of ketamine. Additionally, it is difficult to collect an accurate weight for severely agitated patients who present to the ED; thus, empiric dosing may have been based on estimated weight for a number of patients, potentially contributing to dosing variance beyond the protocol-recommended dosing range.

Several patients also received ketamine doses above the recommended range. This may not portend harm as once dissociation is achieved, there is no further depth to sedation with increased ketamine administration. Additionally, protocol variance may have also been impacted by the specific ED site and emergency physician. Three out of the 18 EDs accounted for 70% of IM ketamine use for severe agitation/ excited delirium. This protocol required attending physician administration of the drug, which may have limited its use.

Table 7. Ketamine protocol adherence.

Proportion of ketamine regimens adherent to health-system protocols	SDDK IV for analgesia	Ketamine IM for agitation/ delirium
Without protocol contraindications	201/210 (96%) Received ketamine when SBP>180 mmHg: 8 Received ketamine presenting with head trauma: 1	Not applicable
Dosing regimens within the approved dose ranges and frequencies based on our institution's ketamine protocols (refer to Table 1)	175/210 (83%) Dosed below range: 24 Dosed above range: 8 Received > 2 doses in same ED visit: 2 Received ketamine <30 min apart: 1	12/37 (32%) Dosed below range: 20 Dosed above range: 5
Total adherence	167/210* (80%)	12/37 (32%)

*One patient received ketamine with an SBP > 180 mmHg and above the recommended dose
SDDK, subdissociative-dose ketamine; *IV,* intravenous; *IM,* intramuscular; *SBP,* systolic blood pressure; *mmHG,* milligrams of mercury; *ED,* emergency department; *min,* minute.

CONCLUSION

Dissociative sedation ketamine dosed at 4 mg/kg IM for severe agitation can result in serious respiratory adverse events. However in our experience, this occurred less frequently than previously reported in single-center studies. When used at subdissociative-doses for analgesia at 0.2-0.3 mg/kg and administered as slow IV push over five minutes, ketamine is associated with minor and self-limited neuropsychiatric adverse events that resolve without further intervention. In summary, the overall favorable safety profile of ketamine use as described in our experience in a number of diverse ED settings supports a more widespread use of SDDK and dissociative dosing for acute agitation. Further research is needed to address barriers that prevent more extensive usage of ketamine by ED providers.

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Co-Occurrence of Multiple Risk Factors and Intimate Partner Violence in an Urban Emergency Department

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Introduction: Urban emergency departments (ED) provide care to populations with multiple health-related and overlapping risk factors, many of which are associated with intimate partner violence (IPV). We examine the 12-month rate of physical IPV and its association with multiple joint risk factors in an urban ED.

Methods: Research assistants surveyed patients regarding IPV exposure, associated risk factors, and other sociodemographic features. The joint occurrence of seven risk factors was measured by a variable scored 0–7 with the following risk factors: depression; adverse childhood experiences; drug use; impulsivity; post-traumatic stress disorder; at-risk drinking; and partner's score on the Alcohol Use Disorders Identification Test. The survey (N = 1037) achieved an 87.5% participation rate.

Results: About 23% of the sample reported an IPV event in the prior 12 months. Logistic regression showed that IPV risk increased in a stepwise fashion with the number of present risk factors, as follows: one risk factor (adjusted odds ratio [AOR] [3.09]; 95% confidence interval [CI], 1.47-6.50; p<.01); two risk factors (AOR [6.26]; 95% CI, 3.04-12.87; p<.01); three risk factors (AOR = 9.44; 95% CI, 4.44-20.08; p<.001); four to seven risk factors (AOR [18.62]; 95% CI, 9.00-38.52; p<001). Ordered logistic regression showed that IPV severity increased in a similar way, as follows: one risk factor (AOR [3.17]; 95% CI, 1.39-7.20; p<.01); two risk factors (AOR [6.73]; 95% CI, 3.04-14.90; p<.001); three risk factors (AOR [10.36]; 95%CI, 4.52-23.76; p<.001); four to seven risk factors (AOR [20.61]; 95% CI, 9.11-46.64; p<001).

Conclusion: Among patients in an urban ED, IPV likelihood and IPV severity increase with the number of reported risk factors. The best approach to identify IPV and avoid false negatives is, therefore, multi-risk assessment. [West J Emerg Med. 2020;21(2)282-290.]

INTRODUCTION

Intimate partner violence (IPV) includes acts of physical and sexual violence, stalking, and psychological aggression perpetrated against a romantic partner.[1] This study, as have previous analyses of these data, [2,3] focuses on physical IPV. Community surveys have shown that about one in five couples in the United States (U.S.) have reported at least one episode of physical IPV in the prior 12 months.[4-6] Data from the 2010-2012 National Intimate Partner and Sexual Violence Survey show 12-month rates for physical IPV of 3.9% among women and 4.7% among men.[7] These rates are lower than those above likely due to differences in survey methods, especially telephone interviewing vs face-to-face, and interviews with one person only and not with both persons in the couple.

IPV screening in urban emergency departments (ED) shows rates ranging from 9–37% for a 12-month timeframe,

and as high as 46% for lifetime exposure.[8-12] A previous analysis of the data herein showed a rate of 23% for physical IPV, 4% for IPV perpetration only, 6% for victimization only, and 13% for mutual violence.[3] Moderate and severe IPV were present in 12% and 11% of the sample, respectively, and about 48% of all IPV was severe.[2] Identification of ED patients involved in IPV helps ED personnel to arrive at a better understanding of patients' reasons for seeking care and to direct such patients to safe environments and support services.

The relatively high rate of IPV present among ED patients in urban settings has multiple causes. First, urban EDs are the entry point and sometimes the only setting for clinical care of health needs for a large part of the U.S. population that is socially disadvantaged, especially the 8.8% (28.3 million) without health insurance.[13] Second, urban ED patients have high rates of substance use problems, unemployment, and depression,[14-16] and are more often exposed to aspects of the social environment that are linked with IPV, such as neighborhood poverty.[17,18] Third, ED patients report other IPV-related risk factors such as impulsivity, post-traumatic stress disorder (PTSD), partner hazardous drinking, adverse childhood experiences (ACE), and stressful life events.[2,10,19-24] Finally, the ethnic composition of urban EDs includes a large proportion of disadvantaged ethnic minorities, some of whom are at higher risk for IPV.[9,10]

Examination of the association of risk factors and IPV in urban ED samples has focused on assessing the effect of each specific factor per se. However, ED patients may present with more than one risk factor, which suggests that it is also important to understand the potential cumulative effect on IPV risk when one, two, three, or more risks factors are reported by a patient. We examine the association between an index representing the cumulative effect of seven different risk factors and physical IPV. The risk factors composing the index are depression, PTSD, impulsivity, drug use, ACE, at-risk drinking, and partner hazardous drinking. Use of indices to create composite measures is a traditional practice in social and epidemiological research.[25] There are two expectations guiding the analyses: a) IPV risk will increase as the number of risk factors increases; and b) IPV severity will also increase as the number of risk factors increases.

Population Health Research Capsule

What do we already know about this issue?
Intimate partner violence (IPV) is highly prevalent in the U.S. population, with one in five couples reporting an incident in the prior 12 months.

What was the research question?
Does a combination of IPV risk factors increase IPV risk above the risk associated with one factor only?

What was the major finding of the study?
IPV rates increased substantially from 11% to 55% as risk factors present increased from one to four or more.

How does this improve population health?
Emergency department personnel should screen all patients for IPV, especially those presenting with multiple risk factors.

METHODS

Sample and Data Collection

Trained, bilingual (English and Spanish) research assistants (RA) recruited non-emergent patients in the ED of an urban Level I trauma center and county safety-net hospital. The initial sample size estimate called for the enrollment of 800 married, cohabiting, or dating adults aged 18-50. This was based on calculations that using linear regression analyses, power would be 80% to detect a small overall effect (R^2 = .02) with 20 predictors, α = .05, and n = 800. Power would be 85% to detect small incremental changes of adding single variables to the regression equations (ΔR^2 = .01) with 19 prior predictors, a prior R^2 of .10, and α = .05.

Participant eligibility criteria included the following: 18-50 years old; English or Spanish speaker; residence in the county where the study was conducted; and married, cohabiting, or in a romantic (dating) relationship for the prior 12 months. The upper age limit was set based on consistent research evidence showing that most IPV occurs in younger age groups.[26] Patients who were intoxicated, experiencing acute psychosis or suicidal or homicidal ideation, were cognitively and/or psychologically impaired and unable to provide informed consent, in custody by law enforcement, or in need of immediate medical attention were excluded.

Two interviewers per shift staffed the ED during weekday peak volume hours (9 AM– 9 PM) to recruit patients to the study. Data were collected from February through December 2017. Patients could opt to be interviewed in English or Spanish. We used a Spanish version of the questionnaire, which had been validated through translation into Spanish and re-translation into English, followed by verification. Once informed consent was obtained, patient survey data were collected by the RAs using computer-assisted personal interview (with computer tablets running the Qualtrics (Provo, UT, and Seattle, WA) platform. The project was approved by the institutional review board of the hospital where we conducted the study.

Measurements

Reliability for the scales described below as measured by

Cronbach's alpha ranged from 0.69 for depression to 0.88 for perceived neighborhood disorder.[2]

Intimate Partner Violence

We measured prior-12 month physical IPV with the revised Conflict Tactics Scale,[27] which has been used in prior ED-based IPV studies.[28-30] Two levels of IPV severity, moderate and severe, were operationalized based on previously published reports.[31] Moderate violence consisted of at least one of the following acts: threw something at partner that could hurt; pushed or shoved; grabbed; slapped; and twisted partner's arm or hair. Severe violence consisted of kicked; punched or hit with something that could hurt; beat up; choked; burned or scalded on purpose; slammed against a wall; used a knife or gun.

Multi-risk Index

This is represented by the sum of seven IPV-related risks identified in previous analyses of this data set.[2,3] Their assessment is described in detail below. These risks are depression, PTSD, impulsivity, drug use, ACE, at-risk drinking, and partner scoring positive on the Alcohol Use Disorders Identification Test- concise (AUDIT-C). Scores in the index vary from 0–7, but because few patients reported more than four risks as present, the variable was truncated at four or more risks.

Partner Problem Drinking

We used the three-item AUDIT-C to measure the respondent's assessment of his/her spouse/partner's drinking.[32,33] Male partners with a score above 4, and female partners with a score above 3 in the test 0-12 scale were considered hazardous drinkers.

Drug Use

This measure covered drug use in the 12 months preceding the interview. Respondents were asked how many days they had used the following drugs: marijuana or hashish (without a doctor's prescription); amphetamines; cocaine; heroin; and prescription pain relievers not prescribed for the user. Drug use was operationalized as any or no drug use.

At-risk Drinking

Respondents who drank alcohol in the prior four weeks were asked: "What was the greatest number of drinks you had on any day in the past 4 weeks?" A "drink" was defined as a 12-ounce can of beer, a five-ounce glass of wine, or a one-ounce shot of liquor. Respondents who did not use alcohol in the prior four weeks were asked the same question over the prior year. Women/men were considered at-risk drinkers if they had had four/five or more drinks on any one day in the prior four weeks (prior 12 months for prior year drinkers).

Adverse Childhood Experiences (ACE)

The modified ACE[34] measures exposure to six adverse experiences during respondents' "first 18 years of life": 1) mentally ill person in the home; 2) parent/caregiver alcoholism; 3) sexual abuse; 4) physical abuse; 5) psychological abuse; and (6) violence directed against the respondent's mother. These exposures are summed to create the ACE variable (range = 0-6). Scores in this variable were highly skewed, with 65% of the sample reporting none or one adverse experience. For inclusion in the multi-risk index in the analysis, this variable was operationalized as dichotomous representing none to one adverse experience vs two to six. Coding the variable as a dichotomy also allowed for a splitting of respondents that isolated the top tertile of the sample in the two or more group, which is the split applied to the impulsivity scale and the life stress scale described below. All of those with a score of two or more were included in the multi-risk index.

Impulsivity

This was measured with three items assessing respondents' agreement with the following statements: I often act on the spur-of-the-moment without stopping to think; You might say I act impulsively; many of my actions seem to be hasty.[35,36] Four response categories ranged from "not at all" to "quite a lot," with scores ranging from one to four per item. For this analysis we divided scores into tertiles, and the scale was dichotomized with the two bottom tertiles coded as "none" and the top tertile coded as "one."

Depression

This was measured with the Hospital Anxiety and Depression Scale,[37] which has been successfully used in previous ED studies.[38,39] Both anxiety and depression were measured with seven items each on a four-point Likert-type scale (eg, one = not at all; four = very often). The items request that respondents describe their "feelings currently." Following Brennan et al.[40] a cut-off point equal to or higher than eight identified positives. This cut off gives sensitivity of 0.82 and specificity of 0.74 for depression. The scale was dichotomized at the cut-off point for inclusion in the multi-risk variable.

Post-traumatic Stress Disorder (PTSD)

This measure is from the Primary Care PTSD Screen,[41] and it too has been successfully used in ED studies (see[42,43]). It asks subjects about prior-month symptoms resulting from a "frightening, horrible or upsetting" experience. Answers were coded "yes" or "no," and a score of three or more is considered positive.

Perceived Neighborhood Disorder (PND)

This was measured with Hill and Angel's 10-item scale of neighborhood disorder.[44] Items cover the extent to which assaults, muggings, drug dealing, gangs, unsafe streets, thefts, teenage pregnancy, abandoned houses, police not available, unsupervised children, and high unemployment, are neighborhood problems.

Respondents could select one of the following three categories to answer each item: not a problem; somewhat of a problem; or a big problem.

Stressful Life Events

This was measured with 14 items from the Alcohol Use Disorder and Associated Disabilities Interview Schedule-IV.[45,46] The items covered events such as the following: was laid off from a job; unemployed and looking for a job for more than a month; had trouble with boss or coworker; and had changed jobs, jobs responsibilities, or work hours. The items present were given a value of one and counted to create an index that varied from 0-14. Test-retest reliability is intraclass correlation = 0.94.[47] For the present analysis scores were divide into tertiles, and the scale was dichotomized with the two bottom tertiles coded as "none" and the top tertile coded as "one."

Other Sociodemographic Variables

Gender: A dichotomous variable coded as male and female (reference). *Age*: Coded as a categorical variable: 18-29, 30-39, and 40-50 (reference). *Level of education:* Respondents were categorized into four education categories: a) less than high school (reference); b) completed high school or GED; c) some college or technical or vocational school; d) completed four-year college or higher. *Importance of religion:* This variable had four categories – very important (reference); somewhat important; not very important; not important at all. *Marital status:* This is a three -category variable – a) married living with partner (reference); b) separated or divorced; c) never married. Widowers (n=33) were dropped from the analyses because 23 had no alcohol use disorder, which created estimation problems in the multivariable analysis. *Food insufficiency:* Respondents were asked their level of agreement with the statement, "In the past 12 months, the food we bought ran out and we didn't have money to get more." Response categories were never (reference), sometimes true, often true. *Ethnicity:* Based on self-identification. Respondents were asked: What racial or ethnic group(s) best describes you? Response categories were Asian; Black, African American; Latino, Hispanic (reference); White, Caucasian; Native American Indian/Alaskan Native; Native Hawaiian/other Pacific Islander; some other race (specify). Respondents who selected more than one category were identified as multiethnic.

Statistical Analyses

We conducted all analyses with Stata 15.0 (StataCorp, College Station, TX).[48] Associations in bivariate analyses (Tables 2 and 3) were tested with chi square. However, because the specific risk factors in each column of Table 3 are not mutually exclusive, the chi square tests differences in rates within each column, assessing first differences in the distribution of rates for any IPV vs none when a specific risk factor was or was not present. This was then repeated for differences in rates of no IPV, perpetration, victimization, and mutual violence, and for differences in rates of no IPV, moderate and severe IPV for each specific factor. Thus, we conducted a total of 18 chi-square tests (Table 3), which resulted in a Bonferroni corrected level of significance of .002 (.05/18) in that table.

We conducted multivariable logistic analysis (Table 4) with Stata's "logistic" procedure. Independent variables were entered in the model in one step. Variables selection was based on previous analyses of the data set and previous results in the literature.[6,19,10,23,24,28,49] We selected Hispanics as the reference group because they were the largest group in the sample (N = 520); this allowed for a contrast with Blacks, the second largest group (N = 299), and maintained consistency with a previous analysis focused on ethnicity and IPV.[2] We conducted multivariable analysis of IPV severity (Table 4) with Stata's "ologit" procedure, which implements an ordered logistic regression under a proportional odds assumption. Results indicated that the model tested fits the proportional odds assumption: $chi^2 = 9.05$ with df =11 and p = 0.61. Therefore, only one set of adjusted odds ratios (AOR) are presented in Table 4. This is because the AORs represent both the odds of moderate plus severe IPV contrasted with no IPV, and the odds of severe IPV contrasted with no IPV plus moderate IPV.

RESULTS

Missing data were negligible; none of the variables analyzed in this paper had more than 2.6% information missing. Thus, no imputation was conducted to address missing data, which were left as missing. We excluded from the study 34 ED patients who did not speak either English or Spanish.

Sample Sociodemographic Indicators and Intimate Partner Violence Risk Factors

The sample is almost equally divided between men and women, with a mean age of 35.2 years (Table 1). About half of the sample is Hispanic, and about a third is Black. About a quarter of the sample did not report any of the seven IPV risk factors under analysis, and another quarter reported one risk factor.

Intimate Partner Violence and Multi-Risk

About 48% of those who reported any IPV involvement experienced severe IPV (116/241), and of all IPV events reported, 16% were perpetration only, 26% were victimization only, and 57% were mutual violence. The proportion of all IPV reported by those with none, one, two, three, and four to seven risk factors is 4%, 13%, 23%, 19% and 40%, respectively. The proportion of all IPV reported by those with each specific factor under analysis is as follows: drug use, 60.2%; ACE, 49%; PTSD, 47.7%; impulsivity, 47.6%; partner AUDIT-C positive, 45.7%; at-risk drinking, 42%; and depression, 25.7%.

Results in Table 2 show that about a quarter of the sample reported at least one incident of IPV in the prior 12 months (rightmost column Table 2). The proportion of respondents reporting any type of IPV increases in a statistically significant

Table 1. Sample characteristics: sociodemographic characteristics and intimate partner violence risk factors.

	% or M, SD
Sociodemographic characteristics	
Gender	
Male	46.6
Female	53.4
Marital status	
Married	40.2
Cohabiting	31.6
Single, separated, divorced	28.1
Education	
Less than high school	32.7
High school graduate/GED	35.5
Some college	22.4
College graduate+	9.4
Race/ethnicity	
Hispanic	49.2
Black	29.8
Multiracial	5.4
Other	9.2
White	6.4
Mean Age (range 18-50)	35.2 (8.5)
Food insufficiency	
Sometimes/often	49.6
Never	50.4
Number of risk factors	
None	23.0
One	25.3
Two	21.7
Three	12.4
Four or more	17.5
Specific IPV Risk Factors	
Adverse childhood experience (2+)	35.2
Drug Use (past 12 months)	33.0
At risk drinking (4+ women/5+ men)	28.0
Impulsivity (upper tertile score)	27.9
PTSD screen (positive)	25.1
Partner's AUDIT-C (positive)	21.5
Depression (positive)	17.0

GED, general education degree; *M*, mean; *SD*, standard deviation; *IPV,* intimate partner violence; *PTSD*, post-traumatic stress disorder; *AUDIT-C*, Alcohol Use Disorders Identification Test-concise.

way with the number of risk factors. Rates of IPV perpetration only, IPV victimization only, and mutual PV also increase in a statistically significant way as the number of reported risk factors increases. Rates of moderate and severe IPV also increase steadily with the number of risk factors.

Intimate Partner Violence and Specific Risk Factors

Any IPV is present in 33% to 44% of respondents reporting the risk factors in Table 3. Rates of perpetration and victimization are lower than rates of mutual violence and do not vary much across respondents with any of the seven specific risk factors. Rates of moderate IPV are lower than rates of severe IPV for respondents reporting drug use, partner AUDIT-C positive, PTSD, and depression. Among respondents reporting impulsivity, at-risk drinking, and ACE, rates for moderate and severe IPV are similar.

Correlates of Intimate Partner violence

The odds of reporting any IPV (first column of Table 4) increase with the number of risk factors. Blacks and multiethnic respondents are 1.8 and 2 times more likely, respectively, than Hispanics to report IPV. Finally, respondents who scored higher in the neighborhood social disorder scale are also more likely to report IPV. Mutivariable results for IPV severity are similar to results for any IPV.

DISCUSSION

Both hypotheses put forward in the Introduction were confirmed: IPV risk and IPV severity increase as the number of risk factors reported by respondents increase. Rates for perpetration and victimization in Table 3 plateau when the number of risk factors reaches three. This may be because mutual IPV tends to be more severe,[2] which means that it would be more strongly associated with three and four or more risk factors. Indeed, results in Table 2 show that the rate of mutual IPV among those with four or more risk factors is almost eight times higher than among those with one risk factor only.

But perhaps more importantly, respondents presenting with multiple risk factors may have IPV odds that can be six times higher than those with a single risk factor (Table 4). Further, assessment of one risk factor only may allow up to three quarters of IPV cases to go undetected. Given the high prevalence of IPV in ED populations and its numerous health-related consequences,[8-12] the implication of these results is clear: assessment of multiple IPV risk factors is an important step to implement effective ED care in urban settings.

The two multivariable models in Table 4 confirm the results in previous tables with the added strength of controls for various potential confounders. IPV risk and severity increase in a stepwise fashion as the number of risk factors reported by patients goes from one to four or more. In addition, two other variables are important for the identification of subgroups with a higher prevalence of IPV: ethnicity and neighborhood disorder. Black and multiethnic respondents compared to Hispanics are about two times more likely to report IPV, which agrees with previous studies.[9,10,31,49,50] The finding for the multiethnic group is challenging to understand because there have not been studies of IPV focusing on this population group in the U.S. The

Table 2. Intimate partner violence (IPV) rates (proportions) by number of present risk factors in an urban emergency department sample.

	None (235)	One (259)	Two (225)	Three (129)	Four + (181)	Sample (1029)
% Any IPV***	3	11	26	37	55	23
Type of IPV***						
% Perpetration	1	2	4	8	7	4
% Victimization	1	4	10	9	9	6
% Mutual violence	1	5	12	20	38	13
IPV Severity***						
% Moderate IPV	3	8	16	19	21	12
% Severe IPV	1	3	9	18	34	11

Chi^2 ***p<.001. The statistical significance of distributions of perpetration, victimization, and mutual violence was tested with a chi square with df = 8. The statistical significance of distributions of moderate and severe IPV was tested with a chi square with df = 4.

Table 3. Intimate partner violence (IPV) rates (proportions) by specific risk factor in an urban emergency department sample.

	Drug use		Partner AUDIT-C positive		PTSD		Impulsivity		Depression		At-risk drinking		Adverse childhood experiences	
	No (695)	Yes (334)	No (809)	Yes (220)	No (775)	Yes (260)	No (745)	Yes (289)	No (860)	Yes (174)	No (745)	Yes (290)	No (671)	Yes (364)
% Any IPV	14	44*	19	44*	17	43*	17	41*	21	36*	19	36*	18	33*
% Perpetration	3	6*	4	5*	3	7*	2	7*	4	4*	3	6*	3	6*
% Victimization	5	9	5	12	5	11	5	8	6	8	6	7	6	7
% Mutual Violence	6	28	10	27	9	26	9	25	11	24	10	22	10	20
IPV Severity														
% Moderate IPV	9	19*	10	19*	9	20*	9	19*	12	15*	9	20*	10	16*
% Severe IPV	5	24	7	25	7	23	7	21	9	21	9	16	8	17

AUDIT-C, Alcohol Use Disorders Identification Test-consise; *PTSD*, post-traumatic stress disorder.
*All chi square no IPV x any IPV, no IPV x perpetration x victimization x mutual violence, and no IPV x moderate x severe p< .001.

Table 4. Multivariable logistic regression of any intimate partner violence (IPV) and ordered logistic regression of IPV severity on sociodemographic, drinking, and multi-risk variables.

	Any IPV		IPV Severity	
	AOR	95% CI	AOR	95% CI
Multi-risk (Reference: None)				
One	3.09**	1.47-6.50	3.17**	1.39- 7.20
Two	6.26**	3.04-12.87	6.73***	3.04-14.90
Three	9.44***	4.44-20.08	10.36***	4.52-23.76
Four or more	18.62***	9.00-38.52	20.61***	9.11-46.64
Ethnicity (Reference: Hispanics)				
Black	1.85*	1.22-2.79	1.95**	1.29-2.93
White	1.29	.66-2.49	1.32	.69-2.53
Multiethnic	2.08*	1.05-4.10	2.00*	1.06-3.77
Other	1.77	.94-3.34	1.64	.86-3.14
Neighborhood Disorder	1.04**	1.02-1.08	1.04**	1.01-1.07

AOR, adjusted odds ratio; *CI*, confidence interval.
*p<05; **p<.01; ***p<.001. Also controlling for gender, age, marital status, stressful life events, anxiety, importance of religion, education, and food insufficiency, none of which showed statistically significant associations. The weekly mean drinking volume was not statistically associated with IPV severity.

group comprised 6.9% of the U.S. population in 2015,[51] while the Census Bureau's estimate for people with "two or more races" in 2018 was smaller, 2.7%.[52] Besides the proportion of persons, the share of mixed-race couples has increased since 1980 from 1.6% to 6.3% in 2013.[51] This is a group that deserves more attention in epidemiological studies of IPV. Regarding perceived neighborhood social disorder, it can be associated with situations with lax behavioral norms and less informal social controls that minimize violence (eg, neighbors who call the police or intervene).[24,2]

LIMITATIONS

The multi-risk variable only represents the additive effect of one or more risk factors on IPV. Non-additive effects were not tested but could be with the inclusion of an interaction term in multivariable models. However, the seven different risk factors in the analyses would result in 21 two-way interactions, and without a firm theoretical model to select which interactions to test, a decision was made to test additive effects first and in future analyses test interaction effects. The subjects enrolled were a convenience sample and may not be representative of the population. Results are from analyses of data from a single urban ED; thus, findings may not generalize to other EDs and other health settings. Also, the cross-sectional nature of the data does not support inferences about causation. In addition, recall bias may have affected subjects' information about events that reached back over 12 months, and patient self-reporting of sensitive facts as IPV may lead to under-reporting.

CONCLUSION

Results show that IPV risk factors co-occur in the same individual and that those who report the presence of two or more risk factors have increased odds of reporting IPV. These results, as those reported in a previous paper with a focus on ethnicity and IPV,[2] help identify subgroups of urban ED patients that are more at risk for IPV and that should be the focus of specific IPV-related actions such as screening, brief intervention, or referral to treatment.

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Location of Violent Crime Relative to Trauma Resources in Detroit: Implications for Community Interventions

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Introduction: Detroit, Michigan, is among the leading United States cities for per-capita homicide and violent crime. Hospital- and community-based intervention programs could decrease the rate of violent-crime related injury but require a detailed understanding of the locations of violence in the community to be most effective.

Methods: We performed a retrospective geospatial analysis of all violent crimes reported within the city of Detroit from 2009-2015 comparing locations of crimes to locations of major hospitals. We calculated distances between violent crimes and trauma centers, and applied summary spatial statistics.

Results: Approximately 1.1 million crimes occurred in Detroit during the study period, including approximately 200,000 violent crimes. The distance between the majority of violent crimes and hospitals was less than five kilometers (3.1 miles). Among violent crimes, the closest hospital was an outlying Level II trauma center 60% of the time.

Conclusion: Violent crimes in Detroit occur throughout the city, often closest to a Level II trauma center. Understanding geospatial components of violence relative to trauma center resources is important for effective implementation of hospital- and community-based interventions and targeted allocation of resources. [West J Emerg Med. 2020;21(2)291-294.]

INTRODUCTION

In 2015 there were 1,759.6 violent crimes per 100,000 residents in Detroit, Michigan, the second highest rate in the nation. In 2018 the Federal Bureau of Investigation named Detroit the second most dangerous city in America.[1] Violence disproportionately affects Black adolescents, for whom homicide is the leading cause of death compared to accidental trauma for the general adolescent population.[2] Beyond fatalities, the Centers for Disease Control and Prevention reports that for every homicide there are 94 non-fatal violent injuries.[3] Youth who have been injured are at increased risk for further injury and death, with 44% of injured youth admitted to an urban hospital trauma service later readmitted for assault and 20% ultimately killed within

five years.[4]

After treatment at a medical center, victims of violent crime are often discharged back to the same environment in which they were injured, placing them at risk for continued violence and injury.[5]preventative interventions are often based out of inpatient units; however, the question of how often youth who have been injured due to violence are discharged from emergency departments (EDs However, hospital- and community-based interventions, such as the Safe Streets intervention in Baltimore, have been proven to decrease youths' risk of violence,.[6] For these public health interventions to be effectively and efficiently implemented, they must be appropriately targeted. This is particularly important in cities like Detroit that have relatively low population density (only eight census block groups have greater than 15 housing units per acre, the majority having less than five) spread over 139 square miles.[7] While Detroit has implemented several projects aimed at stemming violence, targeted strategies may improve effectiveness.[8]

Geospatial mapping has previously been used to implement targeted interventions and to manage chronic disease by "hot-spotting" of acute care use.[6] Hot-spotting describes a "data driven process for the timely identification of extreme patterns in a defined region of the healthcare system."[9] Geospatial mapping has also been used to evaluate the geographic distribution of child abuse cases to deliver targeted interventions, as well as to identify communities with high burdens of opioid-related emergency department (ED) visits and hotspots of opioid overdose.[9]

Examination of geospatial data relative to health system resources is a novel approach to inform not only areas of risk but also opportunities for health system-community partnerships. Hospital- and community- based interventions also require well-developed public health infrastructure and partnerships in order to compete for necessary grants and other funding to support such programs.[10] The objective of this study was to analyze the location of homicides and violent crimes in Detroit in relation to the city's trauma centers to explore ways in which hospital- and community-based violence intervention programs could be optimally deployed.

Population Health Research Capsule

What do we already know about this issue?
There are effective hospital- and community-based intervention programs to reduce violence, but they require significant resources and coordination with trauma systems.

What was the research question?
We examined optimal deployment of intervention resources and show a reproducible process for such evaluation.

What was the major finding of the study?
One trauma center was closest to >40% of violent crime in Detroit; most violent crimes occurred closest to a Level II trauma center.

How does this improve population health?
Examination of violent crimes or other public health issues relative to health center resources can inform optimal intervention deployment.

METHODS

We obtained data on the type and location of all crimes in Detroit from 2009-2015 from a publicly available database maintained by the Detroit Police Department via the Detroit Open Data Portal. Crime locations are blurred slightly by the addition of a small amount of spatial "noise" to ensure anonymity but remain accurate to the street block level. Crimes were tagged as "violent" if they were identified as one of the following categories: "AGGRAVATED ASSAULT," "ASSAULT," "HOMICIDE," "JUSTIFIABLE HOMICIDE," or "NEGLIGENT HOMICIDE."

Data on the locations of hospitals in Detroit were obtained from "Data Driven Detroit," a publicly available database. Since the Department of Veterans Affairs Detroit Medical Center, Detroit Receiving Hospital, Hutzel Hospital, Harper Hospital, and Children's Hospital of Michigan are all located in the same hospital complex in downtown Detroit, we created a composite "Downtown Medical Center (DTMC)" surrogate, with coordinates defined as the unweighted geometric average of these hospitals. We performed centroid analysis using the "geosphere" package executed in the R programming language (www.r-project.org). Distances between crimes and hospitals were calculated using the Vincenty ellipsoid method, executed via the "geosphere" package with an equatorial axis of 6,378,137 meters (m), a polar axis of 6,356,752.3142 m, and an inverse flattening of 1/298.257223563. For each violent crime we identified the closest hospital within the city and the distance to that hospital. All further statistical analyses were performed in the R language. This study was determined to not require review by the Emory Institutional Review Board.

RESULTS

During the study period, 1,083,265 crimes were recorded by the Detroit Police Department, including 202,931 violent crimes (18.7%). Table 1 shows the breakdown of crimes by year. While overall numbers of crimes decreased from approximately 181,000 per year to approximately 137,000 per year, the percent of those crimes that were violent rose from 17.6% to 20.5%.

Table 1. Comparison of the numbers of total, violent, and nonviolent crimes reported by the Detroit Police Department from 2009 to 2015.

Year	Total crimes	Nonviolent crimes	Percent	Violent Crimes	Percent
2009	181,427	149,549	82.4%	31,878	17.6%
2010	169,925	138,961	81.8%	30,964	18.2%
2011	156,569	128,172	81.9%	28,397	18.1%
2012	155,581	126,831	81.5%	28,750	18.5%
2013	146,679	119,447	81.4%	27,232	18.6%
2014	136,359	108,672	79.4%	27,687	20.3%
2015	136,725	108,702	79.5%	28,023	20.5%

The median distance between a crime and the closest available hospital was 4.582 kilometers (km) (inter-quartile range [IQR] 2.682 km - 6.428 km). Violent crimes were slightly, although significantly, farther away from hospitals than nonviolent crimes (median distance 4.7 km with IQR 2.9 km - 6. 5km compared to median distance 4.5 km with IQR 2.6 km - 6.4 km, p-value < 2.2E-16). Among the subset of 202,931 violent crimes, 200,348 (98.7%) occurred within 10 km (6.2 miles) of a hospital, 108,918 (53.7%) occurred within 5 km, and 8,782 (4.3%) occurred within one km. Across the study period, the median distance between a violent crime and the closest hospital stratified by year of crime varied minimally.

Over the study period, the hospital closest to violent crimes was most often Sinai-Grace Hospital, which was the closest hospital for 41.2% of violent crimes followed by Henry Ford Hospital (23.6%), Ascension St. John Hospital (19.2%), and DTMC (16.0%). Table 2 depicts the breakdown of violent crimes by closest hospital across each year of the analysis period and shows that these trends are stable across the analysis period. Of the four hospital complexes considered here, the DTMC and Henry Ford hospitals carry Level I trauma designations, while St. John's and Sinai-Grace are Level II trauma facilities. Among violent crimes, only 39.5% occurred closest to a Level I trauma center, while the majority (60.5%) occurred closest to Level II trauma centers.

DISCUSSION

We explored the spatial relationship between violent crimes and trauma centers in Detroit and showed that the majority of violent crimes occur close to hospitals, within five km in most cases. These findings are especially relevant in a city like Detroit with low population density. This analysis aims to understand the best approach to administer resources for violence prevention and intervention in relation to a hospital partner, not simply relative to crime location. Based on this geospatial analysis, Sinai Grace Hospital and the surrounding communities would likely realize the greatest benefit from investment in community violence reduction interventions.

Presenting information with geospatial data centered around well-known community landmarks has previously been employed to engage community organizations and empower community members to organize effectively. The ability to organize multiple stakeholders around an issue would likely be important for violence, which disproportionately affects a marginalized population for whom social support is often lacking.[11] In prior work, researchers reported: "The repeated display of health-disparity hot spot maps ensured that multiple audiences could quickly interpret prevalence and trends."[12] This analysis of violent crime relative to a well-known trauma center location could also be used as a model for community engagement around effective investment in hospital- and community-based interventions for many public health issues.

While resources for trauma care are, by design, concentrated at Level I trauma centers, the communities suffering from violent crimes in Detroit are more often closer to Level II trauma centers. A single Level II trauma center was the closest hospital to over 40% of all violent crimes in Detroit. Based on these results, policymakers and payers should consider incentivizing Level II trauma centers to prioritize violence-related prevention and interventions to optimally address the safety and well-being of the communities they serve. Although they are not necessarily where every patient in the area is treated for injuries, these centers represent opportunities for community-based health system partnership to reduce injury. Further, nonprofit hospitals with Level II trauma centers should consider supporting violent injury prevention as a key strategy to meet community benefit requirements for federal tax exemption.

Table 2. Counts of which violent crimes are closest to each hospital, broken down by year of analysis.

	2009	2010	2011	2012	2013	2014	2015
DTMC	5,399	5,188	4,792	4,673	4,189	3,999	4,072
Sinai-Grace	12,529	12,266	11,222	11,810	11,581	12,014	12,345
Henry Ford	7,925	7,457	6,900	6,738	6,394	6,207	6,315
St. John	6,025	6,053	5,483	5,529	5,068	5,467	5,291

DTMC, Downtown Medical Center.
Level I trauma centers: DTMC, Henry Ford; Level II centers: Sinai-Grace, St John's.

LIMITATIONS

This study has several limitations. First, the analysis relies on a single data source, the Detroit Police Department, with the likely result that not all violent crimes actually occurring in Detroit were included in the analysis. A recent study indicates a large difference in the number of violent injuries reported to police and treated in a trauma center, further reflecting the necessity of health system involvement.[13] Second, we only included hospitals within the city of Detroit, likely resulting in under-sampling the places in which victims of violent crime go to receive care. We also did not consider transportation times or routes that may affect the hospital receiving an injury. This study focused on violent crime and proximity to hospitals in one urban city and is not necessarily generalizable to other localities.

CONCLUSION

The burden of violent injuries in Detroit requires using geospatial data to focus health system efforts of harm reduction and prevention. Evaluating the spatial relationships between violent crimes and trauma centers can serve as a critical tool for strategic assessment of communities at most risk, informing both resource allocation and key partnerships between the community and healthcare systems. Further, this work can inform the research agenda and policy around violent crime prevention and intervention implementation in order to improve the life and health of Detroit residents and other urban centers using a similar approach.

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Quality and Publication of Emergency Medicine Trials Registered in ClinicalTrials.gov

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Introduction: Promoting emergency medicine (EM) clinical trials research remains a priority. To characterize the status of clinical EM research, this study assessed trial quality, funding source, and publication of EM clinical trials and compared EM and non-EM trials on these key metrics. We also examined the volume of EM trials and their subspecialty areas.

Methods: We abstracted data from ClinicalTrials.gov (February 2000 - September 2013) and used individual study National Clinical Trial numbers to identify published trials (January 2007 - September 2016). We used descriptive statistics and chi-square tests to examine study characteristics by EM and non-EM status, and Kaplan-Meier curves and log-rank tests to compare time to publication of completed EM and non-EM studies.

Results: We found 638 interventional EM trials and 59,512 non-EM interventional trials conducted in the United States between February 2000 and September 2013, registered on ClinicalTrials.gov. EM studies were significantly less likely than non-EM studies to be National Institutes of Health-funded or to evaluate a drug or biologic. However, EM studies had significantly larger sample sizes, and were significantly more likely to use randomization and blinding. Overall, 34.3% of EM and 26.0% of non-EM studies were published in peer-reviewed journals. By subspecialty, more EM trials concerned medical/surgical and psychiatric/neurological conditions than trauma.

Conclusion: Although EM studies were less likely to have received federal or industry funding, and the EM portfolio consisted of only 638 trials over the 14-year study period, the quality of EM trials surpassed that of non-EM trials, based on indices such as randomization and blinding. This novel finding bodes well for the future of clinical EM research, as does the higher proportion of published EM than non-EM trials. Our study also revealed that trauma studies were under-represented among EM studies. Periodic assessment of EM trials with the metrics used here could provide an informative and valuable longitudinal view of progress in clinical EM research. [West J Emerg Med. 2020;21(2)295-303.]

INTRODUCTION

Over a decade ago, the Institute of Medicine (IOM) released three reports on the future of emergency medicine (EM) in the United States (US).[1-3] Those reports called for: 1) enhancing EM and trauma care research through additional federal funding; 2) assessing research needs, gaps, and opportunities; and 3) encouraging academic medical centers to provide research time and facilities.[4-5] Those recommendations prompted roundtable

discussions focused on advancing research in three broad areas: trauma; neurological and psychiatric emergencies; and surgical or medical emergencies.[6]

In light of these reports and recommendations, we aimed to characterize the status of clinical EM research and to compare EM with non-EM studies. We restricted our assessment to clinical trials, essential components of evidence-based medicine and of interest to the National Institutes of Health (NIH), which promotes funding opportunities for high-quality, multisite EM trials.[7] We based our assessment on several metrics: study quality; funding source; and dissemination of study findings. These metrics provide quantifiable measures of clinical EM research that can be used going forward to evaluate the characteristics and productivity of this research over time. In addition, we examined the distribution of trials across EM subspecialties (neurological/psychiatric, trauma, medical-surgical), which may help to direct funding to under-researched areas, and we examined the volume of EM registered trials by year and funding source, to assess trends.

We identified trials through ClinicalTrials.gov,[8] which is the largest online trial registration and results reporting repository in the world and includes studies across medical disciplines.[9] As trial registration is required at the time of study enrollment, ClinicalTrials.gov includes published and non-published studies, thereby providing a comprehensive listing of initiated trials. We used this information to compare EM and non-EM studies on the metrics of interest identified above, and to conduct EM-specific analyses on subspecialty and trends in registration. For dissemination of study findings, we examined whether the EM and non-EM trials registered in ClinicalTrials.gov were published in peer-reviewed journals.

Population Health Research Capsule

What do we already know about this issue?
Efforts to advance rigorous emergency medicine (EM) clinical trials continue, but little is known about the current quality and characteristics of this research.

What was the research question?
Using ClinicalTrials.gov and PubMed data, how do EM and non-EM trials compare on funding, quality and publication of results?

What was the major finding of the study?
EM studies had less federal/industry funding, but their quality and likelihood of publication surpassed non-EM trials.

How does this improve population health?
We identified key metrics for monitoring and improving EM research. This paves the way for strengthening the EM evidence base and enhancing patient care.

METHODS

Data Abstraction

We abstracted data from the publicly available Aggregate Analysis of ClinicalTrials.gov (AACT) database, a relational database with multiple tables of downloadable data, provided by the Clinical Trials Transformation Initiative, to facilitate analysis of trial data registered in ClinicalTrials.gov.[10] We restricted our search to studies conducted in the US and downloaded data on trials registered from the inception of the ClinicalTrials.gov website (February 2000) until September 2013.

Search Strategy for Eligible EM and non-EM Trials in ClinicalTrials.gov

To identify potential EM studies, we first conducted an automated keyword search of the title and brief and detailed description fields of each study's ClinicalTrials.gov record that was included in the AACT database We searched for the following terms: 1) emergency; 2) ER; 3) ED; 4) EM; and 5) acute care. Then, ClinicalTrial.gov administrators at our institution with expertise in protocol review and registration (JR, JD, AO, MW) manually reviewed these studies to identify which were truly EM studies, defined as studies that took place in the EM setting or studies that addressed medical issues related to EM. Initially, these administrators examined a subset of studies and collectively discussed and resolved any classification issues. Remaining studies were evaluated by one of these individuals using standardized criteria.

Once the initial set of EM studies was identified, we used a machine learning algorithm based on the study title and brief and detailed description fields to build a text classifier that categorized EM and non-EM studies automatically. For studies identified as non-EM based on the keyword search above, we conducted a keyword search for "trauma" to search for additional EM studies. We applied the text classifier separately to studies that did and did not match on "trauma." For each study, the text classifier generated an estimated probability of being an EM study. For each group based on keyword "trauma," we sorted the studies by estimated probability, and stopped the searches after observing no EM studies below an estimated probability cutoff significantly lower than 1%. We then manually reviewed the studies with the highest EM study probability to determine whether any met criteria for inclusion as EM studies. We further narrowed our inclusion criteria for identified EM and non-EM studies to interventional trials, using the "study design" field in the AACT database to exclude observational studies.

Variables

We included the following measures of study characteristics and quality that we extracted from the AACT database: 1) study phase; 2) intervention type; 3) sample size; 4) randomization; and

5) blinding. Following the methods described by Goswami and colleagues,[11] we derived funding source from AACT database variables: 1) "agency" (NIH, US federal, industry, other); and 2) "sponsor type" (lead sponsor and collaborators). We categorized funding, based on the sponsor, as the following: 1) industry; 2) NIH and US federal funding; and 3) "other."

We manually categorized EM interventional studies by research topic using the NIH Task Force on Research in the Emergency Setting criteria.[6] We used AACT database fields "official title," and the study's "detailed description" to designate the research topic. Initially, two raters (JR and MW) categorized each study. Across 17 studies, chance-adjusted agreement was κ = .79. The original raters then trained one additional rater (AO) and one of these raters then examined each of the remaining studies. Raters could include a study under more than one substantive area, if appropriate.

Identifying Published Studies

We turned to the published literature to assess dissemination because federal law requires that only a subset of registered trials report results in ClinicalTrials.gov, ie, applicable clinical trials that include investigations of a drug or biologic other than phase 1; investigations of Food and Drug Administration-regulated devices other than small feasibility studies and some studies of prototype devices; and pediatric post-market surveillance of devices.[12]

In July 2005, the National Library of Medicine began including the NCT number in the MEDLINE record when it was included in the published paper.[13] Also in 2005, the International Committee of Medical Journal Editors began requiring trial registration as a condition of publication.[14] Hence, we assumed a more complete listing of registered trials beginning in 2005. We began our search for publications with trials completed in January 2007 as we assumed that trials registered in 2005 would take at least two years to complete. We based this assumption on a review of a subset of studies registered in ClinicalTrials.gov by our institution where the average time from registration to study completion was 2.9 years. We included all studies completed up to the final date of data abstraction, September 27, 2013. We followed these completed studies through September 30, 2016, thus providing a minimum follow-up of three years to determine whether the study had been published.

To identify completed studies, we used the "study completion date" provided in ClinicalTrials.gov; if the study was missing that date but had a "primary completion date," we used the latter. We used the same criteria to identify EM and non-EM published studies, ie, matching the unique ClinicalTrials.gov National Clinical Trial (NCT) identifier to the study's MEDLINE record in PubMed.

Statistical Analyses

To compare EM and non-EM studies on study characteristics and quality, funding source, and publications, we used descriptive statistics and chi-square tests. We compared time to publication for EM and non-EM studies using Kaplan-Meier curves and log-rank tests. We also used Kaplan-Meier methods to compare differences in time to publication for EM and non-EM studies stratified by funding source and study phase. We considered unpublished studies censored at the final date of potential publication, September 30, 2016. We conducted two EM-specific analyses: trends in EM trial registration by funding source and year (2000-2013), and proportions of EM trials in three sub-specialties (trauma, neurological and psychiatric emergencies, and surgical or medical emergencies). We used frequency distributions for these analyses.

We used SAS software, version 9.3 of the SAS System for Windows, copyright 2002-2012 (SAS Institute Inc., Cary, NC) for the initial search for EM and non-EM studies, for descriptive statistics, and for comparisons between EM and non-EM studies on trial characteristics. We used R: A Language and Environment for Statistical Computing, version 3.3.0, (R Foundation for Statistical Computing, Vienna, Austria) to develop the automatic text classifier, and to determine time to publication.

RESULTS

Identification of Emergency Medicine Trials

As shown in Figure 1, there were over 72,000 US studies registered between January 2000 and September 2013. The first keyword search on emergency terms yielded 2,735 studies, which we used to develop the automatic text classifier. Using the text classifier and manual review as shown in the figure, we identified a total of 898 EM studies. Omitting observational studies, we found 638 interventional EM trials conducted in US-registered in ClinicalTrials.gov to September 27, 2013 and we identified 59,512 non-EM interventional trials conducted in the US during the same period.

Characteristics and Quality of Registered Trials

Table 1 shows significant differences between EM and non-EM trials on study characteristics and indices of trial quality. More non-EM than EM trials evaluated a drug/biologic (74.2% vs 46.1%). EM trials were more likely to evaluate procedural, device, or behavioral interventions. Only about half of all EM trials reported any study phase, compared with three quarters of non-EM trials and fewer EM (45.6%) than non-EM studies (51.3%) were phase 2 or higher; thus, more non-EM trials met criteria for applicable clinical trials that required study results reporting. With respect to trial quality, EM studies were more likely to be randomized, to use blinding, and to have larger sample sizes. Among EM studies, 59% were classified as medical/surgical trials, 36% as neurological/psychiatric, and 17% as trials involving trauma patients. These proportions sum to greater than 100% and indicate that some trials investigated more than one substantive area.

Funding

Table 1 also shows significant differences between EM and non-EM trials on funding source. Whereas 32.3% and

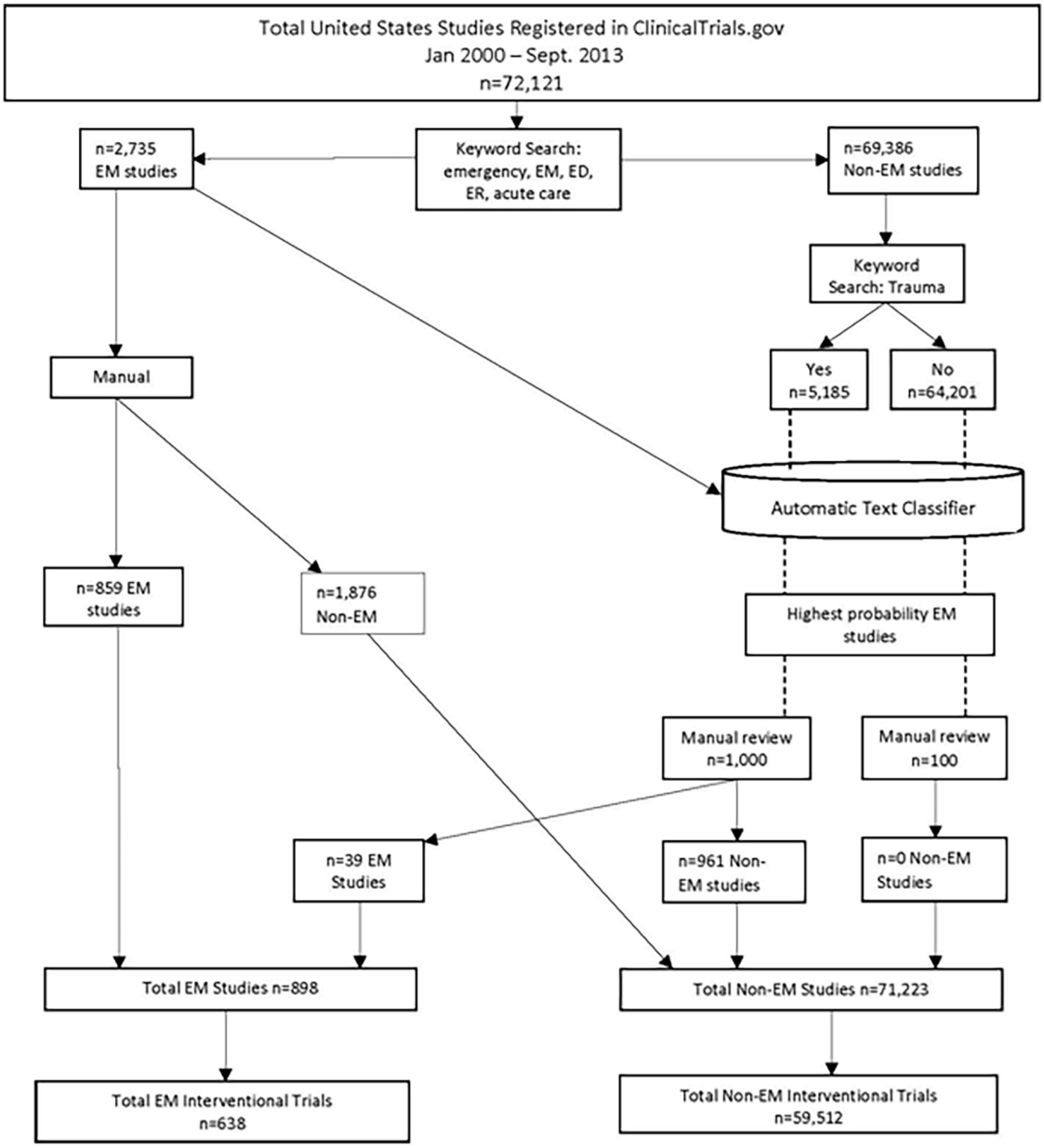

Figure 1. Emergency medicine (EM) and non-EM clinical trials inclusion flow chart.
ED, emergency department; *ER*, emergency room.

41.4% of non-EM trials were funded by the NIH or by industry, respectively; only 23.7% and 17.1% of EM trials were funded by these sources. Figure 2 displays registered EM clinical trials by year and funding. A marked increase in the number of registered trials occurred in 2005, the first year investigators registered trials that were funded by sources other than industry or government. Between 2007 and 2013 EM trial registration was fairly stable, with 65-87 newly registered trials per year. Throughout that period, EM studies continued to be dominated by "other" sources of funding.

Publication of Trial Results

Between September 27, 2007, and September 30, 2016, 216 of 638 EM registered trials were completed (Table 2). Based on linking trial registration number with the PubMed record, we found that 74 (34.3%) of those studies were published in peer-reviewed journals three or more years after completion. Among non-EM studies, 5788 (26.0%) were published during that time frame. Of all completed studies, 97.7% of EM and 92.7% of non-EM studies had a study completion date in ClinicalTrials.gov. Among those, the proportions of EM and non-EM studies that were published within one year were 6.6% and 4.4%, respectively. At two years, 18.0% of EM and 11.9% of non-EM studies had been published in peer-reviewed journals.

Overall, EM studies were more likely than non-EM studies to be published ($p = 0.011$; Figure 3a). By funding source,

NIH-funded EM studies were more likely than NIH-funded non-EM studies to be published (p<0.01; figure 3b). However, among industry- and other-funded studies, publication of EM and non-EM studies did not differ (Figures 3c-3d). In addition, publication of EM and non-EM studies did not differ by study phase (data not shown).

DISCUSSION

Among US clinical trials registered in ClinicalTrials.gov, we found significant differences between EM and non-EM on trial characteristics and quality measures, funding sources, and dissemination of results through publication. Regarding trial characteristics, fewer EM than non-EM trials identified a study phase. This is consistent with our finding that fewer EM than non-EM trials assessed drug and biologic interventions; trials without phases typically assess behavioral interventions or devices. On measures of trial quality, EM compared favorably with non-EM trials; they were more likely to be randomized, to employ single or double blinding, and to include larger sample sizes. However, although of significantly higher quality, fewer EM than non-EM trials in our study received funding from industry or NIH and other federal agencies. There is broad consensus, dating back to the 2006 IOM reports, that there is a need to increase the conduct of EM clinical trials to expand the overall EM evidence base,[4] and that increased funding is needed to meet that goal.[6, 15] The good quality of EM studies that we observed suggests that EM is well positioned to increase its base of funded studies. Indeed, the number of EM projects submitted to NIH has increased in recent years.[17] Still, the number of NIH-funded projects remains low compared with other medical specialties.[16] For example,

Table 1. Characteristics of emergency medicine and non-emergency medicine intervention studies.

Study characteristic	Emergency medicine trials (n = 638) Number (%)	Non-emergency medicine trials (n = 59,512) Number (%)	P-value
Funding source			<0.001
National Institutes of Health/US federal	151 (23.7)	19,197 (32.3)	
Industry	109 (17.1)	24,309 (41.4)	
Other	378 (59.3)	16,006 (26.9)	
Phase			<0.001
N/A	310 (48.6)	14,614 (24.6)	
Phase 0-1	37 (5.8)	14,337 (24.0)	
Phase 2	106 (16.6)	17,052 (28.6)	
Phase 3	79 (12.4)	8,454 (14.2)	
Phase 4	106 (16.6)	5,055 (8.5)	
Intervention			
Drug/Biologic	294 (46.1)	44,153 (74.2)	<0.001
Procedure	84 (12.7)	5,891 (9.0)	0.01
Device	75 (11.8)	4,581 (7.7)	<0.001
Behavioral	125 (19.6)	6,664 (11.2)	<0.001
Other	126 (19.8)	10,891 (18.3)	0.28
Randomized	534 (83.4)	34,105(57.3)	<0.001
Blinded			
Single	129 (20.2)	5,204 (8.7)	<0.001
Double	221 (34.6)	17,895 (30.1)	0.04
Sample size			<0.001
<50	96 (15.3)	24,693 (43.3)	
50-100	118 (21.5)	12,456 (21.9)	
>100	414 (63.2)	19,856 (34.8)	
Topic			
Neurological/Psychiatric	230 (36.1)	N/A	
Trauma	110 (17.2)	N/A	
Medical/Surgical	378 (59.3)	N/A	

US, United States; *N/A*, not available.

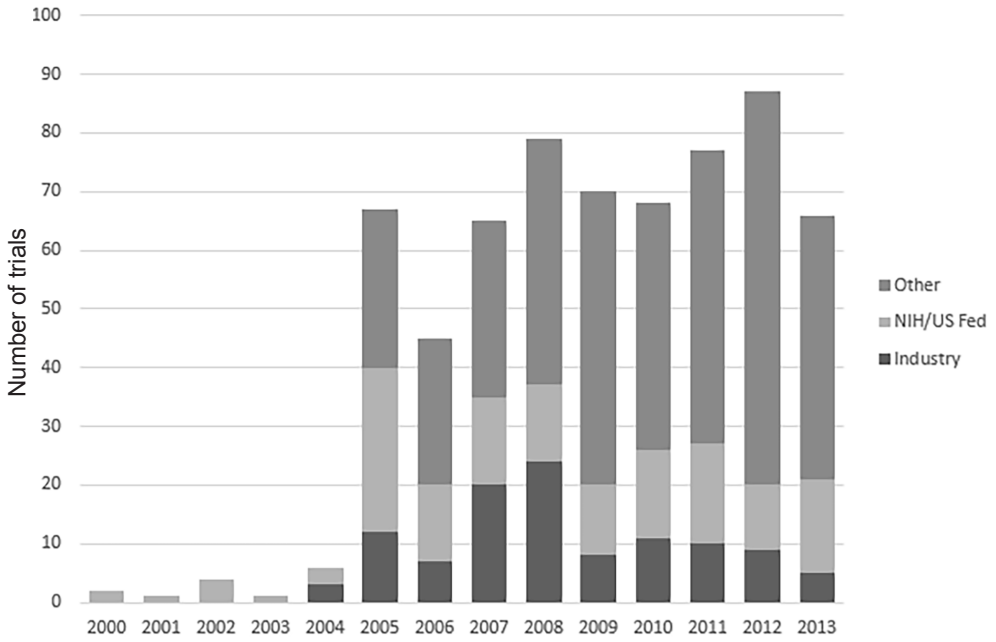

Figure 2. Number of trials registered in ClinicalTrials.gov by funding source from February 2000-September 2013. *NIH,* National Institutes of Health; *US Fed,* United States federal.

EM-funded applications comprised less than 1% of the 2014 NIH research budget, paling in comparison to funding for sleep disorders and rehabilitation research.[16,17]

Continuing to develop, expand, and promote the pursuit of broad and diverse research within EM may help to boost federal funding.[18,19] In that regard, we found that subspecialty areas were not equally represented among EM trials. Nearly 60% of these trials examined medical and surgical topics; only 17% studied trauma. Similarly, Roberts and colleagues (2005) reported that few clinical trials are conducted on traumatic injuries compared with trials across a range of chronic and infectious disease conditions. The authors added that "funding for trauma research is less than for almost any other cause of human suffering" (p. 1095).[20] There are formidable challenges to conducting research in the EM setting, including the fast-paced/high-pressure environment, time constraints, and difficulties obtaining consent.[21] In research involving trauma patients, these challenges may be amplified and contribute to the paucity of studies in this area. Increasing and prioritizing funding, as well as addressing ethical issues, expanding and creating trauma research networks, and developing a standard template for trauma research are some suggestions that emerged from the NIH Roundtable on Emergency Trauma Research convened to enhance research in this field.[22]

Of utmost importance is the dissemination of research findings. Ross and colleagues point out that when trial results are not disseminated, scientific knowledge suffers though potential redundancy of studies and inaccuracies about clinical evidence; commitment to trial participants is violated; and the investigator's ethical obligation to disseminate findings of studies is unmet.[23] In our study, overall, EM trials were more likely than non-EM to be published at all measured time points. Still, we found that only 34.1% and 26.1%, of EM and non-EM trials completed between 2007 and 2013 were published, respectively, when allotting at least three years from study completion to publication. These findings are largely consistent with those of Huser and Cimino who found that 27.8% of their sample of phase 2 or higher studies registered in ClinicalTrials.gov had been published within three years, when they searched for publications via a unique identifier (eg, NCT number or PubMed ID).[9]

Huser and Cimino note that their search strategy, similar to our method, tends to yield a lower proportion of published works

Table 2. Completed and published emergency medicine and non-emergency medicine intervention studies included in ClinicalTrials.gov registry, September 2007-September 2016.

Completed and published studies	Emergency medicine Number (%)	Non-emergency medicine Number (%)
All completed studies	216	22,298
Published in three or more years	74 (34.3)	5,788 (26.0)
Missing/incorrect study completion date	4	1,619
Completed studies with study completion date	211	20,679
Published in three or more years	72 (34.1)	5,390 (26.1)
Published within two years	38 (18.0)	2,459 (11.9)
Published within one year	14 (6.6)	903 (4.4)

than manual article-retrieval methods. Based on studies they reviewed, these investigators report that 46%-68% of registered trials had published results when searches were conducted manually. Given the volume of studies we examined, it was not feasible to conduct a comprehensive manual search and we recognize that our findings likely underestimate the proportions of registered trials that were published. However, our method of identifying publications was consistent across EM and non-EM studies and should thus have obtained an unbiased comparison between these groups. Indeed, our decision to examine dissemination of results based on published papers likely avoided bias that could have arisen had we relied on results reported in the ClinicalTrials.gov database. More non-EM than EM trials were phase 2 or higher and investigated a drug or biologic; thus, more non-EM than EM trials would have met the definition of an applicable clinical trial that requires results reporting in ClinicalTrials.gov.

LIMITATIONS

We limited our study to trials conducted in the US and these results may not generalize to studies of trials conducted in other countries. In addition, we may have missed some relevant trials. First, some trials may have gone unregistered, particularly from the inception of the ClinicalTrials.gov registry until 2005 when the International Committee of Medical Journal Editors (ICMJE) began requiring registration for publication in one of its journals.[14] Second, ICMJE-mandated registration gives investigators the option of several online registries (eg, World Health Organization International Clinical Trial Registry Platform or ClinicalTrials.gov); by limiting our search to ClinicalTrials.gov, we would have overlooked studies in those registries as well.

Although ICMJE requires investigators to register all trials conducted on human subjects, federal law requires registration only of studies that are applicable clinical trials (ACTs).[12] We found that EM trials were less likely than non-EM to be ACTs, so more EM than non-EM trials may have gone unregistered. In addition, by identifying registered EM trials through search words "emergency," "ER," "ED," "EM," "acute care," and "trauma," we may have overlooked and misclassified some EM trials. Furthermore, we did not formally examine the validity of the automatic text classifier that we used to identify EM studies, but we did conduct manual reviews of a subset of the articles that the text classifier prioritized.

With respect to classifying EM studies by subspecialty,

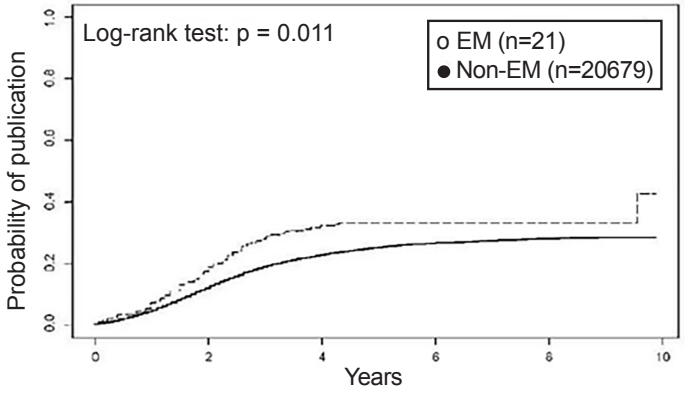

Figure 3a. Cumulative Incidence of Time to Publication (all funding sources)

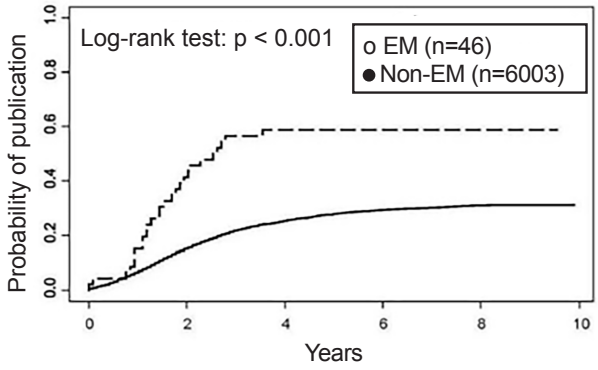

Figure 3b. Cumulative Incidence of Time to Publication (NIH and federally funded)

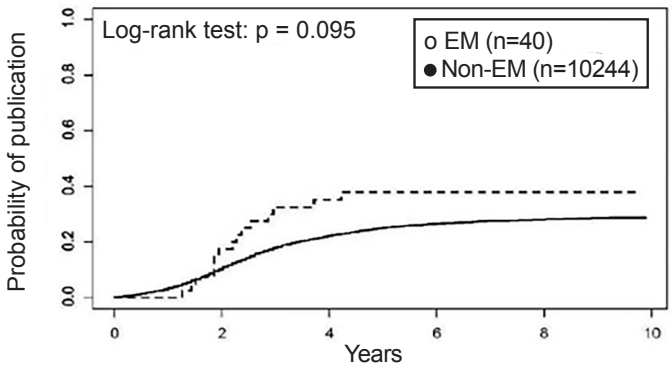

Figure 3c. Cumulative Incidence of Time to Publication (industry funded)

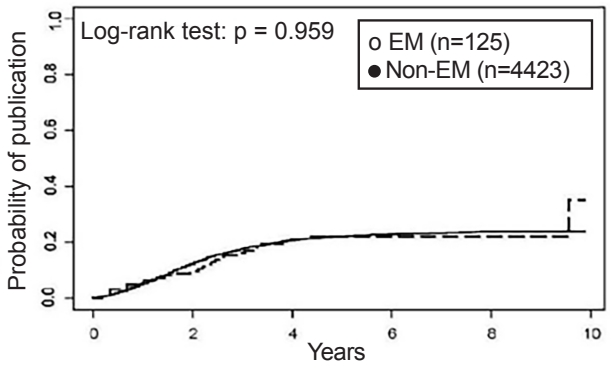

Figure 3d. Cumulative Incidence of Time to Publication (other funding sources)

Figure 3. Cumulative incidence for time to publication overall and by funding source, emergency medicine (EM) and non-EM trials. *NIH,* National Institutes of Health.

we did examine agreement between our initial two raters of EM, but we did not formally compare agreement with a third rater subsequently trained by the initial raters. Our use of NCT number to identify published studies likely underestimated the proportion of published trials; studies that conduct manual searches of the PubMed database find a larger proportion of published studies.[9] Moreover, we restricted our search for publications to MEDLINE, potentially missing published works in other online databases such as the Cochrane Library, Cumulative Index to Nursing and Allied Health Literature, or Excerpta Medica Database.

We collected data on studies registered through September 27, 2013, and concluded our follow-up of published studies in September 2016. It is possible that characteristics of more recently registered trials may differ and our data may not demonstrate newer trends in research. Future studies should examine more recent data and might also extend the follow-up for published work. Future studies should also endeavor to assess clinical EM research and its progress in relation to other specific medical specialties and subspecialties. We compared EM studies with non-EM, the latter being a very broad comparator, likely with wide-ranging differences in study characteristics and quality and publication status by medical specialty.

CONCLUSION

Given the commitment to expand and advance clinical EM research, periodic assessment using quality indicators can provide informative quantitative data to assess its progress. This study used several key metrics for evaluating EM clinical trials including trial quality, funding source, and dissemination of study findings. Data for studies completed through September 2013 and followed for publication through September 2016 indicated that the EM portfolio consisted of only 638 trials over the 14-year study period and that trauma research accounted for only a small proportion of EM studies. Further, compared with non-EM studies, EM studies were less likely to have received federal or industry funding. Nonetheless, the quality of EM trials surpassed that of non-EM trials, based on indices such as randomization and blinding. This novel finding bodes well for the future and advancement of EM research, as does the higher proportion of published EM vs non-EM trials. Periodic assessment of EM trials with the metrics used here will help to provide a valuable longitudinal view of progress in clinical EM research.

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Federal Funding in Emergency Medicine: Demographics and Perspectives of Awardees

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Introduction: Emergency physicians face multiple challenges to obtaining federal funding. The objective of this investigation was to describe the demographics of federally-funded emergency physicians and identify key challenges in obtaining funding.

Methods: We conducted a retrospective database search of the National Institutes of Health (NIH) Research Portfolio Online Reporting Tool (NIH RePORTER) to collect data regarding the distribution and characteristics of federally-funded grants awarded to emergency medicine (EM) principal investigators between 2010-2017. An electronic survey was then administered to the identified investigators to obtain additional demographic data, and information regarding their career paths, research environment, and perceived barriers to obtaining federal funding.

Results: We identified 219, corresponding to 51 unique, mentored career development awardees and 105 independent investigators. Sixty-two percent of investigators responded to the electronic survey. Awardees were predominantly White males, although a larger portion of the mentored awardee group was female. Greater than half of respondents reported their mentor to be outside of the field of EM. The most common awarding institution was the National Heart Lung and Blood Institute. Respondents identified barriers in finding adequate mentorship, time to gather preliminary data, and the quality of administrative support.

Conclusion: The last five years have showed a trend toward increasing grants awarded to EM investigators; however, we identified several barriers to funding. Initiatives geared toward support and mentorship of junior faculty, particularly to females, minorities, and those in less heavily funded areas of the country are warranted. [West J Emerg Med. 2020;21(2)304-312.]

INTRODUCTION

Research grants awarded from federal sources such as the National Institutes of Health (NIH) remain a leading measure of success in academic medicine. Clinician scientists pursing a research career, including emergency physicians (EP), often pursue a career development award (ie, K grants) as a bridge to independent funding status (ie, R-series awards).[1] Career development awards are considered prestigious to the investigator as well as to his or her sponsoring department, but they require a significant investment of time from the trainee

and mentorship team.[2] Successful submission of a federal career development grant may require up to two years of preparation, which includes finding a committed mentorship team, crafting a research and training plan, initiating pilot data collection, generating a sufficient number of publications to demonstrate commitment to academic practice, and undergoing a rigorous review process. During this time, emergency medicine (EM) faculty are faced with significant barriers including clinical commitments, administrative obligations, and time required for mentorship meetings and grant writing.[3] They also face the challenges associated with the transition into junior faculty.[3] Compared to other specialties, EPs submit the fewest mentored career awards (K grants), have the third lowest success rate (60% funded), and submit the fewest grants per faculty size.[2,4]

EPs are well positioned to make meaningful contributions to research given their breadth of clinical expertise across a wide spectrum of disease, unique window into the communities where they practice, and natural collaboration with multiple clinical disciplines. Despite this, a 2006 Institute of Medicine report demonstrated that few NIH training grants were awarded in emergency departments (ED).[5] Recognizing the immediate importance of training future clinician-researchers in EM led to the creation of the Office of Emergency Care Research (OECR) in 2012 to coordinate research in this rapidly growing space. [6,7]

From 2011 to 2014, emergency care research made up only 0.7% of NIH spending on new grants.[8] In response, the Society for Academic Emergency Medicine (SAEM) and the American College of Emergency Physicians (ACEP) recommended four key strategies to increase the pipeline of federally funded emergency care researchers: 1) promote research as a viable career trajectory; 2) identify the availability of senior mentors; 3) understand the process of applying for NIH funding as a financial investment; and, 4) build a supportive culture that fosters research.[9] Currently, several EM-based, NIH-funded training programs (eg, T32, K12) provide structured mentorship and funded protected time that allow junior academicians to gather preliminary data in support of subsequent investigations.[10] These programs, in addition to increased support for a research career path, have resulted in 1.7% of funded NIH grants attributed to EM faculty from 2008 to 2017.[11] Although improved, these statistics indicate that EM researchers still receive relatively few NIH grants in comparison to other specialties.

The NIH Research Portfolio Online Reporting Tool (NIH RePORTER) is a publicly available database and a tool that can be used to better understand NIH funding related to EM faculty in the United States.[12] Outside of official NIH reporting, however, limited data exists to assess variables that are important to achieving NIH funding, such as the clinical specialty of mentors, the availability of protected time, and access to department-funded research infrastructure. Knowledge regarding the prevalence of these important variables among NIH-funded EM investigators may be useful for individuals seeking a research career to help in selecting academic positions, and for EDs working to enhance research among their faculty.

Population Health Research Capsule

What do we already know about this issue?
Emergency physicians (EP) face challenges in obtaining funding, finding mentors, and managing the balance between research and clinical work.

What was the research question?
To define the demographics of federally funded EPs and their barriers to obtaining funding.

What was the major finding of the study?
Most 2010-2017 awardees were White males, although women got more mentored career grants. EPs still experience difficulty finding adequate mentors.

How does this improve population health?
Increased support for the EP researcher, especially for women and minorities, remains important in growing the body of federally funded EPs.

The goal of our study was to use both NIH RePORTER data and individual surveys to describe the following: 1) the distribution and characteristics of NIH grants awarded to EPs; 2) the principal investigator (PI) characteristics and resources accessed for these successful applications; and, 3) perceived facilitators and barriers to the NIH grant funding process from the PI's perspective.

METHODS

Study Design and Selection of Participants

This investigation was composed of two parts. Part one was a retrospective database search using the NIH RePORTER to collect data regarding federally funded grants awarded to EM PIs. We included individuals who were funded by the Agency for Healthcare Research and Quality and the Centers for Disease Control and Prevention, as these federal grants are included in NIH RePORTER. Part two was a survey-based investigation that queried the NIH-funded EM PIs identified in part one to obtain additional demographics as well as information on their career paths, research environment, and perceived barriers to applying for funding. The study protocols for parts one and two were deemed exempt by the human subjects institutional review board by the Partners Human Research Committee.

Part I: NIH RePORTER Data Abstraction

A list of relevant NIH-funded research projects was curated from the NIH RePORTER search function using the following search criteria: 1) funding received between fiscal years 2010-2017 (10/01/10 – 09/30/17); and 2) department type listed as EM. One author (BPC) manually reviewed this list and removed projects funded in this period without a start date in this timeframe. We extracted variables from all remaining records including the PI's gender and academic rank, grant mechanism (eg, K- or R-series), PI contact information, start year of the grant, total years of funding awarded to the grant, and NIH funding institute. We also recorded the geographic location of the PI's primary institution.

Part II: EM PI Survey

Using data extracted from part one, we stratified the identified EM PIs into two cohorts: 1) "mentored PIs" with career development awards (eg, K08, K12, K23); and 2) "independent PIs" with independent research grants (eg, R01, R34, R21). We included individuals supported by a cooperative agreement (U-mechanism) or mid-career mentoring award (K24) with the independently funded cohort. Individuals who were listed as having both a K grant and a subsequent or parallel R grant were included only in the independent PI group. We electronically distributed surveys to all of the PIs identified, based on these two cohorts.

We designed two separate surveys to answer key questions about the demographics of NIH-funded investigators, and the relationship of their research area to EM. Surveys were created through an iterative process among the study team. The study team identified themes surrounding funding, research topic, and mentorship and then drafted several questions surrounding these concepts. Next, the study team selected questions that were clear and piloted these on non-study team EP investigators to ensure clarity of the questions. These final surveys were then administered to mentored PIs and independent PIs. The mentored PI survey (Appendix 1) included questions on demographic data (gender, ethnicity, race, and academic rank) and on research focus and environment (including mentor's academic department, administrative support, pre- and post-award grant administrative support, and average monthly hours worked in the ED during the award period).

The independent PI survey (Appendix 2) was designed to collect demographic data (gender, age, ethnicity, race, academic rank), information about research career (prior K award funding), research focus, and research environment. Both surveys included open-ended questions asking about barriers that EM PIs faced in obtaining career development awards.

Data Management

We used the Research Electronic Data Capture (REDCap) tool to capture and manage all study data including surveys.[13] Reminder emails were sent on days 10, 20, and 30 to individuals who had not started or who had partially completed the survey; the survey link expired on day 31. All study communications were sent via the REDCap database in survey mode.

Data Analysis

For quantitative data, we determined basic descriptive statistics for sociodemographic variables, grant characteristics, and institution characteristics. We calculated percentages for categorical variables, and calculated medians with interquartile ranges for continuous variables. We constructed heat maps using key regions of the United States defined by the US Census Bureau to explore the geographic distribution of identified grants. We analyzed all quantitative data using STATA version 15.1 (StataCorp LLC, College Station, TX).

For qualitative data, we used a conventional content analysis approach to understand participants' experiences.[14] In conventional content analysis, coded categories are taken from the text allowing us to derive information from responses without preconceived categories. Two analysts (PRC, SC) reviewed all of the responses and inductively derived codes based on content similarity within the text. We revised groupings using an iterative process of content review and returning to the data. Analysts debated discrepancies until consensus was achieved.

RESULTS

Part I: NIH RePORTER Results

Over the seven-year study period, we identified 219 grant awards from NIH RePORTER records that met inclusion criteria (Table 1), which were awarded to 156 unique individual investigators. A majority of grants (N = 162, 74%) were awarded to males. Grants were fairly evenly distributed by academic rank, with 39% of PIs listed as professor, 26% as associate professor level, and 31% as assistant professors. The most common awarding NIH institutions were the National Heart Lung and Blood Institute (26%), the National Institute of Neurological Disorders and Stroke (13%), and the Agency for Healthcare Research and Quality (12%). An average of 31 NIH awards were obtained annually from fiscal year 2010-2017, with a steady upward trend from 2013-2017. The most commonly identified mechanisms were R01 (29%), K23 (6%), K12 (5%), and R03 (5%).

We identified a greater clustering of grants awarded to PIs located in the Midwest and New England (Figure 1) than within other regions of the country. Additionally, mentored career development awards and independent investigator awards appeared to cluster together in the same regions.

Part II: Survey results

We sent electronic surveys to 51 unique mentored PIs identified in Part I with a 69% response rate (N = 35), and to 105 independent PIs identified from Part I with a 58% response rate (N = 61).

Table 1. Grant characteristics from NIH RePORTER (N=219).*

Principal Investigator Demographics		
Sex	Female	57 (26.%)
	Male	162 (74%)
Rank	Fellow	2 (1%)
	Instructor	5 (3%)
	Assistant Professor	55 (31%)
	Associate Professor	47 (26%)
	Professor	70 (39%)
Award characteristics		
Activity Code**	K08	9 (4%)
	K12	11 (5%)
	K23	34 (16%)
	K24	3 (1%)
	R01	63 (29%)
	R03	11 (5%)
	R18	8 (4%)
	R21	23 (11%)
	R34	6 (3%)
	R56	5 (2.3%)
	U01	10 (5%)
	U24	9 (4%)
Start Year	2010	29 (13%)
	2011	21 (10%)
	2012	21 (10%)
	2013	18 (8%)
	2014	22 (10%)
	2015	28 (13%)
	2016	37 (17%)
	2017	43 (20%)
Admin Institute***	NHLBI	57 (26%)
	NINDS	28 (13%)
	AHRQ	26 (12%)
	NIA	19 (9%)
	NIDA	17 (7.8%)
	NICHD	11 (5.0%)
	NIDDK	9 (4%)
	NIAAA	8 (4%)
	NIGMS	7 (3%)
	NIMH	7 (3%)
	NIAID	4 (2%)
	FIC	3 (1%)
	NCIPC	3 (1%)
	NIMHD	3 (1%)
	NINR	3 (1%)

*These data include multiple grants awarded to the same individual.

Table 1. Continued.
**Others, < 1 % N = 1-2 UM1, UH4, UH2, U34, U10, T35, T32, T15, RC4, RC1, R35, R25, R24, KL2, K99, K01, G20, F32, F31.
***Others with < 1 % (NCATS, NCRR, NEI, NIEHS, NIOSH, NLM, ONCHIT).
NHLBI, National Heart, Lung and Blood Institute; *NINDS*, National Institute of Neurological Disorders and Stroke; *AHRQ*, Agency for Healthcare Research and Quality; *NIA*, National Institute of Aging; NIDA: National Institute on Drug Abuse; *NICHD*, Eunice Kennedy Shriver National Institute of Child Health and Human Development; *NIDDK*, National Institue of Diabetes and Digestive and Kidney Diseases; *NIAAA*, National Institute on Alcohol Abuse and Alcoholism; *NIGMS*, National Institute of General Medical Sciences; *NIMH*, National Institue of Mental Helath; *NIAID*, National Institute of Allergy and Infectious Diseases; *FIC*, Fogarty International Center; *NCIPC*, National Center for Injury Prevention and Control; *NIMHD*, National Institute on Minority Health and Health Disparities; *NINR*, National Institute of Nursing Research.

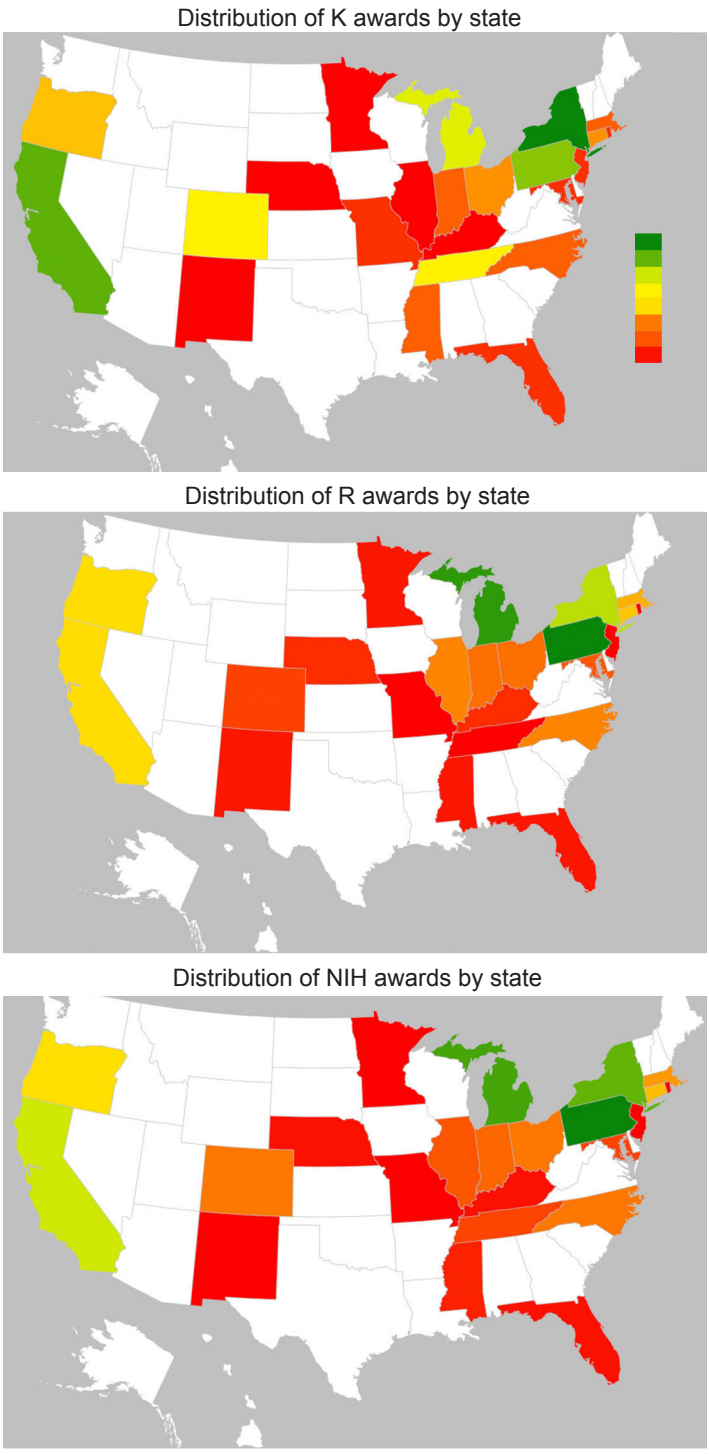
Demographics, Investigator and Research Characteristics

The majority of mentored PIs were male (N = 20, 59%), White (N = 28, 82%), and at the rank of assistant professor (N = 24, 69%) (Table 2). Overall, the proportion of grants awarded to women over the study period was stable. Mentored PIs reported their primary mentors were in EM (N = 11, 32%), cardiology (N = 5, 15%), internal medicine (N = 4, 12%), and infectious disease (N = 2, 6%). Most research conducted under the mentored career development mechanism was focused in EM (N = 24, 71%). Only three (9%) participants did not have grants administration support within their department. Participants reported that they worked an average of 48 clinical hours per month during the time of their K award.

Of the independent PI respondents, the majority identified as male (N=46, 77%) and White (N = 48, 80%). Most participants (N = 38, 63%) did not have a mentored career development award prior to obtaining independent funding. Participants who received a K award reported working an average of 41 clinical hours per month during their K award period. Independent investigators commonly identified having a mentor within EM (N = 22, 40%) or internal medicine (N = 12, 22%).

Barriers to obtaining mentored career development awards

When asked about barriers to obtaining mentored career development awards, 88% (N = 30) of K survey respondents and 28% (N = 19) of R-funded survey respondents provided answers. Commonly identified barriers were similar between both groups: 1) finding appropriate mentorship; 2) having appropriate time to prepare and submit a K award; and, 3) lacking a robust administrative infrastructure to support NIH awards (Table 3). With respect to mentorship, participants specifically reported significant barriers in finding adequate mentors in EM. Twenty-four participants reported that they sought mentorship outside of EM in disease-specific areas; many cited the structure of disease-based NIH awarding



State	Number of K awards	Number of R Awards	Total
Alabama	0	2	2
Arizona	0	1	1
Minnesota	0	1	1
Missouri	1	0	1
New Jersey	1	0	1
New Mexico	0	1	1
Rhode Island	1	0	1
District of Columbia	0	2	2
Florida	1	1	2
Kentucky	0	2	2
Nebraska	0	2	2
Mississippi	2	1	3
Georgia	0	5	5
Maryland	1	4	5
Tennessee	5	0	5
Illinois	0	6	6
Indiana	2	5	7
Wisconsin	3	4	7
Colorado	5	3	8
North Carolina	2	6	8
Ohio	3	5	8
Massachusetts	2	8	10
Connecticut	3	9	12
Oregon	4	10	14
California	9	10	19
New York	11	15	26
Michigan	6	22	28
Pennsylvania	8	24	32

Figure 1. Geographical distribution of NIH awards across the United States.

institutes as a driving factor. Participants also reported that a lack of mentorship at times prevented them from learning about the value of career development awards and detracted from their perceived ability to pursue this line of funding

Participants also reported difficulty in finding time away from clinical and administrative commitments to prepare and submit a K application. The competing priorities of clinical work, teaching, and completing administrative tasks interfered with the time needed to meet mentors, generate sufficient publications, and prepare the grant application. Additionally, participants reported variability in the degree of administrative support their departments provided in applying for NIH awards.

DISCUSSION

This investigation demonstrates that despite recent efforts to foster NIH-funded research in EM, there remain critical barriers to successful funding, particularly for early-career investigators. However, for EM to achieve its maximum

Table 2. Principle investigator survey data.

	K Awardees (N=35)	R Awardees (N=61)
Demographics		
Sex		
Female	14 (41%)	14 (23%)
Male	20 (59%)	46 (77%)
Age (median, IQR)	41 (37, 45)	47 (43, 56)
Ethnicity		
Hispanic/Latino	1 (3%)	4 (7%)
Not Hispanic/Latino	32 (97%)	50 (89%)
Other	0 (0%)	2 (4%)
Race		
Asian	5 (15%)	10 (17%)
Black or African American	1 (3%)	1 (2%)
White	28 (82%)	48 (80%)
Multi-racial	0 (0%)	1 (2%)
Rank at K award		
Instructor	4 (11%)	
Assistant Professor	24 (69%)	
Associate Professor	5 (14%)	
Professor	2 (6%)	
Prior K award		
No	N/A	38 (63%)
Yes	N/A	22 (37%)
Research focus and environment		
Research EM focused		
No	10 (29%)	
Yes	24 (71%)	
Mentor's academic department		
Emergency Medicine	11 (32%)	22 (40%)
Other*	14 (40%)	16 (32%)
Cardiology	5 (15%)	1 (2%)
Internal Medicine	4 (12%)	12 (22%)
Any grant administrator support		
No	3 (9%)	6 (10%)
Yes	31 (91%)	53 (88%)
Grants administrator availability		
Both Pre- and Post-Award	27 (87%)	52 (98%)
Don't know	1 (3%)	1 (2%)
Pre-Award Only	1 (3%)	0 (0%)
Post-Award Only	2 (6%)	0 (0%)
Clinical hours worked per month during K, median (IQR)	48 (32, 55)	41 (32, 55)

* Includes Psychiatry, Surgery, Behavioral Science, and "other".

potential impact in research, we should focus on providing investigators with mentorship, protected time, and grants of administrative support to enhance success.

Almost half (41%) of K-funded respondents identified as female compared to 23% of independently funded investigators. The proportion of female EM investigators funded under a K mechanism is higher than reported in other specialties such as surgery and anesthesiology, yet the total number of grants overall awarded to women has not changed.[15] This may demonstrate success of recent initiatives to promote research among female junior faculty. While the higher proportion of female-mentored PIs compared to independent PIs may reflect a trend toward gender equity, an alternative explanation may be that female investigators are not successfully transitioning to independent funding status. This is concerning because overall NIH data and investigations within other specialties demonstrate increasing parity among men and women who transition from mentored to independent awards.[16,17,18] Among EM investigators, the transition rate from mentored to independent investigator is approximately 40%, yet the proportion of women who successfully complete this transition is unknown.[19] Our data suggests that continued efforts to support women, especially during the end of the mentored award period, is needed within EM to improve gender equity among independent researchers

While initiatives such as junior faculty development programs and female-specific mentoring may increase the number of women pursuing careers in research, a focus on continued mentorship and support for female faculty as they transition from mentored research to independent funding status may help increase the number of independently-funded female investigators in EM. The difficult transition from mentored grants to independent investigator status should not be ignored; support from academic departments at the early career phase should occur in synergy with support at the transition to independent funding.[25]

In parallel with promoting careers in NIH-funded research for women, we should also focus on increasing racial diversity. Our survey respondents of both training and independently funded NIH awards overwhelmingly identified as White. Initiatives that promote research careers among women, as well as among racial and ethnic minorities, should continue to be high priorities for EM.[20]

We found that mentored career-oriented grants and independent investigator awards tended to cluster by geographic region, which is consistent with prior literature.[21] One explanation for this phenomenon is that independently funded investigators attract other EPs who initiate research careers. Departments with a strong research division also offer a large professional network and access to resources that benefit junior investigators. Finally, EDs with senior investigators may indicate a commitment by the department to a career in research, thereby providing strong grants support, mentorship, and even seed funding to junior investigators. Departments with focused mentoring programs result in increased NIH funding success, increased number of publications, and higher levels of perceived success.[22] Academic EDs that may not have NIH-funded scientists on faculty, specifically in rural areas, may have important and fundable priorities to study. Targeted interventions that extend resources to traditionally less research heavy institutions (eg, seed funding for preliminary data, and a network of available mentors willing to work with new investigators at remote sites) can create equitable opportunities for research careers across the country.

Our qualitative survey data suggests that lack of mentoring, time, and grants infrastructure hamper successful NIH award applications among EM investigators. Less than

Table 3. Qualitative themes for barriers to career development awards.

Theme	Illustrative response
Lack of mentorship	"I avoided pursuing a K for a long time due to lack of perceived available mentors and a desire for more research funding and less funding for training."
	"Finding a topical mentor was difficult; I had to go outside my institution to find one."
	"None of my official K award mentors are from EM. I have a joint appointment in another department that has more NIH-funded researchers and research infrastructure, which was important for me to be successful when applying for my K."
Managing time to prepare grants	"Clinical hours are a struggle. I currently need to further buy down my time in order to do the research."
	"Initial buy down of clinical time to write the K23 award was the biggest barrier for me."
Administrative support	"Navigating the complex NIH system with little administrative support was a huge pain."
	"Lack of research infrastructure in the department made non-research related submission details difficult."
	"I did not have grant administration support when I got my K so I had to do all of the pre-award stuff on my own."

half of mentored PIs identified that their primary mentor was in EM. Participants reported that they sought mentorship outside of EM due to a lack of NIH-funded EM faculty and lack of mentorship within a disease state. Continued promotion of the NIH career track and increasing numbers of independently funded EM faculty will hopefully increase the availability of those who can serve as mentors for junior faculty. Comprehensive mentorship programs as part of faculty development programs or department-initiated research mentoring can help create an environment that promotes and supports federally funded research.[3,23]

Participants also commented on the difficulty of preparing a K award in the context of transitioning to junior faculty status and completing clinical and administrative duties within EM. Balancing the unpredictable clinical schedule of an EP with time needed to meet and establish mentoring plans, publish manuscripts, generate preliminary data, and prepare grant submission materials was a barrier reported by participants in this study. Finding protected time to write and conduct preliminary research is especially difficult for junior faculty, yet the value of dedicated time early in one's career cannot be underestimated.[24] The barriers we identified are similar to those addressed by a joint SAEM/ACEP research committee.[9] While many institutions have junior faculty development programs geared toward supporting early-career physicians, EDs must continue to consider the importance of dedicating time and funding to their junior faculty to boost and support research careers during this vulnerable stage. Peer mentoring groups should also be considered as a supplement, although they cannot replace senior mentorship.[3]

LIMITATIONS

Our primary data source from Part One (NIH RePORTER) is limited and would not capture grants or EM PIs listed under a different department, or those listed under institutional career development awards (eg, K12, KL2 mechanisms). We do not know how many potential EM investigators would have been missed through our query using NIH RePORTER. The constraints of our search mechanism and the nature of our study population led to a small sample size, limiting our analysis. The low response rate on our survey component creates potential for missing and/or biased data. Finally, some survey participants reported they had limited time to answer the survey questions, and as a result, did not provide answers to all questions.

CONCLUSION

Our review of funded EM grants through the NIH RePORTER system and individual surveys of mentored and independent investigators demonstrated several positive trends, including increasing gender diversity in early-career mentored grants, yet there continue to be important areas for improvement such as access to mentorship, grants infrastructure, and dedicated time early in a career to develop important research opportunities. Continued support for research as a career path and mentoring of early-career physicians is important in growing the cadre of EM researchers. Future work, such as longitudinal studies to evaluate individual characteristics associated with success and interventions geared toward increasing mentorship and support, are needed.

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"Breaking" the Emergency Department: Does the Culture of Emergency Medicine Present a Barrier to Self-Care?

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Introduction: Our goal was to critically examine emergency physician's (EP) beliefs about taking breaks for self-care on shift. Our operational definition of a break for self-care included time not engaging in direct patient care, eating, drinking, using the bathroom, or leaving a clinical area for a mental break. Using focus groups, the study aimed to accomplish the following: 1) identify barriers to why residents and faculty at our academic center may not take breaks in the emergency department; 2) generate hypotheses for empirical testing; and 3) generate solutions to include in a departmental breaks initiative.

Methods: We convened eight focus groups comprised separately of resident and faculty physicians. Group discussion was guided by eight questions representing a priori themes. The groups were recorded for transcription and subjected to a "cut-and-sort" process. Six themes were identified by consensus after independent review by three of the co-authors, which were confirmed by participant validation.

Results: We identified six themes that represented the pooled outcomes of both resident and faculty focus groups: 1) Physiological needs affect clinical performance, 2) EPs share beliefs around taking breaks that center on productivity, patient safety and the dichotomy of strength/weakness, 3) when taking breaks EPs fear worst-case scenarios, 4) breaking is a learned skill, 5) culture change is needed to allow EPs to engage in self-care; and 6) a flexible, individualized approach to breaking is necessary. Our central finding was that productivity and patient safety are of key importance to EPs when considering whether to take a break for self-care. We identified a dichotomy with the concept of strength related to productivity/patient safety, and the concept of weakness related to self-care.

Conclusion: The current practice culture of emergency medicine and the organization of our unique work environment may present barriers to physicians attempting to engage in self-care. [West J Emerg Med. 2020;21(2)313-321.]

INTRODUCTION

"We have all felt it. The fatigue. The hunger. The hazy fog that ensues 11 hours into our shift."[1]

Many industries recognize the connection between rest breaks on shift and the optimization of performance and the reduction of errors.[2-4] Shift-workers in particular have an increased risk of occupational injury, disability and poor health.[5] There is evidence from the healthcare industry that fatigued shift-workers make more medical errors.[6-8] The recognition of this link between fatigue and error has led to a focus on resident duty-hour restrictions to promote healthcare safety and physician wellness.[9] Such measures address rest off shift but do

not address the possible need for self-care while on shift.

Emergency physicians (EP) work fewer hours on average than many other medical specialties, theoretically affording more time off shift for rest. However, emergency medicine (EM) clinical shifts are fast-paced, and there is a high density of cognitive work and decision-making with providers suffering high burnout rates.[10] It could be argued that in terms of rest, EM is a special case, with a potential need for on-shift breaks to account for the high pace. In addition, duty-hour restrictions focus on physical rest including sleep, but cognitive functioning may also be significantly impacted by immediate physiological needs such as hunger, thirst, and the need to use the bathroom.

There is a paucity of literature on EP breaks for self-care during shifts. We identified a single study during our literature review on the effects of an on-shift break on EPs' clinical performance. This study found that EPs reported significantly less tiredness at the end of their shift if they had taken a break.[11] Intriguingly, for the cohort that took breaks, there were significant improvements in time-to-provider metrics for triage category two and three patients, as well as significant improvements in "time to admission." This study also points to a possible link between a more efficient, rested physician and improved emergency department (ED) flow metrics. Given the increasing demand on EPs to improve their practice efficiency and meet key performance metrics,[12] factors with a potential influence on worker efficiency such as breaks should be empirically investigated.

To begin to investigate the concept of taking rest breaks for self-care while working in the ED, we developed and conducted focus groups to qualitatively examine this specific aspect of our professional practice culture. Our objective was to critically examine our EPs' existing cultural beliefs about taking breaks for self-care on shift in the ED using separate focus groups comprised of resident and attending physicians. It was our hope that in doing so, we could inform a departmental breaks initiative and generate hypotheses for empirical testing.

Population Health Research Capsule

What do we already know about this issue?
While many industries recognize the connection between rest breaks, wellbeing and error reduction, there are few published studies on break-taking in emergency medicine (EM).

What was the research question?
Are there professional cultural beliefs that might be a barrier to physicians at our institution taking breaks on shift?

What was the major finding of the study?
EM culture shows a central dichotomy with strength related to productivity/patient safety, and weakness related to self-care.

How does this improve population health?
Our findings can promote policies that support on-shift cognitive function and physician health, which may result in improved performance and better health outcomes for patients.

METHODS

Study Design

During two separate retreats for both residents and faculty, we conducted a total of eight focus groups of approximately 15 participants per group. The study was given an institutional review board exemption after initial board review.

Study Setting

Within a single, large, academic institution that incorporates five different EDs representing a spectrum of settings from academic to community, 116 EPs took part in focus groups. This included 56 attending physicians who chose to attend a department-wide faculty retreat and 60 resident physicians who participated during an annual mandatory residency retreat.

Study Protocol

Residents were divided into four groups, and there were four faculty moderators who guided the discussions. Moderators received a brief training in focus group dynamics and used eight structured questions to guide the focus groups over the course of an hour. These eight questions were developed based on a priori themes identified by consensus among the investigators. The moderators were faculty known to the resident and attending physicians. We repeated this process with four additional focus groups conducted during a faculty wellness retreat. The faculty and resident focus groups were digitally recorded and transcribed for qualitative analysis.

Data Analysis

Post-transcription coding was completed by digital pawing and the cut-and-sort method. Transcripts were analyzed separately by the principal investigator and two peers. Team analysis then resulted in consensus on six main themes in both faculty and resident cohorts, which were confirmed by participant validation.

RESULTS

The initial focus group was conducted exclusively with 60 resident physicians and generated six themes. The second focus group was conducted with 56 EM faculty physicians who work at five different sites that range from academic to community settings. There was a high degree of convergence between themes, such that the respondents could be pooled to yield six overarching themes. Underlying differences between

the groups existed but were subtle. For example, the belief by many respondents that permission was needed to feel "allowed" to engage in breaks was a common theme. However, residents needed explicit permission from senior residents and attending physicians to engage in self-care, whereas some attending physicians needed permission from colleagues and other staff.

Both attending and resident groups ranked the importance of dealing with particular physiological needs in the same order and at similar frequencies (Table 1) and had similar responses to the ideal length of a break (Table 2).

We report here six overarching themes that captured the responses of both groups.

Focus Group Themes

Table 3 lists the themes that were identified, and key quotations supporting each theme are presented in Table 4.

1. EPs frequently experience basic physiological needs on shift, which can negatively affect cognitive function and emotional self-regulation.

'I get cognitively fatigued, I guess, six or seven hours in. And panicked that I'm not going to last… my brain is just falling apart.'

'I realize my sign-outs are terrible and I can't focus and that's when I know I am hungry.'

'That's how I know it is time to take my break. When I walk into the patient's room and the rage builds instantly. I have no patience, so I go eat for five minutes.'

The physicians and residents in our study readily identified with the experience of hunger negatively affecting their performance on shift. There was a belief that EPs' decision-making and ability to moderate emotional reactions to work-related stressors were also affected. The responses indicated that these negative effects could be positively impacted by caloric intake and cognitive breaks.

Table 1. Frequency in text – self-care needs of emergency medicine attendings and residents.

	Hunger	Thirst	Bathroom	Cognitive Break
Attendings	64.4%	18.2%	13.4%	3.8%
Residents	53%	23%	12%	12%

Table 2. Frequency in text – ideal break length.

	>20 mins	10-20 mins	< 10 mins
Attendings	9.9%	87.9%	12.1%
Residents	7%	79.4%	13.6%

mins, minutes.

2. EPs share beliefs around break-taking that amount to "culture."

'I think that, to get to where we are we've had to be very strong. And you don't want anyone to see your weak side, which might mean needing to go to the bathroom, or needing to eat.'

'..because I always have my water with me; you will never see me without it and I will have a snack-bar in my pocket in case I am hungry; by taking the time off (to have a break) you get judged in your career.'

The responses suggest that there is a set of values and conventions associated with self-care in EM professional culture. The responses point to the implication that productivity/patient safety is strength, and self-care is weakness. The groups identified several exceptions to this culture, as shown in Figure 1.

3. When considering the impact of breaks for self-care on patient safety, EPs frequently imagine worst-case scenarios. However, reports of direct personal experience of negative outcomes are rare.

'I don't think I've ever seen anything bad happen, but I've certainly sat through 15 years of M&Ms, where people who have waited and have died in the bathroom in the waiting room. So, I know it's a real thing. It's a hard thing to quantify.'

'It's the difference between perception and reality…the reality is that the events are few and far between and probably could be mitigated with a little planning. But definitely the perception is… you know... you got sick people.'

'Let me tell you how I learned that it's ok to take breaks. When I was breastfeeding. And guess what, when I came back, all was the same as when I left. Nothing bad happened.'

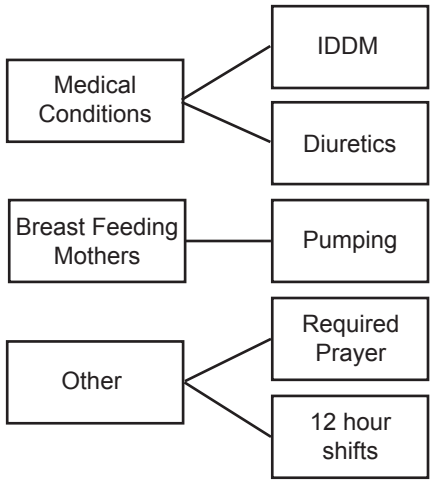

Figure 1. There were several permitted exceptions to the strength/weakness dichotomy where participants overtly agreed with break-taking behavior.

Table 3. Themes identified in the focus group discussion.

1	Emergency physicians (EP) frequently experience basic physiological needs such as hunger on shift, which can negatively affect cognitive function and emotional self-regulation.
2	EPs share beliefs about break-taking that amount to "culture." These beliefs center around productivity, patient safety, and the dichotomy of strength/weakness.
3	When considering the impact of taking a break on patient safety, EPs frequently imagine worst-case scenarios. However, reports of direct personal experience involving negative outcomes were uncommon.
4	Break-taking is a skill that requires practice, appropriate timing, and safety-oriented communication strategies.
5	A new cultural norm requires negotiated agreement with peers and other staff in order to give participants permission to engage in self-care.
6	The ability to engage in break-taking behavior requires strategies that are flexible and individualized.

There is a clear concern among EPs that taking a break will impact patient care. This concern took two forms. First was a concern that patients would become critically unwell in their absence and without their knowledge. Second, they worried that throughput would drop and the flow of patients from the waiting room would slow, thereby keeping an unrecognized unwell patient in the waiting room. This implies a connection between EP break-taking, productivity, and patient safety. If you take a break, you will see fewer patients, those unseen patients may decompensate during the delay, and it will be your fault. When talking about the potential risks to their patients, study participants tended to frequently imagine worst-case scenarios. Among the 116 EPs involved in the focus group process, near-misses were reported but there were no direct personal experiences of serious negative patient outcomes.

4. Taking a break is a skill that requires practice and safety-oriented communication strategies.

'It's almost like leaving your child with a babysitter. It's having the experience of knowing when it's appropriate to go. Do you know what I mean? There's a skill to taking a break, knowing if this is appropriate timing. Maybe, even if it was the culture that we take break, maybe still 1/3 or 1/4 of shifts we wouldn't take breaks.'

'…but can't you be within a vicinity where they can say, "Hey doc, I need you, this patient's taking a turn for the worse."? Yea, be somewhere where they can call you."'

'I guess if you're gone, as long as and people know that you're gone and where to find you…like if you're in the resident room, so you're easily accessible.'

The practice culture of EM requires the acquisition of a well-defined set of learned skills. Group participants responded to break-taking as a learned skill that required timing, intuition, and situational awareness. There was a recognition that this skill required practice in training, until a sense of timing evolved. This could be supported in training by examination of teachable moments where timing was suboptimal. In addition, there was a sense that communication strategies could be learned in order to support safe break-taking. These strategies include explaining to the nursing and ancillary staff what you are doing, where you will be, and having a means of being contacted. The ideal location made both physical absence, to protect the EP from unnecessary interruption, and a timely return to the bedside possible.

5. A new cultural norm in EM would require negotiated agreement with peers and other staff in order to give participants permission to engage in self-care.

'Help us understand that it's normal, and it's ok, and you don't have to do anything targeted or specific. You just need to walk away from the space, get some clarity and re-focus, and then you can continue to do your work.'

I think it needs to be part of the culture. And that's the only time someone's come to me and said, "Hey, I'm gonna be gone for a minute," is when they're going to breastfeed. That's when it's acceptable. But otherwise no--

'Well, I've done it (taken a break), when the Chair came in and she said, 'good for you' and we sat down and talked and ate together and I think if the Chair of the department sat down with me to talk with me then it is ok. And told me 'Good for you,' that's what she said!'

Changing an accepted cultural norm requires agreement and permission to become accepted. Group participants who were early adopters or pioneers risked being viewed as outside the prevailing culture by making an individual decision to engage in a behavior that appeared non-standard. Both resident and faculty groups included a minority of individuals with a "pioneer" or "early adopter" mindset, and a larger majority that needed to negotiate agreed cultural change and permission before engaging in self-care.

6. Taking a break requires strategies that are flexible and individualized.

'You gotta chart, I mean you can chomp and chart.'
'I bring a smoothie and have it on my desk...so if I end up feeling shaky or weird I can end up drinking the smoothie'.

'I take micro breaks. I'm a micro breaker. And maybe if you add it all together it equals a half-hour break, but I mean, if I have to pee, I'll find a good time, go pee for three minutes. Go get coffee for seven minutes, black out on my desk for three minutes.'

What is defined as a break varies across shifts and between individuals, in terms of what is occurring clinically and what the physician needs to have occur to support their optimal physical and cognitive function. For many EPs, meeting their physiological needs on shift requires a variety of strategies, breaks of varied durations, and "formal" vs "informal" eating depending on the circumstances.

DISCUSSION

The current study points to a professional culture in emergency medicine in which an EP who cannot go for 8-12 hours without attending to their basic physiological needs during a period of intense cognitive, physical and emotional

Table 4. Key quotations identified in the focus group discussion.

Theme	Sub-theme	Key quotations
Emergency physicians frequently experience basic physiological needs such as hunger on shift that can negatively affect cognitive function and emotional self-regulation.	Cognitive Function	"I get cognitively fatigued, I guess, 6 or 7 hours in. And panicked that I'm not going to last… my brain is just falling apart.."
		"My brain can't focus, prioritize and or multitask."
		"I realize my sign-outs are terrible and I can't focus and that's when I know I am hungry."
	Emotional Self-Regulation	"That's how I know it is time to take my break. When I walk into the patient's room and the rage builds instantly. I have no patience so I go eat for five minutes."
		"You lose patience with people...how you react to consultants or patients...I get outright cranky."
Culture of Break-Taking	Culture	"..you are soft, you guys are taking wellness breaks, back in our day we never had this and are tougher doctors for it, made me feel like crap and not want to take breaks."
		"..because I always have my water with me; you will never see me without it and I will have a bar in my pocket in case I am hungry; by taking the time off (to have a break) you get judged in your career."
		"I got food and I started to eat and I felt like I was doing something wrong. Look at me, oh my God! What if someone sees me! I felt like I was doing something so wrong, eating for those 15 minutes."
	Strength/ Weakness Dichotomy	"I think you feel guilty, almost weak for needing to stop. In fact, now that I'm older, I feel weak that I have to go to the bathroom twice during a shift. I used to be able to go the whole 12 hours without going."
		"No, no, no. I know that anyone would be willing to cover me, it's more that feeling of weakness."
Fear of Worst-Case Scenarios	Worst-Case Scenariors	"I don't think I've ever seen anything bad happen, but I've certainly sat through 15 years of M&Ms, where people who have waited and have died in the bathroom in the waiting room. So I know it's a real thing. It's a hard thing to quantify."
		"Actually, I don't take breaks because of that. There's not really anybody to cover you when you have 13 sick and dying patients."
		"I've had patients who've deteriorated while I've been in the bathroom. The nurse is looking for you, you know… actually the other day a resident was looking for me and I was coming out of the bathroom, and they were like "We need you in room…"; but luckily I wasn't gone long enough. I guess if you're gone, as long as and people know that you're gone and where to find you…so you're easily accessible."
	Direct Experience	"Let me tell you how I learned that it's ok to take breaks. When I was breastfeeding. And guess what, when I came back, all was the same as when I left. Nothing bad happened."
		"It's the difference between perception and reality…the reality is that the events are few and far between and probably could be mitigated with a little planning. But definitely the perception is… you know... you got sick people."
		"I was getting food in the cafeteria with my radio when they called that something was coming in and I got there before the patient but I didn't like that feeling. Nobody said anything but I didn't like the feeling of being unprepared. It was one of those 2 minutes CPR patients."

Table 4. Continued.

Theme	Sub-theme	Key quotations
Break as Learned Skill	A Practiced Skill	"It's almost like leaving your child with a babysitter. It's having the experience of knowing when it's appropriate to go. Do you know what I mean? There's a skill to taking a break, knowing if this is appropriate timing. Maybe, even if it was the culture that we take a break, maybe still 1/3 or 1/4 of shifts we wouldn't take breaks. Maybe the point is that this is something that could be taught." "It is a learned skill. There was a point in time where I felt I couldn't leave. Then there was a point in time where it felt like I could go stand in the corner for 5 minutes. And now I'm fine leaving for 25 minutes." "You know what's going on, you still control the flow, and you made a conscious decision at this time that it's safe and reasonable to take a break. As opposed to, "Oh it's 12, I have no idea what's going on, but I'm leaving."
	Safety-Oriented Communication Strategies	"…but can't you be within a vicinity where they can say, "Hey doc, I need you, this patient's taking a turn for the worse."? Yea, be somewhere where they can call you." "I guess if you're gone, as long as and people know that you're gone and where to find you…like if you're in the resident room, so you're easily accessible." "It was sort of very clear; you would let your attending know. It wasn't so much that you would sign out to another resident, you would just let your attending know, like 'Here are my patients,' tell them whoever you were worried about" "I think it's good to have the phones with you, because that way you know if something critical is coming in, they need you and you can stop whatever you're doing no matter how important it is and you can rush back…if they need more help. Whereas if you don't have a phone you're completely unaware... what if people need you, what if they need more manpower."
Permission Required		"Help us understand that it's normal, and it's ok, and you don't have to do anything targeted or specific. You just need to walk away from the space, get some clarify and re-focus, and then you can continue to do your work." "I think it needs to be part of the culture. And that's the only time someone's come to me and said, "hey I'm gonna be gone for a minute," is when they're going to breastfeed. That's when it's acceptable. But otherwise no—" "Well, I've done it (taken a break), when the Chair came in and she said 'good for you' and we sat down and talked and ate together and I think if the Chair of the Department sat down with me to talk with me then it is ok. And told me 'Good for you' that's what she said!"
Execution Requires Flexible, Individualized Approach	Strategies	"You gotta chart, I mean you can chomp and chart." "I never bring in anything that would require a fork. It's always a sandwich I can shove down in 2 minutes or less." "I bring a smoothie and have it on my desk...so if I end up feeling shaky or weird I can end up drinking the smoothie." "It would be nice if there was a lounge that provided food."
	Timing and Location	"Gosh, I would have said 10-15 minutes. Just long enough to get away and eat, catch my breath and go back." "I take micro breaks. I'm a micro breaker. And maybe if you add it all together it equals a half hour break, but I mean, if I have to pee, I'll find a good time, go pee for 3 minutes. Go get coffee for 7 minutes, black out on my desk for 3 minutes." "Maybe 10 minutes if you're going to use the bathroom or eat, and if you're pumping, like 20-30 minutes." "I'd rather have multiple small breaks." "Not to speak for the group, but it seems like the consensus is that we all think everyone should eat, a small break is fine... I think when it gets long, I mean I think a 30-minute break, although, everyone is probably DUE a 30-minute break ...it's excessive in our line of work."

work runs the risk of being perceived as "weak." While this study was performed on EPs, the strength/weakness dichotomy may well be an issue more broadly in medical culture. As an occupational group, medical doctors are often viewed as special cases. Few other professions are tasked with sustaining such a high level of productivity, quality, and safety over a working week that can be exceptionally long. This special treatment often extends to an expectation that medical doctors can maintain this productivity, quality, and safety without a formal break to attend to the "housekeeping" that comes with having a body and a mind.

There have been sporadic efforts to introduce mandated rest breaks in the field of medicine. The Australian Medical Association's National Code of Practice makes provision for a mandatory 30-minute meal break, which was proposed in order to reduce fatigue during shifts.[13] In the European Union, a law entitled the "Working Time Directive" mandates 20 minutes of rest after every six hours of work, with no routine exemption for physicians and significant financial fines imposed on employers for infringements.[14]

The American College of Emergency Physicians recently collaborated with the Joint Commission (JCAHO) to challenge a common misconception among EPs that they are prohibited by JCAHO from eating or drinking at their work stations.[17] This clarification was sought in recognition that "not being able to have a drink or eat in the ED can significantly impact both the physical well-being of emergency physicians and their decision-making ability, and therefore risks impacting not just their own health, but that of their patients too."[18]

In terms of health policy, we believe there should be a national conversation about embedding rest breaks into the working lives of doctors. This would require national and organizational change but also a shift away from the professional culture identified in this study of academic EPs that equates self-care with weakness. In the recent Blue Ridge report on wellness in academic centers, there was explicit recognition that attending physicians' behavior is of key importance in modeling wellness behaviors for residents as they train and acquire the skills necessary to work in the ED.[17] This is certainly true in medical training generally, and implies a significant responsibility on the part of attending physicians to model self-care behaviors to residents that will ensure sustained wellness and productivity over a long career. Our findings indicate that rather than training residents how to care for themselves, we are training them to ignore basic physiological needs, which may impact not only their wellness but also clinical decision-making and patient safety.[18,19]

Our study findings underline the fact that productivity and patient safety are of fundamental importance to physicians. In other manufacturing industries, taking breaks decreases occupational injuries, presumably through improved cognitive function.[20] In our groups there was debate among study subjects over whether a break might potentially improve cognitive function and thus safety and productivity. This gain could potentially offset the "lost" time spent engaging in self-care or perhaps taking a break would just negatively impact productivity. Indeed, there was a general sense that while subjects had opinions on this, no one objectively knew the actual impact of their own behavior on their productivity, and there was a strong interest among our subjects in this being studied empirically.

Our study respondents suggested that clear communication strategies could ensure safety for patients without requiring the addition of personnel coverage. Such strategies would involve having a location in the immediate vicinity of the clinical work area but out of the line of sight of personnel who may make non-critical requests or other interruptions. It would also involve clear communication with the charge nurse and other relevant colleagues. More controversial was the idea of keeping a phone or radio to maintain situational awareness and remain contactable. Some EPs felt this made the break possible by ensuring safety, while others felt that a high volume of un-triaged calls could make a break untenable. This would suggest that how these devices are used locally can make them either an "alleviating or aggravating" factor.

Our study shows that having a break imposed on an EP by a superordinate issue such as a medical condition or the desire to pump breast milk for one's child can transcend professional cultural judgment and allow an opportunity for EPs to realize that self-care may not necessarily be anathema to patient safety. Within the general cohort of EPs, breast-feeding mothers formed a distinct subgroup that contributed significantly to the discussion. Breast-feeding mothers have to stop on shift to pump breast milk, and this seems to be a "culturally allowed" exception in our study cohort, in addition to those with medical conditions such as insulin-dependent diabetes or clinicians working 12-hour shifts. EPs in this cohort unequivocally supported breast-feeding mothers and their need to have a break. The EPs who did have the experience of regularly taking a break to pump reported that their previous "worst-case scenario" assessments of the effect of their brief absence on patient safety in hindsight seemed to be inaccurate.

EPs recognized the need to come prepared for a break and that sources of nutrition and hydration ideally need to be prepared and brought to work. Agreement that taking a break is acceptable must be secured locally within individual institutions or work units, and this local agreement could be aided by a broader shift in our national professional culture. Clear communication with other staff needs to occur to ensure patient safety and also to protect the EP from non-critical interruptions. The ability to return in a timely fashion in the event of an emergency is vital, particularly where there is no covering physician. Lastly, the core of the skill is a sense of timing, knowing when it is appropriate to leave given the current status of the ED and the disposition of one's patients. The goal vision arising from the group participants is that of the physician as an organizationally supported and culturally empowered decision-maker equipped with the skills and logistics required to care for themselves and, therefore, their patients.

LIMITATIONS

This was a single-center study in an academic environment, and the findings are specific to an urban, academic setting. The focus group facilitators were faculty members who were known to the study participants, and this may have had an impact on responses. The current study did not include an empiric data-gathering phase that would have created a taxonomy of current break-taking behavior and instead started with the a priori assumption, based on the research team's experience, that many EPs at our center do not take breaks on shift. While there was a mix of academic and community-based EPs, faculty participants were more likely to work in an academic setting with residents, which allows the opportunity for coverage. In addition, while study participants worked at a variety of sites, they were all under the umbrella of a single organization, with its own professional culture and, thus, the results may not be generalizable outside this organization or to a community-based practice setting.

FUTURE DIRECTIONS

EPs are primarily concerned with the safety of their patients and with maintaining their productivity in order to provide efficient timely care for others. We believe that a national survey of current break-taking behavior among EPs would delineate the important issues and help guide further study and the design of educational interventions. It is likely that the need for a break and its effect on cognitive function and decision-making is variable across EPs, but we lack national data to understand this variability and the extent of current self-care behavior. Our qualitative study data also suggests a number of testable hypotheses for future empirical or mixed methods research. Showing benefit beyond productivity is also important. Does eating on shift enhance the EP's important transition to home life post-shift? It may be that the deleterious effects of not taking a break are seen at home rather than on shift.

We suggest that concerns about patient safety are of such central importance to EPs that no cultural change will be possible without data showing that EPs who engage in well-planned, self-care breaks with built-in safety strategies can take breaks without affecting the safety of their patients. Also, empirical research into this question could help delineate the types of safety strategies that work in different practice environments. Such data could also help change the existing cultural belief that self-care and patient safety are opposed and aid in the education of residents in this self-care skill.

CONCLUSION

Training that incorporates self-care as a means of optimizing cognitive performance and emotional self-regulation is more critical than ever given the current high rates of physician burnout and concerns for patient safety. To deliver this training, EM must first acknowledge where we are in terms of our professional culture. While major strides have been made toward placing wellness at the center of EM training, there remains a persistent and uninvestigated professional culture of poor self-care on shift that is ready for examination and change.

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A Playroom Internal Waiting Area Improves Productivity in the Pediatric Emergency Department

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Introduction: Pediatric emergency department (PED) volume is often constrained by the number of available treatment rooms. In many PEDs patients occupy treatment rooms while awaiting test results or imaging, thereby delaying care for patients who arrive after them.

Methods: We opened a PED where selected patients were moved to a playroom when they did not actively require a treatment room. The treatment room was then available for the next patient. We measured the effect of using the playroom on time from arrival to rooming and length of stay (LOS) using proportional hazards regression and the odds of being roomed within 30 minutes of arrival using logistic regression. We adjusted for the number of the previous eight patients who were "playroom eligible"; age; triage category; provider; the number of patients who arrived within the preceding hour; prior census; and testing ordered in the preceding eight patients.

Results: We analyzed 43,634 patient encounters, of which 10,134 (23%) were playroom eligible. The adjusted hazards ratio for the next patient being roomed was 1.14 (95% confidence interval [CI], 1.10-1.18) per prior playroom eligible patient. The adjusted odds ratio of the next patient being roomed within 30 minutes was 1.46 (95% CI, 1.33-1.56) per prior playroom eligible patient. The playroom typically decreased median rooming time by four to 42 minutes and LOS by two to 40 minutes depending on patient volumes and acuity. The benefit of the playroom was maximal at busier times.

Conclusion: Implementing a playroom in the PED for selected patients generally decreased time to rooming of the next patient and LOS. [West J Emerg Med. 2020;21(2)322-329.]

INTRODUCTION

Rapid rooming of patients on arrival facilitates clinical decision-making and disposition, thereby increasing the number of patients a pediatric emergency department (PED) can see per hour; rapid rooming also improves the perception of care and timeliness. Parents value being seen quickly on arrival in the PED and, particularly in non-monopoly markets, this is important. Rapid rooming, however, requires empty treatment rooms, and these are typically limited by physical or staffing constraints.[1-4] Efficiently using the available staffed spaces becomes paramount. Here we describe how we measured the effect of a PED playroom on time to rooming of patients and total length of stay (LOS).

We have observed that in many PEDs most of the time in treatment rooms is spent waiting, rather than being treated or evaluated. Such waiting is typically for patient registration, imaging to be performed, test results to return, and antipyretics to take effect. While waiting, the treatment room itself adds no value to the child's stay. Worse, treatment rooms are designed for clinical care, which is inherently child unfriendly. Frequently, parents spend a good deal of time restraining their child's natural curiosity, adding to the stress of the encounter. The opportunity cost to keeping patients in treatment rooms for the duration of their ED stay is that it prevents other children from being seen.

Despite this, there is a widespread culture in many American PEDs of keeping children in treatment rooms for the duration of their ED visit.

Population Health Research Capsule

What do we already know about this issue?
Children occupying treatment rooms in the pediatric emergency department while awaiting test results or to defervesce delays the evaluation of subsequent children.

What was the research question?
What would be the effect of moving these children from treatment rooms to a shared playroom?

What was the major finding of the study?
A playroom internal waiting area improved throughput times overall except during very quiet times.

How does this improve population health?
In cultures where parents expect to occupy a treatment room for the duration of their child's stay, incorporating a playroom improves patient throughput times.

METHODS

We created a flow system moving children who were not receiving active interventions from their treatment room to a playroom. This space is child friendly and, as with inpatient playrooms, examinations and procedures are prohibited in this "safe space." Children in the playroom are supervised by their parents, not nursing staff. This frees up nursing staff and treatment rooms to allow the next patient to be evaluated. We are unaware of any prior attempts to implement such a playroom model in pediatric emergency medicine.

Randomized controlled trials of interventions such as ours are impractical; the numbers of PEDs being opened is simply too small and the prospect of obtaining consent from hospital administrators to allow their PED to be randomized to a potentially less-efficient flow model is remote. Before and after studies are difficult because the concept is unproven and secular effects are inevitable. Implementing and comparing alternate patient-flow systems on alternate days presents logistical challenges and costs that few healthcare systems would contemplate. Consequently, we tried to demonstrate the effect of a PED playroom on patient flow by comparing patient flow characteristics at times when the playroom model could be of benefit compared with times when we knew by the limits of our design that a playroom model could not help. We would then attribute the difference in performance primarily to the playroom.

This study was exempt from institutional review board review.

Setting

This was a community PED seeing 21,000 patients annually at the time of the study with mixed pediatric/general emergency physicians and advanced practice provider (APP) staffing model. The PED has 11 exam rooms with a guaranteed minimum staffing for eight beds and sees patients up to 21 years of age.

Study Definitions

Time zero was set as the time the patient was entered into the computer system. This was performed by a nurse in the arrival lobby for patients who were brought in by their parents and by the nursing team leader if a patient was brought in by ambulance. We measured the time interval from arrival (time zero as defined above) to either (1) being roomed by a nurse or (2) roomed and evaluated by a physician or an APP, whichever was shorter. This analysis method captured cases where the medical exam was initiated before or during the nursing triage process. We defined LOS as time from arrival to time the patient left the ED.

For analysis purposes we derived playroom eligibility from recorded electronic health record (EHR) variables and the fact of being placed there. This assumes that children who were not placed in the playroom were ineligible to be placed there for subjective reasons (eg, medically or behaviorally unsafe, rather than staff not moving them).

Outcomes

Our primary outcome was the effect of a playroom on rooming times measured by the hazard ratio (HR). We measured the effect of the playroom on the odds of a patient being roomed within 30 minutes of arrival. Our secondary outcome was the effect of playroom use on overall PED LOS. For this we measured the interval from rooming to discharge and added it to the interval from arrival to rooming.

Intervention

The intervention was a PED playroom where patients could await the next task in care. Patients were classified as eligible to be placed in the playroom ("playroom eligible") if they met all the following criteria: required only imaging, urine testing, or venipuncture without intravenous placement; older than eight weeks; not immunocompromised; and not suspected to be medically or behaviorally dangerous to other children. (For example, a suspected case of measles or a child prone to violent outbursts could not be sent to the playroom.) Children not meeting these criteria were "not playroom eligible." Children who were "not playroom eligible" had, except for trips to the radiology suite, to be kept in their treatment rooms for the entire duration of their ED stay. Staff, not parents, determined playroom eligibility.

The PED patient-flow model expected immediate rooming

and in-room triage by the nurse assigned to an exam room unless all exam rooms were occupied. Any team member could room a patient; physician evaluation could occur before, during, or after nursing triage. Nursing triage as in most EDs performs a variety of functions in addition to determining treatment priority. Prior to implementation we trained a core group of nurses who staff the PED and provided immediate feedback when the model was not being implemented. We used nurse staff meetings and weekly electronic newsletters to reinforce use of this model during the initial year.

Analysis

We performed a retrospective analysis using data from all PED visits extracted from the EHR from August 8, 2015, to August 8, 2017. We performed regression parameterized as a proportional hazards model with the Gompertz distribution using Stata 14.2 statistical software (Statacorp LLP, College Station, TX).[5] We adjusted the regression for patients' ages and triage category; individual physician or APP; the number of patients who arrived within the preceding hour; whether any laboratory testing was performed; how many of the preceding eight patients required lab testing. We used the previous eight patients due to the PED's minimum staffing for eight beds. We tested for interactions between variables and retained those that were important.

We included a cluster term for patient to adjust for repeat attendance. We also included a variable for the initial 11-month period when the PED functioned as a discrete unit embedded within an adult ED with limited physical barriers. After this period the PED was relocated within the existing space by bed re-designation and physically separated from the adult unit with three sets (rather than the previous single set) of double doors, and provided with its own ambulance entrance. This change added several minutes walking time for parents from arrival (time zero) to their treatment room.

We graphed the proportional hazards regression to show the effects of the playroom on median time to rooming under differing patient acuity and volume scenarios. These graphs allow the reader to compare scenarios when there were no playroom-eligible patients and when there were more rooms than patients available (ie, the playroom could not affect patient throughput) and with a range of other scenarios when a playroom could improve patient throughput. We used logistic regression, with the same independent variables as the proportional hazards model, to estimate the odds of a patient being roomed within 30 minutes of arrival. The differences observed between these scenarios reflects the effect of the playroom on patient throughput.

For our secondary outcome, we created a proportional hazards regression model of the interval from being roomed to leaving the ED. This prevented incorporation of the direct effects of the playroom noted in the first regression contaminating the second regression. Variables that lead to faster rooming (e.g., higher acuity) may also lead to longer time to discharge. We included the interval from arrival to rooming as an independent variable to see whether there were any indirect effects of changing the time to being roomed on the subsequent duration of the visit. We also included age, triage category, and blood, urine or radiology testing, as independent variables.

We tested for interactions between variables and retained those that were important, including three-way interactions between the number of patients arriving in the PED during that hour, on that day, and the number of the preceding eight patients who were playroom eligible. We again included a cluster term for patient to adjust for repeat attendance. This model better reflected reality than simpler models and allowed for the possibility that the playroom intervention could variably improve or worsen rooming times depending on circumstances. Because of this variable effect, we graphed the effect of the playroom under different scenarios using the marginsplot function in Stata. We estimated the effect on our secondary outcome indirectly using the median time taken to room patients from the second regression (indirect effect) and adding the resulting median time to the time to be roomed (direct effect). We manually graphed our secondary outcome under a selected number of scenarios.

RESULTS

We had 43,634 patient encounters of whom 10,134 (23%) were playroom eligible and 2,260 (5%) were admitted. Table 1 summarizes the demographic characteristics. The adjusted hazards ratio (HR) of rooming from arrival was HR 1.14 (95% confidence interval [CI], 1.10-1.18) per previously arriving playroom eligible patient. There were significant interactions between the HR for initial rooming, the total number of patients seen that day (started at midnight) up to the arrival of the current patient, and the number of patients who arrived within an hour of the patient arriving. The odds ratio (OR) of a patient being roomed within 30 minutes of arrival was OR 1.46 (95% CI, 1.33-1.56) for each previously arriving playroom-eligible patient.

The impact of the playroom on PED LOS varied depending on daily census and recent arrivals. For example, during a quiet period (10 patients seen before the current patient, of whom only two presented within an hour of the current patient), the decrease in PED rooming time, due to four vs zero playroom-eligible patients, was four minutes (10 vs 14 minutes) and overall improvement in LOS was two minutes (96 vs 98 minutes). In sharp contrast, when the department was busy (90 patients seen before the current patient, 12 of these presented within an hour of the current patient), the decrease in PED rooming time, due to four vs zero playroom-eligible patients, was 42 minutes (68 vs 110 minutes), and the overall improvement in PED LOS was 40 (168 vs 208) minutes.

Table 2 shows the effects of each variable and their interactions. Higher acuity in the current patient, lower acuity in the preceding eight patients, and fewer investigations in the preceding eight patients were associated with shorter median rooming times. Conversely, lower acuity in the current patient being treated, higher overall census, and more patients arriving within an hour of the current patient, were all associated with

Table 1. Demographic description comparing patients who were and were not playroom eligible (total not always 100% due to rounding).

	Not playroom eligible	Playroom eligible
N	33,500	10,134
Age by category		
Neonate	1,057 (3.2%)	0 (0.0%)
1-12 months	4,796 (14.3%)	1,364 (13.5%)
1-5 years	11,343 (33.8%)	3,079 (30.5%)
6-12 years	6,162 (18.4%)	2,063 (20.4%)
13-17 years	5,238 (15.6%)	2,009 (19.9%)
18-21 years	4,928 (14.7%)	1,595 (15.8%)
Gender		
Male	16,387 (48.9%)	5,213 (51.4%)
Triage level (Level 1 most severe)		
Level 1	30 (0.1%)	0 (0.0%)
Level 2	2,159 (6.7%)	0 (0.0%)
Level 3	10,783 (33.6%)	3,520 (35.2%)
Level 4	16,535 (51.5%)	6,323 (63.2%)
Level 5	2,632 (8.2%)	161 (1.6%)
Minutes, arrival to room, median (IQR)	16 (8, 34)	18 (8, 38)
Roomed ≤15 minutes of arrival	14,644 (46.1%)	4,411 (44%)
Roomed ≤30 minutes of arrival	22,740 (71.5%)	6,931 (69.6%)
Admitted	2,122 (6.3%)	138 (1.4%)
Number of previous 8 patients who were playroom eligible, median (IQR)	2 (1, 3)	2 (1, 3)
Number of previous 8 patients who had no testing, median (IQR)	4 (3, 6)	4 (3, 5)
Number of previous 8 patients who had no urinalysis, median (IQR)	1 (0, 1)	1 (0, 1)
Number of previous 8 patients who had blood drawn, median (IQR)	2 (1, 2)	2 (1, 3)
Number of previous 8 patients who had imaging ordered, median (IQR)	2 (1, 4)	3 (2, 4)

IQR, interquartile ratio.

longer median rooming times.

Figure 1 shows the effects of using a playroom/internal waiting room model given various scenarios. These graphs show decreased median time to rooming as the number of playroom-eligible patients increases. As patient census increases, particularly when a large number of patients arrive in the hour preceding the arrival of the current patient, the median time to rooming increases, despite increasing numbers of playroom-eligible children. This reflects the point where the number of patients to be seen exceeds staff capacity. Figure 2 demonstrates the effect of the playroom on total LOS in a subset of scenarios presented in Figure 1.

Table 3 shows that the interval between being roomed and being discharged was most heavily influenced by the severity of illness and the extent of laboratory and radiological testing performed on the child him/herself rather than on the investigation testing ordered on other children. We found an association between shorter time to discharge after being roomed and the log(*e*) of the interval between arrival and being roomed (Table 3). This partially offsets the reduction in time to rooming on overall length of stay in the PED and the overall effect of the playroom model varies with increasing PED activity.

DISCUSSION

The answer to the question, "Does a playroom decrease time to rooming and LOS?", is that it depends. The playroom intervention generally decreased patient rooming and LOS times. The effect size varies with how busy the PED is; up to a point, the busier the PED the greater the benefit. When all treatment rooms are filled with non-playroom-eligible patients then the benefit of the playroom disappears. Times to rooming and ED LOS under this scenario reflect the benefit of the playroom and other patient characteristics. Our results adjust for these other characteristics to the extent that we could, but our estimates remain just that.

Conversely, when patient volumes are low, moving patients to the playroom (for example, to defervesce) and sometimes having to move them back to a treatment room for re-evaluation imposes a time cost without clear benefit to the next patient who has not yet presented. The practical implication is that during quiet times, typically 3 AM to 8 AM in our PED when there are open available exam rooms, patients can be allowed to sleep in an

exam room without loss of productivity.

Our other findings, higher acuity in the current patient, and lower acuity and less laboratory testing in preceding patients, was associated with more rapid rooming seem self-evident but their magnitude is important. While acuity cannot be changed, implementation of evidence-informed pathways and additional physician training may decrease reliance on laboratory investigations and thereby further improve patient throughput.

While improving flow in the PED is primarily a PED priority, flow is dependent on many factors that the PED cannot easily control, such as staff and actual or functional space limitations in both the PED itself and in inpatient services.[6,7] Our approach facilitates early clinical decision-making; this is particularly effective at decreasing LOS.[4] Interventions such as those that can be implemented by the PED itself are particularly desirable.[8,9] Decreasing waiting times and LOS decreases the number of patients who leave without being seen and improves patient satisfaction.[10] Parents generally accept this approach. We have found that comparing our approach to Southwest Airlines boarding is both apt and readily accepted.

Our approach fits squarely within the overall strategy of "internal waiting rooms" and "awaiting results" areas used in general EDs. Our data provides objective supportive evidence for general ED directors who wish to implement an internal waiting room. There are unique imperatives to PED playrooms, however. First, a playroom addresses much of the challenge of child-centered care in the ED. Second, it helps decrease parental anxieties as they see their child defervesce and resume normal behavior. In some settings parents' notions of suitability of their children's newly-found playmates may occasionally arise, although in our experience this is rarely verbalized.

This work builds on the underlying time and space limitations thesis of Michelson et al. We effectively created more treatment space and nursing resources by removing those children who need neither from the treatment room.[7] There are limits to what our playroom model can achieve as evidenced by a small offset in the benefit of rapid rooming on the time taken in the next phase of care. This may reflect a difference in settings. Michelson et al. describe an academic setting where doctors are plentiful; in the community setting there are far fewer medical providers delivering more care. Second, in Michelson et al space was a limiting factor 5% of the time. In our setting we anticipated a daily attendance of up to 45 patients a day, but in practice have seen 110 on busy days. This distinguishes our observed practice from Michelson et al's computer models. The underlying principles guiding their models and our intervention are the same.

Table 2. Effect of playroom and other independent variables on time to rooming.

	Time to rooming (HR)	95% CI (lower, upper)	Roomed <30 min (OR)	95% CI (lower, upper)
Current patient variables				
Age in years (per year)	0.986	(0.984, 0.987)	0.980	(0.977, 0.984)
Triage (Level 3 is referent)				
Level 1	1.795	(1.108, 2.907)	3.143	(0.646, 15.296 NS)
Level 2	1.448	(1.380, 1.520)	2.079	(1.810, 2.400)
Level 4	0.827	(0.808, 0.847)	0.614	(0.582, 0.647)
Level 5	0.826	(0.793, 0.860)	0.573	(0.520, 0.631)
Variables for preceding eight patients				
No testing ordered (per patient)	1.146	(1.071, 1.227)	1.067	(1.044, 1.090)
Mean triage level (per category higher means lower acuity)	1.310	(1.195, 1.437)	1.313	(1.213, 1.422)
Playroom eligible (per patient)	1.136	(1.095, 1.178)	1.458	(1.329, 1.560)
Number of patients seen since 00:00 that day (per 10)	0.936	(0.918, 0.954)	0.875	(0.831, 0.917)
Number of patients that hour	0.940	(0.923, 0.956)	0.911	(0.874, 0.948)
Interacted variables. Effects are shown in Figure 2				
Playroom eligible X total patients that day (per 10)	0.970	(0.961, 0.978)	0.926	(0.905, 0.948)
Playroom eligible X total patients that hour	0.989	(0.981, 0.994)	0.963	(0.945, 0.982)
Total patients that day (per 10) X total patients that hour	0.992	(0.989, 0.996)	0.975	(0.965, 0.985)
Three-way interaction of above terms	1.004	(1.002, 1.005)	1.010	(1.006, 1.015)
Seen when PED beds were nearer the main entrance	0.942	(0.922, 0.963)	0.873	(0.832, 0.917)

The first model shows the hazard ratio for time to being roomed after arrival. The second model shows the odds of being roomed within 30 minutes of arrival and although less informative may be easier to operationalize than the first. Retaining the interacted variables fits the observed data better than a parsimonious approach.
HR, hazards ratio; *CI*, confidence interval; *OR,* odds ratio; *min,* minutes; *NS,* not significant at p <0.05.

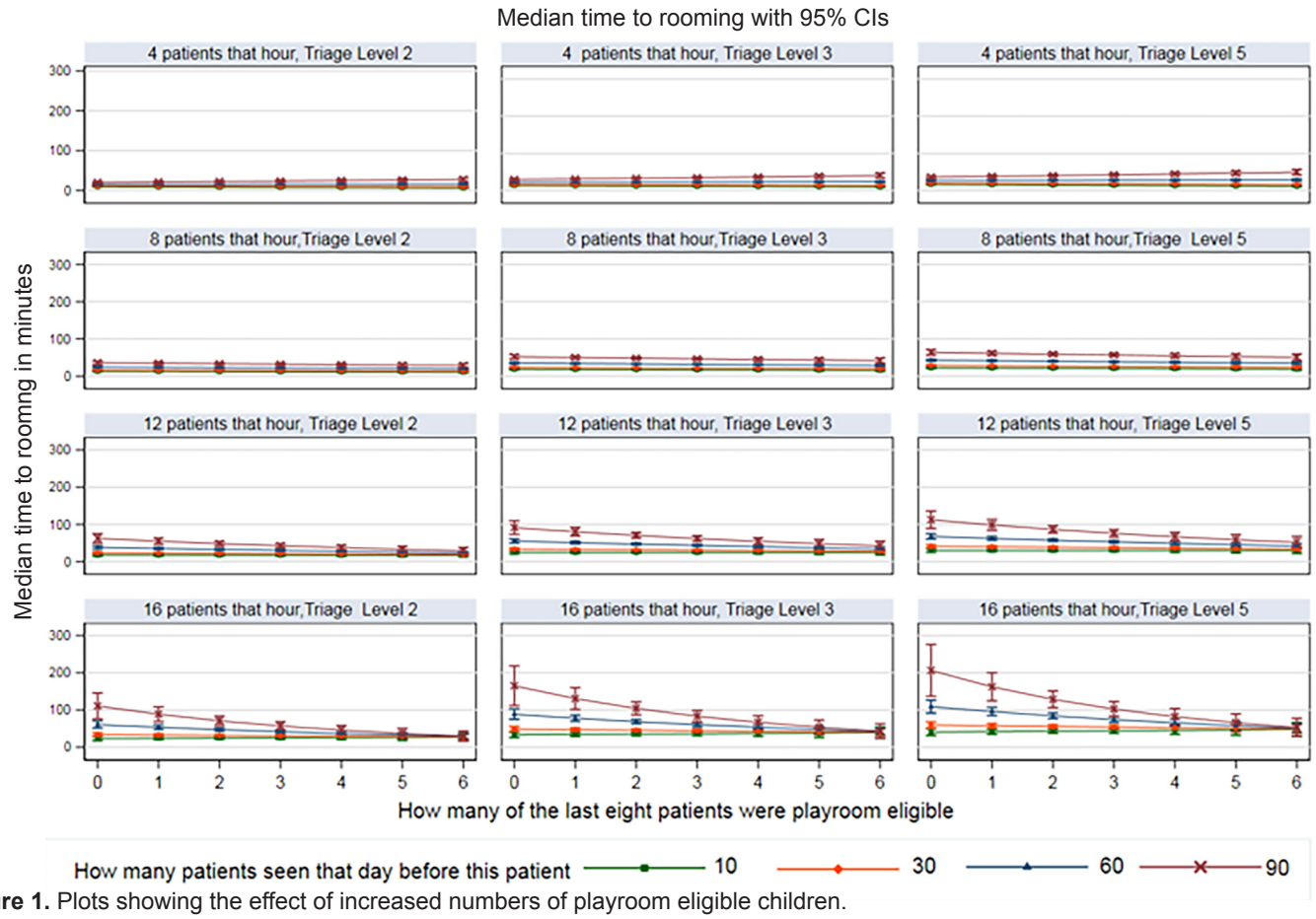

Figure 1. Plots showing the effect of increased numbers of playroom eligible children. *CI,* confidence interval.

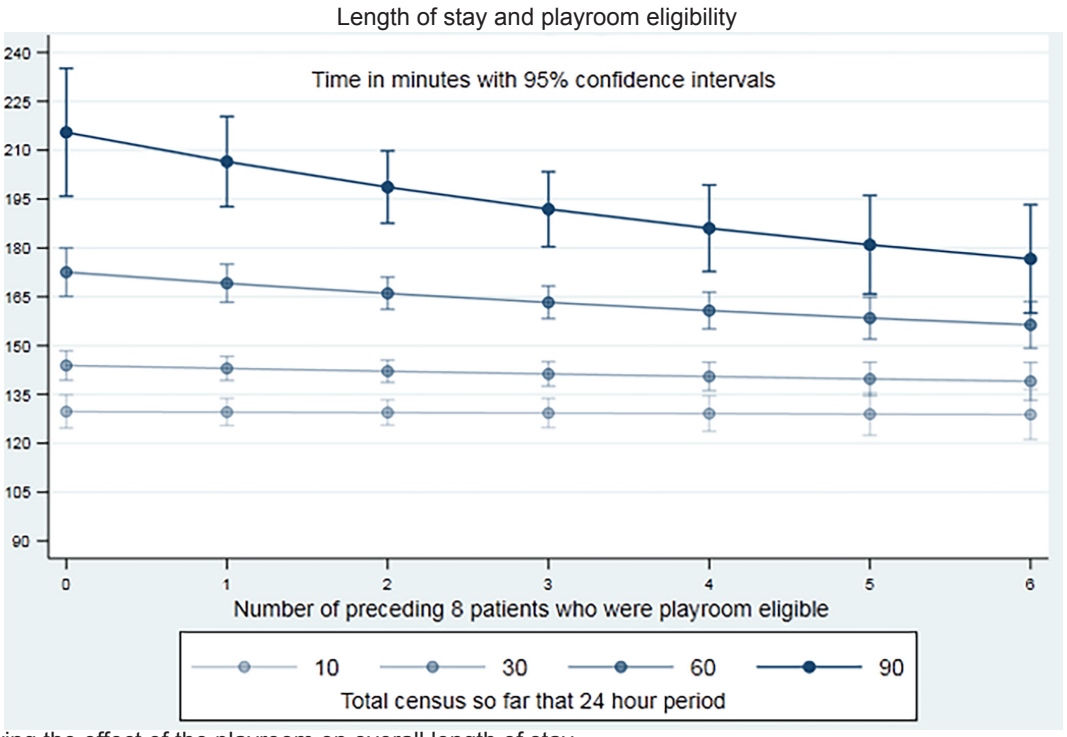

Figure 2. Plots showing the effect of the playroom on overall length of stay.

Other concerns include that increasing PED efficiency results in sufficiently increased census that downstream resources (eg, lab, inpatient services) may find their workload increased.

Ideally, the playroom is a separate physical space with primary stewardship belonging to child life services (play therapy). However, the same benefits could be expected to be obtained by simply moving patients back to the waiting room without the investment in child-centeredness implied by the playroom model. Whether it would be as well accepted by parents depends on the setting. In our case the opposite occurred. Our census is now substantially higher than the 14,500 patients originally planned for when we designed a "no wait" PED. Consequently, some patients now do have to wait to be roomed, and the playroom space is often shared with some patients who have just arrived.

Using the playroom requires PED staff to empower the parents to observe their children as they defervesce, or as part of a head injury observation period, secure in the knowledge that PED staff are immediately available should they be needed. Empowering parents in this way teaches them how to manage simple fevers at home and reassures them in the face of a common tendency to overestimate how sick one's own child is. It also reduces the overall cost of care by allowing staff to see other patients. When a strategy of parental observation in the playroom is used, such as for head injuries, staff need to recognize that interval development of symptoms may require rapidly returning a patient to a treatment room. This is to be expected and should not be interpreted as a failure of the approach.

The concept of playroom/internal waiting area is straightforward, but successful implementation required intensive prolonged effort by physician and nurse leaders with wholehearted support from hospital administrators. This process results in more patients being seen in a shift by the same number of staff. Consequently, these staff need to be supported. Although beyond the scope of the evidence presented here, we observed that additional physician training, with PED management protocols to relieve cognitive load, order sets or order preference lists that align with PED management protocols, and physician scribes are all hugely helpful when implementing this approach. Nursing staff need to be similarly given additional training and supported with respect to streamlining processes and documentation that do not add value to the patient. A key investment is a child life specialist (CLS). We initially relied on inpatient CLS staff, but as their value became clear we brought in two of our own CLS as part of our PED staff.

Future research could focus on refining playroom eligibility, measuring associated parallel flow strategies, the effects of CLS specialists, and reinventing nursing processes, the role of discharge instructions, and in identifying those processes that parents perceive as adding little value.

Table 3. Regression model of variables affecting time from rooming to discharge.

Variables	Hazard ratio	95% CI (lower, upper)
ln (Age in years)	1.020	(1.014, 1.025)
Triage Category 1	0.310	(0.213, 0.450)
Triage Category 2	0.173	(0.151, 0.198)
Triage Category 3	referent	
Triage Category 4	1.434	(1.396, 1.472)
Triage Category 5	1.985	(1.910, 2.063)
ln_ (Arrival to rooming)	1.065	(1.052, 1.078)
Total census (per 10 patients)	0.966	(0.960, 0.971)
Blood test	0.523	(0.507, 0.540)
Urinalysis	0.708	(0.661, 0.758)
Imaging	0.751	(0.731, 0.772)
Blood test X urinalysis	1.201	(1.083, 1.332)
Imaging X Triage Category 1	1.741	(0.443, 6.849)
Imaging X Triage Category 2	3.811	(2.987, 4.861)
Imaging X Triage Category 3	referent	
Imaging X Triage Category 4	0.809	(0.782, 0.836)
Imaging X Triage Category 5	0.588	(0.536, 0.645)

This demonstrates a small indirect offset of the benefit of the effect of faster initial rooming. However, the overall time saving in faster initial rooming more than compensates for this offset.
ln_; natural log of; *CI*, confidence interval.

LIMITATIONS

This was a single center where the model was implemented at the inception of the PED, prior to the establishment of a culture that would allow unnecessary in-room waiting by patients. It is intuitive that the time taken to room a patient could be affected by the number of patients seen that day, that hour, as well as by the acuity and laboratory testing required for the prior patients. Statistical models risk oversimplifying this reality. We have addressed this by using interacted models which, although more complex than parsimonious ones, had better fit characteristics and more faithfully reflect the observed reality. These complex models require graphical description to be readily understood. Even these models are simplifications of reality.

Proving causality is difficult; our approach of comparing time to rooming and ED LOS and when the PED playroom can work (open treatment rooms) and cannot work (all treatment rooms occupied with non-playroom eligible patients) is an estimate, which despite adjustment for other considerations, will always be influenced by patient load and complexity. Nonetheless, given the constraints inherent in this type of research our estimates have been estimated as tightly as possible.

Our results also occur in the context of parallel flow where any team member can room a patient and use an electronic tracking board to communicate that fact. This parallel flow decreases the potential for the triage process to impede overall PED productivity. This effect is approximated in other PEDs by employing multiple nurses dedicated to initial triage.

Parallel rooming and a playroom/internal waiting area represent different independent processes, and the former does not alter our findings about the latter. Our work does not address other factors in PED operations and patient satisfaction such as quality of patient-staff interactions, perceptions of caring, and time spent with patients.[11,12]

We were limited in the variables we could use. Triage category, although used for prioritizing patients, is relatively crude. We accept that some readers may regard our secondary outcome as more important than our primary outcome. We also did not perform a chart review to determine appropriateness of the decision-making as to which children were moved to the playroom. As a group, playroom-eligible children were less sick, older, and had less laboratory testing than those who were not.

CONCLUSION

Implementing a playroom in the PED for selected patients generally decreases time to rooming of the next patient and decreases LOS.

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Triage and Ongoing Care for Critically Ill Patients in the Emergency Department: Results from a National Survey of Emergency Physicians

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Introduction: We conducted a cross-sectional study at the Icahn School of Medicine at Mount Sinai to elicit emergency physician (EP) perceptions regarding intensive care unit (ICU) triage decisions and ongoing management for boarding of ICU patients in the emergency department (ED). We assessed factors influencing the disposition decision for critically ill patients in the ED to characterize EPs' perceptions about ongoing critical care delivery in the ED while awaiting ICU admission.

Methods: Through content expert review and pilot testing, we iteratively developed a 25-item written survey targeted to EPs, eliciting current ICU triage structure, opinions on factors influencing ICU admission decisions, and views on caring for critically ill patients "boarding" in the ED for >4-6 hours.

Results: We approached 732 EPs at a large, national emergency medicine conference, achieving 93.6% response and completion rate, with 54% academic and 46% community participants. One-fifth reported having formal ICU admission criteria, although only 36.6% reported adherence. Common factors influencing EPs' ICU triage decisions were illness severity (91.1%), ICU interventions needed (87.6%), and diagnosis (68.2%), while ICU bed availability (13.5%) and presence of other critically ill patients in ED (10.2%) were less or not important. While 72.1% reported frequently caring for ICU boarders, respondents identified high patient volume (61.3%) and inadequate support staffing (48.6%) as the most common challenges in caring for boarding ICU patients.

Conclusion: Patient factors (eg, diagnosis, illness severity) were seen as more important than system factors (eg, bed availability) in triaging ED patients to the ICU. Boarding ICU patients is a common challenge for more than two-thirds of EPs, exacerbated by ED volume and staffing constraints. [West J Emerg Med. 2020;21(1)330-335.]

INTRODUCTION

The decision to triage critically ill patients to the intensive care unit (ICU) involves both objective and subjective patient-specific factors (e.g., co-morbidities, severity of illness, likelihood to benefit), as well as system factors (e.g., ICU bed availability, other waiting patients, availability of intermediate

care beds).[1] Many hospitals employ triage policies based on consensus recommendations for ICU admission focusing on patient factors (diagnosis, need for critical care interventions), especially during periods of ICU capacity strain,[2] but these protocols are not consistently used even when available.[3] While previous studies have surveyed emergency department (ED) and ICU providers about practice structures and guidelines, less is known about ICU triage decision-making in times of ICU bed shortage from the perspective of emergency physicians (EP).[3,4]

High demand for critical care services also led to significant increases in ED "boarding times"—ED lengths-of-stay greater than 4-6 hours— for critically ill patients awaiting ICU admission, complicating ED throughput and resource management.[4,5] Critical care admission delays due to limited inpatient ICU bed availability have been associated with poorer patient outcomes.[6] While critical care services is generally within the EP practice scope, less is known about their views on the delivery of ongoing ICU care in the ED setting.

The goals of this study were to identify factors contributing to ICU triage decisions and elicit EP perspectives on caring for critically ill patients with prolonged boarding times.

Population Health Research Capsule

What do we already know about this issue?
Intensive care unit (ICU) triage decisions involve various factors, with many of the "accepted" patients experiencing longer emergency department (ED) boarding times.

What was the research question?
This survey elicited emergency physician perspectives on ICU triage decisions and caring for those with long boarding times.

What was the major finding of the study?
Patient factors affect ICU triage more than ICU bed availability, despite increasing frequency of ED boarding.

How does this improve population health?
ED care for ICU boarders is affected by limited resources; more novel ways to improve throughput and deploy different care models may alleviate this growing problem.

METHODS

Study Setting and Population

This study employed a survey administered to a cross-sectional convenience sample of EPs. Respondents were approached for participation at the Icahn School of Medicine at Mount Sinai over three consecutive days. Participants were eligible if they were either enrolled as an upper-level trainee in a US emergency medicine (EM) residency program (limited to postgraduate years 2-4 only) or were currently practicing as EPs at a clinical site in the US. Those who completed the survey were entered into a raffle to win monetary gift cards. Eligible participants were considered non-respondents if they declined to complete the survey. The study was determined to be exempt from review by the institutional review board at the authors' institution, with dissemination of a research information sheet to all participants.

Study Design and Measurements

A 25-item questionnaire-based survey with primarily closed-ended questions, was iteratively developed with content domains as follows: institutional structure for ICU admissions and ongoing management of ICU boarders, individual critical care triage practices and perspectives on how decisions are made,[1] and caring for boarding ED patients awaiting ICU admission.[5] Domains were selected after literature review and content development with ED and ICU physician feedback. Modifications were informed from cognitive interviews with 10 EPs addressing clinical sensibility (clarity, face validity, content validity, and utility) at the authors' institution, followed by pilot testing to academic and community EPs at outside institutions. (See Appendix Survey for the final instrument.)

We collected demographics, training background, and current practice information, including board certification status and completion of critical care fellowship training, if applicable. The survey included multiple-choice, Likert-type scales (five-point), answer selection with rankings in order of importance, and options for free-text completion. Respondents were advised to select one or multiple answers, as applicable to their practice setting.

Analysis

Responses to Likert-type scale questions were coded as ordinal variables. Responses to the question on identification of factors affecting triage decisions were re-coded first as selected vs not selected and then, for those who provided ranking of their selections, factors were categorized based on the identified level of importance (Most/More important, Somewhat important, Less/Least important). The responses were described with univariate and bivariate analysis, stratified by university vs community practice setting, using chi square, Fisher's exact, and independent t-testing, where appropriate. We performed analyses using SPSS Statistics, version 23 (IBM, Armonk, NY).

RESULTS

A total of 732 attendees were approached for participation, with 685 eligible respondents completing the survey (93.6% response rate after excluding 18 surveys for non-US practice settings). Respondents were mostly attending physicians (78.1%), with representation from 47 states (Table 1). The majority reported caring for more than three critically ill patients per week (83.4%), and 72.1% reported that caring for boarding ICU patients was a frequent occurrence during their ED shifts.

Main Results

Approximately one-fifth (n = 141) of respondents stated that their hospital had formal ICU admission criteria; of those, 60.3% reported consistent adherence with these guidelines. In-person ICU team consult for ICU admission was required in a minority of settings (n = 228/663, 33.3%), more commonly seen in university over community settings (45.6 vs 21.6%, p<0.001). While the ED team was identified as the final triage decision-maker for ICU admission in community hospitals (ED 54.3 vs ICU 19.9%), the ICU team finalized the ICU admission decisions more often in university hospitals (ED 42.9 vs ICU 46.8%, p<0.001). A hospitalist team (n = 67/663, 9.8%) or joint decision-making structure (n = 35/663, 5.1%) for triaging ICU admissions was infrequently reported, regardless of practice setting.

Factors identified as contributing to the EP's ICU triage decision included severity of illness (91.1%), need for critical care interventions (87.6), and diagnosis (68.2%), with minimal differences between university or community settings. (See Table 2 for respondent-identified factors; Appendix Table for respondent-ranked factors.) Only 23.2-35.3% of respondents

Table 1. Characteristics of Emergency Medicine (EM) physician respondents, stratified by those who primarily work in university/teaching versus community hospitals.

Characteristics	Respondents (N=685)	University/teaching hospital† (N=342)	Community hospital† (N=286)
Gender (%)**			
Male	461/684 (67.3)	215 (62.9)	208 (72.7)
Female	223/684 (32.6)	127 (37.1)	78 (27.3)
Age (mean ± SD) ***	41.9 ± 11.7	39.2 ± 11.1	44.2 ± 11.2
Geographic distribution (%)**			
Northeast	182/615 (26.6)	116 (33.9)	57 (19.9)
Midwest	180/615 (26.3)	87 (25.4)	81 (28.3)
South	156/615 (22.8)	70 (20.5)	75 (26.2)
West	97/615 (14.2)	39 (11.4)	51 (17.8)
Level of experience (%)			
Current trainee‡	143/654 (21.9)	108 (31.6)	25 (8.7)
Attending physician	511/654 (78.1)	221 (64.6)	249 (87.1)
Years in practice (Median, IQR)*	10 (4-20)	9 (3-18.5)	11 (5-22)
U.S. Board certified in EM	453/613 (66.1)	185 (84.9)	215 (87.8)
Critical care (CC) fellowship	12/659 (1.8)	6 (1.8)	4 (1.4)
Practice setting (%)			
University/teaching	342 (49.9)		
Community	286 (41.8)		
Veterans Affairs	5 (0.7)		
Managed care hospital	6 (0.9)		
Multiple settings	27 (3.9)		
Other/not specified	19 (2.8)		

* p<0.05, ** p<0.01; *** p<0.001;
†Limited to those with identification of the primary practice setting as either university or community hospital. All numbers listed in parentheses are a percentage of the total within the category of either university or community hospital setting.
‡Current trainees are upper-level EM residents, post-graduate years 2-4.
SD, standard deviation; *CC,* critical care; *EM,* emergency medicine; *IQR,* interquartile range; *SD,* standard deviation.

Table 2. Identified factors affecting Emergency Medicine physician ICU triage and admission decision-making,* stratified by hospital setting.

Factors	Total (N=638)**	University/Teaching Hospital† (n=317/589)	Community Hospital† (n=272/589)
Patient-related factors (%)			
Acuity/severity of illness	581 (91.1)	289 (91.2)	249 (91.5)
CC intervention needed	559 (87.6)	282 (89.0)	238 (87.5)
CC diagnosis	435 (68.2)	208 (65.6)	198 (72.8)
Likelihood to benefit	357 (56.0)	182 (57.4)	149 (54.8)
Age and/or co-morbidities	225 (35.3)	108 (34.1)	104 (38.2)
Pre-existing goals of care	221 (34.6)	113 (35.6)	92 (33.8)
Pre-hospital quality of life	148 (23.2)	73 (23.0)	63 (23.2)
Hospital/system-related factors (%)			
ICU team input	203 (31.8)	109 (34.4)	81 (29.8)
Hospital's admission criteria‡	98 (15.4)	59 (18.6)	32 (11.8)
ICU bed availability	86 (13.5)	45 (14.2)	34 (12.5)
Step-down bed availability	70 (11.0)	35 (11.0)	27 (9.9)
Other CC patients in ED	65 (10.2)	38 (12.0)	23 (8.5)

* Identified factors include all selected and/or positively ranked responses: Yes; Most, Very, or Moderately important
** Of the total 685 survey respondents, 638 (97.0%) answered this question. Total includes 49 respondents who identified multiple clinical sites (n=23), Veterans Affairs hospital (n=5), Managed Care Hospitals (n=5), and Other/Non-specified (n=16), as their primary practice setting.
†Question Responses from survey participants who identified University/Teaching Hospital (n=317/342) or Community Hospitals (n=272/286) as their primary practice setting are included in the second and third columns respectively. All numbers in parentheses reflect the percentage of the total of respondents from university or community settings.
‡p=0.022
CC, critical care; *ICU,* intensive care unit; *ED,* emergency department.

emphasized age and prehospital status as contributory to the ICU admission decision, although the perception that patients would likely benefit from critical care intervention was identified as important by 56% of respondents. System factors related to ICU demand (both inpatients and others in the ED waiting for ICU admission) were least important to EPs (10.2-13.5%). Survey respondents reported that it was a common experience for patients to be denied ICU admission by the primary ICU team in their hospital (n = 255/531, 48.0%) reported denials as an "always, often, or sometimes" occurrence), with given reasons by ICU team being more often due to limited ICU bed availability (n = 153/647, 23.6%) and patient suitability for an intermediate care unit as an alternative to an ICU (n = 440/647, 68.0%).

ICU boarding time greater than 4-6 hours was frequently observed (71.5%), with the ED remaining the primary team while boarding (50.8%). The majority (73.7%) reported that these patients typically remained in the ED until an ICU bed opened; temporary transfer to other units (eg, intermediate care unit, post-ambulatory care unit, overflow units, etc) was uncommon. Respondents identified high patient load per provider (64.8%), high overall ED volume (51.5%), and insufficient support staff (51.4%) as the primary barriers to ongoing care, while personal discomfort with caring for boarding ICU patients (18.8%) was less common. Those practicing at community hospitals more often identified staffing and resource constraints as hindering high-quality care delivery to ICU boarders (Figure). Communication with the ICU team was also rated as only sometimes to rarely helpful by over one-third of respondents (n = 235/655, 35.9%). Most agreed with the statement that the ED team should not be required to manage ICU boarders on their own (n = 573/648, 88.4%), but only 38.4% definitively stated it should be the primary responsibility of the ICU or inpatient teams. One-quarter of respondents (n = 167/659) stated that their EDs employed board-certified ED intensivists, with this being a more frequent occurrence in university over community settings (37.6 versus 11.4%, p<0.001).

DISCUSSION

Our study demonstrates that ED triage decisions are more informed by the patient's acute presentation, than by factors associated with the perceived risks and benefits of ICU care. In contrast to past studies, which identify ICU bed availability and consideration of other waiting patients as affecting ICU triage decisions,[1,6] our study also demonstrates that these system constraints appear to factor less into EP decision-making. While past studies have assessed triage decision-

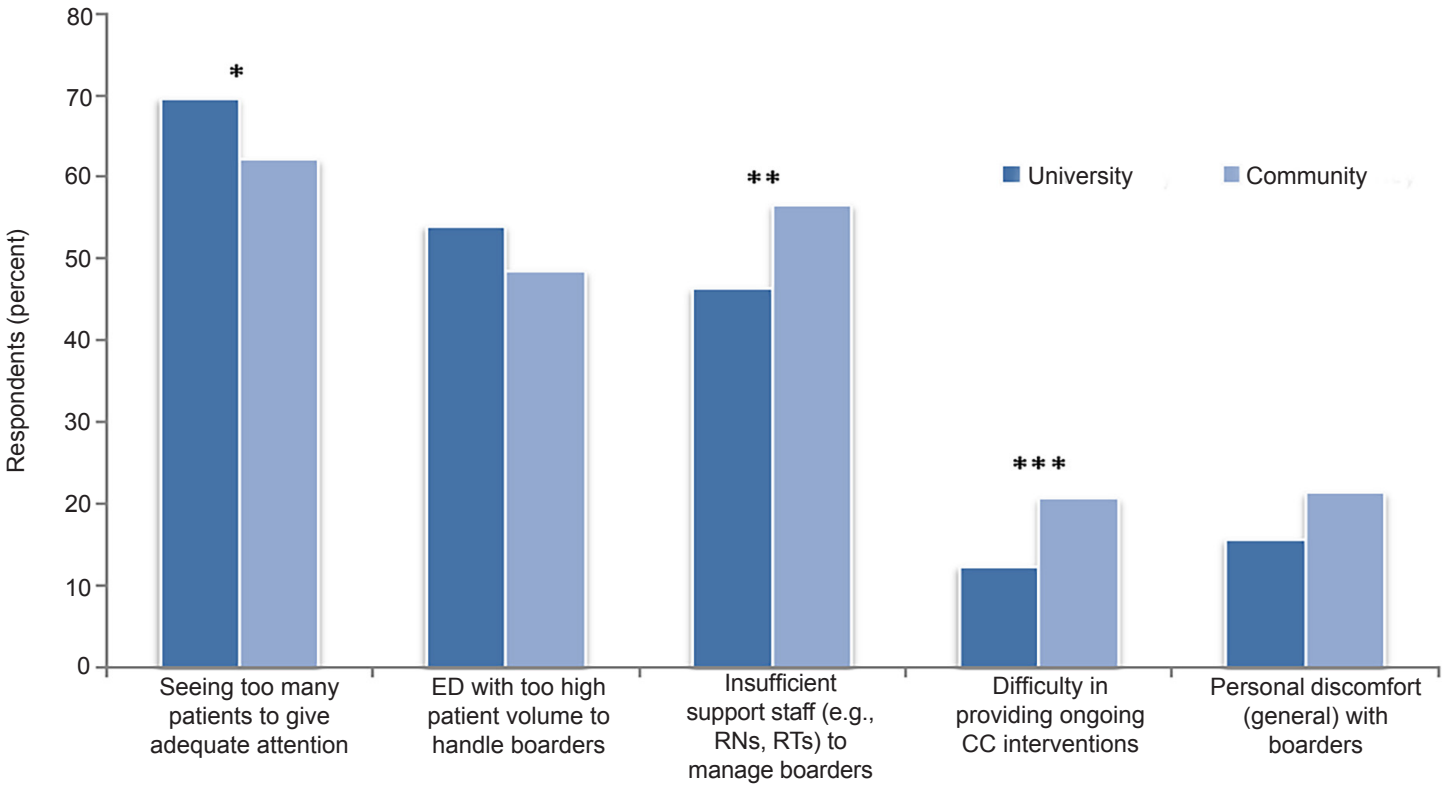

Figure. Attitudes of emergency medicince physicians toward caring for critically ill ED patients wih prolonged ED boarding times (greater than 4-6 hours), stratified by hospital setting.
*p= 0.053; **p=0.012; ***p=0.006
ED, emergency department; *RN,* registered nurse; *RT,* respiratory therapist; *CC,* crtical care.

making from ICU providers' perspective,[7] to our knowledge, this is the first study to elicit EP perceptions about ICU triage decisions and care for critically ill patients "boarding" in the ED. While our study ascertained the relative irrelevance of the system factors to ED decision-making around ICU triage, respondents commonly received ICU denials for their patients, with the perception that ICU capacity does play a role in ICU team decision-making. Similar to ICU physician surveys, EPs highlight that established institutional triage criteria and protocols are infrequently applied.[8]

Our results also support the concern for the growing workload associated with the increasing number of boarding ICU patients in the ED.[4] The majority of survey respondents, regardless of practice setting, reported that patients remain in the ED until ICU beds become available, and that the ED team is primarily responsible for the ongoing critical care management. Delays in ICU admission have been associated with poorer outcomes for critically ill ED patients,[6,9] but as our survey respondents identified, high volume weighs heavily into the ability and capability of EPs to optimally take care of these patients. Crowding and inpatient ED boarding are associated with lower likelihood of receiving best-practice recommendations for various critical diagnoses, including sepsis and myocardial infarction. Improvements in hospital-wide throughput are needed to alleviate inpatient bottlenecks felt by the ED.

With fixed ICU availability and a growing number of ICU boarders in the ED, adaptation and evolution of the traditional critical care delivery model (previously limited to care by ED or inpatient ICU teams) are already being developed to address concerns identified in this survey. Resource and staffing limitations were pinpointed as significant constraints to providing optimal care for critically ill patients while boarding. Many EDs may not have access to flexible nursing pools to maintain ICU-level staffing ratios two patients to one nurse. Additionally, our study supports the fact that communication between the ED and ICU teams has room for improvement. Newer models of ED-based intensive care units or flexible mobile ICU teams may prove helpful in improving collaboration between teams, alleviating some of the workload burden, and sustain high-quality critical care delivery until transfer to inpatient ICU bed occurs.[10] Although our survey identified a fair number of practice settings employing ED intensivists, advanced critical care training for the EP is still in the minority.[11] These alternative care models, while highly variable in structure, provide more specialized opportunities

for the critical care medicine-trained EP and support for both the EM and ICU inpatient teams and potentially improved outcomes for critically ill ED boarding patients.[12]

LIMITATIONS

Limitations of this study include its closed-ended survey design, convenience sampling, and respondent and recall bias for boarding frequency and factors impacting decision-making, precluding a deeper understanding of triage complexity and boarding ICU patient care. Practice locations were not identified, allowing for the possibility of multiple responses from the same institution. However, large response rates with national representation provide confirmation of the system-related challenges associated with boarding commonly felt by many EPs. Triage decision-making, with comparisons between emergency and ICU physicians, warrants further investigation and may be better elicited through interviews or focus groups, and/or a mixed methods approach.

CONCLUSION

In this nationally representative survey of EPs, patient-related factors were seen as more important than system factors (eg, bed availability) in triaging ED patients to the ICU, despite the high frequency of prolonged boarding across practice settings. Caring for boarding ICU patients is affected by high ED volume and staffing constraints, suggesting that more innovative ways to improve ICU throughput and employ alternative critical care delivery models may help to alleviate this growing problem.

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Abscess Size and Depth on Ultrasound and Association with Treatment Failure without Drainage

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Introduction: Skin and soft tissue infections (SSTI) occur along a continuum from cellulitis to abscess. Point-of-care ultrasound (POCUS) is effective in differentiating between these two diagnoses and guiding acute management decisions. Smaller and more superficial abscesses may not require a drainage procedure for cure. The goal of this study was to evaluate the optimal abscess size and depth cut-off for determining when a drainage procedure is necessary.

Methods: We conducted a retrospective study of adult patients with a SSTI who had POCUS performed. Patients were identified through an ultrasound database. We reviewed examinations for the presence, size, and depth of abscess. Medical records were reviewed to determine acute ED management and assess outcomes. The primary outcome evaluated the optimal abscess size and depth when a patient could be safely discharged without a drainage procedure. We defined a treatment failure as a return visit within seven days requiring admission, change in antibiotics, or drainage procedure.

Results: A total of 162 patients had an abscess confirmed on POCUS and were discharged from the ED without a drainage procedure. The optimal cut-off to predict treatment failure by receiver operating curve analysis was 1.3 centimeters (cm) in longest dimension with a sensitivity of 85% and specificity of 37% (area under the curve [AUC] 0.60, 95% confidence interval [CI], 0.44-0.76), and 0.4cm in depth with a sensitivity of 85% and specificity of 68% (AUC 0.83, 95% CI, 0.74-93).

Conclusion: This retrospective data suggests that abscesses greater than 0.4 cm in depth from the skin surface may require a drainage procedure. Those less than 0.4 cm in depth may not require a drainage procedure and may be safely treated with antibiotics alone. Further prospective data is needed to validate these findings and to assess for an optimal size cut-off when a patient with a skin abscess may be discharged without a drainage procedure. [West J Emerg Med. 2020;21(2)336-342.]

INTRODUCTION

Emergency department (ED) visits for skin and soft tissue infections (SSTI) have markedly increased over the last decade,[1,2] accounting for more than 4.21 million ED visits in 2010 alone.[3] SSTIs occur along a continuum from cellulitis to abscess. In patients with suspected SSTI, point-of-care ultrasound (POCUS) is effective in differentiating cellulitis vs abscess, in both adult and pediatric populations.[4-8] This is an important distinction as standard treatment for abscess involves an invasive and often painful drainage procedure,[9-12] while cellulitis is commonly treated with antibiotics alone.[13,14] Smaller and more superficial abscesses may heal without a drainage procedure and with antibiotics alone.

Although soft-tissue POCUS is often incorporated into the clinical evaluation of patients with SSTI, there is limited evidence evaluating the impact of abscess size and depth on

acute management. It is possible that smaller and more superficial abscesses may be managed without a drainage procedure. We set out to assess the optimal abscess size and depth cut-off, as visualized on POCUS, for determining when a drainage procedure is necessary.

METHODS

Study Design

This was a retrospective study of adult patients with a SSTI who received an emergency physician- performed POCUS examination at two urban, academic EDs with a combined volume of >220,000 patient visits per year. We reviewed all soft tissue studies logged into an ultrasound database, Qpath (Telexy Healthcare, British Columbia, Canada), between September 2013 and July 2019. This study was approved by the institutional review board with waiver of consent.

We included all adult patients who presented to the ED with signs or symptoms that prompted an emergency physician to perform a soft tissue POCUS. We included patients with a skin abscess, defined as a well-circumscribed fluid collection with posterior acoustic enhancement. We excluded patients without abscess (i.e., cellulitis alone, simple cysts, lymph node, etc.), those with a peritonsillar or breast abscess, patients requiring hospital admission, patients whose demographics were entered incorrectly into the ultrasound

Population Health Research Capsule

What do we already know about this issue?
Point-of-care ultrasound can reliably differentiate cellulitis from abscess in patients with skin and soft tissue infections.

What was the research question?
The primary aim was to evaluate the optimal abscess size and depth cut-off for determining when a drainage procedure is necessary.

What was the major finding of the study?
Skin abscesses >0.4 centimeters (cm) in depth may require a drainage procedure, while those <0.4 cm may be safely treated with antibiotics alone. Additional data is needed to determine an optimal size cut-off for when a drainage procedure is not necessary.

How does this improve population health?
Superficial abscesses (<0.4 cm deep) may be effectively treated without a drainage procedure, obviating the need for a time-consuming and invasive procedure.

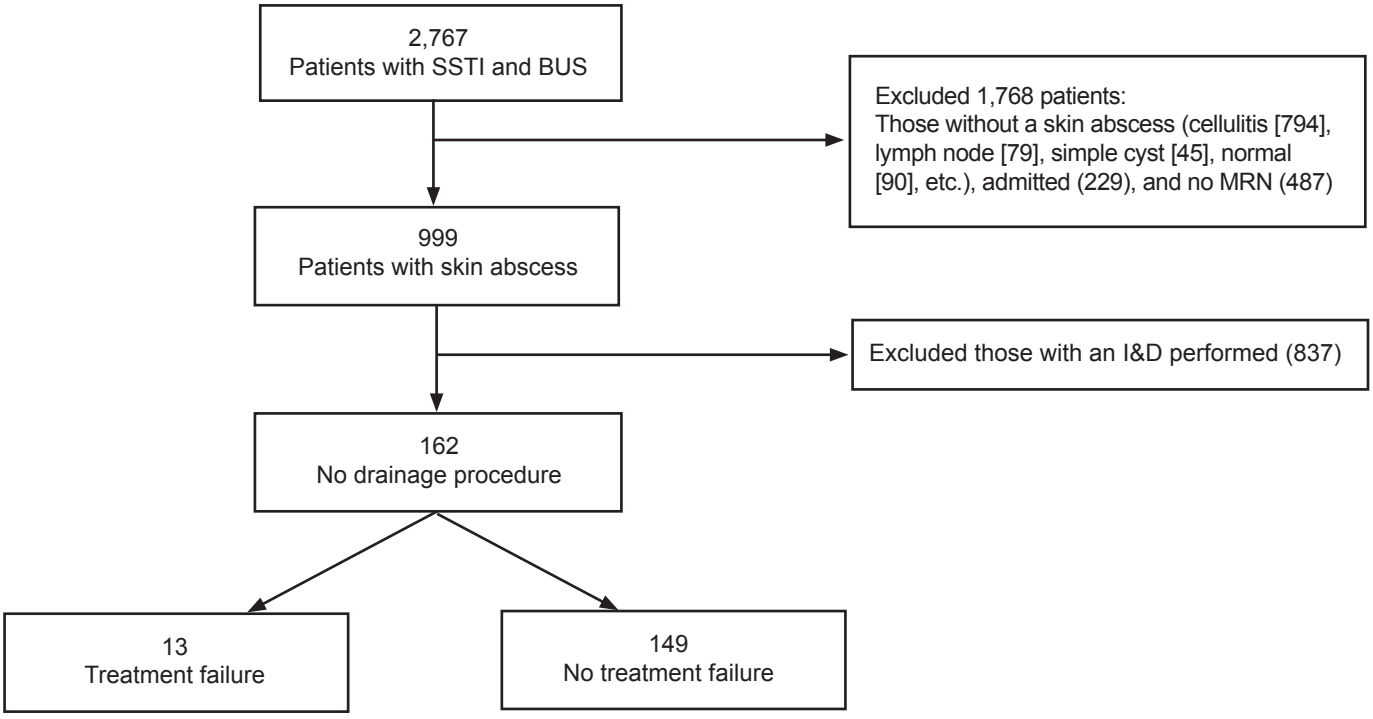

Figure. Patient flow, treatment, and outcomes.
SSTI, skin and soft tissue infection; *BUS,* bedside ultrasound; *MRN,* medical record number; *I&D,* incision and drainage.

database (i.e., we could not identify the patient), and incarcerated patients (Figure).

Study Protocol

Four emergency physicians, including three ultrasound-trained faculty and one senior resident, reviewed previously performed POCUS examinations for the presence of abscess. Ultrasound images included both video and/or still images. Some images included the measurements of the abscess including height, length, width, and depth. If the images did not include measurements or were measured incorrectly, the reviewers performed their own measurements for size and depth.

If identified, the longest diameter in any dimension and depth from the skin surface to the superficial edge of the abscess were measured and recorded on a standardized data collection form. These same emergency physician reviewers then collected patient demographic information, abscess location, whether the patient was immunocompromised, and whether the patient was using intravenous drugs. Immunocompromised states were defined as patients with diabetes, human immunodeficiency virus, or on immunosuppressant medication. Patients' statewide electronic health records, a database external to the hospital electronic health record, were reviewed to determine whether an incision and drainage (I&D) procedure had been performed and to assess seven-day outcomes.

Reviewers followed previously published methods for reviewing charts.[15] This included pre-study training on where to extract data, a standardized data abstraction form, and defining variables pre-study. Study monitoring was performed periodically, after 50 and 100 patients, to ensure all variables were being collected in the same format. Reviewers were not blinded to the study hypothesis. A second investigator reviewed a randomized sample of 64 (15%) patient images to assess for intraclass correlation for abscess size and depth. The second investigator was blinded to prior measurements, patient history and outcome data.

Outcome

The primary outcome was to determine the impact abscess length and depth had on outcomes of ED patients discharged without a drainage procedure. In those patients with an abscess who did not undergo a drainage procedure, we evaluated the optimal abscess size and depth cut-point at which patients did not have a treatment failure. A treatment failure was defined as an unscheduled healthcare visit within seven days requiring hospital admission, a change in antibiotic, or a drainage procedure.

Data Analysis

Continuous data is presented as median with interquartile range (IQR). We calculated percent frequency of occurrence, sensitivity and specificity with 95% confidence intervals (CI). Receiver operating characteristic (ROC) curves were used to determine the optimal cutoff value for both abscess size (longest dimension) and depth from skin surface for an abscess effectively treated without a drainage procedure. We completed statistical analysis using SAS, version 9.4 (SAS Institute, Cary, NC).

RESULTS

Of 999 patients found to have a skin abscess on POCUS after we applied inclusion/exclusion criteria, 162 (16.2%) were discharged from the ED without a drainage procedure (Figure). The median age was 37.6 years (IQR 21, 18-73), and the median duration of symptoms prior to evaluation was three days (IQR 5). The most common abscess locations were the extremities (51%). Twenty-one (10%) patients had diabetes mellitus and 18 (11%) were intravenous drug users (Table 1). The majority of patients were discharged with either clindamycin (31%) or the combination of cephalexin and trimethoprim/sulfamethozaxole (25%). Eighteen (11%) patients were discharged without drainage or antibiotics.

The training level of sonographers included fourth-year medical students, postgraduate year 1-5 emergency medicine (EM)/EM-pediatric residents and board-certified EM faculty. Sonographers did not use a standardized imaging protocol for ultrasound assessment of SSTI; however, they were taught to scan through the area of interest in two planes, orthogonal to each other.

For the 162 patients discharged without a drainage procedure, 13 (8%) had a treatment failure four required admission; eight a change in antibiotics; and seven a drainage procedure during their subsequent encounter (Table 2). No treatment failures went to the operating room. Of these 162, the median length and depth in centimeters (cm) were 1 cm (IQR 0.9, 0.25-4.2) and 0.25 cm (IQR 0.4, 0-2). The optimal cut-off value to predict treatment failure by ROC analysis was 1.3 cm in longest dimension with a sensitivity of 85% and specificity of 37% (area under the curve [AUC] 0.60, 95% CI, 0.44-0.76). The optimal cut-off value for depth was 0.4cm with a sensitivity of 85% and specificity of 68% (AUC 0.83, 95% CI, 0.74-93). One hundred and six (65.4%) patients had an abscess length less than 1.3cm, and 103 (63.5%) had an abscess depth less than 0.4 cm from the skin surface. The length threshold for 100% sensitivity was 0.47 cm with a specificity of 2%. The depth threshold for 100% sensitivity was 0.2 cm with a specificity of 34% (Table 3).

The intraclass correlation between blinded reviewers for abscess size and depth was 0.92.

DISCUSSION

POCUS is readily available and currently used in the ED to guide acute treatment decisions in patients with SSTI.[2] Ultrasound gives clinicians the ability to differentiate between cellulitis and abscess, something that physical examination cannot always do.[4,5] Despite this fact, very little is known about how to manage smaller and shallower skin abscesses.

Table 1. Characteristics of patients without a drainage procedure.

	Total n=162	No treatment failure n=149	Treatment failure n=13
Age (yrs)			
Median (IQR)	37.6 (21)	36 (20)	47 (15)
Range	18-73	18-73	24-64
Race (%)			
White	69 (42.6%)	62 (41.6%)	7 (54%)
Black	66 (41%)	61 (41%)	5 (38.5%)
Hispanic	12 (7.4%)	12 (8%)	0
Other/Unknown	15 (9.3%)	14 (9.4%)	1 (7.7%)
Duration (days of symptoms)			
Median (IQR)	3 (5)	3 (5)	3 (1)
Location			
Extremity	83 (51%)	78 (52%)	5 (38.4%)
Trunk	51 (31%)	46 (31%)	5 (38.4%)
Head/neck	27 (17%)	24 (16%)	3 (23%)
Unknown	1 (1%)	1 (1%)	0
Immunocompromised			
Diabetes	21 (10%)	19 (10%)	2 (15%)
HIV	1 (0.6%)	1 (0.7%)	0
Other	7 (4%)	7 (5%)	0
IVDU	18 (11%)	16 (10.7%)	2 (15%)
Antibiotics at discharge			
Clindamycin	50 (31%)	44 (30%)	6 (46%)
Cephalexin & TMP/Sulfa	41 (25%)	38 (26%)	3 (23%)
TMP/Sulfa	17 (10%)	16 (11%)	1 (8%)
Cephalexin	15 (9%)	15 (10%)	0
Other	21 (13%)	19 (13%)	2 (15%)
None	18 (11%)	17 (11%)	1 (8%)

HIV, human immodeficiency virus; *IQR,* interquartile range; *IVDU,* intravenous drug use; *Sulfa,* sulfamethozaxole; *TMP,* trimethoprim.

Analyzing the size and depth of an abscess may further impact a patient's management course. In this study we found that abscesses less than 0.4 cm deep to the skin surface may be effectively treated without a drainage procedure. This is important as standard treatment for abscess typically involves an invasive I&D procedure.[11,12] Our data suggests that more superficial abscesses may be safely and effectively treated without a drainage procedure. These findings may allow clinicians to avoid an unnecessary, time consuming, and invasive procedure in these select patients.

This is the first study to date to assess the impact of size and depth of an abscess on acute ED management in patients who have more than cellulitis, but may not have a large enough abscess to require drainage. Recent studies differ from ours in that they primarily focused on management of uncomplicated SSTI with I&D with or without the addition of oral antibiotics.[11,12,16] Talan et al[11] found that in patients with abscesses with a median length of 2.5 cm and depth of 1.5 cm who were treated with oral trimethoprim-sulfamethoxazole in conjunction with an I&D procedure had a higher cure rate when compared to patients who received an I&D procedure and placebo.

Daum et a.[12] found that in patients with a skin abscess less than or equal to 5cm in diameter treated with oral antibiotics in combination with I&D had improved short-term outcomes compared to those patients treated with I&D alone. A systematic review and meta-analysis by Gottlieb et al,[16] which included the two previously mentioned studies, found that the addition of antibiotics to a drainage procedure improved clinical cure in patients with a SSTI. In all of these studies all patients with an abscess underwent a drainage procedure.

In this study, we found that the optimal cut-off value to

Table 2. Characteristics of patients with a treatment failure.

Patient number	Patient age (yrs), risk factors	Abscess Characteristics	Reason for treatment failure
1	24; none	Duration: 3; Location: Buttock Length:1; Depth:1	Change in antibiotics
2	27; none	Duration: 1; Location: Face Length:0.4; Depth:0.4	Change in antibiotics, Admission
3	53; none	Duration: 2; Location: Face Length:0.61; Depth:1.75	Change in antibiotics
4	35; none	Duration: 3; Location: Arm Length:3; Depth:0.5	I&D
5	46; none	Duration: 3; Location: Labia Length:0.5; Depth:0.7	Admission
6	50; Diabetes	Duration: 3; Location: Scrotum Length:1.2; Depth:0.3	Change in antibiotics, I&D
7	47; none	Duration: 7; Location: Buttock Length:0.7; Depth:0.5	Change in antibiotics, I&D
8	64; Diabetes	Duration: 2; Location: Arm Length:1.2; Depth:1	Change in antibiotics, Admission
9	36; IVDU	Duration: 3; Location: Arm Length:1.1; Depth:0.7	I&D
10	50; IVDU	Duration: 1; Location: Face Length:0.4; Depth:0.2	Change in antibiotics, I&D, Admission
11	48; none	Duration: 7; Location: Leg Length:0.5; Depth:0.5	Change in antibiotics
12	26; none	Duration: 3; Location: Leg Length:1.5; Depth:0.5	I&D
13	52; none	Duration: 1; Location: Buttock Length:1; Depth:1	I&D

Duration is in days; length/depth are in centimeters.
IQR, interquartile range; *IVDU,* intravenous drug use; *I&D,* Incision and drainage.

predict treatment failure by ROC analysis was 1.3 cm in longest dimension with an AUC of 0.60 (95% CI, 0.44-0.76). Unfortunately, this data is not able to accurately determine an abscess size cutoff. This is likely a reflection of both a small sample size and the low number of treatment failures recorded in our data. Further investigation is needed to better define an optimal size cut-point when a drainage procedure is not indicated and a patient may be safely discharged.

There were only 13 (8%) treatment failures. Seventy-six percent were located on the extremities and trunk. Two patients were immunocompromised with diabetes, and two patients used intravenous drugs. Twelve (92%) were discharged with antibiotics, the majority receiving either clindamycin or cephalexin with trimethoprim/sulfamethozaxole. One abscess was 1.75 cm deep to the skin surface and another was 3 cm in length, which may account for their failure. One patient had a treatment failure with a depth and length of 0.4 cm. The abscess did not require drainage, but a change in antibiotics and admission. It is possible that in this case the type of infection played a role in treatment failure. A different patient had a treatment failure with a depth of 0.2 cm and a length of 0.4 cm. This abscess was located on the face, and it is possible that in this case the location led to more aggressive treatment when the patient returned.

There are some limitations to POCUS for SSTIs. Ultrasound image acquisition and interpretation rely on the sonographer's ability to acquire high-quality images to be able to assess whether an abscess is present. An abscess may appear hypoechoic, hyperechoic or even anechoic, and will typically have posterior acoustic enhancement. Additionally, more complicated infections such as necrotizing fasciitis will have subcutaneous thickening, free fascial fluid, and/or subcutaneous air. It is important for the sonographer to be familiar with different findings on soft tissue ultrasound to guide appropriate treatment.

Future research aimed at prospectively assessing which abscesses can safely be treated without a drainage procedure is needed. Future studies should seek to include pre-study training in soft tissue ultrasound with a standardized scanning approach, a larger sample size, consecutive patients, and structured follow-up.

Table 3. Sensitivities and specificities at different cutoffs for length and depth.

Length (cm)	0.25	0.5	0.75	1	1.3	1.5
Sensitivity	100%	92%	92%	92%	85%	62%
Specificity	0%	5%	17%	24%	37%	45%
PPV	8%	8%	9%	10%	11%	9%
NPV	100%	88%	96%	97%	96%	93%
Depth (cm)	0	0.2	0.25	0.4	0.5	1
Sensitivity	100%%	100%	92%	85%	77%	31%
Specificity	0%	34%	53%	68%	75%	97%
PPV	8%	12%	15%	19%	21%	44%
NPV	100%	100%	99%	98%	97%	94%

PPV, positive predictive value; *NPV,* negative predictive value; *cm*, centimeter.

LIMITATIONS

This study has a number of limitations that may affect its generalizability. It is a retrospective study using a pre-existing database of images. There was potential for selection bias as patients were recruited by convenience sampling and may not have represented the general population. To be included in the study patients had to have a soft tissue ultrasound performed and images saved. These images were acquired by sonographers with varying levels of training. It is possible we missed patients who could have been included in the study as no images were saved or due to incorrect/no patient information. We also excluded a large number of patients who received a drainage procedure, including those with smaller abscesses (<1 cm), as this is the most common treatment for an abscess. It is possible that some of these abscesses did not require a drainage procedure. Future studies should include a pre-defined scanning protocol and treatment algorithm based on ultrasound findings to guide in determining which patients should or should not receive a drainage procedure.

Additionally, the number of patients with a treatment failure was relatively small resulting in large CIs, and poor ROC analysis for longest dimension with an AUC of 0.60. Despite this, the AUC for depth was 0.83 suggesting that a depth of 0.4 cm is a good cut-point to be able to differentiate between patients who will or will not fail treatment without a drainage procedure. It is unclear whether the two measurements, length and depth, had an influence on each other with regard to treatment failure. Lastly, as this was a retrospective study we did not collect any data on the type of bacterial infection or control for the antibiotics prescribed. It is possible there are additional unidentified confounders. The data presented in this study raises further questions that should be explored in future prospective studies.

CONCLUSION

This small retrospective study suggests that a skin abscess less than 0.4 cm deep to the skin surface may be treated successfully without an invasive drainage procedure. Those deeper than 0.4 cm may require a drainage procedure. Further data is needed to validate these findings and to assess for an optimal size cut-off when a patient with a skin abscess may be discharged without a drainage procedure.

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Prediction Model for 30-day Outcomes Among Emergency Department Patients with Lower Gastrointestinal Bleeding

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Introduction: There are currently no robust tools available for risk stratification of emergency department (ED) patients with lower gastrointestinal bleed (LGIB). Our aim was to identify risk factors and develop a preliminary model to predict 30-day serious adverse events among ED LGIB patients.

Methods: We conducted a health records review including adult ED patients with acute LGIB. We used a composite outcome of 30-day all-cause death, recurrent LGIB, need for intervention to control the bleeding, and severe adverse events resulting in intensive care unit admission. One researcher collected data for variables and a second researcher independently collected 10% of the variables for inter-observer reliability. We used backward multivariable logistic regression analysis and SELECTION=SCORE option to create a preliminary risk-stratification tool. We assessed the diagnostic accuracy of the final model.

Results: Of 372 patients, 48 experienced an adverse outcome. We found that age ≥75 years, hemoglobin ≤100 g/L, international normalized ratio ≥2.0, ongoing bleed in the ED, and a medical history of colorectal polyps were statistically significant predictors in the multivariable regression analysis. The area under the curve (AUC) for the model was 0.83 (95% confidence interval, 0.77-0.89). We developed a scoring system based on the logistic regression model and found a sensitivity 0.96 (0.90-1.00) and specificity 0.53 (0.48-0.59) for a cut-off score of 1.

Conclusion: This model showed good ability to differentiate patients with and without serious outcomes as evidenced by the high AUC and sensitivity. The results of this study could be used in the prospective derivation of a clinical decision tool. [West J Emerg Med. 2020;21(2)343-347.]

INTRODUCTION

Acute lower gastrointestinal bleeding (LGIB) is a common presentation to the emergency department (ED) and requires hospitalization for up to 87 per 100,000 adults per year.[1–3] Mortality from LGIB can be up to 5%.[4–10] Further, 20% will have recurrent bleeding while being hospitalized after a first LGIB episode,[7,8,11,12] and as many as 24% of patients require an intervention to control the hemorrhage.[4–8,11] Endoscopy plays a major role in the management of LGIB patients; however, there are limited resources for safe after-hours endoscopy in Canada.[13] Risk-stratification of LGIB patients in the ED could help identify patients who need urgent intervention and those who could be safely managed as outpatients.

While several risk tools have been developed, most are not applicable to ED patients as they only include admitted patients and exclude patients who are discharged. Further, these

studies have small patient cohorts, include a large number of predictor variables in their final model, and have a low diagnostic accuracy.[8,9,14–19] Emergency physicians need a new decision tool that overcomes these limitations and will aid them in making evidence-based disposition decisions. The objective of this study was to identify risk factors for serious outcomes among ED patients with LGIB and to develop a preliminary model for a risk-stratification tool to predict 30-day adverse events.

Population Health Research Capsule

What do we already know about this issue?
There are no robust risk tools to predict 30-day adverse outcomes for emergency department (ED) patients with lower gastrointestinal bleed (LGIB).

What was the research question?
We sought to identify risk factors and develop a preliminary model to predict 30-day adverse outcomes in ED LGIB patients.

What was the major finding of the study?
We developed a preliminary model with five predictors that identifies ED LGIB patients at low-risk for 30-day adverse outcomes.

How does this improve population health?
Risk-stratification of ED LGIB patients could reduce the burden on the healthcare system and the associated healthcare costs.

METHODS

Study Design

This was a retrospective cohort study approved by the Ottawa Health Science Network Research Ethics Boards. The research ethics boards of the Queensway-Carleton Hospital approved the study protocol for health records review for patient follow-up and outcome ascertainment.

Study Setting and Population

We conducted the study at two tertiary-care EDs of the Ottawa Hospital among adult patients who presented with acute LGIB between August 2013–June 2014. Clinically, an acute LGIB was defined as bright red blood per rectum in the prior two days, bright red blood on the glove after digital rectal examination, or a clear red bloody stool during the ED visit. We identified potential eligible patients using *International Classification of Disease,* 10th Revision, codes related to LGIB. We excluded patients with the following characteristics: evidence of an upper gastrointestinal bleed without signs of a LGIB; patients who were already hospitalized; those designated palliative with less definitive interventions offered; LGIB secondary to a trauma; and patients who were not from the local area. We excluded multiple patient visits and only included the first visit for LGIB-related symptoms to the ED.

Study Protocol

One investigator collected variables and outcomes using a standardized case record form. A second investigator collected data for 10% of a random selection of the total patient cohort. We calculated a κ-value for inter-observer reliability.

Outcomes

The primary outcome was a 30-day composite outcome of all-cause mortality; significant rebleeding; an intervention to manage the bleeding; and intensive care unit (ICU) admission. Patients could experience multiple outcomes. We defined recurrent bleeding as a significant rebleeding (drop in hemoglobin, requiring blood transfusion or readmission) after 24 hours of clinical stability that was objectively identified on physical examination or endoscopy after index visit disposition. Need for intervention was defined as receiving any of blood transfusion, undergoing endoscopic or surgical intervention, or having angiographic embolization to control the bleeding after the index visit.

Data Analysis

We calculated a sample size of 376 patients, based on a sensitivity of 95% and a bound on error of estimation between 4%-5%.[20] In order to include predictors in our preliminary model, we excluded variables with >25% of data missing, a cell count of ≤5, or a p-value >0.20 in the univariate analysis. We dichotomized the remainder of the variables based on clinical relevance and statistical significance. We then proceeded with multiple imputation with 10 datasets to account for missing data for variables with <25% missing data. We tested for collinearity and removed variables based on clinical and statistical significance.

We performed logistic regression to identify risk factors and derive a preliminary model. We used a stepwise backward selection method with a p-value of <0.01 and the SELECTION=SCORE function in SAS software 9.4 (SAS Institute Inc., Cary, NC, USA). This method produces a model with a specific number of variables, which is useful when the number of outcomes is limited. We used Rubin's rules to combine the estimates of the datasets from the multiple imputation database.[21]

We developed a scoring system based on the point estimates of the odds ratios for the variables in the logistic regression analysis. Variables with a point estimate between 0.5 and 1.49

were assigned one point in the scoring system, and variables with a point estimate between 1.5 and 2.49 were assigned two points. We then calculated sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (LR+), negative likelihood ratio (LR-) and area under the curve (AUC) with 95% confidence intervals (CI) per cut-off score.

RESULTS

We identified 766 potential eligible patients and included 372. See the Figure for a flow diagram. Outcomes were as follows: 61 patients (16.4%) suffered a serious outcome within 30 days; 13 outcomes occurred in the ED (2.5%), while 48 (12.9%) happened after ED disposition. Four patients died, 12 experienced a recurrent bleeding, and 47 interventions were performed to stop the bleeding.

Despite that the INR was only measured in 200 patients (53.8%), we reasoned that it was a clinically relevant variable and decided to use multiple imputations to deal with the missing data. We calculated the mean international normalized ratio (INR) for patients who were taking anticoagulants or diagnosed with liver cirrhosis (mean INR >2.0) and imputed this mean for patients with a missing INR who were on anticoagulants or had liver cirrhosis. We did the same for patients who were not on anticoagulants and did not have a liver disease (mean INR <2.0).

Using the SELECTION=SCORE option in SAS on the 10 datasets from the multiple imputation database, we found that the following five predictors were statistically significant in all 10 datasets: age ≥75 years; INR ≥2.0; hemoglobin ≤100 grams per liter (g/L); clear red bloody stool in the ED; and past medical history of colorectal polyps. These results were similar using the backward selection method.

We then assigned points to the variables based on the point estimates of the odds ratio derived from the logistic regression analysis (Appendix 1). Patients with a hemoglobin ≤100 g/L or INR ≥2.0 were assigned two points for each positive variable. Patients ≥75 years, who had a clear red bloody stool in the ED, or a past medical history of colorectal polyps were assigned one point for each positive variable. This added up to a maximum of seven points. When using a cut-off score of one, the sensitivity was 0.96 (95% CI, 0.90-1.00) and specificity was 0.53 (95% CI, 0.48-0.59). The sensitivity decreased and specificity increased with a higher cut-off score. The AUC was 0.83 (95% CI, 0.77-0.89) (Appendix 2). See the table for the classification performance of all possible cut-off scores.

DISCUSSION

We found five predictors that could aid in risk-stratification of ED LGIB patients: age ≥75 years; INR ≥2.0; hemoglobin ≤100 g/L; clear red bloody stool in the ED; and a past medical history of colorectal polyps. This model had a very good AUC (0.83, 95% CI, 0.77-0.89). The sensitivity and negative predictive value for a cut-off score of one are high, while the negative likelihood ratio is close to zero. Clinically, this means that patients with no risk factors are at very low risk to experience an outcome (Appendix 3). Therefore, this score could aid emergency physicians in identifying low-risk patients who can be managed in an outpatient setting, which could reduce the burden and associated costs on the healthcare system.

This score is an objective addition to clinical gestalt, as clinical gestalt is often influenced by patient-specific and physician-specific factors. As with all clinical decision rules, clinicians will use their judgment as to whether extenuating circumstances place a given patient at particularly high risk for a poor outcome despite the score placing them at low risk, or vice versa. Our priority was to develop a score that would identify low-risk patients, as we thought this would be most valuable to emergency physicians. However, we do acknowledge that ideally a risk score should identify both low-risk and high-risk patients, and all diagnostic accuracies should be high.

LIMITATIONS

The data were retrospectively collected, which is not optimal for establishing a risk prediction model. However, most of the risk factors identified are reliably recorded, clearly understood clinical variables, which minimizes this limitation. We dealt with missing data by excluding variables with >25% missing data, and by using multiple imputations for variables with <25% missing data. INR had >25% missing data; however, we did not exclude it because it was thought to be a clinically relevant variable. We think INR was missed in so many patients as it is not always initially drawn and sometimes has to be added on to the blood work later. A future derivation study should be prospective with robust data collection to reduce the proportion of patients with missing data.

Another limitation is that we only had 48 adverse outcomes, which limits the number of predictors we could include in the final model. This is acceptable as it is a preliminary model, but a future study should include more patients and more adverse outcomes. Further, we used a composite outcome of death, recurrent bleeding, need for intervention, and ICU admission. This was based on previous GI bleed risk-stratification studies and allowed us to identify all high-risk and low-risk patients. We did not compare our data to clinical gestalt as our data were retrospectively collected. Future prospectively collected studies should compare the use of the risk score to clinical gestalt.

CONCLUSION

In this retrospective cohort study, we identified five predictors that could aid in the risk-stratification of ED LGIB patients: age ≥75 years, INR ≥2.0; hemoglobin ≤100 g/L; clear red bloody stool in the ED; and a past medical history of colorectal polyps. Patients with high-risk criteria should be considered for timely management. Future, multicenter, prospective studies should be done to confirm our results, to externally validate the score, and to study the implementation of the score in clinical practice.

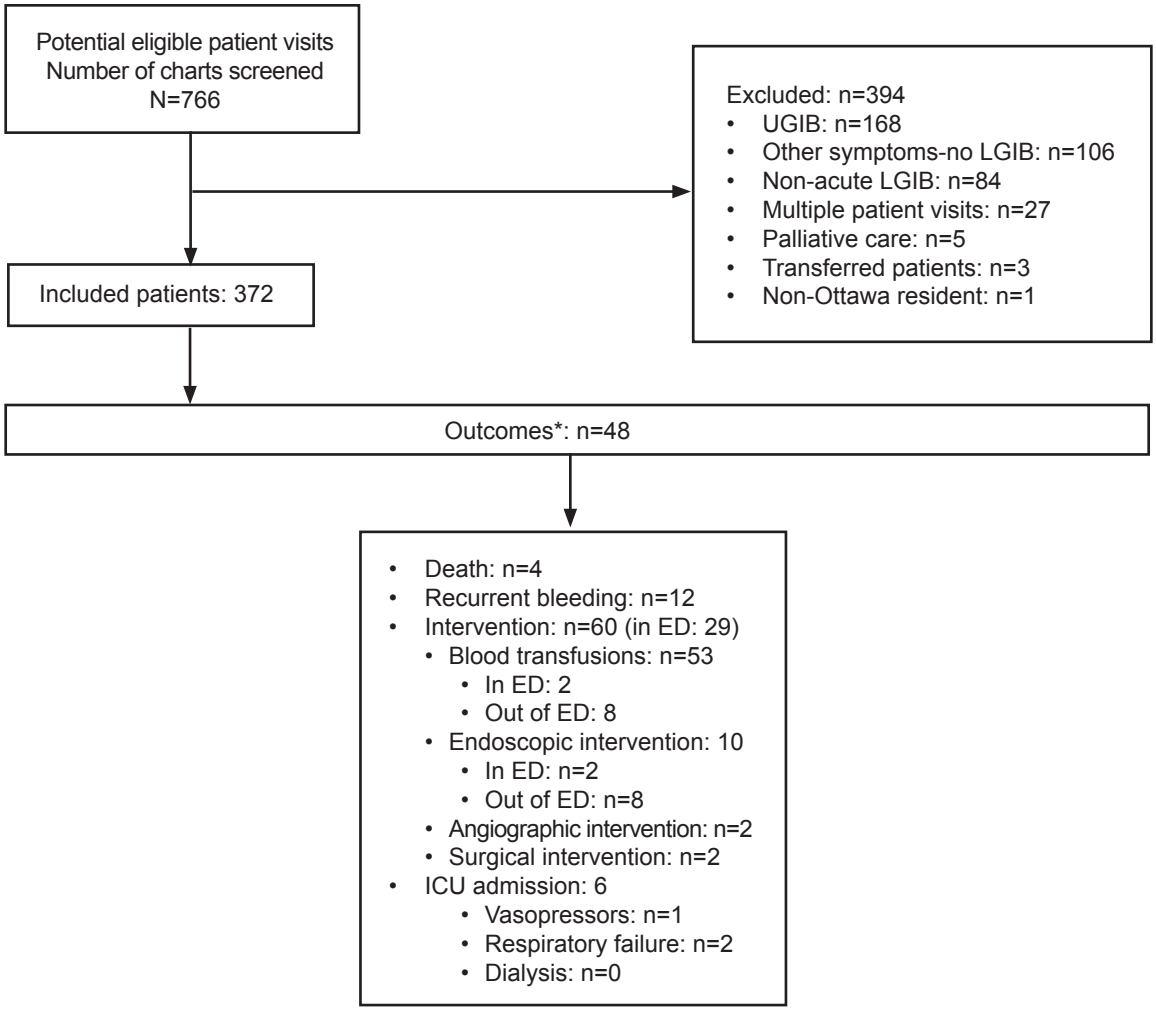

Figure. Flow diagram of patient selection.
*Outcomes after ED disposition. Patients can experience multiple outcomes.
UGIB, upper gastrointestinal bleeding; *LGIB,* lower gastrointestinal bleeding; *ED,* emergency department; *ICU,* intensive care unit.

Table. Diagnostic accuracies of the prediction model per cut-off score.

Cut-off scores*	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)	Positive LR (95% CI)	Negative LR (95% CI)
1	0.96 (0.90-1.00)	0.53 (0.48-0.59)	0.23 (0.17-0.29)	0.99 (0.97-1.00)	2.06 (1.80-2.34)	0.08 (0.02-0.30)
2	0.69 (0.55-0.82)	0.76 (0.70-0.81)	0.34 (0.25-0.44)	0.93 (0.89-0.97)	2.84 (2.11-3.82)	0.41 (0.26-0.64)
3	0.49 (0.35-0.63)	0.91 (0.86-0.94)	0.49 (0.35-0.63)	0.91 (0.86-0.94)	4.93 (3.06-7.97)	0.57 (0.43-0.75)
4	0.33 (0.20-0.47)	0.98 (0.97-1.00)	0.73 (0.54-0.91)	0.91 (0.88-0.94)	18.00 (7.41-44.00)	0.68 (0.56-0.83)
5	0.11 (0.00-0.23)	0.99 (0.98-1.00)	0.60 (0.17-1.00)	0.93 (0.89-0.95)	16.00 (2.80-92.00)	0.90 (0.78-1.02)
6	0.03 (0.00-0.06)	1.00 (1.00-1.00)	1.00 (1.00-1.00)	0.87 (0.84-0.91)	Inf 0.82-482.00	0.98 (0.92-1.02)
7†						

*The diagnostic accuracies are reported for the value of the cut-off score or higher
†0 patients had a score of 7
CI, confidence interval; *PPV,* positive predictive value; *NPV,* negative predictive value; *LR,* likelihood ratio.

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Tricuspid Annular Plane of Systolic Excursion (TAPSE) for the Evaluation of Patients with Severe Sepsis and Septic Shock

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Introduction: Sepsis is a systemic infection that can rapidly progress into multi organ failure and shock if left untreated. Previous studies have demonstrated the utility of point of care ultrasound (POCUS) in the evaluation of patients with sepsis. However, limited data exists on the evaluation of the tricuspid annular plane of systolic excursion (TAPSE) in patients with sepsis.

Methods: We prospectively enrolled patients who presented to the emergency department (ED) with concern for severe sepsis or septic shock in a pilot study. In patients that screened positive, the treating physician then performed POCUS to measure the TAPSE value. We compared the intensive care unit (ICU) admission rate, hospital length of stay, and morbidity with their respective TAPSE values.

Results: We enrolled 24 patients in the study. Eight patients had TAPSE values less than 16 millimeters (mm), two patients had TAPSE values between 16mm-20mm, and fourteen patients had TAPSE values greater than 20mm. There was no statistically significant association between TAPSE levels and ICU admission (p=0.16), or death (p=0.14). The difference of length of stay (LOS) was not statistically significant in case of hospital LOS (p= 0.72) or ICU LOS.

Conclusion: Our pilot data did not demonstrate a correlation between severe sepsis or septic shock and TAPSE values. This may be due to several factors including patient comorbidities, strict definitions of sepsis and septic shock, as well as the absence of septic cardiomyopathy (SCM) in patients with sepsis and septic shock. Future large-scale studies are needed to determine if TAPSE can be beneficial in the ED evaluation of patients with concern for SCM. [West J Emerg Med. 2019;21(2)348-352.]

INTRODUCTION

Sepsis is a systemic infection that can rapidly progress into multi organ failure and shock if left untreated. As a disease process, sepsis carries up to a 25% mortality rate and affects millions of patients annually.[1] Most commonly, a bacterial infection causes a systemic inflammatory cascade leading to a spectrum of physiologic changes.[2,3] The sequelae of sepsis can lead to significant morbidity and mortality in the setting of delayed treatment. As such, there has been increasing pressure on emergency departments

(ED) in the United States to rapidly initiate antibiotics and resuscitative care to patients in early stages of the disease process. Currently, patients are screened using vital sign abnormalities, basic laboratory data, and clinical gestalt. Patients with presumed sepsis are often empirically resuscitated with intravenous fluids and broad-spectrum antibiotics.[4,5]

Septic cardiomyopathy (SCM) is defined as a reversible cardiac dysfunction that results in decreased ejection fraction.[6] In patients with sepsis, the presence of septic cardiomyopathy (SCM) is known to result in significant negative clinical outcomes and a three- to four-fold increase in mortality.[6] Despite the success of sepsis algorithms, a standardized treatment (such as a 30 cubic centimeters per kilogram [cc/kg] fluid bolus) may have uniquely negative consequences in patients with pre-existing conditions such as SCM, congestive heart failure, or pulmonary hypertension. SCM occurs via several different mechanisms. This includes tachycardia, hypotension and eventual end organ damage.[7] While most literature regarding the prognostic implications of SCM has focused on left ventricular function, few studies have evaluated the association between right ventricular dysfunction and sepsis.[8,9] Furthermore, accurately studying the effects of sepsis on SCM is a challenging task due a broad range of variables including systolic vs diastolic ventricular impairment, cardiac output, and end-organ tissue injury.[10] The characterization of sepsis in SCM and alternative management strategies has great potential to positively impact morbidity and mortality in a population predisposed to poor outcomes in the setting of pre-existing conditions.

Previous studies have demonstrated the utility of point of care ultrasound (POCUS) in the evaluation of patients with sepsis.[11,12] However, limited data exists on the evaluation of POCUS for septic cardiomyopathy. There are no specific or sensitive sonographic signs for identifying sepsis or septic cardiomyopathy (SCM) other than those associated with infection at a specific site. Most literature describes SCM in terms of a relationship to left ventricular dysfunction.[13] However, measurements of left ventricular function do not explain the relationship between the high preload from resuscitative efforts. Our study aims to assess the right ventricle in patients with severe sepsis. Specifically, we aim to evaluate tricuspid annular plane systolic excursion (TAPSE), which is an effective indirect method of evaluating right ventricular (RV) function.[14] The American Society of Echocardiography recommends the use of TAPSE as a quantitative method of estimating RV function. Additionally, previous studies have demonstrated that emergency physicians (EPs) are capable of obtaining TAPSE measurements in ED patients.[15,16]

The objective of this pilot study is to evaluate the relationship between RV dysfunction as measured by POCUS obtained TAPSE values in patients presenting to the ED with concern for severe sepsis and septic shock.

Population Health Research Capsule

What do we already know about this issue?
Sepsis is a systemic infection that can rapidly progress if left untreated. No studies have evaluated the tricuspid annular plane of systolic excursion (TAPSE) in patients with sepsis.

What was the research question?
Can TAPSE values be useful in evaluating patients with sepsis and septic shock?

What was the major finding of the study?
Our pilot data did not demonstrate a correlation between severe sepsis or septic shock and TAPSE values.

How does this improve population health?
Point-of-care ultrasound is useful in evaluation of patients with sepsis. However, TAPSE may not be predictive of outcomes for patients with sepsis or septic shock.

MATERIALS AND METHODS

Study Design and Settings

We performed a prospective, observational single-site pilot study using a convenience sample of patients who presented to the ED between March 2018 and February 2019. Patients were enrolled in an urban university hospital ED, which supports an emergency medicine (EM) residency training program as well as an EM ultrasound fellowship. The annual ED census consists of approximately 57,000 patient visits annually with an ethnically and economically diverse patient population. The study was approved by the University of California institutional review board and follows the Standards for Reporting of Diagnostic Accuracy Studies guidelines.

Selection of Participants

Research associates monitored the ED track board for potential patients daily between the hours of 8:00 am and 12:00 midnight. Patients were eligible for inclusion if they were at least 18 years old, able to provide written and verbal consent in English or Spanish, and were undergoing evaluation for sepsis and septic shock. All laboratory tests and imaging studies were performed at the discretion of the treating physician. Patients were excluded if they were pregnant, incarcerated, mechanically ventilated prior to initial evaluation, unable to provide medical consent, or did not meet inclusion criteria. Patients were also excluded if they

had a history of pulmonary hypertension, known pulmonary embolism, or heart failure. The research associates obtained informed and written consent from eligible patients after discussion of the study with the treating physician.

Study Protocol

In patients that screened positive for severe sepsis or septic shock, the treating physician approached the patient for enrollment in the study. Screening for patients was based on the Third International Consensus Definitions for Sepsis and Septic Shock, which includes fever, tachycardia, and hypotension. Screening criteria included at least two of the following: temperature > 38 C or < 36 C, heart rate > 90 beats per minute, respiratory rate > 20 breaths per minute or partial pressure of carbon dioxide (PaCO2) < 32 millimeters of mercury (mmHg), white blood cell (WBC) count > 12,000/mm^3, < 4,000/mm^3, or > 10% bands, and a suspected or present source of infection. For patients with severe sepsis or septic shock, additional criteria included hypotension despite adequate fluid resuscitation or evidence of ≥ 2 organs failing.[5]

Any patient that met criteria was approached for enrollment in the study. Following verbal and written consent, the research team collected data using a systematic approach on a standard data abstraction sheet. Collected data included general demographics such as age and gender, along with history of heart failure, pulmonary hypertension, pulmonary embolism, chronic obstructive pulmonary disease, hypertension, and smoking. Initial vital signs were also collected, along with POCUS measurements in real time during evaluation. Following enrollment and treatment, retrospective data was collected including length of hospital stay (LOS), intensive care unit (ICU) admittance, incidence of respiratory failure, and/or mortality.

TAPSE Protocol

Following consent, the treating emergency physician then performed POCUS to measure the TAPSE value prior to obtaining any laboratory results, imaging test results, or treatment. TAPSE values were obtained using Mindray TE7 (Mindray North America, Mahwah, NJ) ultrasound machines with a phased array transducer in the cardiac software setting. All patients were placed in the left lateral decubitus position to properly obtain an apical 4-chamber view of the heart. An M-mode sampling spike was placed at the right lateral border of the heart at the tricuspid valve annulus, which generated simultaneous live B and M-mode active tracings. A TAPSE value was obtained by measuring the vertical height between the peak and trough in a single cardiac cycle to determine the apex to base shortening.[17] Patients were then differentiated into three groups. Groups included TAPSE values less than 16 mm, TAPSE 16 mm-20 mm, and TAPSE >20 mm.

A total of 14 unique physicians collected TAPSE measurements. This included EM attending physicians, resident physicians, and emergency medicine ultrasound fellows. Prior to the enrollment of patients in the study, all EM physicians underwent a 30-minute didactic lecture followed by supervised hands-on scanning of three healthy volunteer adult models. All practitioners were required to demonstrate the ability to obtain an apical 4-chamber view and correctly take a TAPSE measurement on three models prior to enrolling patients. All POCUS images were archived and reviewed by the ED ultrasound director to confirm appropriate image quality and accurate measurements.

Statistical analysis

Frequencies are represented as count (%) and continuous variables as mean ± standard deviation (SD). Chi square test for trend was used to examine the distribution of death and ICU admission per TAPSE levels. We compared the hospital length of stay and the ICU length of stay with their respective TAPSE values using the Kruskal-Wallis test. The distribution of TAPSE value was examined by using the Kolmogorov-Smirnov statistical test. IBM SPSS Statistics for Windows version 25 was used for data analysis.

RESULTS

32 patients were approached for enrollment in the study. Eight patients were excluded from the final data analysis: two patients declined to participate, five patients reported a history of heart failure, and one patient had a history of pulmonary embolism and was on anticoagulation. A total of 24 patients were enrolled in the study. Four patients (16.7%) were female and 20 patients (83.3%) were male. The mean age of the enrolled patients was 56 ± 18. See Table 1 for full patient characteristics.

Patients were organized into three different TAPSE groups. Eight patients had TAPSE values less than 16 mm, two patients had TAPSE values between 16 mm-20 mm, and fourteen patients had TAPSE values greater than 20 mm. The distribution of TAPSE value was not far from normal (P=0.20). The mean TASPE value was 20.8 with SD of 6.68 (Range: 9.6-34.2). In the TAPSE group less than 16 mm, two patients (25%) were admitted to the ICU and none had mortality during admission. In the TAPSE group 16mm-20mm, one (50%) was admitted to the ICU and none had mortality during admission. In the TAPSE group greater than 20mm, 11 (45.8%) were admitted to the ICU and three (21.4%) had mortality during admission. There was not a statistically significant association between TAPSE levels and ICU admission (p=0.16) or death (p=0.14).

The average hospital length of stay (LOS) for each group was 99±51, 184±92 and 132±57 hours respectively. The average ICU LOS for each group was 34±49, 96±48 and 51±38 hours respectively. The difference of LOS was not statistically significant neither in case of hospital LOS (p= 0.72) nor ICU LOS (p=0.75).

Table 1. Characteristics of study sample.

		Count (%)
Gender	Female	4 (16.7%)
	Male	20 (83.3%)
HTN	No	14 (58.3%)
	Yes	10 (41.7%)
Smoking	No	16 (66.7%)
	Yes	8 (33.3%)
3+ SIRS criteria	No	12 (52.2%)
	Yes	11 (47.8%)
ICU admission	No	10 (41.6%)
	Yes	14 (58.3%)
Mortality	No	21 (87.5%)
	Yes	3 (12.5%)
Age	56±18	Range: 19-87; Median=60
Hospital LOS	118±74	Range: 0-312; Median=12
ICU LOS	38±48	Range: 0-144; Median=24

HTN, hypertension; *SIRS*, systemic inflammatory response syndrome; *ICU*, intensive care unit; *LOS*, length of stay.

DISCUSSION

Severe sepsis and septic shock are commonly evaluated and treated in the ED. However, currently there are no gold standard ultrasound findings that can be used to identify severe sepsis or SCM. Our study aims to determine if there is a role for the assessment of TAPSE in patients with severe sepsis and septic shock. Our pilot data does not demonstrate any significant difference between ICU admission or mortality based on ED measured TAPSE values. On retrospective review of physician charting, all patients received a resuscitative fluid bolus in addition to antibiotics. Based on previous studies, we divided our patients into three categories (TAPSE value 16 mm or less, TAPSE value 16 mm to 20 mm and TAPSE value greater than 20mm). Although we excluded patients with known heart failure and other cardiac co-morbidities, other factors including age may also play a role in TAPSE values distinct from the effects of severe sepsis or septic shock. The lack of gold standard radiologic findings specific to sepsis combined with the broad definition of sepsis made establishing TAPSE cutoffs difficult. Additionally, altering the measurement cutoffs for RV dysfunction in our study did not yield statistically significant results.

A previous study by Daley et al. evaluated TAPSE values in patients with pulmonary embolism and used a cutoff of 20 mm to yield a 72% sensitivity for detecting pulmonary embolism.[15] Other literature uses 17 mm as a threshold for right ventricular dysfunction (RVD).[18] As such, there is no consensus on what TAPSE value predicts worsening or improving right ventricular function or precludes its utility in clinical decision making when evaluating patients with severe sepsis or septic shock. To our knowledge, no previous studies have evaluated the relationship between sepsis or septic cardiomyopathy and TAPSE values. Thus, there are no defined numerical values where TAPSE becomes clinically significant in patients with severe sepsis, septic shock, or SCM.

The most challenging aspect of the research in defining the role of TAPSE in SCM was defining a patient population with sepsis based on non-specific markers, such as vitals, basic laboratory data, and clinical judgement. Recent efforts have been focused on eliminating the Systemic Inflammatory Response Syndrome (SIRS) requirement, as fever, tachycardia, blood pressure, and white blood cell count are too broad to be applied to critically ill patients.[19] Using standard SIRS as criteria, we captured a broad range of infectious sources as well as a range disease pathogenicity. Additionally, we were challenged in attempting to control for the numerous comorbidities with known associations that impact sepsis and shock.[20] Other definitions of sepsis including the quick sequential organ failure assessment (qSOFA) was also considered. However, neither definition is narrow enough. This broad definition of sepsis leads to understanding the condition as a spectrum of disease. Recruiting patients for our study also proved difficult due to comorbidities in this patient population. Eight patients (25%) were excluded from data analysis due to existing cardiovascular conditions that may have affected their TAPSE measurement.

Furthermore, patients who meet SIRS criteria and are ultimately diagnosed with severe sepsis or even septic shock may not exhibit septic cardiomyopathy. While using standards to identify and quickly evaluate patients with infection is useful, the correlation between defined sepsis and SCM is unclear and warrants future projects. The evaluation of the right ventricle in an otherwise healthy patient with severe sepsis or septic shock may not demonstrate signs of SCM based on anatomy and physiology. Furthermore, additional values traditionally evaluated in patients with SCM may not always correlate with TAPSE values. This includes lactic acidosis and troponin.[21] Further studies are warranted to assess the value of TAPSE measurements in select patient populations such as sepsis or SCM. Based on our pilot data, future large-scale studies are needed to evaluate right heart findings in comparison to global cardiac dysfunction in patients with confirmed SCM to better understand the role of TAPSE in this patient population.

LIMITATIONS

This study has several limitations. A small number of patients (24) were enrolled utilizing a convenience sample population. This may have introduced selection bias and decreased validity. A single site was used, and the findings from this site may not be generalizable to other patient populations. SIRS criteria was used to identify patients with sepsis and septic shock. The variability of sepsis and septic

shock allows a broad category of patients to be diagnosed with such conditions making it difficult to study the immediate relationship between TAPSE value and outcomes for these patients. Our study did not seek to determine the amount of training required for proficiency in obtaining or interpreting TAPSE values. Measurements may be affected by operator experience leading to a greater impact on a study, especially with a smaller sample size. Interrater reliability was not measured in this study.

CONCLUSIONS

Our pilot data did not demonstrate a correlation between severe sepsis or septic shock and TAPSE values. This may be due to several factors including patient comorbidities, strict definitions of sepsis and septic shock, as well as the absence of SCM in patients with sepsis and septic shock. Future large-scale studies are needed to determine if TAPSE can be beneficial in the ED evaluation of patients with concern for SCM.

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Comparison of Ultrasound-Guided Vs Traditional Arterial Cannulation by Emergency Medicine Residents

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Introduction: We sought to determine whether ultrasound-guided arterial cannulation (USGAC) is more successful than traditional radial artery cannulation (AC) as performed by emergency medicine (EM) residents with standard ultrasound training.

Methods: We identified 60 patients age 18 years or older at a tertiary care, urban academic emergency department who required radial AC for either continuous blood pressure monitoring or frequent blood draws. Patients were randomized to receive radial AC via either USGAC or traditional AC. If there were three unsuccessful attempts, patients were crossed over to the alternative technique. All EM residents underwent standardized, general ultrasound training.

Results: The USGAC group required fewer attempts as compared to the traditional AC group (mean 1.3 and 2.0, respectively; p<0.001); 29 out of 30 (96%) successful radial arterial lines were placed using USGAC, whereas 14 out of 30 (47%) successful lines were placed using traditional AC (p<0.001). There was no significant difference in length of procedure or complication rate between the two groups. There was no difference in provider experience with respect to USGAC vs traditional AC.

Conclusion: EM residents were more successful and had fewer cannulation attempts with USGAC when compared to traditional AC after standard, intern-level ultrasound training. [West J Emerg Med. 2020;21(2)353-358.]

INTRODUCTION

Arterial cannulation (AC) is often required in critically ill patients for continuous blood pressure monitoring, arterial blood gas sampling, and frequent blood draws.[1,2] A common site for AC is the radial artery due to its superficial accessibility, safety due to the dual blood supply of the hand and relatively low complication rate.[1-3] The palpation technique has long been the standard of care for inserting radial arterial catheters, but this technique can be difficult on obese, edematous, and hypotensive patients, leading to multiple attempts.[2,3] Failure of this procedure can lead to hematomas, hemorrhage, and arterial vasospasm, which can compromise blood supply downstream.[2, 4-6] These complications become more likely with increased number of cannulation attempts.[1-2, 7, 8]

Ultrasound (US) guidance to cannulate central and peripheral veins has proven successful, safe, and effective.[10-12] It has become the standard of care for central line placement at most academic medical centers. Using US for arterial line placement has proven itself in the perioperative setting[4, 8, 13-16] and in several systematic reviews.[9, 17-18] In one systematic review, Shiloh et al demonstrated that "compared with the palpation method, ultrasound guidance for arterial catheterization was associated with a 71% improvement in the likelihood of first-attempt success."

Shiver et al studied US-guided arterial cannulation (USGAC) in the emergency department (ED) and found USGAC was successful more frequently and took less time to establish the arterial line as compared with the palpation

method.[2] Two recent studies involving anesthesia residents found benefit using USGAC.[13,14] However, these perioperative patient populations are typically more hemodynamically stable and AC is less urgent than in an emergency department (ED) setting. USGAC has never been studied with emergency medicine (EM) residents. Our study design mirrored that of Shiver et al, who performed their randomized controlled trial using US-credentialed attending "experts" as operators. We sought to reproduce their findings and validate their results but instead used residents, with standard US training, as US operators. This study sought to compare traditional AC to USGAC as performed by EM residents with varying skill levels in US. We hypothesize EM residents with standard US training will have more success with AC using US guidance vs traditional AC technique.

Population Health Research Capsule

What do we already know about this issue?
Ultrasound (US) is well established in the literature as a procedural adjunct that enhances patient safety and successful placement for central venous catheters.

What was the research question?
Can US novices duplicate this success with arterial lines?

What was the major finding of the study?
Emergency medicine residents with minimal training were able to successfully thread arterial catheters with fewer attempts when they used US.

How does this improve population health?
Physicians should consider using US when available to decrease the number of painful arterial sticks in critically ill patients.

METHODS

This study was a prospective, randomized, interventional study conducted at a tertiary care, academic urban ED with approximately 70,000 adult visits per year. Patients were enrolled over an 18-month (2014-2015) and an additional eight-month (2017) period to allow for additional enrollment in the study. ED patients over 18 years of age requiring AC for continuous blood pressure monitoring or frequent blood draws were enrolled in the study. Exclusion criteria were those with contraindications for radial arterial access, such as overlying cellulitis or bony injury, a pre-existing arterial catheter at an alternative site, or any other reason for exclusion for patient or staff safety at the discretion of the ED attending physician. Research was conducted in accordance with ethical standards of the institutional review board (IRB). The IRB determined that the study was a quality improvement effort because both forms of line placement were currently in use in the ED and in line with the standard of care; thus patient consent was waived.

Second- and third-year EM residents performed AC. Each participating resident completed a four-hour intern training session introducing interns to the focused assessment with sonography in trauma (FAST) exam, vascular access, cardiac, gallbladder, renal, musculoskeletal, thoracic and ocular US. Intern year includes a two-week intern US rotation. This rotation includes scanning sessions with US faculty, and weekly Q/A sessions and instruction. These sessions are standard to the curriculum at our residency; there were no deviations or changes when the study started. This training reflects that residents underwent basic US training as set forth by the 2016 American College of Emergency Physicians (ACEP) Ultrasound Guidelines.[19] These guidelines stipulate the number of US needed in each US competency to qualify for graduation. They all completed at least five US-guided vascular access procedures, and the images were reviewed by the institution's emergency ultrasound director. Residents are required to complete this requirement at the completion of their intern year.

Quality assurance of all procedures is reviewed by the US director, and all invasive lines are supervised by an attending physician. Eligible patients were randomized by the last digit of their medical record number (MRN). If the last digit of the patient's MRN was odd, traditional AC by palpation was performed; if the last digit of the MRN was even, US-guidance was used. Standard Arrow (Teleflex, Morrisville, NC) 20-gauge arterial catheters were used for all procedures.[20] Both Sonosite M-turbo US (Fujifilm Sonosite, Bothell, WA) with 13-6 megahertz (MHz) linear transducers and Philips Sparq (Koninklijke Philips, Amsterdam, the Netherlands) US with 12-4 MHz linear transducers were available for USGAC.

Patients were prepped for an arterial line in the standard sterile fashion with patient supine, wrist extended and hand fixed with adhesive tape. For the USGAC group, the US machine was prepped with a sterile probe cover. The procedure duration was timed by an available attending, nurse, or ED technician; for both techniques, the stopwatch began when the needle punctured the skin. Once the skin was punctured, the resident could redirect the needle, but each time the needle exited and re-entered the skin it was considered an additional attempt. An attempt was successful and time was stopped when pulsatile blood was returned through an advanced arterial catheter, at which point the line was secured. To minimize the possibility of numerous failed attempts at AC, we limited access attempts in each group to three per patient. If they were not successful after three attempts the clock was stopped, time was noted, and they crossed over to the alternative technique as a rescue maneuver to achieve line placement and for patient comfort.

Patient demographic data, heart rate, blood pressure, and characteristics such as vasopressor use and intubation were noted. We recorded data on the number of attempts, time of the procedure in seconds, whether the catheter was successfully placed, or whether they needed to cross over to the alternate technique. Complications at the time of the placement were also noted; these included lacerations, arterial occlusion, and hematoma. Additionally, a record was kept of the degree of previous experience that each subject had with palpation and US-guided arterial lines. All data was stored on a protected institutional server.

The primary outcome variable was the number of attempts needed for successful arterial catheter placement. The secondary outcome variables included time zero to arterial catheter placement and number and type of complications.

Sample-size calculations were based on prior studies. We compared the palpation and US-guided groups using descriptive statistics. The number of attempts needed for successful arterial catheter placement, and time to successful placement was compared using t-tests after normality and variance were assessed. Comparison of the proportion successful and with complications was done using χ^2 tests. We analyzed data using STATA 15.0 (StataCorp, College Station, TX).

RESULTS

A total of 60 patients were enrolled into the study, with 30 randomized to the palpation group and 30 to the US-guided group. Demographic information and indications for AC can be found in Table 1. There were no significant differences between the two groups with respect to any demographic information,

Table 1. Patient demographics, clinical characteristics and indications for arterial line placement.

		Arterial line placement	
	Overall (n=60)	US guided (n=30)	Palpation (n=30)
Gender, n (%)			
Male	32 (53.3)	15 (50.0)	17 (56.7)
Female	28 (46.7)	15 (50.0)	13 (43.3)
Age, mean (SD)	61.2 (±16.75)	62.4 (±16.09)	60.0 (±17.61)
(Missing = 1)			
BMI, mean (SD)	27.3 (±7.75)	27.3 (±8.25)	27.4 (±7.39)
(Missing= 8)			
HR, mean (SD)	87.8 (±27.79)	89.7(±30.77)	85.8(±24.73)
(Missing =1)			
MAP, mean (SD)	92.1(±40.18)	99.7 (±42.57)	84.8 (±36.99)
SBP, mean (SD)	127.9(±59.28)	133.6 (±62.39)	122.1 (±56.37)
Intubated, n (%)			
Yes	30 (50.0)	18 (60.0)	12 (40.0)
No	30 (50.0)	12 (40.0)	18 (60.0)
Pressors, n (%)			
Yes	15 (25.0)	7 (23.3)	8 (26.7)
No	45 (75.0)	23 (76.7)	22 (73.3)
		Indications for arterial line placement	
BP Monitoring, n (%)			
Yes	54 (90.0)	27 (90.0)	27 (90.0)
No	6 (10.0)	3 (10.0)	3 (10.0)
ABG Sampling, n (%)			
Yes	17 (28.3)	10 (33.3)	7 (23.3)
No	43 (71.8)	20 (66.7)	23 (76.7)
Frequent Blood Draws, n (%)			
Yes	7 (11.7)	4 (13.3)	3 (10.0)
No	53 (88.3)	26 (49.1)	27 (90.0)

US, ultrasound; *SD,* standard deviation; *BMI,* body mass index; *HR,* heart rate; *MAP,* mean arterial pressure; *SBP,* systolic blood pressure; *ABG,* arterial blood gas.

clinical characteristics, or arterial line indication ($p<0.05$). Sixteen (53%) patients in the palpation group required rescue with US guidance and one (3%) crossed over from the US group to palpation (Table 2). An arterial line required a mean of 1.3 attempts in the US group vs 2.0 attempts in the palpation group ($p<0.001$). An arterial line was successfully placed in 29 (96%) of the US group vs 14 (47%) in the palpation group ($p<0.001$). Of the 16 failed traditional AC that crossed over to USGAC, there was 100% (16/16) success rate with USGAC rescue. We found no significant differences in the time it took for placement or the complication rate between the two arms. There was no significant difference in the providers' prior experience with respect to USGAC vs traditional AC (Table 3).

DISCUSSION

The study hypothesis stated EM residents with standard US training would be more successful using US guidance for AC than using the traditional palpation technique. This study reproduced the findings and validated the results by Shiver et al, who used US-credentialed faculty instead of residents to illustrate that USGAC was more successful than the palpation technique for placing arterial lines.[2] Our results indicate US is safe, has a high success rate, and can be performed proficiently after standard training. In our clinical experience, USGAC is often used as a back-up when traditional palpation techniques failed. This often occurs with critical patients who are hypotensive, obese or, edematous. The success rate of

Table 2. Mean number of attempts at arterial line placement, number of successful attempts, mean time to complete the procedure successfully, and number of complications.

	Arterial line placement		
	US Guided (n = 30)	Palpation (n = 30)	P-value
Attempts, mean (±SD)	1.3 (±0.596)	2.0 (±0.928)	<0.001
Success, n (%)			<0.001
Yes	29 (96.7)	14 (46.7)	
No	1 (3.3)	16 (53.3)	
Time (seconds), mean (SD)	235.9 (±203.4)	249.1 (±255.0)	0.83
Complications, n (%)			0.15
Yes	6 (20.0)	11 (36.7)	
No	24 (80.0)	19 (63.3)	
Complication type			0.36
Hematoma	5 (16.7)	9 (30.0)	
Laceration	0 (0.0)	0 (0.0)	
Occlusion	1 (3.3)	2 (6.7)	
None	24 (80.0)	19 (63.3)	

US, ultrasound; *SD,* standard deviation.

Table 3. Provider experience: the number of arterial lines placed using ultrasound and palpation by residents in their career, and number of residents by postgraduate year in each group.

	Overall (n = 60)	US Guided (n = 30)	Palpation (n = 30)	P-value
US-Guided Experience; n (%)				0.07
<10 A lines	21 (35.0)	9 (30.0)	12 (40.0)	
10-30 A lines	30 (50.0)	19 (63.3)	11 (36.7)	
>30 A lines	9 (15.0)	2 (6.7)	7 (23.3)	
Palpation Experience, n (%)				0.38
<10 A lines	27 (45.0)	15 (50.0)	12 (40.0)	
10-30 A lines	27 (45.0)	11 (36.7)	16 (53.3)	
>30 A lines	6 (10.0)	4 (13.3)	2 (6.7)	
Resident Level, n (%)				0.07
PGY2	31 (51.7)	12 (40.0)	19 (63.3)	
PGY3	29 (48.3)	18 (60.0)	11 (36.7)	

US, ultrasound; *PGY,* postgraduate year; *A*, arterial.

initial arterial line placement with US over palpation alone is significant (96% vs 47%). Also notable is the percentage of arterial line placements randomized to the palpation technique that converted to US rescue for successful placement (53%). One may argue that the difference between the groups may be because the residents are not good at placing arterial lines by palpation. However, as outlined in Table 3, there was no difference with respect to residents' prior experience with placing arterial lines with or without US.

The ACEP 2016 Emergency Ultrasound Guidelines and several sources routinely highlight the safety and efficacy of US guidance for central venous access, but AC is not universally noted or included.[20] Along with central line placement, US-guided arterial line catheterization should be taught and considered standard of care for physicians who have undergone standard US training for vascular access. Additionally, these findings have implications for other specialties with less standardized or formalized ultrasound education. If novices can do this quickly and successfully, one could conclude this would prove useful in the intensive care and perioperative settings as well.

LIMITATIONS

This study was limited by its single-site enrollment. Due to the critically ill nature of the patients requiring AC, enrollment was likely lower overall and took longer to complete. Our enrollment period was extended to enroll more patients and improve statistical calculations. The gap between enrollment periods was due to new researchers adding to the project. There were no changes to methodology or resident US training during this time period. In a busy ED it often was not feasible to remember to enroll patients for randomization; oftentimes, the procedure needed to be performed emergently. We have a convenience sampling of patients, and sampling bias was involved. Additionally, the 24/7 nature of enrollment meant that the timekeepers were not formally trained and no inter-rater reliability testing could be validated. This may have influenced overall time calculations, likely on the extremes. Future, larger studies are needed to validate our results.

CONCLUSION

This study demonstrated EM residents were more successful and had fewer cannulation attempts with ultrasound-guided radial arterial cannulation when compared to the traditional AC method after standard, intern-level US training. We conclude that using US guidance for AC requires standard training and can be useful for physicians and improve quality of care and safety for their patients.

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Does Orally-Administered Radiocontrast Impair Ultrasound Image Quality in Pediatric Patients?

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Introduction: It is commonly assumed that orally-administered radiocontrast material (ORC) preceding abdominal ultrasound (US) performance can obscure image quality and potentially impair diagnostic accuracy when assessing patients with abdominal pain. Due to this concern, ORC administration per protocol for computed tomography (CT) is often delayed until after US performance, potentially contributing to prolonged length of stay in the emergency department (ED) in patients with concern for abdominal pathology. The objective of this study was to evaluate whether early administration of ORC in children with abdominal pain receiving abdominal CT for possible appendicitis obscures subsequent abdominal US image quality.

Methods: We designed a prospective observational study of children <18 years of age presenting to a pediatric ED with abdominal pain who were set to receive ORC prior to obtaining an abdominal CT. These patients received a point-of-care ultrasound (POCUS) of the abdomen to assess the abdominal aorta and right lower quadrant (RLQ) structures (psoas muscle and iliac vessels) pre- and post- ORC administration. Images were compared independently by two blinded emergency US-certified physician-assessors for quality, specifically to determine whether ORC obscured the anatomical structures in question.

Results: A total of 17 subjects were enrolled, and each subject had two POCUS studies of the abdomen, one pre- and one post-ORC administration looking to visualize the anatomy of the RLQ and abdominal aorta in both studies. Statistical analysis showed no significant differences in mean values of POCUS image quality scoring by two blinded US-trained physician-assessors for either RLQ structures or abdominal aorta when performed pre- and post-administration of ORC.

Conclusion: Early ORC administration in children with abdominal pain does not adversely affect image quality of a subsequently performed abdominal US. Patients who may require abdominal CT to determine the etiology of abdominal pain can receive early administration of ORC prior to US performance to help minimize ED length of stay without impairing US diagnostic accuracy. [West J Emerg Med. 2020;21(2)359-364.]

INTRODUCTION

Abdominal pain is a common pediatric outpatient complaint, accounting for 5-10% of all pediatric emergency department (ED) visits.[1] The differential diagnosis can range from benign conditions to surgical emergencies, or to potentially catastrophic conditions such as malrotation with midgut volvulus. The ability to expeditiously evaluate and accurately diagnose a patient with appendicitis can be challenging and time intensive. Delaying time to diagnosis in appendicitis can lead to perforation, while expeditiously managing patients who require a stepwise approach to pediatric abdominal pain can minimize time to diagnosis and length of stay in a busy ED. Historically, oral and/or rectal contrast has been used when performing abdominal computed tomography (CT) due to the non-opacification in luminal obstruction, such as that that seen in an inflamed or obstructed appendix.

There is a theoretical concern that the presence of orally administered radiocontrast (ORC) in the gastrointestinal tract could obscure ultrasound (US) image quality and therefore potentially affect diagnostic accuracy in evaluating patients with abdominal pain. Thus, ORC administration is often delayed until after US performance. This delay can contribute to inefficient patient flow, prolonged ED length of stay, and ultimately an increase in time to diagnosis. We chose to use the psoas muscle, iliac vessels, and abdominal aorta as the landmarks in this study because these structures are readily and easily identifiable and would be presumed to be obscured by ingested oral contrast in the bowel that overlies these organs. If these structures were easily identified on the same patient in both pre- and post-ORC point-of-care ultrasound (POCUS) images, then we can conclude that administration of oral contrast does not affect US image quality and can be administered as early as possible. This can reduce wait time to CT and shorten time to diagnosis in patients with abdominal pain potentially leading to less complications. We know of no such study that has looked at this issue in children.

The purpose of this study was to determine whether ORC administration in children with abdominal pain affects the image quality of a subsequently performed abdominal US, either POCUS or formal radiological study.

Population Health Research Capsule

What do we already know about this issue?
It is thought that orally administered radiocontrast (ORC) before abdominal ultrasound (US) can obscure image quality and impair diagnostic accuracy in patients with abdominal pain.

What was the research question?
Does ORC in children receiving computed tomography (CT) for appendicitis obscure subsequent abdominal US images?

What was the major finding of the study?
Early ORC in children does not adversely affect image quality of a subsequently performed abdominal US.

How does this improve population health?
Patients requiring CT to determine the etiology of abdominal pain can receive ORC prior to US to help minimize ED length of stay without impairing US diagnostic accuracy.

STUDY DESIGN AND SETTING

We conducted a prospective observational study on children <18 years old who presented to the pediatric ED (PED) between June 2014 and March 2016. We used a convenience sample, as eligible children were screened whenever study personnel were available. The study was approved by the hospital's institutional review board. Children with abdominal pain were selected if there was a consideration for abdominal pathology requiring US and, if not diagnostic, subsequent CT. The hospital's PED is located in Brooklyn, New York, with an annual patient volume of approximately 36,000; of that total, approximately 200 children are diagnosed with appendicitis each year.

Prior to initiating the study, all participating emergency physicians in the PED received formal instruction in performing POCUS examinations of the abdominal aorta and right left quadrant (RLQ) structures (psoas muscle and iliac vessels) or received in-service training on POCUS examination of the abdominal aorta and RLQ structures. Prior to enrolling patients, the non-fellowship trained physicians were also required to perform 25 scans in which image quality was evaluated and approved by physicians in the division of emergency US. There were three enrolling physicians: two were pediatric point-of-care emergency ultrasound fellowship- trained attendings and one was a pediatric emergency medicine (PEM) fellow with no prior background in emergency US. The PEM fellow researcher received in-service training on POCUS examination of the abdominal aorta and RLQ structures, and prior to enrolling patients was also required to perform 25 of these scans in which image quality was evaluated and approved by physicians in the division of emergency ultrasound. POCUS examinations were performed with a Siemens Zonare Z.one Ultra (Zonare Medical Systems, Inc. Mountain View, California) US machine, using a curvilinear probe (6-2 megahertz [MHz] transducer) and/or a linear probe (8-10 MHz transducer).

Inclusion and Exclusion Criteria

Children met inclusion criteria if they were <18 years old with a non-diagnostic radiology-performed US for abdominal pain, who then required ORC for subsequent abdominal CT. We excluded children with a chronic gastrointestinal condition, a prior history of appendicitis, a history of allergy to ORC, a patient who had received ORC prior to arrival to the PED, and/or patients who had unstable vital signs.

Methods

After we obtained informed written consent, patients received an emergency physician-performed POCUS evaluation, specifically imaging the abdominal aorta and RLQ structures (psoas muscle and iliac vessels) pre-ORC administration. Physicians obtained images, as per protocol, which entailed taking representative images in longitudinal and transverse orientation at the level of the cecum looking at the iliac vessels and psoas muscle and of the abdominal aorta. This was to ensure that differences in image quality would not be due to differences in technique or location. These images were recorded and stored.

Patients were then transported to the radiology department and received a formal radiology-performed abdominal US exam. Once the radiologist interpreted their study as non-diagnostic for appendicitis or other abdominal pathology, and the treating team felt the need to continue the diagnostic work up with a CT, ORC was ordered. The patient then received a weight-based dose of ORC, either diatrizoate meglumine 66%-diatrizoate sodium 10% and organically bound iodine (Gastroview) 366 milligrams organic iodine per milliliter (mgI/mL); OR iohexol 1.21 milligrams per milliliter (mg/mL) tromethamine and 0.1 mg/mL edetate calcium disodium and organically bound iodine (Omnipaque) 240 mgI/mL mixed with a weight-based amount of water or apple juice as per protocol, at time zero minutes. A repeat ED abdominal POCUS was performed by the same study physician who performed the initial ED POCUS in the same exact method between 90-120 minutes post-ORC administration. Once these images were recorded the study was concluded for that patient (Figures 1 and 2). The radiology-performed ultrasound had no bearing on the study parameters and was not assessed by the study team.

Additional data collected (Table 1) included the child's age, gender, weight, height, body mass index, type and volume of contrast received, time interval between ORC administration and performance of US exams, volume and time of contrast ordered and ingested, and whether or not the patient vomited after drinking contrast.

Both pre- and post-ORC POCUS images were randomized with a non-descript code, and blinded physician-assessors were not aware which images were pre- or post-ORC. Individual subjects were not otherwise identifiable. The physician-assessors of the US images were fellowship-trained in point-of-care emergency ultrasonography and each had performed well over 1000 POCUS examinations, and over 10,000 quality assurance reviews of POCUS examinations. Assessors were blinded to all clinical details and identities and were not involved in recruitment of patients or image acquisition. All POCUS images were compared, evaluated and rated using a five-point Likert scale: 1 = not interpretable; 2 = barely interpretable; 3 = adequate for interpretation but of poor quality; 4 = interpretable and of average quality; 5 = interpretable and of superior quality.[2]

It was the goal of the assessors to determine whether the structures in question – the psoas muscle, iliac vessels and abdominal aorta – were either visible or not visible in each image. The assessors responsible for the blinded image review of the pre- and post-ORC POCUS studies did not perform any of the study ultrasounds on the subject patients. Again, the "formal" radiology-performed studies were not reviewed as they had no bearing on the study question.

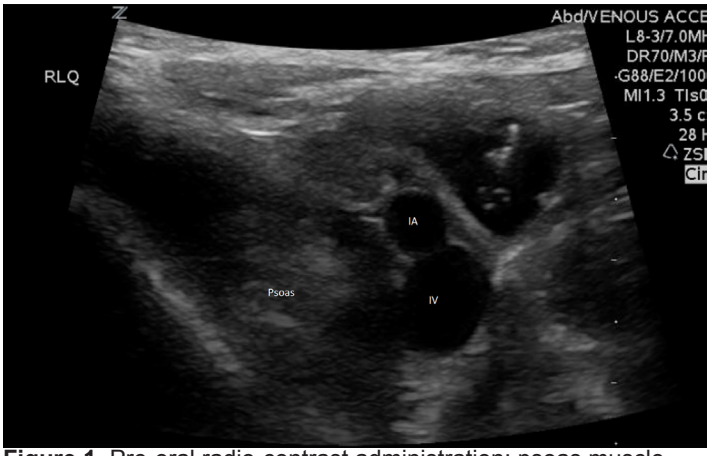

Figure 1. Pre-oral radio-contrast administration: psoas muscle and iliac artery (IA) and iliac vein (IV) labeled.

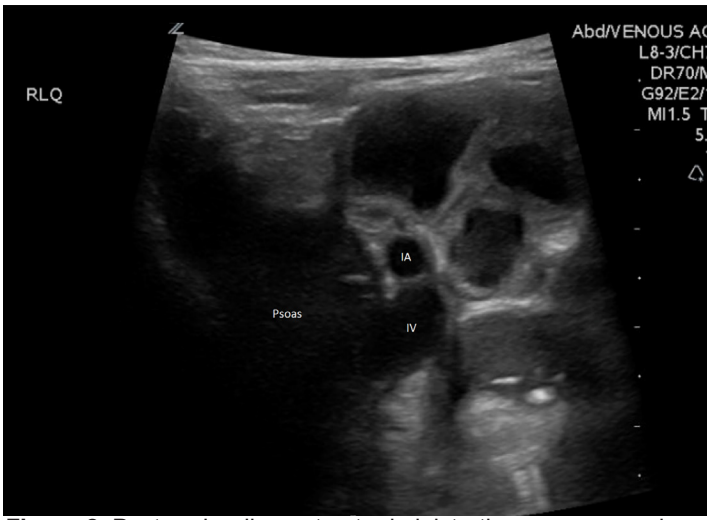

Figure 2. Post-oral radio-contrast administration: psoas muscle and iliac artery (IA) and iliac vein (IV) labeled.

Table 1. Patient characteristics.

	N=17	
Mean age, years	10.3	±3.8
Male gender	10	59%
Mean weight, kg	41	±17.1
Mean height, cm	140.3	±24.2
Mean BMI	19.4	±5.1
Omnipaque™	12	71%
Gastroview™	4	29%
Median contrast ordered, ml	18	(12.8, 21.5)
Median total volume ordered, ml	360	(300, 475)
Vomiting	0	0%
Median time to drink contrast, min	15	(10, 22.5)
Median time to post-ORC US, min	95	(90,112.5)

Kg, kilograms; *cm*, centimeters; *BMI*, body mass index; *ml*, milliliters; *min*, minutes; *post-ORC US*, post oral radio-contrast ultrasound.
± values are standard deviations, numbers in parentheses are interquartile ranges (IQR) (25th percentile, 75th percentile).

Table 2. Comparison of ultrasound image quality of the right lower quadrant (RLQ) structures and abdominal aorta pre- and post-oral radio-contrast (ORC) administration.

Study	Pre-ORC	Post-ORC	P-value
RLQ structures (N=17)	3.68±0.81	3.41±0.66	0.132
Abdominal aorta (N=17)	3.65±0.81	3.18±0.90	0.060

Mean values (±standard deviation).
Results based on a 5-point Likert Scale (Norman G, 2010).

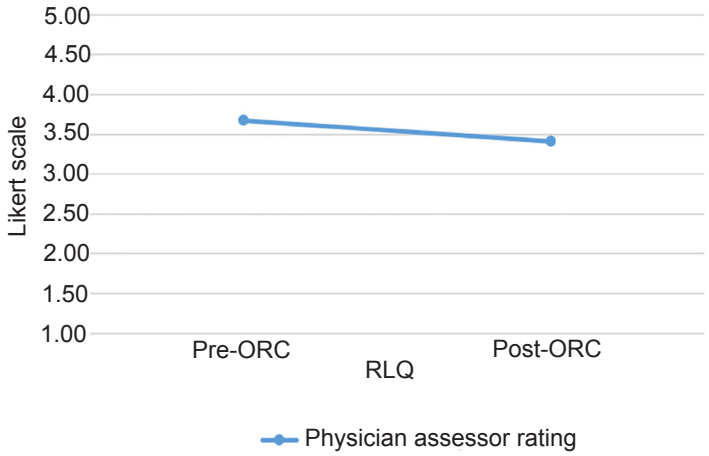

Figure 3. Mean physician-assessor scores of right lower quadrant (RLQ) ultrasound images.
ORC, oral radio-contrast

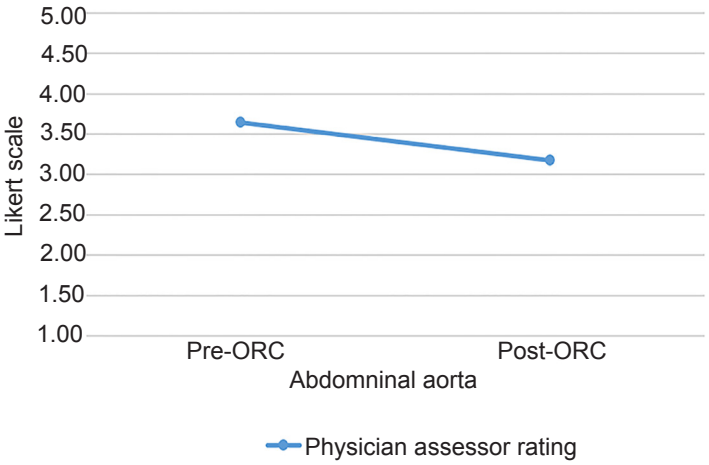

Figure 4. Mean physician-assessor scoring of abdominal aorta ultrasound images.
ORC, oral radio-contrast.

Statistical Analysis

A sample size calculation indicated that studying a minimum of 15 subjects' POCUS exams would provide 80% power to detect at least a one-point Likert score difference (our minimal clinically significant difference) between mean pre- and post- ORC administration scores. Assuming a standard deviation of 1.25 and an effect size of 0.80m, we achieved a power of 83% by enrolling 17 patients.

We used SAS (Statistical Analysis System v9. SAS Institute, Cary, North Carolina) package for analysis of all results. A paired T-test was used to compare the mean difference in image quality scoring between pre- and post-ORC administered groups. A p-value <0.05 was considered statistically significant.

RESULTS

Of the 17 patients enrolled in the study, all of them received two POCUS exams (pre- and post-ORC administration), each assessing the psoas muscle, iliac vessels and abdominal aorta. There was a total of 34 sonographic exams performed with two static images taken of the RLQ anatomy and the abdominal aorta, totaling 68 images for blinded review. The demographic profiles of study patients are given in Table 1. Figures 3 and 4 show no significant statistical differences noted for either RLQ structures or abdominal aorta image quality scoring.

Table 2 shows that although image quality was lessened after contrast, it was not significantly lessened. With regard to image quality, all post-ORC mean values were within 0.5 rating points of the pre-ORC mean values and, therefore, well within our predetermined range of a non-clinically significant difference (≤1 point on the Likert scale). Between the two physician assessors, there are four instances (24%) of differences of two on the Likert scale for aorta images compared to zero instances (0%) for the RLQ. Given these results, we can conclude that ORC does not significantly obscure abdominal US image quality.

DISCUSSION

Patients presenting to the ED with abdominal pain often undergo diagnostic imaging, especially when attempting to determine whether appendicitis or other abdominal pathology is present. This often initially includes the performance of an abdominal US exam. When, as is frequently the case, the US result is non-diagnostic, performing advanced imaging (including abdominal CT) may be indicated. Optimally, abdominal CT is performed after ORC and maximized by waiting 90-120 minutes post-administration for contrast to transit to the lower reaches of the intestines.[3,4] This can be time consuming, making it desirable to institute ORC as early as possible to maximize efficient patient flow and cycle time.[4,5-7]

Multiple imaging modalities can be used in diagnosing pediatric appendicitis, each with inherent risks and benefits. Historically, abdominal CT was favored due to its superior diagnostic accuracy. In children, sensitivity for the diagnosis of acute appendicitis by CT ranges between 94-100%[6,9-12] with specificity at 93- 100%. Subsequently, concern regarding the risk of CT ionizing radiation exposure and the potential for possibly developing a malignancy[13,14] contributed to the increasing popularity of US.[15] The benefits of US vs CT include lack of exposure to ionizing radiation, rapid performance, and relative inexpense.[15] Additionally, US is often readily available throughout the day at many hospitals; and even more so as a point-of-care test that can be accurately performed by emergency physicians trained in this modality.[16,17]

When US is used but results are non-diagnostic, the next step in imaging is often the performance of abdominal CT. Children have a relatively lesser degree of intra-abdominal fat as compared to adults, which makes the distinction of periappendiceal fat-stranding relatively more difficult to detect on unenhanced CT. Thus, some experts recommend ORC prior to obtaining CT.[4-7] Moreover, identification of other acute abdominal pathologic conditions may be enhanced using ORC.[3] To achieve maximal quality images, it is recommended that CT be performed between 90-120 minutes after ORC administration to achieve optimal contrast delivery to the RLQ structures.

A commonly cited yet unsubstantiated clinical concern is the notion that ORC presence in the intestine can impair abdominal US image quality. This has prompted the practice of delaying the administration of ORC until after US completion. The only prior study related to this issue that we identified was by Dang et al,[18] who recently reported results in adults who received ORC with comparison of abdominal US image quality pre- and post-ORC. They found no statistical or clinical difference in image quality obtained at each of the three time points: pre-ORC, followed by both one and two hours post-ORC.[18] We know of no other study that similarly assesses this issue in children.

Similar to the results of the Dang study, our data likewise demonstrates no statistically or clinically significant differences in RLQ US image quality when obtained pre- and post-ORC administration. However, there is a possibility that aorta scans are affected clinically, but not statistically by ORC. We hypothesize that this could be due to the distention of bowel and gas caused by oral contrast creating a greater distance between the probe and the area of interest. It is important to note that aorta US is not widely done or used in the pediatric population when compared to the adult population and was included in this study solely for predictable anatomical location and location below the bowel. Thus, we feel ED protocols for diagnostically managing children with abdominal pain can allow for "early" administration of ORC, which can overlap with the clinical time necessary to obtain and interpret a radiology-performed US exam. Doing so could help minimize ED length of stay and allow for the expedited time to diagnosis. The implications of maximizing efficiency in patient flow includes improved metrics in ED throughput, superior patient satisfaction, and overall decrease in cycle time without compromising diagnostic accuracy in a busy ED setting.

LIMITATIONS

This study was performed in a busy, single-center, diverse urban community with excellent integration of POCUS in the PED, which may limit its reproducibility to other centers. Many institutions either perform abdominal CT without the use of ORC or use other diagnostic modalities such as abdominal MRI to determine the case of abdominal pathology, making our study non-generalizable for these centers. Finally, we performed the study on a convenience sample limited by the number of recruiters that could be trained and the time of day that recruiters were present.

CONCLUSION

Orally administered radiocontrast prior to performing an abdominal ultrasound in children with abdominal pain does not adversely affect US image quality. The early provision of ORC in children who may eventually require performance of an abdominal CT can maximize patient flow, cycle time, and ultimately diagnostic efficiency in an already busy pediatric ED setting.

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How to Stop the Bleed: First Care Provider Model for Developing Public Trauma Response Beyond Basic Hemorrhage Control

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Introduction: Since 2013, the First Care Provider (FCP) model has successfully educated the non-medical population on how to recognize life-threatening injuries and perform interventions recommended by the Committee for Tactical Emergency Casualty Care (C-TECC) and the Hartford Consensus in the disaster setting. Recent programs, such as the federal "Stop The Bleed" campaign, have placed the emphasis of public training on hemorrhage control. However, recent attacks demonstrate that access to wounded, recognition of injury, and rapid evacuation are equally as important as hemorrhage control in minimizing mortality. To date, no training programs have produced a validated study with regard to training a community population in these necessary principles of disaster response.

Methods: In our study, we created a reproducible community training model for implementation into prehospital systems. Two matched demographic groups were chosen and divided into "trained" and "untrained" groups. The trained group was taught the FCP curriculum, which the Department of Homeland Security recognizes as a Stop the Bleed program, while the untrained group received no instruction. Both groups then participated in a simulated mass casualty event, which required evaluation of multiple victims with varying degree of injury, particularly a patient with an arterial bleed and a patient with an airway obstruction.

Results: The objective measures in comparing the two groups were the time elapse until their first action was taken (T1A) and time to their solution of the simulation (TtS). We compared their times using one-sided t-test to demonstrate their responses were not due to chance alone. At the arterial bleed simulation, the T1A for the trained and untrained groups, respectively, were 34.75 seconds and 111 seconds (p-value = .1064), while the TtS were 3 minutes and 33 seconds in the trained group and eight minutes in the untrained groups (physiologic cutoff) (p-value = .0014). At the airway obstruction simulation, the T1A for the trained and untrained groups, respectively, were 20.5 seconds and 43 seconds (p-value = .1064), while the TtS were 32.6 seconds in the trained group and 7 minutes and 3 seconds in the untrained group (p-value = .0087). Simulation values for recently graduated nursing students and a local fire department engine company (emergency medical services [EMS]) were also given for reference. The trained group's results mirrored times of EMS.

Conclusion: This study demonstrates an effective training model to civilian trauma response, while adhering to established recommendations. We offer our model as a potential solution for accomplishing the Stop The Bleed mission while advancing the potential of public disaster response. [West J Emerg Med. 2020;21(2)365-373.]

INTRODUCTION

Active violence incidents continue to push the envelope of prehospital trauma care. The improvised explosive devices (IED) used in the 2013 Patriot's Day bombing in Boston left three dead and 265 injured.[1] While the attacks in Orlando, Dallas, and San Bernardino injured 152 and killed 68, these numbers could have been much higher if the IEDs in San Bernardino had performed as planned.[2] As these attacks become more deadly and elaborate, so too must public preparation. Despite improved integration in active shooter incidents, first responders are challenged by caring for large numbers of victims within a "hot zone" where the threat is still ongoing. Despite our best efforts, victims of active shooter incidents face delays in receiving healthcare.[3]

Knowing that any delay in the treatment of trauma injuries can increase mortality, many agencies have made recommendations to include bystander involvement into the planning framework for both natural and man-made disasters.[4,5] Since the First Care Provider (FCP) concept was proposed at the Medical Response to IED/Active Shooter Next Steps & Tactical Emergency Medical Services (TEMS) Standardization summit in 2014, there has been consensus among trauma providers and EMS systems that a community response is necessary. Following this meeting, the Hartford Consensus III documented the need for "empowering the public to provide emergency care" and recognizing hemorrhage control techniques.[6]

Concurrently, the Committee for Tactical Emergency Casualty Care (C-TECC) created a working group to research the evidence to support the education of non-medical providers.[7,8,9] In 2015, the FCP white paper described the systemic requirements for community empowerment.[10] Most recently, in 2015, the Presidential Policy Directive on Preparedness and the Department of Homeland Security (DHS) announced the "Stop the Bleed" campaign, which recognized the need for early hemorrhage control through the widespread use of tourniquets.[11]

Events in Boston and as Vegas, in particular, reveal that access to the wounded, recognition of significant injury, and rapid evacuation to medical care is at least equally important as immediate hemorrhage control.[12,13] A recent study published in the *Journal of Trauma* proposed a framework for how these concepts could be incorporated by smaller agencies.[14] We propose that our FCP training, which is recognized by the DHS as a Stop the Bleed program, is an efficient and effective means of educating the civilian public to recognize trauma, identify life-threatening physiology, and empower them with the tools to prevent traumatic mortality.

MATERIALS AND METHODS

Our hypothesis in initiating the study was that by providing non-medical lay public with a structured public educational model based on existing C-TECC and Hartford Consensus recommendations and as outlined in the FCP white paper, civilians would be able to successfully assess and treat the most common causes of preventable death during disaster scenarios.

Population Health Research Capsule

What do we already know about this issue?
Despite growing worldwide momentum for "Stop the Bleed" interventions by civilians, no studies to date have validated the effectiveness of available curricula.

What was the research question?
Can a curriculum be shown to improve both medical skills and recognition of life-threatening injury?

What was the major finding of the study?
Laypersons trained as First Care Providers responded to trauma faster than nursing graduates or untrained public.

How does this improve population health?
We demonstrate an effective, reproducible model for improving disaster resilience by developing public trauma response beyond basic hemorrhage control.

Participant Selection

Participants for this study were canvassed as volunteers through the city of Westminster, California, with the goal of representing a cross-sectional demographic of the local population. The 75 volunteers included recent nursing graduates and undergraduate nursing students, local teachers, city employees, private security personnel, and high school students. A total of 51 participants took part in the exercise. Prior to the evaluation phase of the program, the volunteers were then assigned into "trained" and "untrained" groups. Newly graduated nurses with a Bachelor of Science with a major in nursing (BSN) degree served as the control for recent, medically "trained" individuals without FCP training. They were included to determine whether any trauma response had been incorporated into their recent nursing curriculum. A local fire department engine company was used as a first responder (EMS) baseline for any natural or man-made disaster.

Training

In conjunction with an ongoing disaster effort piloted by the city of Westminster (CA), each of the trained groups participated in the four-hour FCP curriculum, which is recognized by the DHS as a Stop the Bleed program. This interactive lecture familiarized students with the DHS "Run, Hide, Fight" curriculum, activating the emergency response system, applying the TECC medical guidelines for civilians, and familiarized them with trauma equipment. The training seminars were conducted six weeks prior to the simulation. Prior to participation in the natural disaster simulation, all participants took a pre-test with 14 questions.

Participants first self-identified their level of training. The remaining 14 questions were designed to assess the participant's understanding of general trauma and current level of comfort and preparedness, with and without training.

Simulation and Grading

To simulate a disaster, the event was held in an open storefront at the local mall during daytime operations. To ensure reproducibility, each group received a scripted overview detailing the exercise scenario: a large earthquake. The briefing included rules of engagement, set expectations, and defined objectives (Appendix 1). The room was arranged to simulate a major earthquake with debris strewn about and lighting problems. The subjects were assessed in groups, to both maintain realism as well as the integrity of each group's interventions.

Each group encountered the same four victims. Victim 1 was deceased with a closed head injury. This injury pattern ensured that trainees had been adequately trained on assessment of life or death. Victim 2 had a simulated arterial bleed and open chest wound. This pattern was selected to evaluate prioritization of bleeding control in a complex wounding pattern. Victim 3 was unconscious but breathing, to assess subject's ability to maintain airway patency while assisting other first care providers. Finally, Victim 4 had only superficial injuries. This use of a "distractor" was meant to challenge the subject's ability to perform assessments on animated patients and prioritize more severe injuries. Again, to ensure reproducibility, victims received scripted information including type of injury and appropriate interaction with subjects.

The participants were evaluated on two criteria: time to first action (T1A) and time to solution (TtS). T1A was identified as a surrogate for recognition of a preventable cause of death. This subjective marker recognized the participant's first response, whether moving toward a victim, instructing others, calling 9-1-1, or retrieving a trauma kit. TtS was an objective marker that records a proper intervention on a preventable cause of death. This data was captured through redundant mechanisms. First, a time was digitally recorded by tactical operations manikins (TOMManikin models) donated by Innovative Tactical Training Solutions (ITTS) and operated by an ITTS professional representative. Additionally, each evaluator was given a standardized scoring sheet and assigned to only evaluate one "victim" (Appendix 2).

We did not limit the subject's interaction with the victims, although a maximum "physiologic viability" time of eight minutes was recorded. This time was allotted to generously account for either exsanguination or fatal anoxic injury. Evaluators did not interact with the test subjects during the simulation.

Analysis

We compared the trained and untrained groups using a one-sided t-test, with the test looking for "less." This tests for "trained" having a smaller mean than "untrained." The alternative hypothesis that we are rejecting is that the true difference in means is less than zero at a 95% confidence interval (CI).

RESULTS

Pre-Test Results

All participants were given a 14-question pretest. The questions were selected to provide insight into perceptions held by participants, and to focus on areas for instruction and barriers to retention. The following five questions demonstrate significant findings in the responses.

Question 1: "What is the number one cause of death in the US population ages 1-44?" The correct answer, "Trauma," was appropriately identified by 85% of the trained participants, as opposed to only 15% of the untrained participants (Table 1). Also of note was the preponderance of security officers who answered cardiac arrest as the leading cause of death. This likely reflects conditioning of non-medical personnel by the training they receive (e.g., cardiopulmonary resuscitation [CPR] training).

Table 1. Answers to Question 1 of the pre-test, organized by group number.

Group number	Group	Cardiac arrest	Trauma	Cancer	Medication OD
1	Nursing- grad	1	3		
2	Nursing- undergrad		4		
3	Teacher-trained		5		
4	Teacher-untrained				3
5	City-trained		5		1
6	City-untrained		2		3
7	Security-trained	1	2		
8	Security-untrained	4	1	1	
9	Students-trained		5		1
10	Students-untrained	3	1		1
11	Engine Co		4		

OD, overdose; *grad,* graduate; *undergrad,* undergraduate.

Question 2: "What do you think is the standard response time for a medical emergency when 9-1-1 is called?" This question was answered correctly as 8-11 minutes by only 35% of the trained individuals and 11% of the untrained individuals (Table 2).[16] A majority of participants believed the correct answer to be 5-7 minutes. This "public perception gap" may be propagated by the reported "successes" of the combined response in the Boston bombing and other recent terror incidents.[12,17]

To determine the mindset of course participants, Question 3 gave test subjects a range of options describing their primary concern following a disaster or emergency situation. The results show that "safety" was widely identified at 86% (Table 3). Interestingly, no participants listed treating other victims as their main concern. This result is intriguing because we see a natural response to find safety or shelter as the driving motivation. This facilitates education of the "Run, Hide, Fight" curriculum and allows a natural conduit to more complex discussions such as communicating with emergency dispatchers and providing medical care.

We also sought to evaluate common misconceptions regarding tourniquet use. Question 9 (Table 4) focused specifically on civilian application of a tourniquet to someone who is bleeding and asks whether the subject would remove it because of pain. The correct response is to reassure them and leave the tourniquet in place, as it could prevent the victim from exsanguination. All participants nearly unanimously identified this, with 88% responding correctly (Table 4). This finding encourages continued focus on hemorrhage control programs such as the federal Stop the Bleed campaign.

Finally, in order to understand the barriers to public implementation, the participants were asked what would prevent them from intervening on behalf of a victim following a disaster or emergency situation (Question 5). These groups were split across three answers: not knowing what to do (lack of education); uncertainty whether their assistance would make the victim worse (lack of understanding); and their concern for disease. Only two test participants identified litigation as a reason to not render aid in an emergency situation. This finding is open to interpretation, but appears to suggest that the overwhelming majority of people are willing to aid others in a disaster provided they have a framework for providing such care.

Simulation Results

Current recommendations by the Hartford consensus and the TECC Committee suggest that the priorities of civilian care in a disaster situation should be focused on hemorrhage control, airway maintenance, and rapid extrication to medical facilities.[12] Our study focused on the two objective medical interventions from these recommendations. For our results, we have included "trained" civilians with untrained civilians, and made comparison to an engine company first responders who are regarded as trained in disaster response, and new-graduate nurses (BSN graduates) who are regarded as individuals recently involved in standard healthcare curricula including CPR. Nursing undergraduate results were compiled with the "untrained" civilians.

Time to First Action (T1A) - Arterial Bleed Station

In our simulation, subjects were timed and their initial actions were monitored and recorded. When responding to the victim with an arterial bleed and open chest wound, the trained group performed their first action in an average time of 34.75 seconds, while the untrained group performed their first action with an average time of 111 seconds (p-value = .1064, CI ($-\infty$, 47.15)). The engine company provided a first action time of 48 seconds. This served as a baseline for "First Responders" (Figure 1).

All trained group's first action was to control the hemorrhage, either by direct pressure or through the use of a tourniquet. The untrained teachers and municipal employees did not treat this victim. The untrained security guards and students unsuccessfully attempted improvised tourniquets. It is worth noting that one of the untrained students was a former Junior Reserve Officer Training Corps (JROTC) candidate with previous

Table 2. Answers to Question 2 of the pre-test, organized by group number.

Group number	Group	2-4 min	5-7 min	8-11 min	12-15 min
1	Nursing-grad		3	1	
2	Nursing-undergrad		3		1
3	Teacher-trained		1	5	
4	Teacher-untrained		3		
5	City-trained	1	4		
6	City-untrained	1	4		
7	Security-trained		1	2	
8	Security-untrained		4	1	1
9	Students-trained	4	2		
10	Students-untrained	2	2	1	
11	Engine Co		1	3	

min, minutes; *grad,* graduate; *undergrad,* undergraduate.

Table 3. Answers to Question 3 of the pre-test, organized by group number.

Group number	Group	Call 911	Fleeing safety	Ensure safety	Treating victims
1	Nursing-grad			4	
2	Nursing-undergrad			4	
3	Teacher-trained			5	
4	Teacher-untrained			3	
5	City-trained			6	
6	City-untrained	3	1	2	
7	Security-trained			3	
8	Security-untrained	1		5	
9	Students-trained			6	
10	Students-untrained	1	1	3	
11	Engine Co			4	

grad, graduate; *undergrad,* undergraduate.

Table 4. Answers to Question 9 of the pre-test, organized by group number.

Group number	Group	Loosen the TQ	Remove the TQ	Reassure them	Tourniquets are an outdated means for hemorrhage control
1	Nursing-grad			2	2
2	Nursing-undergrad			4	
3	Teacher-trained			5	
4	Teacher-untrained			3	
5	City-trained			6	
6	City-untrained			5	
7	Security-trained			3	
8	Security-untrained			6	
9	Students-trained			6	
10	Students-untrained	1		3	1
11	Engine Co	1	1	2	

TQ, tourniquet; *grad,* graduate; *undergrad,* undergraduate.

tourniquet instruction. The T1A for nursing graduates (registered nurse (RN) or RN-eligible) was 75 seconds, with evaluation of the bleeding as their first action and direct pressure next. The nursing undergraduate students simply applied a non-occlusive compression wrap with a time of 60 seconds. Only one untrained students' group and the engine company addressed the open chest wound, which was covered by debris.

Time to First Action (T1A) - Airway Obstruction Station

The average T1A of the trained groups responding to the airway-compromised victim was 20.5 seconds, while the T1A of the untrained groups was 43 seconds, respectively (p-value = .0659, CI, -∞, 2.73524). The T1A for the trained groups was similar to that of the EMS baseline, which had a first time to action of 25 seconds. All trained groups placed the victims in the rescue position to maintain airway competency. The untrained city worker and teacher groups both placed the victim in an unsustainable position that compromised the airway immediately after their attempt at intervention. The EMS providers first performed a jaw thrust, and then instructed actor "bystanders" to maintain the position. After assessing the scenario, EMS returned to the "airway" victim and placed him in the rescue position. The RNs responded with a jaw thrust maneuver at 1 minute and 27 seconds, while the nursing undergraduate students performed CPR at 1 minute and 3 seconds (Figure 2).

Time to Solution (TtS) - Arterial Bleed Station

Students were instructed that when treating the arterial bleeding victim, the appropriate action is to immediately apply direct pressure to the wound and/or apply a tourniquet to the affected extremity. With regard to treating the arterial bleeding,

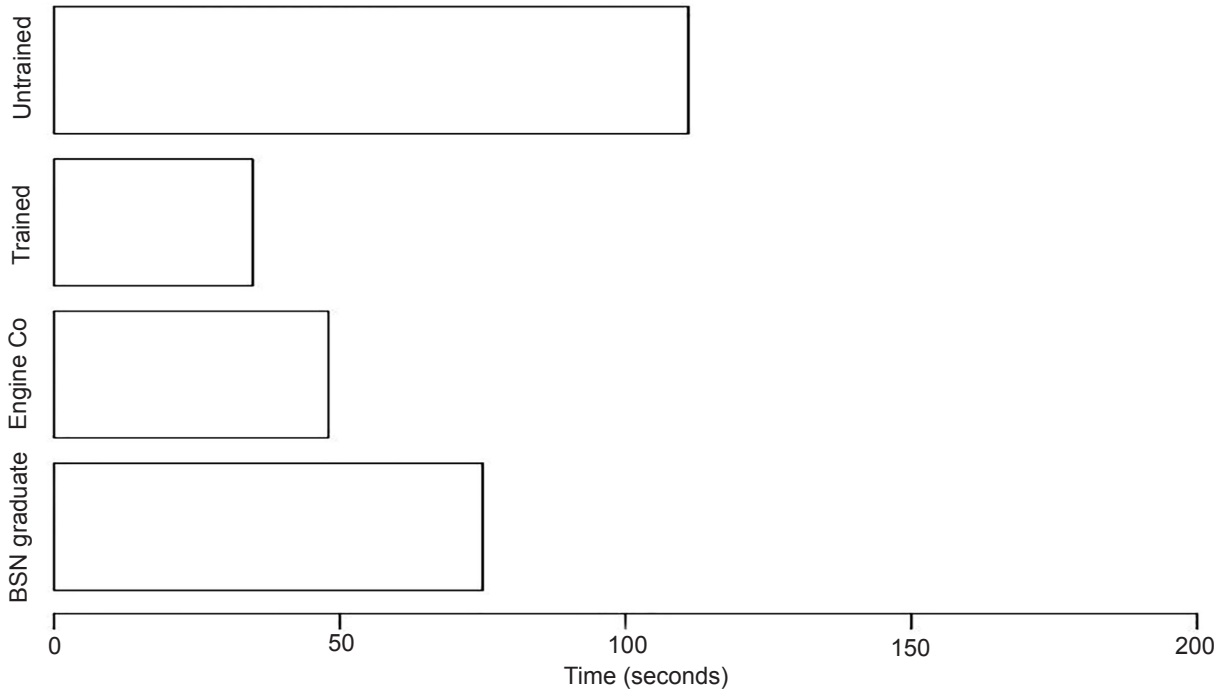

Figure 1. Time to first action of trained vs untrained groups in arterial hemorrhage control scenario, as well as of emergency medical services and healthcare (nursing graduates) professionals.
Engine Co, fire department first responders; *BSN,* Bachelor of Science with a major in Nursing.

the trained groups had a significantly faster time than the untrained group when preventing exsanguination (p-value = 0.001446, CI, -∞, -204.416). The four trained groups had an average time to solution of 3 minutes and 33 seconds, while the four untrained groups were unable to arrive at a solution before the eight-minute physiologic cutoff. The average TtS of the trained groups approached that of our EMS baseline designated by the engine company first responders, who had an average time to solution of 2 minutes and 38 seconds (Figure 3).

Time to Solution (TtS) - Airway Obstruction Station

When assessing an unconscious victim, students were instructed to place the victim on his or her side to prevent airway aspiration or obstruction (e.g., Rescue or Recovery Position). The four trained groups had an average TtS of 32.6 seconds, while the four untrained groups had an average TtS of 7 minutes and 3 seconds. Once again, the trained groups performed a much more efficient TtS than that of the untrained group (p-value = 0.008729, CI, -∞, -191.5561). Only one untrained group was able to come to a solution before time expired (security officers). Once again, the trained groups' average time to solution approximated that of the trained EMS professionals who had an average time to solution of 1 minute and 21 seconds (Figure 4).

DISCUSSION

While the EMS response system in the United States has been evolving in reaction to active shooter events and disasters, there is still a notable delay.[13] Because of the impact of such disasters, the push to incorporate civilian medical care is being viewed as a force-multiplier to existing response plans.[15] While recommendations have been proposed to address this need in civilian action, no widespread implementation methods have been shown to be statistically beneficial.

Conversely, the FCP curriculum showed a threefold improvement in recognition and treatment of airway obstruction and control of arterial hemorrhage. There were additional positive outcomes associated with completion of the FCP curriculum. First, we can conclude that a concise, organized approach to disaster education stimulates independent thinking in the student population. While we used T1A as a marker for recognition of a preventable cause of death, it also served as an objective data point for action. In all cases, the trained groups moved with concise action when confronted with trauma victims, despite not meeting 95% CI. The TtS demonstrates that having a plan and knowing the basic signs to recognize victims leads to successful outcomes, even equal to those of EMS responders.

Furthermore, within these groups there was an observed willingness to lead the interaction with first responders. We propose two reasons for this observation. First, having an organized framework for responding to emergencies developed the students' sense of control of a dynamic situation, which improved their ability to convey information to uniformed responders. Additionally, the guided medical training provided through the FCP curriculum lessened uncertainty regarding the care of those injured. The FCP curriculum enabled a technical

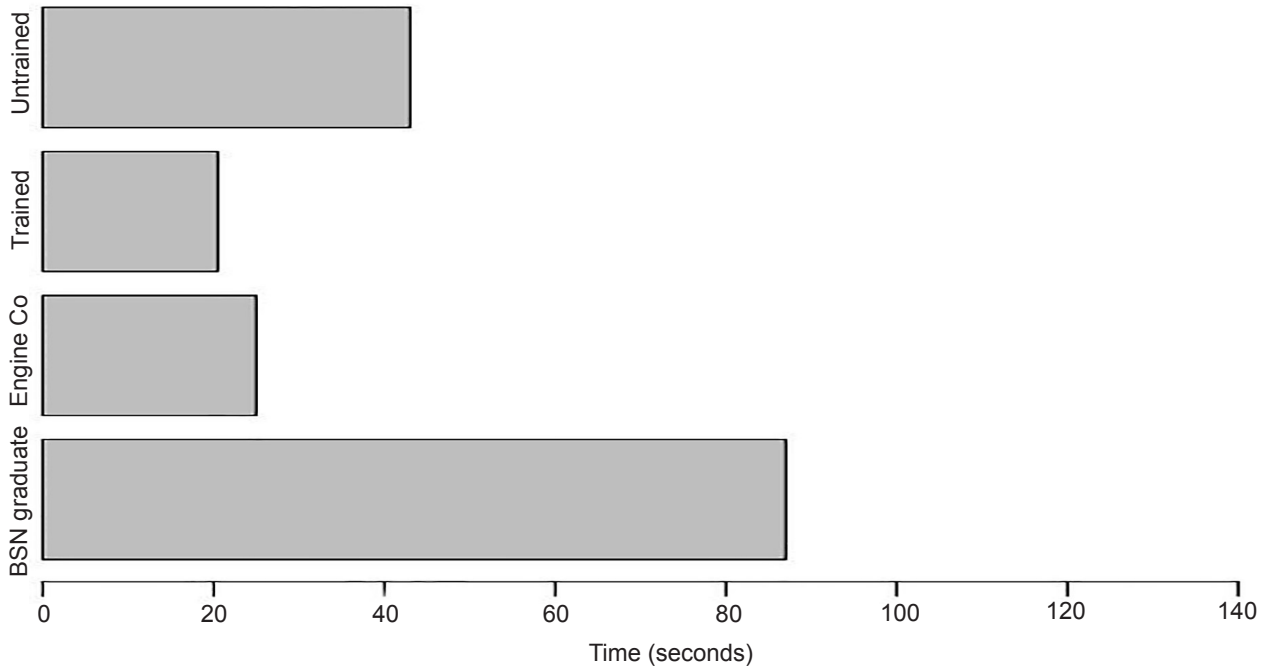

Figure 2. Time to First Action, of trained versus untrained groups in compromised airway scenario, as well as emergency medical services and health care professionals = nursing graduates.
Engine Co, fire department first responders; *BSN,* Bachelor of Science with a major in Nursing.

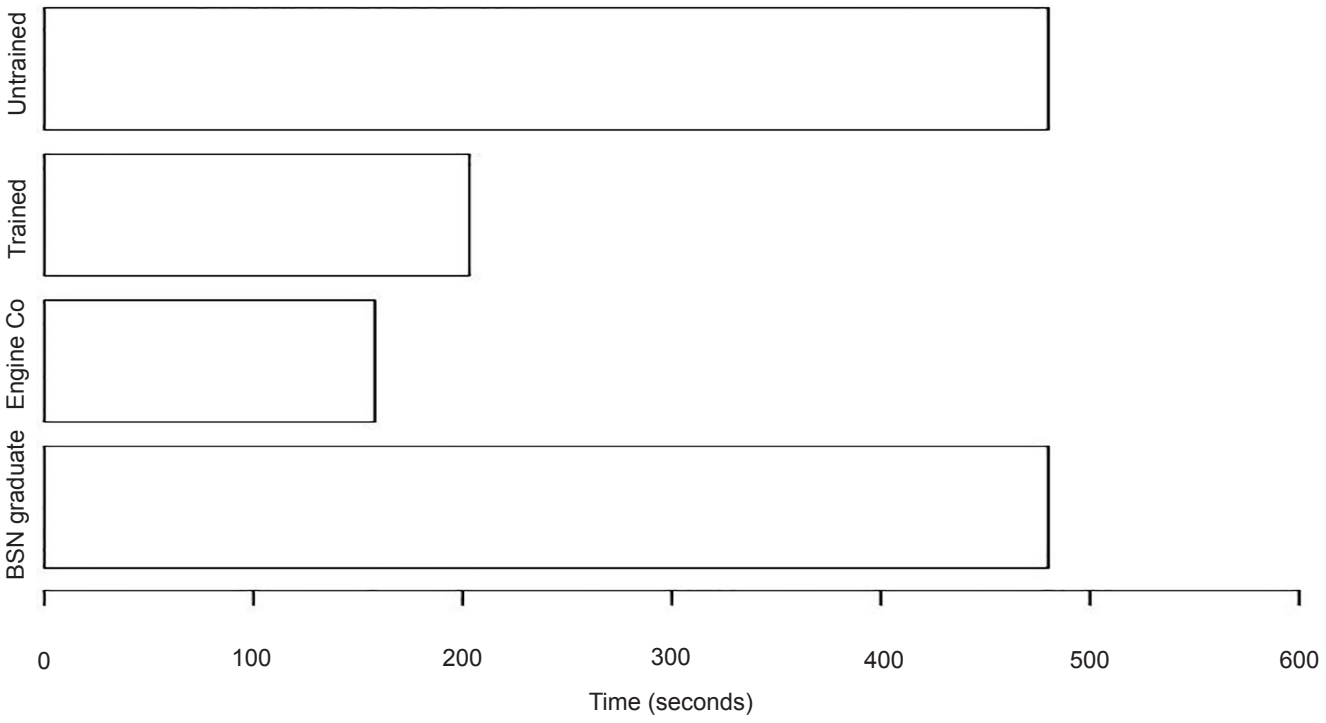

Figure 3. Time to Solution (TtS) of trained vs untrained groups in arterial hemorrhage control scenario, as well as emergency medical services and healthcare (nursing graduates) professionals (p-value = 0.001446, confidence interval [CI], -∞, -204.416).
Engine Co, fire department first responders; *BSN,* Bachelor of Science with a major in Nursing.

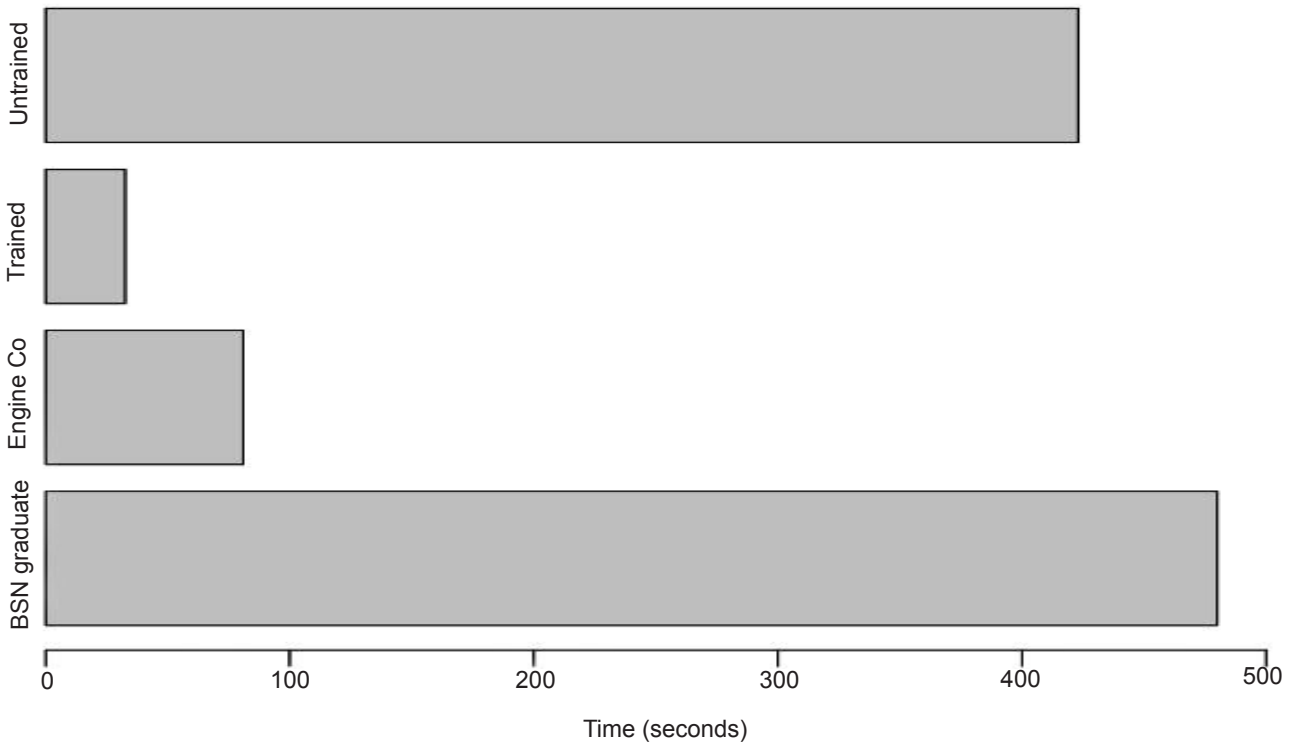

Figure 4. Time to Solution (TtS) of trained vs untrained groups in airway obstruction station, as well as emergency medical services and healthcare (nursing graduates) professionals (p-value = 0.008729, confidence interval [CI], [-∞, -191.5561]).
Engine Co, fire department first responders; *BSN,* Bachelor of Science with a major in Nursing.

foundation for decisive action, as well as a base for planning and a sense of control.

LIMITATIONS

There are limitations to our study. Time constraints and the complexity of using an operational shopping center during working hours to stage a mock mass casualty incident contributed to the small number of test subjects in our sample set. The populations of both the trained and untrained volunteers represent another potential source of bias, although there were no exclusionary criteria for the two populations. Another source of potential bias was the use of the closest engine company as the "EMS/First Responder" control for our study. However, the consistency of the prehospital education curriculum was thought to negate any interdepartmental variation.[18] Finally, the equipment used in the study was donated by Tactical Medical Solutions, Inc. Although the kit we used consisted of a windlass tourniquet, adhesive chest seals, gauze, and a trauma dressing, it is possible that brand familiarity may have affected outcomes.

Our preliminary study also revealed several potential areas for further investigation. The performance of the nursing graduates indicates a gap between policy recommendations and training curricula for our in-hospital healthcare providers.[19] In addition, many agencies use the same criteria for tourniquet selection for public-access tourniquets as for first responders. Although there is widespread support encouraging civilian tourniquet use, there has yet to be a comparative analysis on the effectiveness of commercially available tourniquets applied by a purely civilian demographic in a stress-induced environment.[20,21] It will be interesting to learn whether some requirements, such as one-handed application, are consistent in the civilian setting. Finally, while it has been demonstrated that children in sixth grade can effectively recognize cardiac arrest and use an automated external defibrillator, there is only anecdotal evidence that children can be effectively trained to recognize and intervene on the preventable causes of death in trauma.[22] Statistical demonstration of effective education of this at-risk population would be critical.

CONCLUSION

Our study demonstrates that it is possible to create an effective and retainable solution to disaster response to augment the first responder system while adhering to the recommendations of C-TECC, the Hartford Consensus, and the Department of Homeland Security. Further, because of its basis on well-recognized medical guidelines and ease of integration, the First Care Provider model provides an efficient and effective method for implementation of the federal government's "Stop the Bleed" campaign, bridging the gap between theory and implementation. The FCP system can be integrated into local law enforcement and fire/EMS systems to reduce system reflex time to disaster and improve ground-zero time for response.

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Tree of Life Synagogue Shooting in Pittsburgh: Preparedness, Prehospital Care, and Lessons Learned

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On Saturday, October 27, 2018, a man with anti-Semitic motivations entered Tree of Life synagogue in the Squirrel Hill section of Pittsburgh, Pennsylvania; he had an AR-15 semi-automatic rifle and three handguns, opening fire upon worshippers. Eventually 11 civilians died at the scene and eight people sustained non-fatal injuries, including five police officers. Each person injured but alive at the scene received care at one of three local level-one trauma centers. The injured had wounds often seen in war-settings, with the signature of high velocity weaponry. We describe the scene response, specific elements of our hospital plans, the overall out-of-hospital preparedness in Pittsburgh, and the lessons learned. [West J Emerg Med. 2020;21(2)374–381.]

INTRODUCTION

On Saturday, October 27, 2018, a man with anti-Semitic motivations entered Tree of Life synagogue in the Squirrel Hill section of Pittsburgh, Pennsylvania. He had an AR-15 semi-automatic rifle and three handguns, and used these to open fire upon the worshippers. Eventually, eleven civilians died at the scene and eight people, including five police officers, sustained non-fatal injuries. Each person injured but alive at the scene received care at one of three local level-one trauma centers and survived. We describe elements of out-of-hospital and in-hospital preparedness in Pittsburgh, medical response during the event, and the lessons learned.

PREPAREDNESS IN PITTSBURGH

Prehospital Physician Response

Since its origin in 1981, the Emergency Medicine (EM) residency at the University of Pittsburgh includes a "24/7/365" physician response to specific out of hospital emergencies.[1,2] Emergency Medicine residents (PGY II and PGY III) with Emergency Medical Services (EMS) training and certification staff a response vehicle equipped with radios, emergency warning lights, medications, and medical equipment; they are overseen by a certified attending EMS medical command physician available by radio and phone. Emergency medicine faculty and residents work closely with members of the City of Pittsburgh Bureau of Public Safety (Police, Fire, and EMS) to give protocol and on-scene medical direction while gaining out of hospital care experience.

Tactical EMS in Pittsburgh

The National Tactical Officers Association recommends that special weapons and tactics (SWAT) teams include trained tactical emergency medical providers.[3] In 2011 the City of Pittsburgh EMS division enrolled 16 paramedics into SWAT courses and subsequently integrated them into a Tactical EMS (TEMS team). Members of the TEMS team assist with medical threat assessment, pre-deployment team preventative health care, and point-of-injury medical care. The SWAT/TEMS Regional Medical Director, an emergency physician serving as a faculty member in the residency training program at the University of Pittsburgh, trains and deploys with the team. Each SWAT operator carries a standardized Individual First Aid Kit (IFAK) and tourniquet (Table 1), and the TEMS medics carry similar equipment augmented with additional medical gear.

Out-of-Hospital Preparation and Practice

Based on learning from prior events, UPMC and the City of Pittsburgh recognized the importance of joint training

Table 1. Contents of Individual First Aid Kits (IFAK) carried by Pittsburgh SWAT officers.

1x - Ratcheting medical tourniquet (RMT) 1.5" - Tactical
1x - Hemostatic gauze bandage
1x - Compression bandage
1x - Nasopharyngeal airway 28Fr with lubricant
1x - FASTBreathe thoracic seal (FTS) - vented
1x - FAST combat wound seal (CWS)6
1x - Compressed sterile gauze 4" x 4 yards
2x - Tefla non-adherent pad 3" x 6"
1x - Emergency Mylar blanket
1x - Band-aid pack
1x - Surgical cloth tape 1" x 10 yards
1x - HD nitrile gloves (pair) extra large
1x - Activity trauma shears 5"
1x - Casualty/treatment card
1x - Active trauma pouch "ATP" vehicle system

and response coordinated centrally across all arms of local public safety. In 2017, the city began a joint active shooter training series for public safety agencies, beginning with a formalized introductory course, followed by focused agency level training, and finally, ongoing joint exercises of varying scales. The goal was to develop and practice a preferred model of response to active shooter events that would function in parallel with tactical operations of SWAT and TEMS units.

The joint model utilizes combined response teams that allow first responders rapid access to patients to provide immediate lifesaving interventions, rapid extrication, and transport to a trauma facility under the protection of law enforcement personnel. Formation of a Rescue Task Force (RTF) made up of SWAT and TEMS personnel aids in early patient intervention beyond the cold zone and with limited staging delay.

On-scene medical preparation for law enforcement and first responders is led by the City Bureau of EMS, with a focus on standardizing self- and buddy-care of law enforcement personnel along with immediate external hemorrhage control of victims by any available responder. Tourniquet training and dissemination, along with adding IFAKs to duty gear, followed in all public safety agencies. The City also added protective ballistic body armor to standard EMS uniforms.

Our EMS providers are trained in systematic triage and implementation of life-saving interventions in zones of active fire, upon extrication from danger and during transport.

This training uses the Sort, Assess, Lifesaving Interventions, Treatment/Transport (SALT) triage system and the principles of Tactical Combat Casualty Care, teaching techniques for extremity and junctional hemorrhage control and utilization of hemostatic agents. The program also focuses on key rapid life-saving interventions, including airway maneuvers and ventilation, chest decompression and seals, intraosseous access, fluid resuscitation principles, and optimal care of the head injury patient. This background translated into efficient and directed care on scene at Tree of Life.

Years before this event, the Pittsburgh Bureau of Public Safety proactively developed an active threat plan and practiced in advance; they did this after heeding experiences locally and nationally. The most recent preparedness session occurred just months earlier, a few blocks from the synagogue involved.

In-Hospital Preparation

University of Pittsburgh Medical Center Presbyterian University Hospital, which received the bulk of the patients from this event, has a Mass Casualty Incident(MCI) plan refined through several years of exercises and informed by lessons learned elsewhere, especially in Israel. The approach uses the underlying principle of keeping care as simple as possible.[4] Based on the Israeli model, "Job-Action cards" exist (e.g., ED attending, charge nurse, triage nurse, lead trauma attending, etc.) and are distributed at the time of MCI plan activation. Each card is a single laminated page with a stepwise checklist of actions to be completed. Provider instructions are simple and focus on simplicity of duties and roles: "You don't need to memorize the plan, you just have to know where to find it when you need it and then follow the checklist."

The plan calls for a lead ED attending and trauma surgeon to divide providers into care teams. The anesthesia liaison in the ED coordinates with the operating rooms to cancel elective surgery. The critical care liaison works with the Administrator on Duty (AOD) to create Intensive Care Unit capacity. The internal medicine liaison prepares to call in additional inpatient staff and create capacity.

The hospital central supply unit sends three large pre-prepared disaster carts with additional trauma and respiratory supplies. These carts are kept centrally and sent to the ED with MCI plan activation. Similarly, the hospital pharmacy maintains an emergency cache of medications for pain and rapid sequence induction which are also automatically sent to the ED. The blood bank sends a pre-prepared cache of emergency blood products.

Community Readiness

Over the past three years, our region adopted a model that stresses the importance of layperson action in an emergency. This is a paradigm shift from the previous "call 911 and wait" to one of engaging the layperson in providing basic aid after calling for help. Our system started with focus on three key emergent conditions as targets for prehospital citizen intervention: out-of-hospital cardiac arrest (OHCA), opioid overdose, and severe hemorrhage.

To lay a foundation for citizen response, our 911 infrastructure incorporates a bystander notification system, PulsePoint (www.pulsepoint.org). When 911 dispatches units

to an OHCA, laypeople within a quarter-mile radius of the scene are simultaneously dispatched via GPS localization. The smartphone-based application also provides access to our county-wide Automated External Defibrillator (AED) registry on the map.

Public safety and government partners worked with local philanthropic and healthcare entities to allow for implementation of PulsePoint and initiate mass-training programs in public arenas such as schools and universities, religious sites, and local events. Where early efforts concentrated on CPR and AED, the citizen response model also began opioid overdose and severe hemorrhage intervention teaching.

Regarding efforts for severe external hemorrhage, the national Stop the Bleed (STB) Campaign empowers laypeople in first response to bleeding emergencies, especially of the extremities. Through the multidisciplinary work of trauma surgery, emergency medicine, Pittsburgh EMS, and local philanthropic support, we trained over 37,000 individuals and distributed over 500 bleeding control kits, and 9,000 tourniquets to police officers. The program also employs mass training programs at schools. STB efforts in Pittsburgh involved the Jewish community, where several synagogues (including Tree of Life) trained and received bleeding control kits prior to the event on October 27, 2018.

EVENT TIMELINE AND MEDICAL RESPONSE

Scene Response

Just before 10 AM on the event date, the Allegheny County 911 Center alerted Pittsburgh EMS and police of a possible active shooter at a synagogue in Squirrel Hill. An EM resident, the City EMS Medical Director, and a City Assistant EMS Medical Director responded to a staging area, while the SWAT/TEMS Medical Director rendezvoused with his team.

The Tree of Life congregation recently had STB training and had a fully stocked STB kit near a main entrance of the facility. Unfortunately, wounded civilians on scene were unable to access the kit due to the ongoing danger of the shooter moving through the structure.

Within minutes of the initial alert, an EMS Command Post was created two city blocks from the active shooter event to allow briefing of all physicians and other personnel by the Incident Commander. At Command Post set-up, gunfire existed in the synagogue and it was unclear how many worshipers were in the synagogue for Sabbath services. The synagogue is home to three congregations, multiple classrooms and a basement meeting room.

Meanwhile, staff at the UPMC Communications Center, which provides medical command and hospital notifications for regional ground and aeromedical agencies, along with the county 911/Emergency Operations Center, gathered regional hospital capabilities and relayed that information to the EMS Incident Commander. In addition, communications specialists tracked ambulance transport destinations and provided that information to the on-scene physicians. The EMS physicians on-scene spoke directly to EM leadership, who relayed information to all sites involved and gave real time updates. The on-scene EMS physicians also assisted with patient destination decisions (Figure 1).

TEMS paramedics initiated care of trauma victims based on statewide protocols and at the direction of the physician embedded with the tactical teams. Although there was no shortage of supplies, multiple SWAT operators lacked IFAK and tourniquets when inspected after the event.

Victims, including two civilians and four police officers, were transported to the two closest adult trauma centers. Proximity to the scene was the primary motivation for transporting patients to the closest appropriate facility. Physicians relayed the capacity of the facilities based on real time information from the hospitals. Based on the location of the incident, limited exit routes, and the capacity of the hospitals at the time, most patients were transported to UPMC Presbyterian, which lies on the most direct route from the scene and was prepared to accept a large number of patients. Once captured, the injured gunman was transported to the third adult trauma center; this was a decision made jointly by on-scene physicians and the EMS Incident Commander, seeking to separate the assailant from the victims.

All victims with extremity injuries had a tourniquet(s) placed on-scene or en route. Eleven additional victims in the synagogue were recognized dead and not transported. Prior to leaving the scene, the EMS physicians gathered patient status information from the receiving facilities and this information was relayed to the EMS Chief.

Timeline of EMS activity on scene

Note: timeline is based on radio traffic, which may not always reflect real-time (Figure 2).

09:55 – Call received at Public Safety Answering Point of an Active Shooter at Tree of Life Synagogue. Local police patrol units and medic units dispatched to the scene.

09:57 - EMS requested a Rapid Activation Team activation, which includes: One District Chief, five Advanced Life Support units, two Basic Life Support ambulances, two rescue trucks, mass casualty unit, field physician, plus a level-one county MCI response of five ambulances and one supervisor. The SWAT/TEMS team activation also occurred.

09:59 - Two police patrol units arrived and engaged the gunman as he appeared to be leaving the synagogue. Both law enforcement officers incurred injuries during the exchange. EMS requested to have both injured officers brought out to the "warm zone," a distant safer area with physical structures impeding the shooter's line of site.

Upon assessment by EMS, one officer was found to

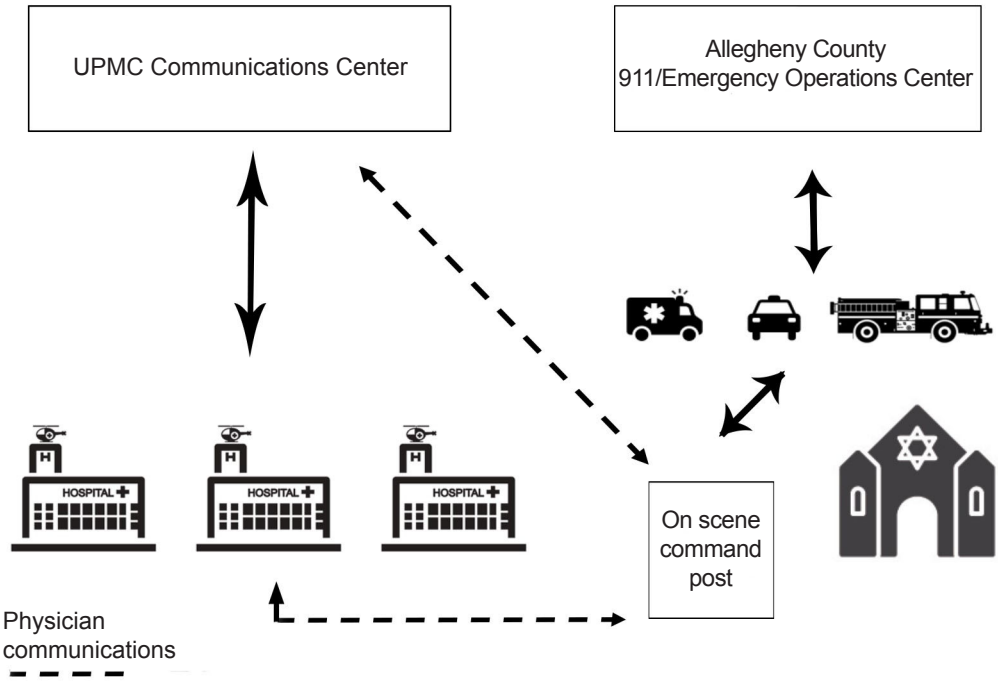

Figure 1. Communications network utilized during the event.
UPMC, University of Pittsburgh Medical Center.

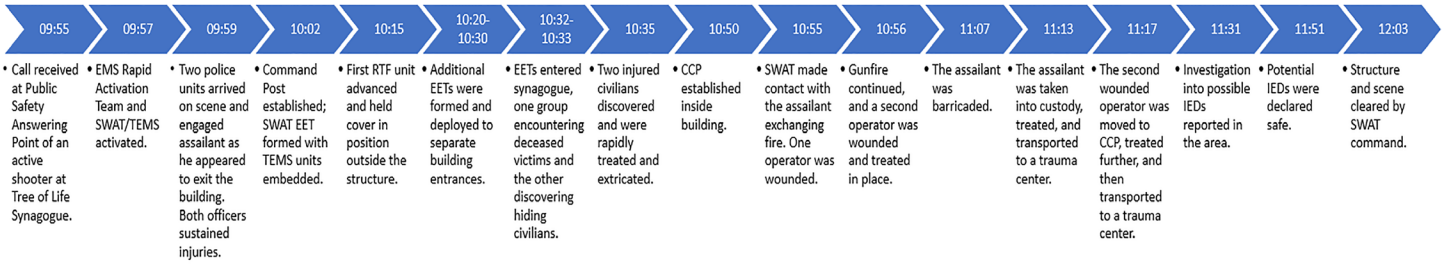

Figure 2. Timeline of EMS activity on scene during the Tree of Life synagogue mass shooting in Pittsburgh, October 27, 2018. *EMS*, Emergency Medical Services; *SWAT*, Special Weapons and Tactics; *TEMS*, Tactical Emergency Medical Services; *EET*, Emergency Entry Team; *RTF*, Rescue Task Force; *CCP*, Casualty Collection Point; *IEDs*, Improvised Explosive Devices.

have upper and lower extremity wounds (patient 1) that were treated at the scene with compression dressings and a tourniquet before the officer/patient was transferred to a local trauma center. The time from injury to Emergency Department (ED) arrival was under 20 minutes. A second law enforcement officer assessed by EMS had superficial lacerations of the face and was transferred non-emergently to the hospital (patient 2). A summary of patients is presented in Table 2.

10:02 -EMS established an Incident Command post and safe staging area approximately two blocks from the scene. In the next four minutes, five medic units arrived and the EMS District Chief on duty began staging at the post.

Over the next several minutes, arriving SWAT team operators formed an Emergency Entry Team (EET). As TEMS paramedics arrived on scene, they paired with law enforcement to form an RTF. As the EMS Physicians arrived, they reported to the EMS Command post. Local hospitals leaders – using pre-established protocols - were notified of the event to prepare and to gain bed availability data for the EMS incident command post.

10:15 – The RTF unit at the staging post moved closer in to the active area and held a cover position outside the structure.

10:20 to 10:30 – Additional SWAT and TEMS personnel arrived and more EETs formed. These teams deployed to separate entrances of the synagogue. Each EET had embedded TEMS.

Table 2. Description of injuries and on-scene medical interventions.

Patient	Description	On-Scene Interventions
1	Police officer with upper/lower extremity wounds	Tourniquet, compression dressings
2	Police officer with superficial facial lacerations	Simple bandages
3	Civilian with gunshot wound to lower abdomen	None
4	Civilian with extremity injury	Tourniquet and compression dressings
5	SWAT officer with head, neck, multiple extremity wounds	Tourniquets, wound care
6	SWAT officer with extremity wound	Tourniquets, hemostatic agent, pressure dressing
7	Shooter with extremity wounds	Tourniquet, hemostatic agent, pressure dressing
8	SWAT officer with hearing loss	Not transported by EMS

SWAT, special weapons and tactics; *EMS*, emergency medical services.
Additionally, eleven victims sustained fatal wounds on-scene of the incident.

10:32 to 10:33 – The EETs entered the synagogue via separate entrances and began clearing their respective areas. One EET remotely assessed their assigned area and found what appeared to be multiple deceased victims. This was confirmed upon entry. The second EET discovered several civilians hiding and escorted them out of the synagogue.

10:35 – Two injured civilians were found as the entry teams and TEMS medics pushed forward; one with a gunshot wound to the lower abdomen, one with an extremity wound (patients 3 and 4). Patient 4 had pressure dressings and a tourniquet applied, followed by extrication from the synagogue.

10:50 – As the EET passed through the structure, members of the TEMS team established a Casualty Collection Point (CCP) inside the building.

10:55 - SWAT contacted the shooter, with initial reports of shots fired and an officer down and officer wounded transmitted. The injured SWAT operator was removed from the area of the gun battle and carried to the CCP established by TEMS (patient 5). At the CCP, the TEMS paramedics and physician assessed the injured officer and identified multiple extremity injuries along with a head wound. The team placed tourniquets on the bleeding extremities and bandaged the head wound. Once extricated, the officer went to a Level I trauma center via ambulance. Time from TEMS contact to ED arrival was approximately 20 minutes.

10:56 - A second SWAT operator (patient 6) suffered an upper extremity wound but was unable to move to the CCP because of his position and the ongoing gunfight. Another SWAT operator applied a tourniquet.

11:07 – The assailant was barricaded.

11:13 – The shooter (patient 7) was taken into custody. His extremity wounds received a tourniquet and hemostatic dressings, and he was taken to the third trauma center.

11:17 – The second wounded SWAT operator (patient 6) moved to the CCP; the team noted an upper extremity wound. Despite initial placement of a tourniquet, hemostasis was inadequate. A second tourniquet and a hemostatic dressing then controlled the bleeding. The wounded SWAT officer walked to an ambulance and arrived at a Level I trauma center approximately 38 minutes after TEMS contact.

11:31 - Reports of possible Improvised Explosive Devices (IEDs) inside the structure and the shooter's vehicle. All units and individuals staged in the warm zone pulled back.

11:51 - All potential IEDs are inspected by Explosive Ordinance Disposal and declared safe.

12:03 - Structure and scene declared safe and cleared by SWAT command.

Hospital Response

Pittsburgh has three level-one adult trauma centers: UPMC Presbyterian (2.4 miles from the scene), UPMC Mercy (3.7 miles), and Allegheny General Hospital (8 miles). The only pediatric trauma center is the Children's Hospital of Pittsburgh of UPMC (2.7 miles). UPMC Presbyterian Hospital, the closest trauma center to the incident, had ten patients in the ED (an atypically low number) when the shooting began. There were two attending physicians and four residents on duty, along with a trauma team staffed by one attending trauma surgeon and four surgical residents.

At 10:04 am, the ED received the first notification of the active shooter situation. ED and trauma staff and the hospital AOD immediately activated the hospital MCI plan. However, due to confusion in terminology between the AOD and hospital operator, a "Bronze Alert," the hospital's designation for an active shooter *inside* the building, was sent out through the Emergency Notification System (ENS) to more than 10,000 staff members. This led to confusion amongst some off-duty providers as to whether it was safe to respond to the hospital and amongst those already in the building as

to the location of the incident. This represents one area for improvement from the incident.

Nonetheless, many providers quickly mobilized to the ED. In a trend like that noted in past mass shooting events, many of these providers "self-dispatched" from other areas in the hospital and from home. The attending trauma surgeons also communicated internally using a group-text. Within 45 minutes of the initial notification, there were approximately 100 additional providers and ancillary staff ready to receive wounded patients, including physicians from emergency medicine, trauma, vascular, orthopedic, and neurological surgery, anesthesia, and critical care.

During the time that it took to declare the shooting scene safe, information on the number and type of patients being transported varied. Hospital providers, getting information from news media, personal contacts, and official channels, had wide estimates - ranging from four to 40 patients. Ultimately, five patients came to UPMC Presbyterian, one to UPMC Mercy, and one to Allegheny General Hospital.

During and after the incident, dozens of armed law enforcement officers from various agencies (local, county, and state police and federal agents) presented to the ED, leading to some angst with staff about who was responsible for verifying their credentials.

LESSONS LEARNED FROM THIS EVENT (Table 3)

Acts of Violence Can Happen Anywhere

Since 2000, Pittsburgh has topped the most livable city lists six times.[5] The city celebrates its diversity and is known for its friendly demeanor. Pittsburgh is now added to the list of cities that believed "this could never happen here" but experienced an event.

SWAT Operators Need IFAK Checks, Like for Any Equipment

The SWAT officers tend to have multiple armor sets/ configurations that they don and doff. Officers frequently move their IFAK and tourniquets between armor sets. This risks leaving the operators without IFAK and tourniquets because of the need for rapid response and forgetting to transfer their medical gear. We recognized some gaps in this facet that were apparent once debriefing occurred.

Wounds Can Mirror Modern Combat Theatre Even in Civilian Public Mass Shooting Incidents (CPMS)[6]

The two injured SWAT operators suffered extremity hemorrhage like combat theatre injuries. As with the military, the type of armor used during SWAT operations protects most of the thoracoabdominal area and head but exposes the extremities and face/neck areas to injury.[7] This makes extremity hemorrhage control extremely important. Civilian wounds from this incident, as observed by on-scene physicians and EMS personnel, closely matched injury patterns in other CPMS events.[8]

A Single Tourniquet May Not Achieve Adequate Hemostasis

Both SWAT operators wounded in the shooting required multiple tourniquets on their wounded limbs. Each tourniquet was properly placed, tightened, inspected, and re-tightened before deploying a second tourniquet. As noted, one operator suffered upper extremity bleeding that was not adequately controlled by a single tourniquet. Due to his location, he was isolated from TEMS personnel for ~18 minutes due to active gunfire and juxtaposition to the rest of the team. This case illustrates the importance of every officer having at least one tourniquet on their equipment, and having multiple tourniquets and IFAK for select personnel who are "in close" to any exchange of gunfire.

TEMS Elements Deployed As Far Forward as Safely Possible Save Lives

In the instance of the most critically injured SWAT operator, minutes elapsed between him being shot multiple times and delivery to the TEMS staging area. Immediate point-of-injury care was started by the embedded SWAT physician (the team's medical director) and a full complement of TEMS medics. This allowed for a full assessment and treatment in under three minutes with transport immediately afterward. Two other patients with potentially life-threatening extremity hemorrhages received TEMS forward care; both patients' wounds could have easily resulted in death if delays occurred. As such, aggressive uniformed officer engagement with the assailant, persistent and infiltrative tactics by SWAT operators and accompanying TEMS units, and parallel formation and utilization of RTFs should serve as a response model when feasible.

The Location of Staged Medical Equipment Matters

On scene medical equipment was not accessed because of security concerns. The synagogue's STB kit was in a visible, central location – a location creating danger since the shooter had access to the area. Although we feel that STB training is an invaluable community resource, we did learn in this case that the location of staged equipment is a critical (and perhaps under-emphasized) point.

Training on Terminology and Activation of Hospital-wide Alerts is Critical and Requires Frequent Reinforcement

The initial activation of the Bronze alert led to confusion. Our hospitals have responded with increased training for staff and updated guidelines on how to activate the MCI plan.

In the Event of an MCI, Many Providers Will Self-present to the Hospital Without Being Called

While it is important to have a pre-designated system for calling in back-up, this volunteerism can create the possibility of having too many providers respond. A process should be in place to screen, allocate, and decline use of additional volunteers. Our hospital MCI plan is being updated to establish a "volunteer" center in an area separate from the ED.

Table 3. Lessons learned from the Tree of Life synagogue mass shooting in Pittsburgh, October 27, 2018.

Preparation and planning
• Acts of violence can happen anywhere.
• The location of staged medical equipment matters.
• Training on terminology and activation of hospital-wide alerts is critical and requires frequent reinforcement.
• Mass casualty planning shuold be multi-disciplinary and involve both healthcare providers and ancillary services. Frequent exercises are crucial.
• Have plans to confirm the identity of law enforcement officers and to manage their flow into care sites.
Incident response
• SWAT operators need IFAK cheks, like for any equipment.
• Wounds can mirror modern combat theatre even in civilian public mass shooting incidents.
• A single tourniquet may not achieve adequate hemostasis.
• TEMS elements deployed as faw forward as safely possible save lives.
• In the event of a mass casualty incident, many providers will self-present to the hospital without being called.
• Casualty data are unreliable early in an MCI or active shooter situation. Err on the side of over-estimating need during the initial response.

SWAT, Special Weapons and Tactics; *IFAK*, Individual First Aid Kit; *TEMS*, Tactical Emergency Medical Services; *MCI*, Mass Casualty Incident.

MCI Planning Should be Multi-disciplinary and Involve Both Healthcare Providers and Ancillary Services. Frequent Exercises are Crucial

The hospital response involved a highly coordinated set of actions involving numerous personnel and predesignated supplies. These actions all came from a plan, created in advance and practiced in both table-top and simulation drills.

Casualty Data are Unreliable Early in an MCI or Active Shooter Situation. Err on the Side of Over-estimating Need During the Initial Response[9]

With numerous sources of information, accurate planning based on need is challenging. A lesson learned from previous drills was that of having MCI plans (prehospital and hospital) that are activated based on known *or* anticipated victims to avoid delay or an inadequate medical response. In this event, the number of potential victims was initially unknown; the closest adult trauma center initiated their MCI plan based on the limited information available, "preparing for the worst." As a result, the hospital easily accepted all incoming patients and had the capacity to care for more injured patients if needed. Similarly, the other two adult trauma centers enacted response plans, each ready to accept patients above the usual expected for a Saturday morning.

Have Plans to Confirm the Identity of Law Enforcement Officers and to Manage Their Flow into Care Sites

While understandable (and perhaps unavoidable) that law enforcement will present to the hospital, preparedness efforts should include coordination with hospital security personnel to create plans for their access.

CONCLUSION

The mass shooting incident at the Tree of Life synagogue on Oct 27, 2018 in Pittsburgh used a coordinated multi-agency response. Planning, practice in advance, close medical provider and safety officer integration, scene safety, initial evaluation zones, and tourniquet use saved lives in this event, and we learned lessons to improve future preparations and responses.

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UNIFIED: Understanding New Information from Emergency Departments Involved in the San Bernardino Terrorist Attack

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Introduction: Emergency departments (ED) are on the front line for treating victims of multi-casualty incidents. The primary objective of this study was to gather and detail the common experiences from those hospital-based health professionals directly involved in the response to the San Bernardino terrorism attack on December 2, 2015. Secondary objectives included gathering information on experiences participants found were best practices.

Methods: We undertook a qualitative study using Consolidated Criteria for Reporting Qualitative Research (COREQ) guidelines by performing semi-structured interviews with physicians, nurses, and incident management staff from multiple institutions responding to the San Bernardino terrorist attack. We coded transcripts using qualitative analysis techniques and we delineated and agreed upon a refined list with code definitions using a negotiated group process. Final themes were developed and analyzed.

Results: A total of 26 interviews were completed; 1172 excerpts were coded and categorized into 66 initial themes. Six final categories of communication, training, unexpected help, process bypassed, personal impact/emotions, and practical advice resulted.

Conclusion: Our study provides context regarding the response of healthcare personnel from multiple institutions to a singular terrorist attack in the United States. It elucidates several themes to help other institutions prepare for similar events. Understanding these common experiences provides opportunity to prepare for future incidents and develop questions to study in future events. [West J Emerg Med. 2020;21(2)382-390.]

INTRODUCTION

Active shooter incidents, a subcategory of mass casualty incidents (MCI), while relatively rare, are increasing in the United States (US). The average of 11.4 active shooter incidents between 2000-2013 increased to 20 each year 2014-2016, and 30 in 2017.[1,2] Casualty numbers during 2016-2017 were higher than prior years due to the incidents at the Route 91 Harvest Festival in Las Vegas, NV, Pulse Nightclub in Orlando, FL, and the First Baptist Church in Sutherland Springs, TX.[3] MCIs are "an imbalance between the

numbers of injured who need medical care and the medical ability of emergency systems to deliver optimal care to each individual."[4] In the 2013 Boston Marathon bombing, 118 people were transported to nine hospitals in 18 minutes with more than 264 seeking treatment.[5] During the response to the Route 91 Harvest Festival mass shooting incident in 2017, the University Medical Center of Southern Nevada cared for 104 patients, Sunrise Hospital and Medical Center received 212 patients, and St. Rose Dominican Hospital cared for 37 patients.[6] Hospitals must prepare for MCIs.[4,7-10]

On December 2, 2015, a terrorist attack in San Bernardino killed 14 and injured 22. Incident details were described in an earlier publication.[11] The response involved six local hospitals in a regional network, the Inland Counties Emergency Medical Agency, [12] using ReddiNet[13] (ReddiNet, Los Angeles CA), a communications network (Table 1). Previous studies have illuminated hospital responses to terrorist attacks.[14-16] Common experiences of individual health professionals responding to a singular event are less well understood.

Importance

Understanding common experiences of health professionals from different medical centers responding to the same, singular terrorist attack may provide new insights into shared challenges, best practices, and lead to questions worthy of additional study. Our study is the largest qualitative study of healthcare professionals responding to terrorism in the US. Previous studies have focused on attacks in Europe or Israel, or on responders other than physicians and nurses (i.e., social workers).[17,18]

Goals of This Investigation

Our primary objective was to gather and detail the common experiences from those hospital-based health professionals directly involved in the response to the San Bernardino terrorism attack. Secondary objectives included gathering information on experiences participants found were best practices. The analysis of this information should allow professionals to generate questions for further study as well as review and improve their current MCI planning.

Population Health Research Capsule

What do we already know about this issue?
Mass casualty incident (MCI) responses push the limits of individual hospital based providers. Institutional preparation is essential as incident numbers increase.

What was the research question?
What common experiences of hospital providers directly involved in a terrorist response inform improvements in MCI planning?

What was the major finding of the study?
Common Experience: communication, training, unexpected aid, process bypass, personal impact, practical advice.

How does this improve population health?
Insights inform improvements in MCI planning at both individual & institution level. Planning for after event processing is essential to support clinical providers.

METHODS

Study Design and Setting

We undertook a qualitative study using Consolidated Criteria for Reporting Qualitative Research (COREQ) guidelines by performing semi-structured interviews with physicians, nurses, and incident management staff from multiple institutions responding to the San Bernardino terrorist attack.[19-21] We chose this approach because terrorist attacks on US civilian targets are relatively rare and the inductive approach uncovers a deeper understanding of elusive or unexpected responses to clinical problems by allowing for probing questions.[22,23] The Loma Linda

Table 1. Responder resources to the San Bernardino mass shooting.

Resource hospitals	Service area
Loma Linda University Emergency Department	Level I Trauma, Adult and Pediatric Patients
Arrowhead Regional Medical Center	Level II Trauma, San Bernardino County
Riverside University Health System Hospital	Level II Trauma, Riverside County
St. Bernardine's Medical Center, San Antonio Regional Hospital, and Kaiser Permanente Fontana Medical Center	Community hospitals
Inland Counties Emergency Medical Agency (ICEMA)	Regional Disaster Response System. Oversees prehospital services in the area and provides opportunities for collaboration and integration.
REDDINET	Emergency medical communications network links hospitals, first responders, law enforcement, and public health assets.

University Institutional Review Board approved the study as exempt. Participants provided verbal consent.

Selection of Participants and Data Collection and Processing

Three emergency physicians and one public health PhD, trained in qualitative approaches, interviewed participants. We used purposive and then snowball sampling to select participants whereby we contacted facility medical directors and asked them to provide a list of potential interviewees. We recruited from multiple distinct hospitals to achieve data source triangulation, building a comprehensive and thorough model by using diverse data sources by recruiting.[23] Interviews were conducted at participant's hospital or by phone, per interviewee's choice, January 13, 2016 – March 17, 2016, using a standardized interview guide (Table 2). All interviews were audiotaped and then transcribed by paid transcriptionists. Interviews lasted between 13-60 minutes with a median of 31 minutes. We interviewed until theoretical saturation was achieved as no new relevant ideas were mentioned by additional participants. Another indication of saturation was repetitive themes that supported the resulting model. [22, 24] We analyzed data using DEDOOSE version 7.5.16 (Los Angeles, CA).

Primary Data Analysis

Researchers independently coded four transcripts using qualitative analysis techniques.[22] We refined the list using a negotiated group process until code definitions were delineated and agreed upon. We developed final themes using an inductive process over multiple meetings. Once themes were identified, team members performed additional data analysis together to identify relevant contrarian viewpoints found within the themes. Study participants did not provide feedback, but we included de-identified quotations emblematic of the discovered themes.

RESULTS

Characteristics of Study Subjects

We completed 26 interviews with hospital-based responders (Table 3). One hospital system treating only one patient declined participation. Interview coding produced 1172 excerpts categorized into 66 initial themes, which collapsed to six general categories: communication, training, unexpected help, processes bypassed, personal impact/emotions, and practical advice.

Main Results

Active shooter incidents challenge traditional communication channels.

Active shooter incidents present challenges of scale and function by occurring unexpectedly, demanding resources that are not typically available on a regular day, and challenging pre-identified hierarchies and defined job descriptions. Study participants used multiple communication methods, including REDDINET, in- person conversations, handheld hospital "disaster phones" distributed for MCIs, two-way pagers, and work or personal cell phones for voice and texting. Additional resources included television, hospital computers, social media, and other phone apps to stream news reports. Despite using multiple communication methods, participants reported having an incomplete picture of what to expect.

> *Initially we got a lot more information, we were just trying to gather more information. The first call they said that it was 10-20 victims we didn't know if they were coming to us, or how many or if all of them were coming to us.*

> *I don't know what's coming in. I didn't even know if it was a patient themselves or the shooter. It could have been either of them. No one knew anything.*

Many respondents reported trusting information using peer-to-peer (PTP) methods such as text and Facebook messages. PTP methods seemed weighted more than other communication methods, especially when the messenger was a personal acquaintance. Physicians promptly responded to the PTP requests for resources, including residents at the trauma centers. It was an education day at two locations so many residents were on site. Administrative response was quick at all locations. For example, it was clear that administrators intervened to move patients up to floors to open ED beds for potential victims. On the other hand, the administrative response also increased ED traffic leading to potential confusion about who was in charge. The large number of available physicians created the potential for confusing communication.

> *For instance one of my colleagues was astute enough to recognize our communication difficulties; some of the leadership drifting around the campus, whether they were out in the parking lot or central supply or CAT scan or whatever, did not have direct communication with each other. So she secured more handsets, more mobile handsets so the leadership could talk amongst each other directly. The rest of us gained more supplies and prepared each room for whatever might come. It was both direct and indirect leadership. We got direction and then we self-assigned some of our own duty.*

Hospital personnel streaming news on their office computers led to Internet system degradation. Ultimately clinicians depended on a combination of their own judgment and leadership messages to make patient care decisions.

> *So they were getting private phone calls and private texts from outside sources; who knows if they were actually on the scene? They were listening to their radio or texts from a friend. So all kinds of external stuff were coming but none of it was correct either. And then that was causing the nurses and staff down here to continue to follow whatever media station they could catch on their cell reception or the Wi-Fi reception we had here and that did not work well at all.*

Table 2. Standardized interview guide for mass shooting study.

Demographics	How long have you been at your medical center? How many years have you been in the emergency department? Where did you do your training? How old are you? What is your gender?
Grand Tour Question	Tell me about that day.
Overall Framing	What was your job title that day? (prompt: medical director, doctor on duty, nurse on duty, tech, etc.)
Process & Logistics	What worked well? What didn't work well? Was there anything that didn't work well? Was there anything you weren't prepared for? Has anything changed in the emergency department as a result of these events?
Disaster Plan	Did you activate your disaster plan and if so, how did it go? Were you able to move low acuity patients out? Were you able to make room for more traumas? Did you call other hospitals? Have you had training to deal with active shooter events? If yes: Was this through your work or another venue? What aspects of the training you had were especially helpful? If no: Do you plan on attending training to prepare for this type of event?
Unexpected Outcomes	Did anything surprise you about the response? Some people we have spoken with at various sites have said they know certain hospital guidelines or rules were broken to care for patients that day. Are you aware of any hospital rules or guidelines that were broken that day?
Communication	How was the communication? Were there any disruptions or breakdowns? What would have improved communications? How was the electronic medical record?
Emotional State	Did you feel safe? Do you think that impacted patient care? How has your perspective regarding future threats changed? What impact has the terrorism had on you professionally? What impact has the terrorism had on you personally? (prompt: Did you do anything differently as a result such as changes to how you take care of yourself?) What would have helped you process the incident? Did you attend a debriefing? If yes: What aspects of the debriefing were helpful? Imagining future scenarios, would you play the same role or would you want to take on a different role? Would you respond the same way or a different way? What training or information do you feel you need to do in order to be better prepared next time?

Our hospital system was overwhelmed. You couldn't send pages. You couldn't send emails. You couldn't send out announcements because the system was completely clogged.

Security planning is often independent of medical care processes. As a result, communication between security and the hospital incident command system sometimes lagged. Respondents who worked with victim families noted there was some confusion about how to confirm family member identities and who was allowed to be with the patient.

Security had earpieces and nobody had access to what they're hearing. They need to be sharing what they're hearing. In the future I hope to get one administrator with the same equipment so administration isn't closed off and we're not left out of that critical information.

The use of social media sometimes added inaccurate information and unnecessary stress.

So that was kind of hard because we didn't know what was real and was not real coming in.

Most clinicians felt prepared due to ongoing training drills.

ED training is both clinical-role specific, completed as a professional requirement, and interprofessional. Some respondents had completed active shooter training prior to the attack. Prior training had limited influence, however, since the attack was technically not an active shooter incident at their facilities.

Most participants said disaster drills were helpful because most people knew their role and task. Clinicians knew how to form response teams, prepare treatment beds/areas and assemble

Table 3. Demographic characteristics of interview subjects.

	Male (n=14)			Female (n=12)			Total (n=26)		
	Median	1st Quartile	3rd Quartile	Median	1st Quartile	3rd Quartile	Median	1st Quartile	3rd Quartile
Age	39.5	36.5	48.0	44.5	39.3	54.8	41.0	37.3	50.8
Years post degree	10.0	5.0	13.0	14.5	9.5	17.8	12.0	6.3	16.5
		n	%		n	%		n	%
MD/DO		12	46		6	23		18	69
Nurse or Admin		2	8		6	23		8	31

MD, Doctor of Medicine; *DO,* Doctor of Osteopathic Medicine; *admin,* administration.

appropriate equipment. People moved to their roles without conflict. Clinicians felt confident and competent to treat patients regardless of condition. Two hospitals had recently held drills and respondents felt this was a contribution.

> *You know, I was just prepared for the worst. I didn't know if there were shooters who were going to try and attack the hospital. Whatever it was, I was prepared for it. I was good, I'm going to protect my staff, I'm going to treat as many patients as I possibly can, we are going to do the best we can. I think everyone acted that way.*

Respondents identified some training gaps, including working with non-clinical administrators and patient/family liaisons, increased people in the ED, and how to handle media. Some remarked that without media training they had to develop a response extemporaneously.

> *We had a lot of media turning into a circus. So they can video off the hospital front and we had patients coming in. A nurse mentioned, 'why don't we drop blankets and cover up patients to protect them from this media circus. These patients deserve privacy.' We surrounded that patient as we brought them in and protected their identity.*

Some expressed a desire to understand more about weapons and ballistics.

> *Especially when the detectives come to talk to you, you're the only access they have to the patient and they're asking you questions that you probably can't answer because you're not a ballistics specialist.*

Lots of people want to help but they need direction to know where to be effective.

Everyone commented on the spontaneous help offered.

> *It made me very proud to work here – to be a part of it. To see how everybody wanted to help…to see that we were all here as a team…was amazing.*

For the EDs, that meant doctors and nurses calling to offer clinical assistance, as well as local businesses dropping off food and water. When a bomb threat was called into one facility a local casino security force immediately brought bomb-sniffing dogs to the hospital. Those already working stayed significantly beyond their shifts. Unexpected help from qualified individuals already credentialed to work in the hospital was welcomed and represented an extended workforce. Calls came in from hospitals in adjacent counties offering operating space. There was a need for a better process for integrating (or not) volunteer clinicians into patient care in the ED.

> *It was crowded with the number of emergency physicians and trauma surgeons who were there and so pile on top of that people who came down wanting to help who really didn't need to be there. That got in the way a little bit. But I think on our side, we did a pretty good job of policing that I mean nobody kicked anybody out, but there could have been a way I think to regulate better who was down there. It's just human nature to want to help. It's hard to be critical of that.*

> *There could be something to the effect of a central station where all providers check in and are doled out to certain areas.*

> *I think pairing off worked well when you have sets or surplus of staff where you can handle every patient that comes. You know, the way we paired off was one trauma attending, and one ED attending for each patient. I think that worked very well. And because we were so overstaffed accompanying those patients up to OR really worked for us.*

The terrorist attack tested limits of responder security, media management, securely identifying patient families who should have access, and securing places where people might have access to view things they should not (i.e., rooftops of buildings). Help from outside agencies did provide needed support.

> *I mean we just felt completely safe. There were people everywhere. I knew their job was mainly to protect hospital staff but they weren't just police officers in uniform, they had their vests on, their dogs and their guns, and their SWAT cars. It was a whole army of people…*

Table 4. Practical advice for hospital response to mass casualty incidents.

Practical Advice	Create separate teams to care for patients already in the emergency department (ED) and the non-MCI patients who present to the ED.
	Create and distribute a paper list of disaster phone numbers of specific individuals/roles and designation of several individuals to serve as runners to communicate with people not immediately reachable by phone.
	Recognize the value of social media, especially peer-to-peer/text messaging, and plan for personal phone use instead of expecting people to only communicate via specific hospital disaster phones.
	Use of personal protective equipment, including gowns, can make it difficult to identify the roles of those providing patient care. Using stickers to identify individual roles as physician, nurse, or respiratory therapist, solves this issue.
	Integrating blood bank services into the disaster plan to temporarily bring blood supply into the ED while maintaining strict protocols.
	Encourage IT to plan for significantly increased streaming and Internet usage during MCIs. One hospital had to temporarily suspend Internet service because so many people were streaming news on their desktop computers it slowed the patient care activities that required IT resources.
	Out of concern for bombs or other weapons, decide in advance whether patients will have clothes removed prior to entering heavily populated trauma bays.
	Work with administrators to limit the number of extra people entering the ED by establishing a check-in system for volunteer clinicians. This plan needs to include a central place where people standing by also receive communication and updates about the disaster response and needs.
	Provide additional security to control who enters the ED, as well as identifying and controlling access to the hospital and grounds/parking lots surrounding the area.
	Immediately engage media in a single defined location to limit disruptive impact on patient care. Provide a direct liaison while remaining in control of where they can park to prevent blocking traffic flow of responders, patients and family.
	Establish a liaison to accompany family members of patients. The liaison may assist in obtaining identification, communication with providers, and to serve as a shield from media questions until the families are ready to manage it themselves.
	Develop a plan for debriefing of critical incidents that recognizes the personal and emotional impact on clinical responders.

MCI, mass casualty incident; *IT,* information technology.

Most responders were OK bypassing normal processes to expedite patient care.

All of the facilities activated some level of their disaster plan. MCIs may create scenarios where bypassing an approved process or policy is considered prudent to quickly treat more patients effectively. Most respondents reported some kind of process deviation and felt that decision was warranted by the circumstances.

> *I had 3-5 ambulances on delay on the wall; I wanted to consolidate patients and have one crew watching patients to release the other crews because I didn't know how many patients were trying to get in. I was able to release one crew.*

Multiple respondents documented moving patients out of the ED to admitted beds upstairs more quickly than the norm. In some cases this happened without written orders because of lack of access to computers, which is consistent with documented MCI responses.[4] Additional deviation examples included patients taken to the operating room without computer physician orders, a blood bank moved to the ED, a low-acuity, non-trauma patient discharged without paperwork, briefly releasing emergency physicians to accompany patients transferring to the OR with surgeons, and transferring patients to ICU earlier than usual.

> *I did find one patient that was in severe respiratory distress. So I grabbed one of my emergency residents who was superfluous for the traumas and I said, "Do you want to intubate or do you want me to?" and he was very happy to intubate…then I called the I.C.U. attending and said, "I normally stabilize these patients down here for a while. Do you mind taking them up right now?" and it was delightful. They said, "Sure. Send them right up" even before I had a blood gas.*

MCIs have personal and emotional impact on clinical responders.

Several respondents reflected on their personal situation while providing patient care, which was while the shooter identity was unknown and still at large.

> *I was scared for my family, honestly but not for anything that was happening in the ED or for my own safety. But my family's I was.*

Several had children in schools on lockdown. One facility received a bomb threat during this time. Clinicians did not know if they were treating victims or the shooter. Most respondents were not afraid, and expressed commitment to patient care regardless of their personal concerns.

Fear was not a factor in providing patient care. No one retreated, despite the threat of an at-large shooter, several physicians provided care in an open area established for disasters in the ED parking lot.

Most respondents said they employed their usual methods to deal with stressful days. Others felt that discussing their feelings in safe environments was key.

I was uncomfortable being out in large crowds after this. I did feel anxious coming into work. So it definitely impacted me personally. It hasn't affected how I do things around here, professionally, because I think I can separate that. But definitely I do think it has impacted me personally.

I voiced a lot of concerns to my wife. The thing that may have helped … was realizing how much more other people have to process, like there was the big shoot-out where the police shot the shooters and I'm thinking, I'm coming home to a normal life after helping to save this patient, what about those police officers? They were just involved in a shoot-out, and killed somebody, but in the process probably saved, I don't know, how many other lives?

Debriefing occurred in different settings post event and were typically held in conference rooms in the respective hospitals or attached campus grounds. Most respondents felt these were useful in processing the MCI. Many respondents commented that the event resulted in a lingering malaise that was difficult to shake for many weeks. Several people expressed gratitude for debriefing meetings that were mostly organized by clinical leadership and by clinical role (physicians separate from nurses). Two people commented they wished the debriefing had happened sooner and interprofessionally.

We talked about it amongst emergency physicians, trauma surgeons and nursing. I never really go home and think about patients ... I'm pretty good at brushing things off. Even though the actual patient care was no different than what we usually do, the context and knowing that it was this mass shooting and everything really sticks with you and obviously with all the news coverage and everything that occurs afterwards it was something that weighed on me for I would say at least a week.

While most felt that debriefing sessions were helpful in dealing with the incident, some felt that attending these were too painful and made them feel depressed and vulnerable.

My experience was debrief once and then do not talk about it. Forget it. Every time you talk about it, you're going to have a nightmare, that's what happened to me.

A few respondents felt that everyday security measures could be improved.

I think the best thing [hospital] has done is they've put in those metal detectors just like at the airports.

Many of the respondents felt a need to enhance their personal safety, mentioning being more aware of their surroundings, choosing when and where to walk, and considering training and/or acquisition of firearms.

I trained my family and my children to stay alert about surroundings…We teach them that we live in a different world. These things that are happening, it's not pretty. It's not what people should be doing to one another and bad things are happening and we need to be aware and protect ourselves.

Practical Advice

All respondents offered practical advice for preparing for a MCI response. These are summarized in Table 4.

DISCUSSION

Our qualitative study examined a MCI from the perspective of clinicians first caring for patients at area hospitals. Our study elucidated several themes to help other institutions prepare for similar incidents.

System resilience seemed bolstered by already established relationships. People relied on trust already developed from working together. They were proud about how a broad network of individuals, including prehospital responders, came together for a common goal. Literature documents that working together promotes resilience and training drills emphasizing "communicating, coordinating, and cooperating" promote social relationships because "emotional interaction may have a positive influence on team effectiveness."[5,25-27] Community relationships were also essential to obtaining water, food, and information. People worked at their level of training for the common goal and avoided power struggles because they already knew each other and what to do.

Social media was a two-sided issue. Consistent with similar events, responders used social media news reports to make decisions but not all information was accurate.[28] Instead of relying on limited "disaster phones" distributed only to leadership, all respondents could group text or receive news updates. However, there was no designated authority to confirm information accuracy. Individuals made decisions based on a combination of their own judgment and leadership messages, but everyone yearned for timely, accurate updates. The healthcare system should "adopt, use and leverage social

media," but usage standards have not been established and are often at odds with the general public who are able to post pictures and information in real time that may violate privacy standards at care facilities.[28]

Most interviewees felt safe in the work environment and did not feel their fears impacted their work. EDs are high-stress environments and workers are often exposed to violent acts during their regular work.[29] Their reported coping mechanisms were consistent with prior research about how protective skills and resilience develop after traumatic events.[30] Some described ways they were increasing their personal safety independent of work, including possible gun acquisition.[31]

Based on our interviews, debriefing sessions, in multiple contexts and venues, should be available, but not mandatory. Hospital disaster plans should include ongoing debriefing and counseling access, including individual follow-up with non-attenders. Sessions should address common maladies such as difficulty sleeping, increased fear and hypervigilance reported from other incidents.[16] Lingering effects from MCIs may be exacerbated by personally knowing the victims and the randomness of events (e.g., it might happen again.), and women typically report more symptoms.[16,32]

LIMITATIONS

Study limitations included clinicians who had the strongest negative impact from the incident may not have responded to our interview requests, which may have resulted in selection bias. Most of the interviews were from the Level I trauma center. Our sample under-represented nursing and administrative staff. The smaller sample size and time lapse between the event and interview completion may also hinder validity.

CONCLUSION

This study provides context regarding the response of healthcare personnel from multiple institutions to a singular terrorist attack in the U.S. While most responders felt prepared, non-traditional communication channels, managing volunteer assistance, and corralling media presented novel challenges not included in current disaster plans. Developing post-event debriefing plans that acknowledge personal impact on providers should also be a priority. By understanding these common experiences, opportunities arise to prepare for future incidents. Additionally, knowledge gained from participants sharing their best practices allows both an occasion to review and improve individual current MCI plans as well as an opportunity to study methods described in future events.

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Predictors of Patient Satisfaction and the Perceived Quality of Healthcare in an Emergency Department in Portugal

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Introduction: The predictors of patient satisfaction in emergency medicine (EM) have been widely studied and discussed in the scientific literature; the results vary depending on the specific EM attributes, cultural aspects, researchers' preferences, and approaches. However, it is not clear whether the same predictors of patient satisfaction can contribute to a better-perceived quality of healthcare or whether patients' perceptions form a different attitude toward satisfaction and perceived quality of healthcare. The goal of this study was to identify the key predictors of patient satisfaction and perceived quality of healthcare in the framework of an emergency department (ED).

Methods: We conducted a retrospective study of patients seen at an ED between January -December 2016. Data collection took place in the public hospital in Lisbon, Portugal, between May - November 2017. The total sample size included 382 patients. The sample distribution had a 5% margin of error and a 95% confidence interval. Data for this research, using a questionnaire, was collected by mail or e-mail according to the respondent's preference.

Results: A detailed analysis showed that three out of the 18 predictors had a statistically significant relationship with satisfaction: overall satisfaction with doctors, with a positive correlation ($r = 0.14$, $p \leq 0.01$); qualitative perceived waiting time for triage, with a positive correlation ($r = 0.08$, $p \leq 0.05$); and meeting expectations, with a positive correlation ($r = 0.53$, $p \leq 0.01$). Furthermore, a detailed analysis showed that only two out of the 18 predictors had a statistically significant relationship with the perceived quality of healthcare (PQHC): overall satisfaction with doctors, with a positive correlation ($r = 0.43$, $p \leq 0.01$) and meeting expectations, with a positive correlation ($r = 0.26$, $p \leq 0.01$).

Conclusion: The main predictors of satisfaction and perceived quality of healthcare were overall satisfaction with doctors and meeting expectations. We should note that "meeting expectations" plays the most important role in terms of satisfaction; however, in terms of PQHC the predictor "overall satisfaction with doctors" plays the most important role due to its stronger correlation. In addition, the qualitative perceived waiting time for triage could be considered as another predictor, influencing satisfaction only, thus emphasizing similarities and differences between satisfaction and the PQHC in an ED context. [West J Emerg Med. 2020;21(2)391-403.]

INTRODUCTION

Patient satisfaction plays a crucial role in the healthcare system as an indicator of the quality of care.[1] Importantly, the patient's experience of care is increasingly being used to determine hospital and physician reimbursements.[2] In this respect, patient satisfaction is subject to monitoring and assessment on an individual, community, and regional scale. The predictors of patient satisfaction in an emergency department (ED) are widely studied and discussed in the scientific literature, where the primary focus is ED staff. It is generally accepted that good nursing care as well as friendly and attentive staff members are of high importance for patients

when visiting the ED.[3,4,5] Patient dissatisfaction with the ED encounter is frequently related to poor communication.[6,7] The physician-patient relationship, built upon verbal and non-verbal communication, is particularly important in EDs.[7,8,9] However, it is not clear whether the same predictors of patient satisfaction could contribute to a better-perceived quality of healthcare or whether patient perceptions could form a different attitude toward satisfaction and the perceived quality of healthcare.

Patient experience measures have been shown to be indicators of healthcare quality; at the same time, there is no common approach for defining "patient satisfaction."[10] Patient satisfaction is measured through patient experiences with the healthcare system, which allows researchers, industry professionals, and policymakers to identify problems and outline areas for improvement to ensure equity in access and the availability of care services.[11] The main aim of measuring patient experience and satisfaction is to understand how the patient feels about being treated, learn about his/her perceptions of the quality of care and any related constructs, and to highlight areas of practice that could be improved to achieve better health outcomes and patient loyalty.[12]

One of the important parameters of patient satisfaction with the ED is based on how patients select a particular ED and whether they would recommend it to other patients.[13] Such important metrics contain patients' viewpoints and expectations, which are necessary to improve the quality of healthcare services. However, the relationship between expectation and satisfaction is unclear.[14] Since healthcare is targeted at patients, it is only natural that their expectations and ideas be incorporated into the delivery of healthcare services. Patient satisfaction with the ED may be influenced by numerous factors, including experience with nursing care, communication, infrastructure, and environment in which the healthcare professional practices.[9,15] Patient factors that may influence satisfaction include age, gender, income, education level, expectations, marital status, and where they live.[13] Hospital-related factors such as staff, waiting times, facilities, and processes may also influence patient satisfaction.[16] Hence, satisfaction is a widely measured concept that is not easy to define; however, it still needs to be developed.[14,17]

Patient satisfaction is related to the quality of care provided, and correlation between these two constructs highlights the need for collecting opinions regarding the care provided by the healthcare system.[18,19] Collecting patients' perceptions of quality of care is indispensable to attain crucial insight into their experiences, views, and opinions about hospital wards. What quality of care means is different depending on the different stakeholders. The Institute of Medicine's "Crossing the Quality Chasm"[20] provides a framework for defining the quality of healthcare. It provides guidelines to evaluate and determine the quality of healthcare delivery. The report conceptualizes the quality of care in six dimensions: safety; efficiency; effectiveness; timeliness; equity; and patient-centeredness.[20]

The World Health Organization[21] associates the quality of healthcare with six dimensions: effectiveness; efficiency; accessibility; acceptable/patient-centered care; equitability; and safety. The determinants of the quality of care include patient factors, technical quality, the quality of interpersonal interactions, and clinical factors.[16] Communities and service users, health service providers, and policy and strategy developers all have roles and responsibilities to ensure the delivery of quality healthcare.[21] Therefore, it is necessary to distinguish between satisfaction and the perceived quality of healthcare. It is also important to understand whether the same or a different set of factors could contribute to their improvement in the ED. Our main goal was to identify the key factors promoting patient satisfaction and perceived quality of healthcare in the ED including the following: 1) expectations (meeting expectations); 2) global perceptions (accessibility, availability; facilities, physical conditions; privacy; busyness of the ED in terms of number of people); and 3) perceived quality dimensions (ED staff; agreement with color assigned (triage level); waiting times; and information about possible delays).

Population Health Research Capsule

What do we already know about this issue?
Patient satisfaction and perceived quality of healthcare (PQHC) are used as measures of the evaluation of patients' experiences and perceptions in the emergency department.

What was the research question?
What are the key predictors of patient satisfaction and the PQHC, and do these or a different set of factors contribute to perception of quality of care in the ED?

What was the major finding of the study?
Patient satisfaction and PQHC have two key predictors in common, overall satisfaction with doctors and meeting expectations.

How does this improve population health?
Patient satisfaction is a more important measure than PQHC, influenced by a larger number of factors while at the same time sharing some similarities with PQHC.

METHODS

Data collection was carried out from May 18 - November 30, 2017, in the Hospital de São Francisco Xavier, the public hospital in Lisbon, Portugal. All responders were at least 18 years old, able to answer the questions, residents of Portugal,

and Portuguese-speaking. We excluded respondents who were unable to answer the questions, who resided outside Portugal, or had psychiatric illnesses. Probability sample with a 5% margin of error and a 95% confidence interval was examined. The total sample size was 382 patients. To calculate our random probabilistic sample size, we used a list of 55,903 patients who entered the ED (January 1 - December 31, 2016) at least once at the public hospital. Before sending the questionnaire, all patients were contacted by telephone to obtain permission to send the questionnaire and consent to participate in the survey.

When a chosen individual had more than one ED admission in the year under study, we chose the last admission according to the date of admission. Telephone calls were made three times during the day at different times and if our attempts to reach him or her were unsuccessful, the patient was classified as not responsive. The questionnaire was sent either by mail or e-mail, depending on the respondent's preference. If regular mail service was used the questionnaire was sent to the home address with an enclosed prepaid envelope. In cases of e-mail distribution, we used Qualtrics software (Qualtrics XM, Provo, UT/ Seattle, WA) to collect the data online. During the data collection period we made a total of 4,413 telephone calls, just including the first-call attempts and excluding all repeat calls afterwards. Those who did not have a telephone number in our list were excluded prior to the initiation of the calls. In total, 2,512 (56.9%) individuals agreed to participate in the survey. Among the remaining 1,901 (43.1%) who did not participate 333 (7.5%) individuals declined to participate due to various reasons or simply did not want to participate in the survey; 157 (3.6%) individuals had already died, and 43 (1.0%) were ineligible per the exclusion criteria, as the phone was answered by another person. A total of 1368 (31.0%) individuals either did not respond to the telephone call, or had unassigned, invalid, temporarily disconnected, or incomplete phone numbers. Eventually, 1,553 patients agreed to participate and gave permission to us to send the questionnaire by mail; however, only 506 questionnaires were sent due to the study's financial constraints. We received 143 (9.2%) responses to our questionnaires, and 363 (23.4%) did not respond. With respect to the e-mail distribution, 959 patients agreed to participate and gave us permission to send the questionnaire by e-mail. Of those email recipients, 340 (35.5%) responded to the questionnaire online, and 619 (64.5%) did not respond. Those individuals who did not respond and did not send back the questionnaire were contacted again and asked to complete it. In the case of an incorrect home address, the respondent was contacted again and then sent the questionnaire. The same was done with e-mail distribution; after a certain period of time the respondent was contacted again through e-mail and asked to respond to the online questionnaire. The total number of obtained questionnaires (483) exceeded the total number of a calculated necessary sample size (382), resulting in exclusion of 101 incomplete/poorly completed questionnaires where the number of questions answered was very low, as well as questionnaires that were returned after our data analysis had already begun. Thus, among the 382 individuals, 75.9% were online (e-mail) respondents, and 24.1% responded via regular mail.

Our modified-elaborated questionnaire was partly based on the questionnaire used by Pereira et al.[22] and was partly based on the *Instrumentos de Avaliacao da Qualidade Hospitalar – Urgencias Adultos* [Portug.][Instruments for Evaluating Hospital Quality - Adult Emergency], which was designed, developed, and tested by the Centro de Estudos e Investigacao em Saude da Universidade de Coimbra [Portug.] [Center for Studies and Research in Health of the University of Coimbra].[23,24] In addition, we took into consideration the fourth national health survey (Portugal) prepared by the Instituto Nacional de Saude Dr. Ricardo Jorge/Instituto Nacional de Estatistica [Portug.] [National Institute of Health Dr. Ricardo Jorge/National Institute of Statistics],[25] as well as the survey used to investigate the aging process in Portugal.[26]

Variables that measured more than one item were simplified into a single composite measure. This was the case with the set of eight variables: 1) accessibility and availability; 2) facilities and physical conditions; 3) satisfaction with staff at the registration counter; 4) with personnel, conducting the triage; 5) with doctors; 6) with nurses; 7) with auxiliary staff; 8) and with health technicians responsible for examinations and/or tests. Accessibility and availability consisted of five items: 1) location; 2) orientation; 3) distance between the different areas; 4) availability of equipment and of specialist staff; and 5) overall satisfaction with accessibility and availability.

Facilities and physical conditions consisted of six items related to the condition, comfort, and convenience of the following areas: 1) the waiting room; 2) the observation room; 3) the facilities where tests were carried out; as well as 4) age and operation of equipment; 5) cleanliness and hygiene of the facilities; and 6) overall satisfaction with facilities and physical conditions. Patient satisfaction with staff at the registration counter, with personnel conducting the triage, nurses, auxiliary staff, with health technicians responsible for examinations and/or tests consisted of three items: 1) friendliness and helpfulness; 2) competence and professionalism; and 3) overall performance. Satisfaction with doctors consisted of six items: 1) friendliness and helpfulness; 2) competence and professionalism; 3) the way the doctor explained a health problem (diagnosis); 4) explanations given by the doctor on the exams performed and the objectives of the treatment to be undergone; 5) information provided on precautions to be taken, recommendations, and how to take or apply the medications prescribed; and 6) overall performance.

We used an exploratory factorial analysis (EFA) to test for the items' underlying factors .The EFA was conducted

using the principal axis factoring method for extraction, the scree plot for selecting the number of factors, and the oblimin rotation to interpret the factor loadings. We used a factor analysis to model the inter-relationships between multiple items but with fewer variables, to reduce composite scale variables with several measures into one single scale.[27] Factor loading expressed the association of the variables to their underlying factors. The statistical significance of factor loadings was based on their magnitude.[27] For the rotated factor loading for a sample of at least 300 participants to be statistically significant at an alpha level of 0.01 (two-tailed), it would need to be greater or equal to 0.32.[28] In turn, we considered factor loadings above 0.30 to be acceptable, being statistically significant at 382 participants. All items used could be aggregated into single factors due to the strong correlations observed. More specifically, high alpha coefficients (0.87 to 0.99) evidence that the items have a relatively good internal consistency,[27] consequently giving us confidence that our measures were reliable and correct.

RESULTS

Descriptive Analysis of Patient Satisfaction and Perceived Quality of Healthcare

The participants were mostly from Lisbon (96%) and were grouped into persons with dual nationality (2.1%), other nationality (2.6%), and Portuguese (95.3%), with the proportion of females to males at 61.3%: 38.7%. The age distribution of participants across age groups was almost uniform: 18-30 years (14.9%), 31-40 (19.1%), 41-50 (14.4%); 51-60 (17.6%); 61-70 (9.2%); 71-80 (9.8%); 80+ y (14.7%). The mean values, standard deviation, and correlation coefficients with two main variables, including descriptive statistics of the variables are shown in Tables 1 and 2.

The results show that two core variables of this study, satisfaction and PQHC, are strongly correlated (r = 0.80). Considering the possible correlations between satisfaction, PQHC, and other variables we were able to evidence that even though satisfaction and PQHC are very close concepts, they still differ. The data presented in Tables 1 Table 2 show the differences between satisfaction and the PQHC. Furthermore, the data demonstrate the different degree of correlation between the variables (moderate vs strong) in terms of satisfaction and PQHC, variables that disunite satisfaction and PQHC according to inclusion criteria (weak vs very weak correlation), and variables that unite satisfaction and PQHC.

Regarding satisfaction and PQHC, 24 variables appear to unite them, as compared to two variables that separate them. These two variables slightly differ in terms of the patients' views. Agreement with the triage color assigned, for example, can be perceived as a more relevant issue in terms of satisfaction (r = 0.20), but slightly less relevant (r = 0.17) in terms of the PQHC. On the contrary, other variable such as a discharge note given to a patient (r = 0.20 vs r = 0.16) was slightly more relevant in terms of PQHC than in terms of satisfaction. An additional three variables – nursing personnel; evaluation of the treatment received; and evaluation of communication with relatives or with the people accompanying them about their health situation – showed a slightly different degree of correlation (moderate vs strong) in terms of satisfaction and the PQHC. With reference to ED personnel, patients relate nursing staff to PQHC (r = 0.61 vs r = 0.58) as being more relevant than satisfaction. Similarly, the evaluation of communication with relatives or with the people accompanying the patient about his or her health situation (r = 0.70 vs r = 0.47) and the evaluation of the treatment received (r = 0.66 VS r = 0.57) appear to be more relevant regarding the PQHC.

In terms of the waiting time variables (waiting time for triage; waiting time after triage; waiting time for examinations and/or tests; waiting time to be called back by the doctor after the examinations and/or tests; discharge waiting time), we analyzed the qualitative perceived waiting time (on a scale of 1-10) and the quantitative perceived waiting time (with an exact time scale evaluation). For example, waiting time for triage was measured both using a 1-10 scale and an exact time scale evaluation. The same was done with all other waiting time variables. It is important to manage the qualitative perceptions of waiting times, as different patients may perceive the same waiting time interval in a different way that may lead to contradictory results. Thus, our data show that qualitative perceived waiting times (on a 1-10 scale) have a stronger correlation with satisfaction and PQHC than quantitative perceived waiting times (with an exact time scale evaluation), represented in Tables 1 and 2.

Overall, it appears that the potential predictors correlate with satisfaction and the PQHC, among which some of them have stronger correlations than others, with either satisfaction or the PQHC. It suggests that, although being similar constructs, different predictors might explain them.

Predictors of Patient Satisfaction and Perceived Quality of Healthcare

We applied a multiple regression analysis to identify the main predictors of satisfaction and the PQHC. Two important issues were examined: 1) how much the selected predictors account for satisfaction and the PQHC; and 2) which predictors stand out and how they differ between satisfaction and the PQHC. As expected, the qualitative perceived waiting time appeared to be the major predictor of satisfaction and the PQHC due to its stronger correlation level (Tables 1 and 2). In addition, other potentially relevant variables were excluded from the regression analysis due to extensive missing values (at least 30% of the total participants) among which were nursing personnel, auxiliary staff, evaluation of the treatment received, and evaluation of communication with relatives or with the people accompanying the patient about the health situation. We should note that the missing values in these variables

Table 1. Means, minimum, maximum, standard deviations, and correlations with satisfaction and the Perceived Quality of Healthcare.

	n	Mean	Minimum	Maximum	SD	$r_{Satisfaction}$	$r_{Quality}$
Age (years)	382	53.19	20	92	20.235	0.20	0.21
Accessibility and availability						0.65	0.63
Location of the hospital and emergency department within the city	379	8.20	1	10	1.96	-	-
Orientation within the emergency department	374	7.44	1	10	2.05	-	-
Distance between the different areas of the emergency department	363	7.46	1	10	1.92	-	-
Availability of equipment and of specialist staff to conduct tests, blood tests	366	7.32	1	10	2.19	-	-
Overall, accessibility, and availability	375	7.49	1	10	2.08	-	-
Facilities and physical conditions						0.63	0.60
Conditions, comfort, and convenience of the waiting room	371	5.07	1	10	2.43	-	-
Conditions, comfort, and convenience of the observation room	379	6.17	1	10	2.31	-	-
Conditions, comfort, and convenience of the facilities where tests were carried out	363	6.68	1	10	2.15	-	-
Age and operation of equipment	339	6.81	1	10	2.06	-	-
Cleanliness and hygiene of the facilities	377	6.72	1	10	2.37	-	-
Overall, the facilities, and physical conditions of the emergency department	376	6.48	1	10	2.13	-	-
Privacy						0.45	0.46
The way the privacy was safeguarded	372	7.27	1	10	2.41	-	-
Staff at the registration counter						0.54	0.51
Friendliness and helpfulness of staff at the registration counter	371	7.22	1	10	2.22	-	-
Competence and professionalism of staff at the registration counter	368	7.40	1	10	2.15	-	-
Overall, the performance of the staff	372	7.46	1	10	2.13	-	-
Waiting time for triage (perception)						0.47	0.40
Waiting time for triage in view of the severity of condition	362	7.35	1	10	2.37	-	-
Staff conducting the triage						0.51	0.52
Friendliness and helpfulness of the nurse conducting the triage	367	7.73	1	10	1.99	-	-
Competence and professionalism of the nurse conducting the triage	366	7.82	1	10	1.94	-	-
Overall, the performance of the nurse conducting the triage	366	7.84	1	10	1.92	-	-
Waiting time after triage (perception)						0.55	0.43
Waiting time to be seen by a doctor after the triage in view of the severity of the condition	372	5.21	1	10	2.98	-	-
Doctors						0.65	0.76
Friendliness and helpfulness of the doctor(s)	379	7.74	1	10	2.17	-	-
Competence and professionalism of the doctor(s)	374	7.90	1	10	2.15	-	-
The way the doctor explained a health problem (diagnosis) during the examination	378	7.78	1	10	2.30	-	-
The explanations given by the doctor on the exams performed and the objectives of the treatment to be undertaken	366	7.77	1	10	2.39	-	-

Table 1. Continued.

	n	Mean	Minimum	Maximum	SD	$r_{Satisfaction}$	$r_{Quality}$
The information provided on precautions to be taken, recommendations, and how to take or apply the medications prescribed (written or oral) after leaving hospital	370	7.95	1	10	2.23	-	-
Overall, the performance of the doctor(s)	378	7.89	1	10	2.26	-	-
Nursing personnel						0.58	0.61
Friendliness and helpfulness of the nurses	258	8.05	1	10	1.93	-	-
Competence and professionalism of the nurses	256	8.22	1	10	1.87	-	-
Overall, the performance of the nurses	260	8.20	1	10	1.92	-	-
Auxiliary staff						0.44	0.51
Friendliness and helpfulness of the auxiliaries	123	8.17	1	10	1.89	-	-
Competence and professionalism of the auxiliaries	121	8.17	1	10	1.76	-	-
Overall, the performance of the auxiliary staff	122	8.26	1	10	1.78	-	-
Waiting time for examinations and/or tests (perception)						0.58	0.54
Waiting time for examinations and/or tests in view of the severity of the condition	311	5.98	1	10	2.66	-	-
Waiting time to be called back by the doctor (perception)						0.59	0.57
Waiting time to be called back by the doctor after the examinations and/or tests in view of the severity of the condition	314	5.58	1	10	2.71	-	-
Health technicians						0.58	0.59
Friendliness and helpfulness of the health technicians in question	322	7.52	1	10	2.04	-	-
Competence and professionalism of the health technicians in question	312	7.77	1	10	1.99	-	-
Overall, the quality of the services provided with examinations or tests	319	7.72	1	10	1.94	-	-
Evaluation of the treatment received						0.57	0.66
Evaluation of the treatment received	224	8.24	1	10	1.90	-	-
Evaluation of communication with relatives or with the people accompanying the patient about health situation						0.47	0.70
The way the emergency physician or nurse communicated with relatives or with the people accompanying about health situation	164	8.30	1	10	1.79	-	-
Discharge waiting time (perception)						0.44	0.43
Waiting time from when the patient was informed about discharge until the patient left the hospital	317	7.67	1	10	2.60	-	-
Expectations						0.83	0.70
Meeting the expectations	375	6.65	1	10	2.39	-	-
Satisfaction							0.80
Considering the entire experience at the ED, the level of satisfaction	380	7.10	1	10	2.38		
Perceived quality of healthcare						0.80	
Overall, evaluation of the quality of healthcare	373	7.65	1	10	2.10		

Table 2. Total number, percentage, and correlations with satisfaction and Perceived Quality of Healthcare.

	n	%	$r_{Satisfaction}$	$r_{Quality}$
Lack of any type of staff			-0.37	-0.30
You did not feel the need for any type of staff	120	31.4	-	-
Doctors	148	38.7	-	-
Nurses	95	24.9		
Auxiliaries (for example, those bringing food, moving stretchers, accompanying patients, etc.)	81	21.2	-	-
Health technicians (conducting tests)	50	13.1	-	-
Administrative staff	12	3.1	-	-
Busyness of the emergency department, in terms of number of people (users/patients)			-0.27	-0.21
Not very busy	21	5.6	-	-
Normal number of people	110	29.6	-	-
Very busy	147	39.5	-	-
Too busy	94	25.3	-	-
Total	372	100.0	-	-
Information about possible delays in receiving treatment or waiting times			0.24	0.21
Yes	59	16.6	-	-
No	297	83.4	-	-
Total	356	100.0	-	-
Explanations for the delay			0.39	0.33
Yes	24	6.7	-	-
No	235	65.8	-	-
I did not wait for a long time	98	27.5	-	-
Total	357	100.0	-	-
Agreement with (triage) color assigned			0.20	0.17
Yes, I agreed with the color assigned	225	75.5	-	-
No, I should have been assigned a more urgent color	73	24.5	-	-
Total	298	100.0	-	-
If the patient was given a discharge note (letter summarizing what happened in the emergency department)			0.16	0.20
Yes	265	75.7	-	-
No	85	24.3	-	-
Total	350	100.0	-	-
Waiting time for triage			-0.25	-0.22
No waiting period	46	12.6	-	-
Up to 5 minutes	110	30.1	-	-
Over 5 and up to 15 minutes	114	31.1	-	-
Over 15 and up to 30 minutes	49	13.4	-	-
Over 30 minutes up to 1 hour	25	6.8	-	-
Over 1 hour	22	6.0	-	-
Total	366	100.0	-	-

Table 2. Continued.

	n	%	$r_{Satisfaction}$	$r_{Quality}$
Waiting time to be seen by a doctor after the triage			-0.35	-0.31
No waiting period	20	5.6	-	-
Up to 15 minutes	47	13.1	-	-
Over 15 and up to 30 minutes	57	15.9	-	-
Over 30 minutes and up to 1 hour	76	21.2	-	-
Over 1 and up to 2 hours	69	19.2	-	-
Over 2 and up to 4 hours	61	17.0	-	-
Over 4 and up to 6 hours	29	8.1	-	-
Total	359	100.0	-	-
Waiting time for examinations and/or tests			-0.31	-0.33
No waiting period	19	6.2	-	-
Up to 15 minutes	57	18.7	-	-
Over 15 and up to 30 minutes	77	25.2	-	-
Over 30 minutes up to 1 hour	56	18.4	-	-
Over 1 and up to 2 hours	48	15.7	-	-
Over 2 and up to 4 hours	35	11.5	-	-
Over 4 and up to 6 hours	11	3.6	-	-
Over 6 and up to 9 hours	2	.7	-	-
Total	305	100.0	-	-
Waiting time to be called back by the doctor after the examinations and/or tests			-0.33	-0.34
No waiting period	15	5.1	-	-
Up to 15 minutes	30	10.1	-	-
Over 15 and up to 30 minutes	39	13.1	-	-
Over 30 minutes up to 1 hour	61	20.5	-	-
Over 1 and up to 2 hours	69	23.2	-	-
Over 2 and up to 4 hours	53	17.8	-	-
Over 4 and up to 6 hours	22	7.4	-	-
Over 6 and up to 9 hours	8	2.7	-	-
Total	297	100.0	-	-
Waiting time from when the patient was informed about discharge until the patient left the hospital			-0.18	-0.17
No waiting period	98	30.9	-	-
Up to 5 minutes	42	13.2	-	-
Over 5 and up to 15 minutes	68	21.5	-	-
Over 15 and up to 30 minutes	38	12.0	-	-
Over 30 minutes and up to 1 hour	34	10.7	-	-
Over 1 hour	37	11.7	-	-
Total	317	100.0	-	-

result from the fact that not all the participants had contact with nursing personnel or auxiliary staff, received treatment, or were accompanied by a relative or another person. The benefits of still including these variables with missing values to have a more extensive list of the predictors did not justify the costs of having a reduced sample size and, consequently, reducing the test power for the study of the predictor.

Finally, only variables with a strong, moderate, or weak correlation with satisfaction and the PQHC were taken into consideration. Two regression models were computed, including the 18 selected predictors and including either satisfaction or PQHC as the dependent variables. We used the forced entry method (all predictors entering simultaneously into the regression model) as there were no specific predictions about the relative contributions of each variable (or block of variables).

The regression model with satisfaction shows statistically significant results (Table 3): $F(18,234) = 45.49$, adjusted R square = 0.76, and $p \leq 0.01$. A more detailed analysis shows that three out of the 18 predictors have a statistically significant relation with satisfaction: *overall satisfaction with doctors,* with a positive correlation ($r = 0.14$, $p \leq 0.01$); *qualitative perceived waiting time for triage,* with a positive correlation ($r = 0.08$, $p \leq 0.05$); and *meeting expectations,* with a positive correlation ($r = 0.53$, $p \leq 0.01$).

The regression model with the PQHC also showed statistically significant results (Table 4): $F(18,248) = 33.97$, adjusted R square = 0.69, and $p \leq 0.01$. In the given case, the results show that only two out of the 18 predictors have a statistically significant relationship with the PQHC: *overall satisfaction with doctors*, with a positive correlation ($r = 0.43$, $p \leq 0.01$) and *meeting expectations,* with a positive correlation ($r = 0.26$, $p \leq 0.01$). Consequently, it appeared that *overall satisfaction with doctors* and *meeting expectations* could be the main predictors of satisfaction and the PQHC, while *qualitative perceived waiting time for triage* could be considered as another relevant predictor, but only in terms of satisfaction.

DISCUSSION

In the first definition from the year 1975, patient satisfaction referred to "the degree of congruence between a patient's expectation of the ideal care they receive."[29] A growing body of literature has focused on determining the value of obtaining patient expectations in a written format prior to receiving care in the ED.[30] In turn, unmet expectations can result in patients' non-compliance and may impact the providers' reputation in a community; an estimated 70% of litigation involving medical practitioners can be related to real or perceived problems in communication, which influence patients' expectations.[31] Indeed, in our analysis, meeting patients' expectations turned out to be among the main predictors of satisfaction and the PQHC. A strong correlation between two core variables, ie, satisfaction and PQHC, united in our study by 24 variables, further supporting the close similarity of these two concepts. However, some of the variables have stronger or weaker correlations to others, with either satisfaction or the PQHC demonstrating the subtle differences of these two core variables. It suggests that although being similar constructs, different predictors might explain satisfaction and the PQHC.

Patient satisfaction is identified as one of the most important goals in any ED, relying on patient-reported experience measures (PREM), which gains increasing attention as an indicator of the quality of health care.[32] According to a recent systematic review, currently available PREMs for use in EDs have uncertain validity, reliability, and responsiveness.[33] Several attempts to upgrade the validity of PREM have been explored. PREMs differ from patient-reported outcome measures, which aim to measure the patient's health status quality, as well as more subjective patient satisfaction measures.[32] According to our analysis, both satisfaction and PQHC appear to be subjective concepts, influenced by subjective measures, where patients tend to emphasize the importance of the same/various predictors at a different level in terms of satisfaction and PQHC that leads to distinction between them. Thus, we may observe a different level of correlation that proves that patients may form different views regarding these two concepts, even though observing their similarity at the same time.

It is important to give patients time to deliberate over their experience, forming a true point of view. In prior research on access to, evaluation of, and attitudes toward the health system in the Portuguese population, it was shown that the memory of the hospital experience is valid up to three years, depending on the type of services and care received. In these studies, the experience in the ED was shown to be recalled for up to three years (last experience), which supports our temporal option about the research period.[34,35,36] The decision to cover a full year aimed to take into account the effects of seasonality, which affects the use of emergency services and the type and incidence of different illnesses. For example, when a patient's satisfaction is measured one hour after a single treatment in the ED, it does not capture a patient's view of their entire visit.[37] Healthcare service quality indicators, including health providers' interpersonal care, are repeatedly the most influential determinants of patient satisfaction.[38]

Some researchers have pointed to an important role of nurses in the ED. The role of nurses in the ED influences the quality of care because the early recognition and addressing of symptoms can determine the quality of patient outcomes.[39,40] Nursing care, including care and concern, keeping patients informed about delays, technical skills, keeping family and friends informed extend the role of nursing staff and were significantly associated with patient satisfaction.[39] Nursing personnel in our study were excluded from the regression analysis due to extensive missing values, even though we observed a strong correlation with the PQHC.

According to the results from the regression analysis, overall satisfaction with doctors came to the fore among the main predictors of satisfaction and PQHC that incorporated several items: friendliness and helpfulness; competence; and

Table 3. Multiple regression analysis results for satisfaction.

	Stand. Beta	T	Sig.
Constant		-1.30	0.20
Global perceptions			
Accessibility and availability	0.07	1.53	0.13
Facilities and physical conditions	0.04	0.69	0.49
Privacy	0.04	0.88	0.38
Busyness of the ED in terms of number of people	0.00	-0.03	0.98
Perceived quality dimensions			
ED personnel			
Staff at the registration counter	0.08	1.60	0.11
Staff conducting the triage	-0.04	-0.95	0.34
Doctors	0.14	3.09	0.00
Health technicians	0.00	-0.08	0.94
Lack of any type of staff	-0.02	-0.50	0.62
Admission to the ED/triage process			
Information about possible delays	0.06	1.82	0.07
Agreement with triage color assigned	0.01	0.39	0.70
Waiting time			
Waiting time for triage (perception)	0.08	2.08	0.04
Waiting time after triage (perception)	0.07	1.55	0.12
Waiting time for examinations and/or tests (perception)	0.02	0.46	0.65
Waiting time to be called back by the doctor (perception)	0.00	-0.04	0.97
Waiting time from when the patient was informed about discharge until the patient left the hospital (perception)	0.03	0.88	0.38
Expectations			
Meeting expectations	0.53	11.44	0.00
Social and demographic attribute:			
Age	0.04	1.18	0.24

ED, emergency department.

professionalism. Among the other important items were the way the doctor explained a health problem (diagnosis), explanations given by the doctor on the exams performed and the objectives of the treatment to be undergone, the information provided on the precautions to be taken, recommendations and how to take or apply the medications prescribed, and the overall performance. Physician care and concerns expressed, giving advice and follow-up, the accuracy of explanations regarding the treatment and tests, and keeping the patient informed; all these items were strong predictors of overall patient satisfaction.[39] The high importance of the doctor-patient relationship and communication, which can influence patient satisfaction, has been pointed out by several reserachers.[41] Patients placed a high importance on the use of plain language by a doctor (the way the patient understands) (92.1%), and the explanations given during each step of examination (90.8%).[42] Consequently, observing different attributes incorporated into the doctors' notion, our results are consistent with other results from the literature.[39,41,42]

Another major predictor of satisfaction identified in our analysis was the qualitative perceived waiting time for triage. This time factor may vary across EDs, hospitals, regions, and even countries, depending on the efficiency of the ED and healthcare system. Several researchers investigated waiting time for triage in the ED and patient satisfaction resulting from a color assigned in triage.[43] Our results confirmed the importance of this waiting time having a significant relationship with overall satisfaction.

By understanding that the essence of the main predictors of patient satisfaction is the importance of communicating with patients it will become clearer how providers can identify ways to improve their interactions with patients.. Prioritizing fulfillment of medical functions, ED clinical staff may ignore spending time on interacting with patients since approximately 75% of a patient's time in a care area is spent not interacting with care providers.[44] Neglected communication may cause acute problems in emergency medicine since 12% of errors

Table 4. Multiple regression analysis results for Perceived Quality of Healthcare.

	Stand. Beta	t	Sig.
Constant		0.36	0.72
Global perceptions			
Accessibility and availability	0.09	1.68	0.09
Facilities and physical conditions	0.06	1.01	0.31
Privacy	0.09	1.89	0.06
Busyness of the ED in terms of number of people	-0.01	-0.35	0.73
Perceived quality dimensions			
ED personnel			
Staff at the registration counter	-0.06	-1.16	0.25
Staff conducting the triage	0.07	1.39	0.17
Doctors	0.43	8.35	0.00
Health technicians	0.00	0.02	0.98
Lack of any type of staff	0.01	0.22	0.83
Admission to the ED/Triage process			
Information about possible delays	0.03	0.77	0.44
Waiting time			
Waiting time for triage (perception)	0.00	0.09	0.93
Waiting time after triage (perception)	-0.06	-1.18	0.24
Waiting time for examinations and/or tests (perception)	0.03	0.58	0.57
Waiting time to be called back by the doctor (perception)	0.10	1.79	0.07
Waiting time from when the patient was informed about discharge until the patient left the hospital (perception)	-0.01	-0.21	0.83
Discharge process			
If the patient was given discharge note	-0.02	-0.65	0.52
Expectations			
Meeting expectations	0.26	5.07	0.00
Social and demographic attribute:			
Age	0.06	1.69	0.09

ED, emergency department.

are attributed to communication problems.[45] Continuous overload and exposure to physical suffering reduce the staff's susceptibility to the emotional needs of acute care patients.[46] Several researchers have emphasized the importance of communication in the ED context that may influence the experience of waiting time as well as the importance of the responsiveness of staff that capture patient satisfaction.[47,48,49] In the context of waiting times, the absence of physician or nurse attention forms the overall perception of ED care.[17] In the pursuit of patient satisfaction, physicians and nurses modify their clinical and communication practices boosting an improvement in the quality of care.[50]

LIMITATIONS

Our data collection was subject to some limitations as it was confined to one ED in one country. In addition, we took into consideration only the Portuguese-speaking population and those who were able to answer the questions, which further reduces the generalizability of our findings. We chose the sample distribution with a 5% margin of error rather than a lower margin of error due to time and financial constraints. A longitudinal study would be a preferable choice, as some of the effects may present temporal lags.

CONCLUSION

Several patient- and hospital-level predictors can be consistently associated with patient satisfaction where patient-centered communication plays a vital role. Our study confirmed that overall satisfaction with doctors and meeting expectations are the main predictors that influence satisfaction and the PQHC. We should note that meeting expectations plays the most important role in terms of satisfaction; however, in terms of PQHC the most important factor is overall satisfaction with doctors due to its stronger correlation.

Qualitative perceived waiting time for triage is considered to be another predictor that will influence only satisfaction, thus emphasizing similarities and differences between satisfaction and the PQHC in an ED context.

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Role of Point-of-Care Testing in Reducing Time to Treatment Decision-Making in Urgency Patients: A Randomized Controlled Trial

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Introduction: Shortening emergency department (ED) visit time can reduce ED crowding, morbidity and mortality, and improve patient satisfaction. Point-of-care testing (POCT) has the potential to decrease laboratory turnaround time, possibly leading to shorter time to decision-making and ED length of stay (LOS). We aimed to determine whether the implementation of POCT could reduce time to decision-making and ED LOS.

Methods: We conducted a randomized control trial at the Urgency Room of Siriraj Hospital in Bangkok, Thailand. Patients triaged as level 3 or 4 were randomized to either the POCT or central laboratory testing (CLT) group. Primary outcomes were time to decision-making and ED LOS, which we compared using Mann-Whitney-Wilcoxon test.

Results: We enrolled a total of 248 patients: 124 in the POCT and 124 in the CLT group. The median time from arrival to decision was significantly shorter in the POCT group (106.5 minutes (interquartile [IQR] 78.3-140) vs 204.5 minutes (IQR 165-244), p <0.001). The median ED LOS of the POCT group was also shorter (240 minutes (IQR 161.3-410) vs 395.5 minutes (IQR 278.5-641.3), p <0.001).

Conclusion: Using a point-of-care testing system could decrease time to decision-making and ED LOS, which could in turn reduce ED crowding. [West J Emerg Med. 2020;21(2)404-410.]

INTRODUCTION

Emergency department (ED) crowding has become a major worldwide issue. Many previous studies have shown that ED crowding resulted in delayed management, thereby affecting overall healthcare quality.[1] Examples of the effect of ED crowding are delayed time to antibiotics administration in patients with pneumonia[2] and increased adverse cardiovascular outcomes in patients with chest pain.[3] Such delays may lead to higher morbidity and mortality among emergency patients.[4] One way to solve this is to improve patient flow by minimizing ED length of stay (LOS). Shorter LOS is associated with higher patient satisfaction[5] and a decrease in mortality and morbidity.[6,7]

Laboratory turnaround time (TAT) is defined as the time from blood sample accessing to reporting of results.[8]

Prolonged TAT may cause delayed treatment and increased LOS, ultimately leading to ED crowding. Point-of-care testing (POCT), which can be performed immediately at bedside, can shorten TAT and LOS.[9] Several studies have reported that the median (interquartile range [IQR]) TAT of POCT was shorter than that of the central laboratory test (CLT).[10-14] One study also found that POCT could decrease mean and median LOS.[15] However, many studies have found no significant difference in LOS between patients using POCT and CLT.[16,17]

Due to the contrasting results of those previous studies, our goal was to evaluate the effect of POCT using the i-STAT system (Abbott Laboratories, Abbott Park, IL) on time to decision-making and LOS in urgency patients.

Population Health Research Capsule

What do we already know about this issue?
The implementation of point-of-care testing (POCT) could provide a decrease in laboratory turnaround time compared to central lab testing.

What was the research question?
To evaluate the effect of POCT on time to decision-making (TOD) and emergency department length of stay (ED LOS) in urgency patients.

What was the major finding of the study?
This study demonstrated a significant decrease in the lab turnaround times, time to decision, and ED-LOS after the implementation of POCT.

How does this improve population health?
Using POCT could result in better utilization of resources, more patient access, and potentially less ED crowding.

METHODS

Study population

This randomized controlled study was conducted at the urgency room of Siriraj Hospital by the Department of Emergency Medicine and Clinical Pathology of the Faculty of Medicine, Siriraj Hospital. The hospital is the largest tertiary-care university hospital in Bangkok, Thailand, accommodating over 2,800,000 outpatient visits and around 18,000 ED visits per year. We included patients if they were (1) over 18 years old, (2) classified as triage level 3 (urgency) and 4 (semi-urgency) by the Siriraj Adult Triage System (Table 1), and (3) clinically required electrolyte blood tests (sodium, potassium, chloride, bicarbonate). We excluded pregnant, traumatic and bedridden patients.

Sample size calculation

Per a previous study by Loten et al,[18] turnaround time of central lab testing was assumed to be about 1.5 hours. To detect a time difference between two groups of approximately 30 minutes, with $p = 0.05$, power of 80% and 1:1 randomization, 104 participants per group was required. After adding another 20% to prevent missing data, the estimated sample size per group was 124.

Table 1. Adult triage system used in the urgency room of Siriraj Hospital, Bangkok.

Siriraj Adult Triage System*	Time to medical attention
Level 1	Immediate life-threatening conditions requiring emergent medical attention
Level 2	Emergency, requiring medical attention within 10 minutes
Level 3	Urgency, requiring medical attention within 30 minutes
Level 4	Semi-urgency, requiring medical attention within 60 minutes
Level 5	Non-urgency, requiring medical attention within 2 hours

*Patients classified as levels 1 and 2 were admitted to the emergency department while those categorized as levels 3 to 5 were transferred to the urgency room.

Outcomes

The primary outcomes were time to decision-making (TOD) and ED LOS. TOD is the period from ED arrival to the time the physician made a decision on patient treatment and recorded it in the physician order sheets. We defined LOS as the period from ED arrival to the time that the patient left the ED. The secondary outcomes were satisfaction of physicians, nurses ,and patients, assessed by a questionnaire. The satisfaction scale was graded from 1 (very poor) to 5 (excellent). (See supplementary appendix.).[19] A project investigator would assess the satisfaction scale from the physician, the nurse, and the patient after all treatment was completed and before the patient was discharged.

Study Flow

At the urgency room of Siriraj Hospital, patients triaged level 3 and 4 are assessed by attending physicians who determine whether the patients require any lab tests. Once blood electrolyte was ordered, the nursing staff would allocate these patients and notify the project researchers for patient recruitment. We then obtained written informed consent from eligible patients or their relatives. Included patients were randomized to either the CLT group or the POCT group in a 1:1 ratio. Randomization was generated by software in blocks of four using sealed opaque envelopes. Both groups received standard therapy for any medical problem.

Central lab test (CLT) group

In this group, blood samples were drawn and transferred to the central lab as usual. The nursing staffs would report the results to the attending physician once the results were reported online.

POCT system group

Patients in this group also had their blood drawn by nurses. The blood samples were then analyzed using the POCT system in the Urgency Room. Printed results were then attached to the patient's medical record. The nursing staff would report the results to the attending physicians as soon as possible. If other laboratory profiles were ordered, the blood samples were also sent to the central lab for those results.

For this study we used the i-STAT system (Abbott Laboratories, Abbott Park, IL), a portable blood analyzer composed of a handheld device and cartridges. A test is done by inserting 2-3 drops of blood into the cartridge; the cartridge is then inserted into the handheld device. The results can usually be read within five minutes for most cartridges. The device operates with single-use, disposable test cartridges. The CHEM 8+ cartridge used in this study consisted of sodium, potassium, chloride, ionized calcium, total CO_2, glucose, blood urea nitrogen (BUN), and creatinine. The precision and accuracy of the tests in determining sodium, potassium, and BUN were found to be acceptable.[12,14] Likewise, the POCT analyzer used in our study had been verified and validated to be precise and accurate compared to the hospital's central lab analyzer prior to the commencement of this study.

The nurses were trained to operate the POCT system prior to the study. And quality control was assessed as per the manufacturer's guidelines before trial initiation and during the data collection period by an Abbott representative. The POCT handhelds and cartridges were supported by Transmedic Thailand Co, Ltd. For both groups, the attending physicians would make the decisions on patients' management according to the lab results. Project researchers collected the data required and interviewed the physicians, nurses, and the patients for their feedback and level of satisfaction.

Data collection

We recorded baseline characteristics. Also recorded were the times of ED arrival, initial assessment by attending physicians, and first blood draw. We also recorded the following times: lab results were reported; when the physician was notified; and the time of decision-making.

Statistical analysis

We performed all analyses on an intention-to-treat basis. We present a flow diagram of progress through the phases of the trial, as suggested by the CONSORT 2010 statement (Figure 1). Demographics and baseline characteristics of all randomized participants were summarized by treatment arms. Continuous variables were presented as mean and standard deviation. We described categorical variables as frequencies and percentages, while time intervals were presented as median and interquartile ranges (IQR). We compared intervals between the two groups using the Mann-Whitney-Wilcoxon test, while Pearson chi-square test was used to compare qualitative variables.

All statistical tests were performed using PASW 18.0 statistics for windows (SPSS Inc., Chicago, IL). P-value of less than 0.05 was considered of statistical significance.

This research was reviewed by the Thai Clinical Trials Registry (TCTR) Committee. TCTR identification number is TCTR20170324005 (prospectively registered on March 24, 2017). Ethics approval for the study and a research approval code, 802/2559 (EC4), were provided by the Siriraj Institutional Review Board.

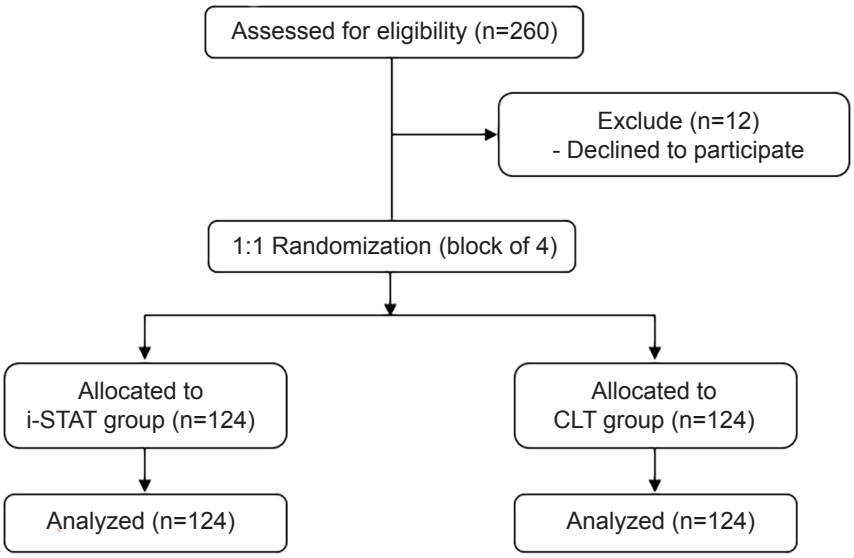

Figure 1. Study flow.

RESULTS

Baseline Characteristics

We conducted our study between April–October 2017. Of the 260 patients who were eligible for inclusion, 12 declined to participate. Consequently a total of 248 patients were included and randomized. The mean age was 61 ± 19 years, and 115 (46.4%) patients were male. Demographic and clinical characteristics at baseline were similar between the two groups (Table 2). There was no difference in time of ED arrival. There were more patients triaged as level 3 and patients with no medical conditions in the POCT group. Fever was the most commonly observed chief complaint in

Table 2. Baseline characteristics.

Baseline Characteristics	Total	POCT, n (%)	CLT, n (%)	P-value
Patient age (in years, mean ± SD)	61 ± 19	60 ± 20	62 ± 17	0.299
Gender				0.702
Male	115 (46.40%)	56 (45.20%)	59 (47.60%)	
Arrival period				0.491
Working hour	164 (66.10%)	84 (67.70%)	80 (64.50%)	
Holiday hour	84 (33.90%)	40 (32.30%)	44 (35.50%)	
Triage				0.047
Level 3	89 (35.90%)	52(41.90%)	37 (29.80%)	
Level 4	159 (64.10%)	72 (58.10%)	87 (70.20%)	
Chief complaint				
Fatigue	31 (12.50%)	18 (14.50%)	13 (10.50%)	0.337
Diarrhea	17 (6.90%)	7 (5.60%)	10 (8.10%)	0.451
Dyspnea	19 (7.70%)	11 (8.90%)	8 (6.50%)	0.474
Alteration of consciousness	27 (10.90%)	13 (10.50%)	14 (11.30%)	0.838
Fever	49 (19.80%)	19 (15.30%)	30 (24.20%)	0.079
Dizziness	23 (9.30%)	11 (8.90%)	12 (9.70%)	0.827
Nausea and vomiting	26 (10.50%)	12 (9.70%)	14 (11.30%)	0.678
Abdominal pain	42 (16.90%)	22 (17.70%)	20 (16.10%)	0.735
Exacerbation of underlying disease	4 (1.60%)	1 (0.80%)	3 (2.40%)	0.313
Weakness	13 (5.20%)	7 (5.60%)	6 (4.80%)	0.776
Others	43 (17.30%)	25 (20.20%)	18 (14.50%)	0.240
Medical conditions				
Old CVA	16 (6.50%)	7 (5.60%)	9 (7.30%)	0.605
Dyslipidemia	42 (16.90%)	25 (20.20%)	17 (13.70%)	0.176
Diabetes mellitus	82 (33.10%)	40 (32.30%)	42 (33.90%)	0.787
Hypertension	91 (36.70%)	46 (37.10%)	45 (36.30%)	0.895
Asthma/COPD	12 (4.80%)	2 (1.60%)	10 (8.10%)	0.018
Chronic kidney disease	25 (10.10%)	11 (8.90%)	14 (11.30%)	0.527
Cirrhosis	6 (2.40%)	1 (0.80%)	5 (4.00%)	0.098
Malignancy	39 (15.80%)	21 (17.10%)	18 (14.50%)	0.582
Cardiovascular disease	50 (20.20%)	25 (20.20%)	25 (20.20%)	1
No medical conditions	45 (18.20%)	29 (23.60%)	16 (12.90%)	0.03
Disposition				0.496
Discharge	172 (69.4%)	83 (66.90%)	89 (71.80%)	
Transfer to the ED	19 (7.7%)	9 (7.30%)	10 (8.10%)	
Refer to other hospital	10 (4.0%)	4 (3.20%)	6 (4.80%)	
Admit to ward	47 (19.0%)	28 (22.60%)	19 (15.30%)	

POCT, point-of-care testing; *CLT,* central laboratory testing; *CVA,* cerebrovascular accident; *COPD*, chronic obstructive pulmonary disease; *ED*, emergency department.

the study population. Disposition rate was similar between the two groups.

Primary outcomes

Median TOD in the POCT group and CLT group were 106.50 minutes (IQR 78.25-140) and 204.50 minutes (IQR 165-244), respectively (p <0.001) (Table 3). Median ED LOS was also significantly shorter in the POCT group (240 minutes (IQR 161.25-410) vs 395.50 minutes (IQR 278.50-641.25); p <0.001). Arrival to time of first physician assessment, time for the physician assessment to draw blood , and result reporting to decision-making time were not significantly different between the two groups. However, time from first physician assessment to decision-making was significantly shorter in the POCT group (70 minutes (IQR 53.50-115.50) vs 169.50 minutes (IQR 141-208); p <0.001), as well as the overall time from decision-making to ED disposition time (117.50 minutes (IQR 30.50-298.75) vs 185.50 minutes (IQR 100.75-389.25); p =0.001). Additionally, the lab turnaround time of the POCT group was shorter ((5 minutes (IQR 4-6) vs 87.5 minutes (IQR 70-103).

Secondary outcome

Satisfaction

The POCT system was rated as excellent and had a higher satisfaction score from physicians (84.7% vs 16.1%, p <0.001), nurses (68.5% vs 50.0%, p = 0.001) and patients (71.8% vs 46.8%, p <0.001) (Table 4).

DISCUSSION

In this randomized control trial, the application of POCT resulted in a reduction in TOD and ED LOS. To our knowledge, this was the first study comparing a newly-developed POCT device to the CLT in a major university hospital in Thailand. Our results were concordant to the initial hypothesis that POCT cartridges consisting of basic metabolic panels would be sufficient for the physicians to make earlier treatment decisions. Moreover, there was still a 155.5-minute decrease in median LOS compared to the CLT group, even though 98 of 124 patients in the POCT group also required other central lab tests. This might have been because those other tests were mainly complete blood count, whose results were usually delivered earlier than electrolytes. However, our findings are in contrast with the studies by Kendall et al[16] and Parvin et al[17] in which POCT did not have a significant impact on ED LOS. Those authors postulated that the lack of significant impact was due to multiple factors such as unavailability of medical personnel and hospital access block, which did not occur in our study. Moreover, this contrasting result might have been due to the fact that there were more patients with no comorbidities in the POCT arm in our study, making it easier for the physicians to make their decisions and thereby facilitating faster ED disposition.

Additionally, turnaround time was significantly reduced from 87.50 minutes in the CLT to five minutes in the POCT group. This finding was similar to a previous study by Nørgaard et al,[13] which demonstrated a decreased turnaround time by almost 45 minutes with the use of POCT. Reduced turnaround time may allow patients to receive earlier treatment, especially for emergency patients who required immediate management. Furthermore, since POCT can be performed and interpreted bedside, it helps to minimize transport distance and time to the central lab. It also helps to reduce documentation and delay and minimize the risk of wrong designation. From our results, there was an additional transfer time of 21 minutes from the urgency

Table 3. Time difference between point-of-care testing and central lab testing.

	Time in minutes, median (IQR)		
	POCT	CLT	P-value
Primary outcomes			
Arrival to time of decision-making	106.50 (78.25-140.00)	204.50 (165.00-244.00)	<0.001
ED length of stay	240 (161.25-410.00)	395.50 (278.50-641.25)	<0.001
Time intervals			
Arrival to physician assessment time	25.00 (15.00-42.25)	25.00 (15.00-39.75)	0.571
Physician assessment to blood draw time	36.50 (23.00-51.00)	32.50 (25.00-50.00)	0.685
Physician assessment to decision-making time	70.00 (53.50-115.50)	169.50 (141.00-208.00)	<0.001
Result reporting to decision-making time	10.00 (5.00-49.75)	15.00 (10.00-20.00)	0.139
Decision-making to ED disposition time	117.50 (30.50-298.75)	185.50 (100.75-389.25)	0.001
Laboratory turnaround time			
POCT group	5.00 (4.00-6.00)	-	N/A
CLT group	-	87.50 (70.00-103.00)	N/A
Blood draw to complete laboratory time*	72.00 (54.50-90.00)	87.50 (70.00-103.00)	<0.001

*Defined as the period between time of blood draw to the time all the results were reported.
IQR, interquartile range; *POCT,* point-of-care testing; *CLT,* central laboratory testing.

Table 4. Satisfaction scale.

Satisfaction scale	POCT, n(%)	CLT, n(%)	p-value
Physician satisfaction			<0.001
Good	18 (14.50%)	63 (50.80%)	
Excellent	105 (84.70%)	20 (16.10%)	
Nurse satisfaction			0.001
Good	38 (30.60%)	51 (41.10%)	
Excellent	85 (68.50%)	62 (50.00%)	
Patient satisfaction			<0.001
Good	33 (26.60%)	54 (43.50%)	
Excellent	89 (71.80%)	58 (46.80%)	

POCT, point-of-care testing; *CLT,* central laboratory time.

room to the central lab in the CLT group. The use of POCT could eliminate that transfer time.

Of the 147 cartridges used in this study, 23 could not be analyzed by the system. Additionally, there was one case with a falsely elevated potassium value. These errors might have been caused by improper storage of the cartridge or pre-analytical errors. The cartridges must be stored at temperatures between 2˚-8˚Celsius (C) (35˚-46˚ Fahrenheit (F) and should not be exposed to temperatures exceeding 30˚C (86˚F). The cartridges should also be used immediately after they are removed from packaging to ensure accuracy of results. Moreover, the users should be trained to avoid pre-analytical errors such as inappropriate sample collection, which can cause hemolysis and subsequently hyperkalemia. Quality system instructions must be followed strictly to ensure accuracy.

Similar to the previous study by Steindel et al,[20] more physicians, nurses, and patients preferred the POCT system over routine lab testing. One interesting finding was that there were more physicians than nurses who rated the POCT system as excellent. This might have been because POCT could deliver fast results with only a five-minute time to analysis, therefore this might not waste their time. The nurses might prefer POCT with the same reason as physicians, however POCT could not reduce the overwhelming workload of nurses. Despite the perceived advantages of POCT, we found that personnel need to be more properly trained to use system since the number of failed cartridges was nearly 15%. Most failures occurred during the initial phase of the study. This resulted in time delays and possible additional expense that could have been avoided.

LIMITATIONS

Because this was a single-center study, it would be difficult to generalize our results to hospitals in different settings. Second, we found that the nurses failed to use the POCT device properly in the initial phase of the study, which resulted in a high cartridge-failure rate even though they had been trained beforehand by the manufacturer's representative. The errors were mostly blood spillage over the cartridge or too much blood inserted into the cartridge, which could have made the cartridges unanalyzable. One approach to solve this problem would be more personnel training. Nevertheless, we did not record the rate of specimen recollection or hemolyzed specimens in the CLT specimens.

Third, although POCT had higher satisfaction scores from physicians**,** nurses ,and patients, we did not assess the validity and reliability of the satisfaction questionnaire. Lastly, our study was conducted only in patients triaged as level 3 and 4. They were the population of interest since the urgency room was crowded from these patients. In fact, the POCT system would be of most benefit in level 1 and 2 patients (eg, patients with cardiac arrest or lethal electrolyte disorders) for whom POCT could facilitate prompt diagnosis and treatment decisions. However, TOD may not change in those patients because they are usually under resuscitation and receive continuous management, and it is hard to judge which treatment decision was made based on electrolyte results.

CONCLUSION

This study demonstrated a significant decrease in lab turnaround times, time to decision-making, and ED length of stay after the implementation of a point-of-care testing system. Physicians, nurses, and patients were more satisfied with the POCT compared to central lab turnaround times. This intervention led to better utilization of resources and more patient access, as well as faster time to decision-making and shorter lengths of stay in the ED.

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New Clarification About Observation Billing May Improve Care for Behavioral Health Patients

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To the Editor:

Emergency physicians (EP) provide ongoing care to psychiatric patients beyond the confines of a standard emergency department (ED) visit. Often, when we identify patients who need specialty psychiatric care, patients board in the ED awaiting acceptance and transfer to an outside facility. Even when it has taken multiple days to complete the transfer, it has been unclear how to properly obtain reimbursement for this care.

Two years ago, the American College of Emergency Physicians (ACEP) Observation Medicine Section surveyed its members as to their usual care of psychiatric patients. This small, 100 ACEP-member survey showed a byzantine distribution of care models, ranging from EPs rounding on the patients, to intermittent psychiatric re-evaluation, to no evaluations beyond medical clearance. Some 86% of respondents indicated they order medications for psychiatric patients while boarding, and a mere 46.5% of respondents use home medications in limited circumstances.

There was also significant variability in the billing for observation services related to psychiatric conditions in the ED. These services were billed by respondents almost as frequently as they were not billed (35.0% vs 31.0%), while 35.0% were unsure whether their observation services were being billed at all.

Recently, the ACEP Coding and Nomenclature Committee and the ACEP Emergency Medicine Current Procedural Terminology (CPT) representatives received clarification regarding how to report extended-stay mental health services. The ACEP Emergency Medicine CPT team submitted a typical case of a prolonged behavioral health stay to the CPT panel. CPT's response, as described in July 2019 *CPT Assistant,*[1-2] supports the use of observation coding (CPT 99218-99220 for the initial days, CPT 99224- 99226 for the middle days, and 99217 for discharge day) for these patients.

There is face validity to this approach, as EDs are providing medical services and ongoing treatment to determine the need for admission during the boarding period. Just as observation services and observation units can standardize the care of patients with chest pain or transient ischemic attack, creating observation treatment pathways for boarding psychiatric patients can provide protocolled medications and re-evaluations, improving care while they await transfer. Ultimately, some patients may improve enough to be safely discharged from the ED, avoiding more costly inpatient care.

This recent clarification, while not directly reducing boarding of psychiatric patients, can improve their care, and allow EPs to get credit for their work. Bringing additional funding to a tremendously under-resourced mental health system is a step in the right direction.

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Evidence-Based Interventions that Promote Resident Wellness from the Council of Emergency Residency Directors

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Initiatives for addressing resident wellness are a recent requirement of the Accreditation Council for Graduate Medical Education in response to high rates of resident burnout nationally. We review the literature on wellness and burnout in residency education with a focus on assessment, individual-level interventions, and systemic or organizational interventions. [West J Emerg Med. 2020;21(2)412-422.]

BACKGROUND

Burnout syndrome was defined in the 1970s as a triad of emotional exhaustion (EE), depersonalization (DP), and a low sense of personal accomplishment (PA).[1] Almost half of physicians report burnout, and emergency physicians (EP) are near the top of the list.[2] In 2018, 48% of EPs reported burnout.[3] Physician burnout has been shown to negatively correlate with patient safety, quality of care, physician professionalism, and patient satisfaction.[4,5] In EPs, burnout was associated with increased frequency of self-reported, suboptimal patient care, including admitting or discharging patients early, not communicating effectively with patients, ordering more tests, not treating patients' pain, and not communicating important handoffs.[6] Additionally, burnout has been associated with substance use, relationship issues, depression, and suicide.[5,7,8]

Originally, burnout was believed to manifest in those who practiced medicine for a prolonged amount of time. However, recent evidence has shown that burnout may begin as early as medical school and residency.[9-10] In fact, recent studies on emergency medicine (EM) residents reported burnout rates ranging from 65-76%.[9,11] Across all fields of medicine, residents have shown higher rates of burnout when compared to medical students and early-career physicians.[9,10]

In response to this data indicating early onset of burnout, the Accreditation Council for Graduate Medical Education (ACGME) has pushed for initiatives on resident wellness, revising their Common Program Requirements for accredited residencies and fellowships to "emphasize that psychological, emotional, and physical well-being are critical in the development of the competent, caring, and resilient physician."[12] A needs-assessment performed on EM residents has shown that residents believe the topic of wellness is relevant and valuable to their career. However, they do not feel comfortable with their knowledge of wellness principles.[13] As medical educators and residency program leaders work to meet the ACGME requirements and emphasize resident well-being at their institutions, they will benefit from current evidence on the various assessment tools, individual- and organizational-level interventions. This article provides a narrative summary of the literature and recommendations for best practices for assessing burnout and creating wellness initiatives in graduate medical education (GME), focusing on EM residency programs.

CRITICAL APPRAISAL OF THE LITERATURE

This is the third in a series of evidence-based best practice reviews from the Council of Residency Directors in Emergency Medicine (CORD) Best Practices Subcommittee.[11,12] Two authors independently performed a search of PubMed for articles published from inception to April 26, 2018, using a combination of the following search terms: wellness, wellness

programs, well-being, stress, burnout, physicians, residents, and health personnel. Articles were prioritized if they focused on EM residents. When EM-specific literature was not available, we included relevant articles pertaining to wellness among other healthcare personnel. Bibliographies of all relevant articles were reviewed for additional studies. The literature search yielded 2931 articles, which were screened by two authors to include any papers addressing the following themes: assessment tools for wellness/burnout; individual interventions to treat/prevent burnout; and organizational interventions to treat/prevent burnout. After screening, 112 articles were deemed directly relevant for inclusion.

We provide level and grade of evidence for each statement according to the Oxford Centre for Evidence-Based Medicine criteria (Tables 1 and 2). When supporting data were not available, recommendations were made based upon the authors' combined experience and expert opinions. Prior to submission, the manuscript was reviewed by the CORD Best Practices Subcommittee for additional comments and identification of missed references. It was additionally posted to the CORD website for two weeks for review from the CORD community.

Table 1. Oxford Centre for Evidence-Based Medicine criteria.[16]

Level of evidence	Definition
1a	Systematic review of homogenous RCTs
1b	Individual RCT
2a	Systematic review of homogenous cohort studies
2b	Individual cohort study or a low-quality RCT*
3a	Systematic review of homogenous case-control studies
3b	Individual case-control study**
4	Case series or low-quality cohort or case-control study***
5	Expert opinion

*defined as <80% follow up; **includes survey studies; ***defined as studies without clearly defined study groups.
RCT, randomized controlled trial.

Table 2. Oxford Centre for Evidence-Based Medicine grades of recommendation.[16]

Grade of evidence	Definition
A	Consistent level 1 studies
B	Consistent level 2 or 3 studies or extrapolations* from level 1 studies
C	Level 4 studies or extrapolations* from level 2 or 3 studies
D	Level 5 evidence or troublingly inconsistent or inconclusive studies of any level

*"Extrapolations" are where data were used in a situation that has potentially clinically important differences than the original study situation.

DISCUSSION

Assessment of Burnout/Wellness

The first step in any successful intervention is a needs assessment. While large population-level studies have demonstrated a need to improve physician well-being,[2] a targeted needs assessment and problem identification is suggested prior to any specific intervention, according to the second step in Kern's six-step approach to curriculum development.[17] A comprehensive needs assessment first requires identification of the population of interest (e.g., EM residents in a single training program) and the specific problem (e.g., burnout). A common pitfall is failure to narrow the scope of the problem that an intervention is designed to address. This can be challenging as there is lack of an agreed-upon definition for "burnout" or "wellness."[18,19] Because burnout is not listed in the *Diagnostic and Statistical Manual of Mental Disorders*-V,[20] it is common for the term "burnout" to be incorrectly used to refer to anything ranging from depressive symptoms to increased work demands. For this reason, surveys that ask participants to self-identify their perceived burnout as a single-item Likert response (e.g., "rate your level of burnout") are not valid measures.

Wellness may be variably defined as "work-life balance," "life satisfaction," or "the absence of burnout," depending upon the context of an intervention.[21] It is not sufficient to state that an intervention is designed to "promote wellness" without first specifying the framework that defines wellness in a particular circumstance. Knowledge of the operating characteristics of commonly used assessment tools can facilitate problem identification. For example, burnout,[22] depression,[23] anxiety,[24] perceived stress,[25] and resilience,[26] each have validated assessment tools for measurement in different demographic groups, such as medical students, physicians, and the health professions in general. Table 3 provides a review of the key tools available to assess these components, including whether it was validated specifically in physician populations.

Other things to consider when selecting an appropriate assessment tool include cost, ease of completion, potential confounding factors, and whether it has been studied in target populations. Cost may be a significant factor for selection of the assessment tool. Although some surveys such as the Maslach Burnout Inventory (MBI-HSS) require payment for use,[27] many tools are available at no cost. Survey length can have a negative impact on the response rate, influencing the tool selected. One must also consider the influence of confounding factors; for example, the MBI-HSS emphasizes the assessment of thoughts and feelings in the workplace and is less likely to be confounded by non-workplace related factors than other tools.[28] Lastly, not all tools have been created with attending or resident physicians in mind. This particular population may face unique stressors and challenges and may not exhibit the same response patterns as the general public.

The MBI-HSS is probably the most widely recognized measure of burnout in physicians. Maslach and colleagues

operationally defined burnout for workers in the helping professions (e.g., healthcare workers, first responders, social workers) as a combination of three domains: EE, DP and lack of PA.[22] The original authors preferred that burnout be reported as a continuous variable (i.e., high, medium, or low) rather than as a dichotomous one (i.e., burnout or no burnout).[22] Since then, multiple researchers have applied their own criteria for burnout using the three subscales, which has resulted in at least 47 distinctly different definitions of burnout using the MBI-HSS alone.[29] Therefore, when considering the assessment of burnout, it is essential to remember the framework used and the test characteristics of the tool selected.

Ongoing assessment and program evaluation are essential to determine the efficacy and successful achievement of goals and objectives. The interval of measurement can vary from weeks to months depending upon the scope and outcome of interest. For example, optimism is considered a relatively stable quality[30] and unlikely to be sufficiently changed by a single four-week curricular intervention; therefore, an optimism/pessimism assessment tool (e.g., the Revised Life-Orientation Test) would be ill-suited for a pre-/ post-measurement in this context. It is also important to note that survey fatigue can result in lower quality data by introducing bias, including non-response bias.[31]

Finally, a distinction should be made between institution- and individual-level assessment. The updated ACGME Common Program Requirements emphasize the need for mechanisms to identify residents at risk of burnout, depression, substance abuse, suicidal ideation, and the potential for violence.[32] They specify the need for program-level assessment, individual-level assessment, and self-screening measures. The ACGME has endorsed the MBI-HSS, Mayo Clinic Well-Being Index, Patient Health Questionnaire-9, and the Professional Quality of Life Scale as potential tools for assessment at the program-level and individual-level.[12]

While each of the recommendations and tools discussed above can be used for assessment of either the program or individual residents, extra caution should be taken when assessing specific residents who may be at risk. Evidence exists that trainees at risk of suicide completion are often difficult to identity,[33,34] and overreliance on any one assessment tool should be avoided. Identification of at-risk residents should be a composite evaluation of attention to professional duties, clinical performance, known work-related or personal crises, and concerning changes in behavior or language used by the resident.[35]

Individual Interventions

Over the last two decades, there have been increasing calls for high-quality randomized controlled trials of specific burnout interventions. A recent, systematic review summarizing psychosocial interventions for managing physician workplace stress identified over 15,000 studies containing the keywords physician, stress, and burnout. Unfortunately, only 20 were intervention studies, and among these only 12 included pre- and post-intervention assessments.[36] None were deemed high-quality or specific to EM residents.[36] A similar systematic review in GME found only three intervention studies.[21] Several barriers common to medical education research exist, including variable definitions, small sample sizes, the ethics of randomization, difficulty with individual assessments, long-term follow-up, and external validity. Among the higher-quality intervention studies, relaxation training, behavioral interventions, and self-care were demonstrated to be most effective.[21,36]

Best Practice Recommendations for Assessment

1. Clearly define the purpose and need for an intervention, then choose an assessment tool for gathering data, establishing a baseline, measuring outcomes, and/or monitoring. (Level 5, Grade D)
2. Understand that there is variability in the definitions of burnout, wellness, and other outcomes. Be clear on the limitations of any defining criteria being used when interpreting the results of any assessment tool. (Level 3a, Grade C)
3. Each assessment tool has unique benefits and limitations. Consider the intended purpose, cost, length, confounding factors, and population of interest when selecting a tool. (Level 3b, Grade C)

Mindfulness is defined as an awareness of the present situation while accepting thoughts, emotions, and physical sensations.[37] Being mindful can be a valuable tool for combating burnout. One randomized controlled trial focusing on mindfulness-based coping strategies demonstrated enhanced well-being and decreased rates of burnout after the intervention.[38] Another study using a modified mindfulness-based stress reduction program, consisting of a workshop followed by eight weeks of daily meditation, showed improvement in general health and stress.[39] Similar mindfulness and meditation studies have been reported in the undergraduate and the nursing wellness literature.[40-44] More feasible interventions, such as 10-20 minute mindfulness meditation for 30 days and a one-hour online module focusing on "mind-body skills training," have also been demonstrated to reduce stress and burnout.[45-52] Mindfulness and self-awareness can be enhanced by journaling, narrative medicine, and reflective questioning, potentially reducing burnout rates,[50-51] although other studies have not shown improvement in burnout.[52]

Focused training in behavioral skills, such as cognitive reframing, self-compassion, and empathy, can also improve wellness.[56-61] A survey of winners of the American Medical Association Foundation's Pride in Professions Award identified self-compassion and self-care as key components for combating burnout.[62] A study of internal medicine residents found that residents who employed strategies of active coping and positive reframing of difficult situations had lower rates of EE and DP.[25] Similar results have been found in the nursing literature.[63] While behavioral skills training has been shown to improve physician

Table 3. Selected assessment tools.

Name of instrument	Brief description and cost	Access	Pros	Cons
Inventory - Human Services Survey (MBI-HSS)	• 22 items • 10 minutes to complete • $15 per individual report; $50 for the manual; $250 add-on to analyze group results	http://www.mindgarden.com/117-Maslach-Burnout-Inventory	Most widely used and recognized Validated in physician populations	Significant cost Variable methods of interpretation of results
Copenhagen Burnout Inventory (CBI)	• 19 items • 10 minutes to complete • Free	http:// www.arbejdsmiljoforskning.dk/upload/cbi-scales.pdf	Assesses burnout in the context of work-related and patient-related factors	Less commonly used tool than the MBI for assessing burnout
Professional Quality of Life Scale (ProQol)	• 30 items • 15 minutes to complete • Free, but must credit the author	http://www.proqol.org/Home_Page.php	Validated in multiple populations and has demonstrated good reliability Assesses compassion and satisfaction, burnout, and secondary traumatic stress	One of the longer assessment tools. Recommended to complete in entirety rather than divide by subscales
Mayo Clinic Well-Being Index (WBI)	• 9 items • < 5 minutes to complete • Free for individuals; $10K license plus $5K yearly for organizations	https://www.mededwebs.com/physician-well-being-index	Validated in physicians Provides self-directed learning resources	Significant cost More useful as a screening tool than a detailed assessment
WHO Well-Being Index (WHO-5)	• 5 items • < 5 minutes to complete • Free	https://www.psykiatri-regionh.dk/who-5/Pages/default.aspx	Widely validated in multiple populations Can be used to monitor changes in well-being	Not well studied in physicians Does not specify any work-related factors
Perceived Stress Scale (PSS)	• 14 items • 10-15 minutes to complete • Free	http://www.psy.cmu.edu/~scohen/scales.html	Can be used to monitor changes in perceived stress	Not validated in physicians
Patient Health Questionnaire (PHQ-2)	• 2 items • < 2 minutes • Free	http://www.phqscreeners.com/	Widely used and recognized	Some concerns about reliability given brevity of test
Connor Davidson Resilience Scale (CD-RISC)	• 25 items • 10 minutes to complete • Cost dependent on agreement with authors	http://www.connordavidson-resiliencescale.com/index.php	Well validated in the general population	Not well studied in physicians Resilience may be a more enduring trait and less subject to change based on a single intervention
Single-item measures of emotional exhaustion (EE) and depersonalization (DP)	• 2 items derived from the full MBI-HSS • < 2 minutes to complete • Free	West CP, Dyrbye LN, Sloane JA, Shanafelt TD. Single-item measures of EE and DP are useful for assessing burnout in medical professionals. J Gen Intern Med. 2009;24(12):1318-21.	Validated in physician populations	Some concerns about reliability given brevity of test

wellness, stress management training has not been shown to improve burnout rates in physicians.[52,64]

Physicians who are able to engage in regular self-care, such as ensuring adequate physical health, sleep, nutrition, and exercise, consistently have lower rates of burnout.[65-70] Although scheduling can be a challenge, regular exercise improves physician wellness.[71,72] Incentivized exercise programs, however, have not been shown to improve physician wellness.[52,64] A study of approximately 7000 surgeons showed that those who visited their primary care physician (PCP) in the prior 12 months had lower rates of burnout and a higher quality of life.[71] Unfortunately, a recent survey reported that nearly half of surgical residents reported not being able to visit their PCP regularly and gaining weight during residency.[73] Fortunately, the literature demonstrates that we can teach our trainees how to implement effective behavioral change plans to improve personal behaviors such as exercise, nutrition, sleep, personal hygiene, and emotional health.[74]

In addition to physical health, psychological health is also important. A survey of anesthetists and intensivists showed that alcohol dependence, abuse of sedative medications, and overeating were correlated with higher rates of depression and burnout.[75] Another study looking at residents found that only 24% of residents who felt they needed mental health care sought treatment.[76] Residents cited lack of time, concern of confidentiality, and cost as barriers to treatment. Encouragingly, studies looking at physicians who participated in either individual or group counseling with a trained professional showed a lasting reduction in EE for up to three years.[77]

Building a strong friend and colleague support network is associated with lower burnout scores.[78-81] Indeed, Dr. Maslach herself recently proposed that civility and teamwork are fundamental to physician wellness.[79] A survey of 198 physicians-in-training showed that loneliness was significantly associated with both personal and professional burnout.[81] Peer- and faculty-mentoring programs may help create these needed support networks as they are correlated with lower burnout rates.[82]

For residents currently suffering from burnout, the road back to wellness begins with an empathetic discussion with a program faculty member or impartial third party (e.g., designated institutional officer). Confidential meetings need to ensure the resident's health and safety and to develop a personalized wellness plan specific to the type of burnout, circumstantial or existential. Circumstantial burnout originates from acute, self-limited situations.[83] Helpful interventions may include speaking with a professional therapist, developing strategies for mitigating life or workplace difficulties, creating daily time for self-care, and even providing brief time off from clinical duties.[83] Existential burnout originates from a chronic loss of joy from the practice of medicine itself. Helpful interventions may include speaking with a professional therapist, examining the origins of burnout, developing better relationships with patients and colleagues, and even reshaping the resident's professional identity.[83] Consistent follow-up ensures that the resident is recovering and provides opportunities to identify when other interventions are needed.

It is important to note that while individual interventions to improve wellness show some promise, evidence suggests that intervention programs based on the individual are associated with only small benefits on burnout and should be supplemented by the adoption of organizational approaches.[84]

Organization-Level Interventions

In addition to individual interventions, institutional, organizational and departmental wellness committees have been widely recommended as a strategy to address physician, staff, and trainee wellness.[40,85,86] Committees should be composed of residents and faculty members, who meet regularly to assess, analyze, and develop systematic initiatives to improve the clinical learning environment for all.[40]

Committee members should contribute to the creation of a wellness program or curriculum. Lefebvre discussed the key components of a resident wellness program, which include creating a safe space; having one-on-one meetings with residents; and designing residency events focused on physical, mental, social, intellectual, and community wellness.[82] Wellness programs should combine both passive (e.g., safe places, lectures, website resources) and active (e.g., meetings, workshops, outings, small group activities, service projects, gym access) strategies.[86] Other components could include strategies to help deal with the wide range of issues that may be encountered during residency, such as stress management, behavioral issues, marriage or family problems, financial troubles, substance abuse, disruptive colleagues, or mental health issues.[85,87-88]

In addition to institutional programs, residency curricula have been shown to be beneficial.[45,86, 90-97] Studies recommend a multicomponent wellness curriculum, including resilience, professionalism, emotional wellness, physician suicide, social wellness, financial wellness, team building, and mindfulness.[89-90,98] Occupational wellness components have also

Best Practice Recommendations for Individual Interventions

1. Mindfulness training should be incorporated into residency training to improve wellness and reduce burnout (Level 1b, Grade B).
2. Consider incorporating behavioral interventions, such as reframing, self-compassion, and empathy into residency training (Level 4, Grade C)
3. Encourage self-care with respect to physical, psychological, and emotional health. This should include an emphasis on sleep, healthy eating, regular exercise, development of social and professional support networks, PCP visits, resources for substance abuse, and counseling or mentoring programs (Level 4, Grade C)
4. Program faculty should meet privately with residents potentially suffering from burnout to identify the unique causes and appropriate interventions. Close follow-up meetings should assess improvement (Level 4, Grade C)

PCP, primary care physician.

been suggested, including ethical and interpersonal encounters (eg, difficult patients, difficult consultants).[45,89,94] Many residency programs have been using Balint groups to supplement their resident wellness initiatives.[91-92,99] Balint groups focus on the doctor–patient relationship by enhancing communication skills among physicians; however, studies show variable results on the ability of Balint groups to improve wellness.[52,64,87,88,95,100] While curricula should be program-driven, most studies recommend the inclusion of out-of-hospital components, including retreats, workshops, and social outings.[86,89,93]

Studies of curricula that emphasize mindfulness, resilience training, and stress management have demonstrated improved physician wellness and reduction in burnout scores.[101-103] While it seems intuitive that mindfulness and resilience, the ability of an individual to effectively cope with and adapt to adverse situations, would have positive effects on the wellness and burnout of EM residents, it is useful to review the literature on systemwide interventions in these areas. One particular study by Krasner, involving a longitudinal curriculum on mindful communication, noted both short-term and sustained improvements in well-being and attitudes associated with patient-centered care.[104] Another study by West involved a nine-month curriculum, in which physicians met in small groups on a biweekly basis for discussion groups that incorporated elements of mindfulness, reflection, shared experience and small-group learning. This curriculum improved rates of high DP, which was sustained at 12 months, as well as improvements in empowerment and engagement at work.[101]

Evaluation of a stress management and resiliency training (SMART) curricula found improved stress, anxiety, and overall quality-of-life scores among both radiology and internal medicine faculty physician participants.[105,106] Another institutionally implemented resiliency curriculum for palliative care and neonatal providers led to improved compassion sensitivity and burnout scores after completion of the program.[107] Critical care fellow participants in a SMART program intervention felt the training provided them with tools to apply during stressful situations, but did not demonstrate improved burnout scores.[108] Similarly, Maher found that a departmentally-instituted educational program designed to improve surgical resident performance during stressful scenarios showed a trend toward improved performance scoring but no difference in anxiety levels. However, 91% of residents rated the stress training as valuable.[108-109] While residents and fellows consistently report subjective benefit from resiliency training, improvement in burnout scores have not been reliably demonstrated. Resiliency training is not the only intervention that has failed to show an improvement in burnout scores. Studies of stress management workshops and training sessions have also demonstrated no difference in physician burnout rates.[52,64] Similarly, a recent study evaluated burnout scores of EM residents before and after implementation of a corporate wellness intervention, "The Happiness Practice." The resident burnout scores did not improve; in fact, 43% of residents stated that this intervention worsened their overall level of burnout.[110]

Despite lack of overwhelming evidence that resilience training programs improve burnout scores in residents, there are several studies that demonstrate the importance of the personal trait of resilience in preventing burnout.[99,101,111-112] One study assessed the role of resilience in the relationship between burnout and health among critical care professionals and found that resilience was a key component in mitigating burnout syndrome.[113] Another study demonstrated that a resilience-building intervention for physicians improved meaning and work engagement while also reducing DP, with sustained results at 12 months.[101] A well-diversified pool of social resources and interests, together with realistic expectations and good self-knowledge, were found to support sustainable coping in a study of 200 physicians from multiple specialties and career stages.[111] A 2015 survey of 616 ED healthcare professionals demonstrated that an individual's coping style may be a predictor of burnout and compassion fatigue.[112] This study found that task-oriented coping is associated with a decreased risk of burnout in contrast to emotion and avoidance coping styles.[112] The cumulative data strongly suggests that resilience is a burnout mitigating factor; therefore, residency programs should consider making resilience training programs available to residents either on an individual or systemwide level.

Resident wellness can also be optimized by evaluating workplace and workflow interventions.[114-116] Workflow interventions include electronic health records (EHR) optimization, improving staff-provider communications, and offloading both clinical and non-clinical tasks that could be performed by other members of the medical team.[116-117] EHR efficiency training and the use of scribes or dictation devices has been shown to decrease stress and burnout in attending physicians.[114-115] Additionally, delegating administrative tasks to non-clinical staff has been shown to improve overall wellness.[115,118] Improved workplace conditions, including optimizing workflow, can lead to overall decreased resident physician stress and burnout.

Resident schedules are often a topic of discussion in the medical education community. Since the ACGME duty-hour changes over the past decade, many studies have evaluated the effect of duty-hour restrictions on patient outcomes and resident wellness across specialties.[64,117,119-121] Studies suggest that working >80 hours per week correlates with higher rates of burnout when compared to working <80 hours per week.[120] Another study found that working >60 hours per week was associated with higher rates of burnout and psychological morbidity.[121] According to multiple meta-analyses, the implementation of the ACGME guidelines for duty hours resulted in an increase in resident wellness and PA, as well as a decrease in EE, DP, and burnout.[64,117,119] Additionally, it has been suggested that implementing protected sleep time, an uninterrupted period of sleep during overnight call, better aligns with circadian physiology and can improve fatigue and prevent burnout.[117] This may be of particular importance during off-service rotations and transitions between rotations.

Scheduling can also affect the ability to access personal medical care. Resident physicians are significantly less likely to have a PCP than their demographically-similar peers outside of medicine.[122] According to a study by Cedfeldt and colleagues, residents in a department with a personal time policy were more likely to find time to fulfil personal needs.[122] Residents who took personal time off had significantly higher proportions of positive experiences and emotions, lower proportions of negative experiences and emotions, higher satisfaction with their career choice, and less perceived stress.[123] Another recent study looked at implementation of a universal well-being assessment for residents, by scheduling each resident for a mental health evaluation based on the residents' schedule with the ability to opt out.[124] The study found that 93% of residents participated in the program, increasing resident utilization of mental health resources.[124] The residents also felt that the scheduling provided convenience, allowing residents to prioritize their mental health and self-care.[124]

In addition to total hours worked, many residents also reported that scheduling directly affects their wellness.[122,125] Lack of control over their schedule can make it challenging to find time with family and friends, increasing burnout.[125] EM residents have been shown to appreciate shift work guidelines that focus on the importance of circadian scheduling (i.e., advancing shift times progressively from day to evening to night) but, if given one option, prefer having the ability to request days off and have a full weekend off.[126] A recent study showed that 93% of EM residency programs allow residents to make schedule requests.[127] Programs should consider having "special requests" days each month to allow residents to attend important life events and to ensure residents have protected time off to attend healthcare appointments. Program leadership should work with residents to identify ways to balance increased resident control of scheduling while ensuring appropriate emergency department coverage. Program leadership should engage residents in the re-evaluation of current scheduling/staffing models, especially night shift models. Residency programs should recognize that giving residents more direct control of their schedule, schedule requests and sleeping patterns may help improve overall wellness.

LIMITATIONS

It is important to consider several limitations with respect to this article. While we used multiple methods to identify relevant articles, it is possible that some articles may not have been identified by the current review. However, we used an inclusive search strategy, as well as review of the bibliographies of included articles to identify the most relevant literature. We also included several nationally recognized experts on wellness and engaged in pre-publication peer review by the CORD Best Practices subcommittee and the larger CORD community.

Additionally, article selection was based upon relevance to the specific themes selected. The topic of wellness is extensive, and we selected for review only specific components deemed to be most relevant to the clinician educator. Finally, while preference was given to data directly evaluating wellness assessment and interventions in EM residency programs, the data were limited. Therefore, when data specific to EM residency programs were not available, we used data from other medical residencies and fields as a surrogate.

CONCLUSION

This paper provides an evidence-based review of the literature on wellness in residency education. Strategies for identification, as well as individual and system-level interventions that have shown improvement in resident wellness are discussed along with recommendations for best practices. After reading this paper, readers should have a greater understanding of how to engage in wellness assessment and intervention at their home institution.

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Best Practice Recommendations for Institutional Interventions

1. Creation of a departmental or institutional wellness committee is vital, should include residents and faculty, and should be involved in the planning and creation of wellness interventions, including curricular design (Level 5, Grade D)
2. Institutional resources should be dedicated toward resident wellness programs (Level 3b, Grade C)
3. Wellness curricula should address multiple domains of wellness and contain both passive and active components (Level 3b, Grade C)
4. Consider developing workflow interventions, such as EHR optimization, and providing increased administrative support (Level 3b, Grade C)
5. Schedules should be optimized to allow residents to request personal time off, to avoid excessive work hours, and to ensure appropriate transitions and circadian rhythms (Level 2b, Grade C)

EHR, electronic health records.

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The Impact of Due Process and Disruptions on Emergency Medicine Education in the United States

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Introduction: Academic Emergency Medicine (EM) departments are not immune to natural disasters, economic or political forces that disrupt a training program's operations and educational mission. Due process concerns are closely intertwined with the challenges that program disruption brings. Due process is a protection whereby an individual will not lose rights without access to a fair procedural process. Effects of natural disasters similarly create disruptions in the physical structure of training programs that at times have led to the displacement of faculty and trainees. Variation exists in the implementation of transitions amongst training sites across the country, and its impact on residency programs, faculty, residents and medical students.

Methods: We reviewed the available literature regarding due process in emergency medicine. We also reviewed recent examples of training programs that underwent disruptions. We used this data to create a set of best practices regarding the handling of disruptions and due process in academic EM.

Results: Despite recommendations from organized medicine, there is currently no standard to protect due process rights for faculty in emergency medicine training programs. Especially at times of disruption, the due process rights of the faculty become relevant, as the multiple parties involved in a transition work together to protect the best interests of the faculty, program, residents and students. Amongst training sites across the country, there exist variations in the scope and impact of due process on residency programs, faculty, residents and medical students.

Conclusion: We report on the current climate of due process for training programs, individual faculty, residents and medical students that may be affected by disruptions in management. We outline recommendations that hospitals, training programs, institutions and academic societies can implement to enhance due process and ensure the educational mission of a residency program is given due consideration during times of transition. [West J Emerg Med. 2020;21(2)423-428.]

INTRODUCTION

Due process rights of physicians come from many sources. The legal requirement of due process in the United States (U.S.) ensures that an individual not lose rights without access to fair procedural process. In clinical practice, due process means clinicians do not lose their medical staff privileges without a fair hearing. For the specialty of Emergency Medicine (EM), residency program faculty are assigned their roles and duties as members of a larger clinical provider group, which in turn has a contractual relationship with a specific hospital/healthcare entity to provide clinical care. In a university-based model, the relationship between individual clinicians, the academic group and the hospital is well-defined. However, the traditional university-based model is not the only employment model. In some community training settings, the relationship between individual physicians, the contract holding group and the hospital is less secure and subject to change on short notice. A sentinel case created enormous upheaval for faculty, residents and medical students and demonstrated the problems that can occur for lack of due process and a standardized approach to transitions for emergency medicine training programs.

METHODS

The Council of Residency Directors in EM (CORD) Board of Directors formed the Faculty Due Process Task Force in 2017. The group was made up of 17 representatives from emergency medicine training programs across the country. The members were tasked to determine the key elements of due process for academic faculty and develop a position statement on due process to ensure the maintenance of high standards of excellence within training programs that undergo transitions.

Three subgroups were identified to address the ways due process affects the major stakeholders: individual faculty, residency programs, and EM trainees. Each subgroup reviewed the relevant literature and identified best practice recommendations.

Background

Major program disruption may include administrative, financial or operational changes, or natural disasters. In 2017, a sentinel case in Ohio demonstrated that emergency medicine training programs are at risk. An academic group that administered an EM residency program since its inception lost its contract at the residency's primary clinical site and was abruptly replaced.[1] In addition, at the time of preparation of this manuscript, the closing of a Philadelphia hospital is currently underway, which will affect an entire EM residency program as well more than 500 other trainees.[2] Previously, the largest hospital closure impacted approximately 350 trainees in New York City in 2010.[3] Multiple stakeholders are affected when a major disruption occurs: the program itself, the institution's graduate medical education (GME) enterprise (GME Committee and Sponsoring Institution), the EM trainees, as well as the patients in the community. Disruptions due to hospital finances, contract change and turnover in the faculty typically allows for some period of preparation. Due process impacts each of the involved parties, and therefore must be considered.

Major transitions as the result of natural disasters differ a bit, as they may occur without significant time for advanced planning. Hospitals, like all large institutions, are expected to have a disaster and business recovery/continuity plan. Based on our review, it is rare for these documents to address recovery/continuity of their educational mission.

DUE PROCESS FOR INDIVIDUAL FACULTY

Individual Emergency Physicians (EPs) derive their due process rights from various sources, including the U.S. Constitution and position statements from national specialty organizations.[4-6] The Fourteenth Amendment and subsequent Supreme Court rulings defined due process protections as the procedures in place when the government attempts to deprive individuals of their rights. Darlak versus Bobear (1987) was the first case to apply this concept to the medical setting. The U.S. Court of Appeals affirmed that Dr. Darlak's medical staff privileges constituted a property interest protected by the due process clause of the Fourteenth Amendment and ruled that the hospital satisfied this obligation with hearings before the credentials committee.[7]

Physicians working outside of government institutions have other sources of due process rights. The Healthcare Quality Improvement Act of 1986 (HCQIA), which applies to all hospitals receiving federal funds, outlines fair hearing procedures for physicians and establishes immunity for members of peer review committees. The hearing requirements include: at least 30 days' notice, a right to representation, the right to call and examine witnesses and to present evidence, the right to submit a written statement, the right to receive a written communication of the decision, and the right of appeal.[8] Due process is also required by the Joint Commission standards.[9] The standards include delineation of medical staff privileges and development of medical staff bylaws, along with procedures for physicians prior to having their medical staff privileges revoked. Physicians must have access to a fair hearing and appellate review.[10]

Several national physician organizations have documents that address the importance of due process protections for individual physicians. These include the Code of Medical Ethics of the American Medical Association (2007),[4] position statements on due process from the American Academy of Emergency Medicine, (1995, 2005),[5] and the American College of Emergency Physicians' Emergency Physician Rights and Responsibilities (2001).[6] Per the ACEP statement: "Emergency physicians should be accorded

due process before any adverse final action with respect to employment or contract status, the effect of which would be the loss or limitation of medical staff privileges. Emergency physicians' medical and/or clinical staff privileges should not be reduced, terminated, or otherwise restricted except for grounds related to their competency, health status, limits placed by professional practice boards or state law."[6]

EPs have a fundamental role in patient safety. Emergency Medical Treatment & Labor Act (EMTALA) obligations ensure public access to emergency care regardless of insurance status or ability to pay. EPs are part of the safety net of emergency care and have a duty to advocate for the patient's best interest. Physician autonomy is an essential component that enables an EP to provide safe care. EPs may face pressures regarding financial matters including admission, discharge or transfer of patients. In 2012, CBS's *60 Minutes* special, "The Cost of Admission" details EPs pressured to perform unnecessary tests and admit a minimum number of patients.[11] A 2016 issue of *Common Sense* details the story of a Florida emergency physician who was terminated without recourse after reporting a patient safety problem to hospital leadership.[12] A lack of due process limits a physician's ability to defend their actions in such cases.

In a 2013 study published in the Journal of Emergency Medicine, 62% (197 of 317) of EP respondents reported that their employer could terminate them without complete due process and 76% (216 of 284) reported that hospital administration could order their removal from the clinical schedule. Nearly 20% self-reported a "possible or real threat to employment" if they raised quality-of-care concerns.[13] Beyond the role of patient advocate, EP faculty members also advocate for their EM trainees to help maintain educational and professional standards within their training program. In 2011, an EP was terminated without a hearing after reporting concerns of a fellow faculty member harassing female residents. In 2016, a jury found in his favor despite claims by the hospital that their actions in firing him were for "legitimate, non-retaliatory purposes."[14] Providing faculty with guaranteed due process protects trainees by ensuring that EPs can advocate for EM trainees without fear of termination.

There are several essential elements to due process protection for individual EPs outlined in statements from the national physicians' organizations above. The AMA Code of Ethics stipulates the principles of a fair and objective hearing and stipulates that specialty medical societies "provide procedural safeguards for due process."[4] The American Academy of Emergency Medicine has detailed further that every physician is entitled to a fair hearing for adverse decisions regarding medical staff privileges, including unilateral termination by employer or other restrictions on clinical privileges. This may include revocation of medical staff membership or manipulation of clinical schedules.[5] Due process for individual faculty is recommended by our national organizations and provides protection for faculty to voice concerns about patient safety and academic integrity.

IMPACT ON RESIDENCY PROGRAMS AND THE GME ENTERPRISE

Residency Program

A residency program is an entity with its own dimensions and identity, and unplanned changes can have repercussions on the program as a whole. The Accreditation Council of Graduate Medical Education (ACGME) notes that "residency is an essential dimension of the transformation of the medical student to the independent practitioner" and states that "the essential learning activity is interaction with patients under the guidance and supervision of faculty members who give value, context and meaning to those interactions."[15] These statements recognize that a residency program is comprised of more than a location, group of individuals, or a name.

Evaluation of the residency program is outside the scope of this paper. Instead, we focus on the effects of *en-masse* turnover of a program's faculty in the residency program. Any large-scale turnover of faculty is disruptive. The faculty "administer and maintain an educational environment conducive to educating EM trainees in each of the ACGME competency areas."[16] Furthermore, faculty must also "devote sufficient time to the educational program to fulfill their supervisory and teaching responsibilities; and to demonstrate a strong interest in the education of residents," and "maintain an environment of inquiry and scholarship with an active research component."[17,18] Every program requires a cohesive group of faculty members fully invested in education and scholarship. A primary requirement of incoming faculty must be that they possess the requisite skill set and experience to meet these expectations in order to maintain a program's integrity.

If turnover of a program faculty does occur, the outgoing program leadership has a professional obligation to bequeath materials and processes necessary for the continued operation of the program. It would be helpful if the process for this handoff were standardized across the medical specialties. In the absence of such standardization, the faculty are left to determine which products and processes are the assets of the program and which are the intellectual property of the individual physicians. Examples of materials which are clearly in the program domain include resident evaluations, resident scholarly activities, curriculum organization, rotation goals and objectives, and Program Evaluation Committee (PEC) and Clinical Competency Committee (CCC) meeting minutes.

The incoming program must assume the responsibility for continuation of the residency program according to the ACGME Common and EM Program Requirements with little tolerance for deviation. The incoming program faculty should start with all core requirements in place and the ability to maintain the program during their tenure as program faculty.

The Sponsoring Institution

The sponsoring institution of any program has an ethical, legal, and financial responsibility to residents and faculty of accredited programs to help ensure the stability of resources required to meet the educational mission of the training program. The ACGME has acknowledged the potential for the changing landscape of healthcare to impact residency education and as a result convened the Sponsoring Institution 2025 (SI2025) Task Force which wrote that "three forces—democratization, commoditization, and corporatization—were seen as drivers of change that appear to be guiding the future of healthcare, and thereby shaping the conditions to which GME and Sponsoring Institutions will need to adapt."[19] The ACGME also recognizes the importance of the sponsoring institution as demonstrated by the inclusion of hospital administrators in regular Clinical Learning Environment Review (CLER) on-site visits. The CLER Program is designed to provide hospitals and other clinical settings affiliated with the sponsoring institution with periodic feedback addressing patient safety, quality, care transitions, supervision, well-being, and professionalism. ACGME Institutional Requirements dictate that the sponsoring institution "ensure that each of its ACGME-accredited programs is in substantial compliance with the ACGME-accredited Institutional, Common and specialty-specific Program Requirements."[20] While major program transitions may be unavoidable, the sponsoring institution must ensure compliance with ACGME requirements and policies. During periods of transition, the highest priority is to ensure that qualified educators are in place to maintain medical education with proper supervision and minimal disruption.

The sponsoring institution is ultimately responsible for safeguarding the educational environment of a residency program despite the many contractual paradigms by which EDs are staffed. Faculty must meet educational requirements such as scholarly activity and appropriate clinical oversight even during times of transition with close monitoring by the sponsoring institution. The task force recommends the development of clear and appropriate standards; expectations and guidelines in advance of transitions will provide hospital administrators, medical administrators, program directors, staff and EM trainees with transparency during transitions. Clear educational expectations should be delineated in contract language as well as in request for proposals (RFPs); see examples in Appendices A and B.

Graduate Medical Education Enterprise

Events that threaten the stability of a program's faculty, leadership structure, clinical training environment, or administrative resources may also impact GME accreditation. In order to maintain the integrity of its academic mission, it is critical that each institution's GME committee (GMEC) maintain oversight and sole governance of its training programs, similar to the self-governance of Medical Staff.

Therefore, the task force recommends that the GMEC should ideally be notified of any potential threats to the stability of a program in order to anticipate intervention and provide guidance early. GMEC involvement may prevent transition and/or help mitigate potential negative impact that may ensue. The GMEC should be consulted with appropriate notice prior to any transition to ensure that all educational needs are addressed and should be notified when a current contract is at risk of being terminated. Core faculty should never be dismissed without due process, and the GMEC should be closely involved to ensure this essential protection is not threatened. Similarly, efforts on recruitment and installation of new program oversight must involve the GMEC. The ACGME has demonstrated its willingness to suspend both Program and Institutional Accreditation if these expectations are not met at all times.

IMPACT ON EM TRAINEES

EM residents are subject to the oversight of both the ACGME and their individual employer, which complicates their potential due process rights. From an ACGME and Residency Review Committee (RRC) perspective, EM trainees are learners. Legally, the majority are considered employees of their sponsoring hospital as well. GME funding contributes to the complexity of due process for EM residents. Federal GME funds are appropriated to hospitals, not medical schools. However, many training programs have expanded the number of residents they sponsor beyond the Centers for Medicare and Medicaid Services (CMS) cap imposed in 1997, using alternative funding including hospitals and other arrangements.[21] Additionally, a small number of GME positions are unionized.[22] Thus, at the individual resident trainee level, due process is dependent upon each employment scenario. In situations where residents are considered an "individual employee," due process rights are limited. Unfortunately, most residents have little knowledge about their funding stream or their due process rights.

During major program disruption, residents are at risk due to preexisting commitments. Many have purchased homes or signed leases, have families and/or an employed spouse, children attending school, and limited financial resources, to name a few of their immediate challenges. Faculty who have been their support through EM training may now face personal employment concerns. To the trainees, communication about a transition or closure may be limited at a time when they desire transparency. These circumstances may leave the resident without clear knowledge of what to do or where to go for guidance.

This confusion may be compounded because many residents are unaware of the source of their training funds. They are also contractually bound to the residency program where they have matched, and in the event of program or hospital closure their transition to a new program is contingent upon their federal funding being released by their sponsoring

institution. Funding is even more complicated for 4-year training programs, individuals with prior training or when funding comes directly from the hospital, as is the case with institutions over their CMS cap. Given the myriad of potential sources of funding for faculty positions, it is not surprising that many trainees do not understand how their EDs are staffed and under which circumstances staffing might change. Departmental, hospital, program and GME administrators have an ethical obligation to keep residents informed of the details of an expected or ongoing major transition of staff. In the case of a potential contract changeover, trainees should be made aware of general timelines for business decisions and opportunities to initiate contingency plans. The RRC-EM should be informed in advance of the potential for program disruption to allow for an independent body to provide support and ensure clear communication to affected residents. Historically, the RRC appears to have been hesitant to get involved until change has occurred. This task force recommends a more proactive stance to better support the affected residents.

Strong, clear, and proactive hospital, departmental, and program leadership is critical. Accurate and timely information helps alleviate uncertainty. The GMEC and program leadership should work together to update residents and detail available options. While faculty will have varied availability or capability to provide advice, CORD may provide a cadre of experienced program directors to guide residents through their available options in a "just in time" fashion. A clearly identifiable point of contact to address EM trainees' concerns is essential.

IMPACT ON PATIENT SAFETY

Patient safety during times of transition or disaster is a primary concern. During a transition or disaster, ACGME-mandated levels of clinical supervision may be compromised to meet increased demand for emergent care of patients in need. Every effort must be made to quickly return to the accepted standard of practice, including appropriate clinical supervision. Similarly, abrupt change in faculty composition may also compromise patient care and safety. Clinical workflow processes are essential in EM and new staff may be unfamiliar with these. As EPs who are invested in residency training, faculty in emergency medicine training programs should be on the forefront of protecting both our residents and our patients. Patient and trainee safety in the clinical environment must be paramount during times of transition.

CONCLUSION

An emergency medicine training program is a complex enterprise with multiple stakeholders. Disruptions to the educational mission include natural disasters that impact the physical training environment and wholesale faculty turnover, both of which have the potential to affect patient care and resident education. Due process protections are particularly important for individual faculty to ensure the ability to advocate for both patients and trainees. Better processes and procedures are needed to ensure the best interests of the many involved parties - the faculty, sponsoring institution, GME enterprise, trainees and patients. Clear guidelines around transitions are needed to protect the educational integrity of a training program and meet the requirements outlined by the ACGME. Improved education for residents regarding due process and GME funding issues are also essential, as we face the increasingly complex employment models that are commonplace in our specialty.

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Innovative Approaches to Emergency Medical Services Fellowship Challenges

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Introduction: Since the development of an Accreditation Council of Graduate Medical Education (ACGME)-accredited emergency medical services (EMS) fellowship, there has been little published literature on effective methods of content delivery or training modalities. Here we explore a variety of innovative approaches to the development and revision of the EMS fellowship curriculum.

Methods: Three academic, university-based ACGME-accredited EMS fellowship programs each implemented an innovative change to their existing training curricula. These changes included the following: a novel didactic curriculum delivery modality and evaluation; implementation of a distance education program to improve EMS fellows' rural EMS experiences; and modification of an existing EMS fellowship curriculum to train a non-emergency medicine physician.

Results: Changes made to each of the above EMS fellowship programs addressed unique challenges, demonstrating areas of success and promise for more generalized implementation of these curricula. Obstacles remain in tailoring the described curricula to the needs of each unique institution and system.

Conclusion: Three separate curricula and program changes were implemented to overcome specific challenges and achieve educational goals. It is our hope that our shared experiences will enable others in addressing common barriers to teaching the EMS fellowship core content and share similar innovative approaches to educational challenges. [West J Emerg Med. 2020;21(2)429-433.]

INTRODUCTION

In 2012, the Accreditation Council for Graduate Medical Education (ACGME) approved an accredited fellowship in the area of emergency medical services (EMS).[1] Along with this accreditation, curricular core content and competencies were identified to guide the education and training of EMS physicians.[2] While prototype fellowship and residency EMS curricula have been previously outlined prior to EMS ACGME accreditation, there is little published material to guide effective content delivery or innovation in training modalities and to evaluate whether these changes and methodologies have been effective.[3-5] Available guidance has emphasized the importance of creating a formalized curriculum that reflects core content in a diversity of educational formats.[6]

In creating a delivery model for the EMS fellowship curriculum, different institutions have taken modified approaches to best suit their individualized needs given the resources at hand. The EMS fellowship curriculum requires an average of three

hours per week of planned didactic experiences, totaling over 150 hours of time per year.[1] These didactics, often presented to a single fellow, can easily become dry and monotonous. For the first intervention, we discuss the incorporation of a variety of lecture, discussion, and training formats in the development of an interesting and dynamic didactic portion of the curriculum.

Additionally, ACGME-accredited EMS fellowships are mandated to provide fellows with an experience in rural EMS.[1] Numerous demands on a fellow's time coupled with low call volume in rural settings have limited the rural EMS experience. For the second intervention, we discuss distance-based efforts to improve rural EMS education for EMS fellows. Finally, although physicians of any specialty may pursue an EMS fellowship, most curricula assume fellows will have an emergency medicine (EM) background, which may leave gaps in clinical training and challenges in maintaining board certification for non-EM trained fellows. For the third intervention, we discuss the adaptation of a standard EMS fellowship curriculum to accommodate non-traditional specialties.

METHODS

Outlined below are the methods undertaken for each of the three discussed interventions.

Novel Didactic Curriculum

We conducted a before-and-after retrospective review, approved by our institutional review board, comparing grand rounds evaluation data from before and after the implementation of a novel EMS fellowship curriculum. At this institution, grand round presentations for the EMS fellowship are typically provided for three hours on Thursday afternoons. Following each presentation, each attendee completes an evaluation form scoring the presentation on effectiveness and value, context (applicability to EMS practice and boards), content (instructor expertise on information delivered), and tension (active learner engagement and level of instructor expertise). These are each evaluated on a scale of 1-9 with 9 being the highest score achievable. Overall score is the average of each of these categories. In the 2014-2015 academic year, a conventional, lecture-based curriculum was in place based on topics drawn from both lecturer experience and expertise as well as from the core content required for EMS fellowship.

During the 2015-2016 academic year, instead of traditional didactic sessions delivered by an EMS core faculty using PowerPoint slides, we developed a novel approach to grand rounds by implementing thematically-focused weeks consisting of a combination of experiential-focused lectures (such as an individual lecturer's experience managing a mass gathering event); system-specific topics (such as continuing education processes in our regional EMS system); chapter-focused discussions; case discussions; journal clubs; and special events. Special events included hands-on training modules, procedural skill practice, and interactive-lecture formats with medical students and residents.

A variety of instructors, ranging from core faculty and content experts to local providers and EMS fellows, were incorporated. Examples of the modified novel didactic curriculum are provided in Table 1. Data from attendees who completed presentation evaluations for EMS grand rounds presentations from the 2014-2015 "conventional" curriculum and the novel 2015-2016 curriculum. Linear mixed models accounting for random lecturer effect were used for post- vs pre-intervention comparisons.

Table 1. Novel didactic curriculum examples.

Format	Examples
Experiential focused	• Scene Safety and Size Up • Just Culture Model in EMS • Delivering an Effective Presentation
System specific	• Education in Milwaukee County EMS • Wisconsin Disaster Preparedness • History of Milwaukee County EMS
Chapter focused	• Interfacility Transportation • Ambulance Safety • Medical Management of Mass Gatherings
Case discussions	• Public Relations Case Review • UW Madison Football Crush • Complications in Air Transport
Journal clubs	• Point of Care Ultrasound in EMS • SALT Triage • Treating Confined Space Injuries
Special events	• Emergency Vehicle Operations Course • Physician Base Training • Trauma Stabilizing Procedure Practice

EMS, emergency medical services.

Distance-Based Tool for Rural Engagement

In 2016, while expanding the EMS fellowship complement from one to two fellows per year a distance-learning platform was implemented allowing EMS fellows to participate in the fellowship didactic curriculum when off-site, at a rural EMS location (Table 2). This project addressed two problems: 1) the need to provide more time for fellows at rural EMS locations; and 2) the need to prevent EMS clinical (field time) overlap between fellows. By implementing this distance education program, on didactic days the EMS fellows could both participate in didactic experiences while operating clinically in different geographic regions (one physically located at their rural EMS clinical site while the other was at their primary urban site). After completing didactic requirements, the rural fellow was able to spend the remainder of the day interacting on-site with the rural crews.

To implement this project, existing equipment and programs were used including the Panopto video platform (Panopto, Seattle, WA, Version 5.4.0), a web-based system supporting a live webcast including lecture slides with audio and video transmission to the distance site. The live webcast was supplemented by real-time discussion along with question-and-

Table 2. Key Elements of Distance-Based Tool for Rural Engagement.

Key elements
• Located at rural site
• On-scene rural emergency medical services (EMS) care
• Web-based live lecture engagement
• Enhanced rural EMS provider continuing education
• Social media-based question and answer sessions

* Linear mixed models accounting for random lecturer effect were used for post versus pre intervention comparisons.

answer sessions between the broadcasting location and the rural site using a social media platform Convo (Convo.com, Los Altos, CA). Both systems were available free of charge from the hosting institution and could be run from a computer or a mobile device. To improve audio quality a microphone was purchased at a cost of less than $150.

Approach to a Non-Emergency Medicine-Trained Fellow

A similar approach was used in development of the curriculum for two non- EM trained fellows: one from a pediatric background and one from an anesthesiology background. The curriculum included identifying gaps in the non-traditional fellows' knowledge, addressing those gaps using customized supplemental experiences in the field or in the emergency department (ED) setting as appropriate, providing personalized oversight and support from fellowship faculty and supervising medical directors, and developing a plan to address the fellows' maintenance of their primary board certification (Table 3).

Once gaps in knowledge and skills were identified prior to the start of the academic year, novel processes and experiences were developed to address these gaps. To address one fellow's concern about inexperience in management of critically ill adults, an "Adult EM Boot Camp" was developed including target, high-volume ED shift exposure while paired with EMS educational faculty, specific training on specialized areas such as electrocardiogram interpretation and cardiovascular care, and discussions on management of critical and non-critical patients. As additional measures to enhance clinical education, the fellowship didactic curriculum was front-loaded with topics identified as knowledge gaps, fellows attended the affiliated EM residency's didactic conference when appropriate, and fellowship faculty used cadaver labs and simulation to address gaps in knowledge and experience in the non-traditional EMS fellows. The fellows were also given assignments to complete within the scope of their medical direction responsibilities outside of their core specialty, such as the pediatric-trained fellow focusing on adult-oriented projects.

Table 3. Key elements of training the non-emergency medicine (EM) fellow.

Key elements
• Identify gaps in knowledge and procedure skills
• On shift training with EM faculty
• Front load didactic curriculum with knowledge gap topics
• Utilize existing grand rounds topics as applicable
• Implement cadaver and simulation experiences
• Choose field responses and online medical control reviews strategically to address gaps
• Accommodate time for maintenance of primary board skills

When operating in the field setting, the non-traditional fellows were provided modified oversight and support by the EMS faculty and supervising medical directors. During field operations with faculty, educational conversations and didactic sessions were geared toward knowledge gaps while emergency calls were preferentially selected as those likely to fill a gap in knowledge or experience for the fellow. Additionally, tapes of direct medical oversight interactions were reviewed with the fellows, especially for patients outside of the fellows' previous training.

Finally, accommodations were made to allow for the maintenance of primary board certification for non-EM fellows. Intradepartmental agreements were made to allow for clinical work in their area of primary board specialization, while maintaining duty-hour and fellowship requirements.

RESULTS

With the introduction of the novel didactic curriculum, a total of 537 evaluations were completed and evaluated for 115 distinct lectures between the before-and-after periods. The before (conventional) period consisted of 210 completed evaluations for 54 distinct lectures and the after (novel) period consisted of 327 completed evaluations for 61 distinct lectures. Significant improvements in the after group as compared to the before group were noted in the categories of effectiveness and value, content, tension, and overall score (Table 4). No significant difference was noted in the category of context.

Using the distance-based rural curriculum, 48 lecture sessions were delivered over the course of the 2016-2017 academic year. On three occasions (6.25% of sessions) technology issues prevented successful delivery of the didactic curriculum. Didactic material was successfully presented from both the primary EMS fellowship site and the distance or rural EMS site. Fellow time at the rural EMS site doubled from five hours per day to 10 hours per day (Table 5). In addition, the fellow was able to be present for crew change, doubling the number of EMS providers he or she had contacted with for the day. Additionally, prior to this intervention EMS provider continuing education (CE) was widely available but required off-shift participation and was limited to one on-site lecture per year. After this intervention, rural EMS providers had access to an expert physician and more than 60 hours of annual EMS-provider CE available on site with optional on-shift participation.

In the case of the pediatric EM/EMS fellow, not only did the fellow express confidence in performance of the skills and tasks required of an EMS fellowship graduate and EMS

Table 4. Fellow schedule at rural emergency medical services location before and after distance education intervention.

Category	Total (n=537)	Before (n=210)	After (n=327)	P Value*
Effectiveness and value	6.7 (1.4)	6.4 (1.3)	6.9 (1.5)	<0.001
Context	6.9 (1.4)	6.9 (1.2)	6.9 (1.5)	0.508
Content	6.9 (1.4)	6.6 (1.3)	7.1 (1.4)	<0.001
Tension	6.8 (1.2)	6.6 (1.2)	6.9 (1.2)	0.001
Overall	6.8 (1.2)	6.6 (1.1)	7.0 (1.2)	<0.001

Table 5. Key elements of training the non-EM fellow.

Key elements
•Identify gaps in knowledge and procedure skills
•On shift training with EM faculty
•Front load didactic curriculum with knowledge gap topics
•Utilize existing grand rounds topics as applicable
•Implement cadaver and simulation experiences
•Choose field responses and online medical control reviews strategically to address gaps
•Accommodate time for maintenance of primary board skills

physician, but the fellow subsequently passed her American Board of Emergency Medicine (ABEM) EMS subspecialty board exam on her first attempt. The anesthesia/EMS fellow continues his fellowship at the time of this writing and has successfully transitioned to taking independent calls with faculty oversight in specific cases and feels confident in performing his fellowship duties after the modified fellowship orientation. He ranked among the top scores on the in-service EMS board exam and sat for the EMS subspecialty boards in 2019, the results of which are expected to further validate the process.

DISCUSSION

As a relatively new ABEM board subspecialty, EMS fellowships continue to develop and identify best practices and strategies to overcome common training program barriers. Working within EMS systems and with individual educational institutions may present both opportunities and challenges to fellowship programs. Given the large variability of EMS system structures, practices, and resources across the country, individual fellowships must be able to build on system strengths and develop innovative solutions for system challenges. We presented three such approaches to innovate within the structure of the EMS fellowship to maximize learning for fellows. We believe that these approaches have applicability to many different fellowship programs across the country.

While literature on best practices and innovative approaches to the EMS fellowship is sparse, fellowships from other specialties may serve as guides to how to overcome the didactic, distance, and knowledge gap challenges faced by our three described programs. From a general curriculum design perspective, the radiology fellowship at Emory University School of Medicine has described its efforts to develop a multifaceted didactic curriculum that involves a variety of educational formats to engage learners beyond the traditional lecture.[7] In addressing distance-education based challenges, several surgery fellowships have shared programs designed to enhance rural and international experiences while maintaining strong core content.[8,9] Likewise, a distance-based educational program has been developed into its own fellowship for general practice doctors in India to allow for a supportive and engaging learning environment during the early years of practice.[10] Faced with gaps in clinical knowledge among residency graduates, a hematology oncology fellowship developed interactive, cadaveric, and simulation-based workshops to prepare trainees for the fellowship experience.[11]

As these and other innovations are implemented and evaluated within any fellowship, it is important to maintain an overarching goal of pursuing best practices. First, specific to the EMS fellowship, one must optimize the fellow's experience and education by ensuring a variety of experiences and opportunities across the spectrum of prehospital care. Second, one must improve the fellow's clinical exposure in both controlled and uncontrolled settings, using experiences both on scene and during transport, in addition to experiences in the ED as appropriate. Lastly, the fellows' procedural skill competency and teaching skills must be improved through both hands-on experiences and by instructing other learners such as paramedics. Achieving these best practices in fellow education can be at times challenging given resource limitations and the various clinical, financial and political implications of fellow participation in each unique EMS system.

Several limitations were present with each of the discussed interventions. While we did note improved ratings for the novel didactics presented in the first intervention, the limited number of one to two fellows per year made it difficult to evaluate actual learner outcomes and the extrapolation of results to educational importance or performance outcomes proves challenging. With the distance-based rural curriculum, technical challenges occurred that resulted in at times difficult communication. Additionally, the increase in the EMS fellow compliant from one to two fellows may have confounded the improved relationship with the rural EMS agency due to increased physician exposure. In the training of the non-EM trained fellow, quantitative results were difficult to attain given the limited number of fellows. In all of the interventions, the creation and implementation of modified curricula may be time and resource intensive for some fellowship programs.

In this report, we highlight three novel approaches to modify EMS fellowship curricula to overcome barriers while maintaining educational goals and providing optimal fellowship experiences. While each addresses a specific area of the fellowship–creating an engaging and diversified didactic curriculum; developing a distance-based tool for rural EMS education; and modifying a curriculum to train a non-EM trained fellow–we believe that these

modifications are widely applicable to other fellowship programs facing similar issues. The interventions put in place were not unique to our institutions, but rather were common to most academic EDs and could therefore be implemented at other programs facing similar challenges. While we recognize that each fellowship program faces a unique set of challenges and resources may vary potentially limiting the broad applicability of our approaches, we hope that our experiences can inform other fellowships.

CONCLUSION

We have presented interventions in which three separate EMS fellowship programs across the United States developed different, successful models to overcome specific challenges and achieve educational goals. We believe that these issues are generalizable and potentially faced by other EMS fellowship programs and may aid in overcoming similar challenges. We hope that others will share similar experiences, thereby encouraging the development of best practices for educational curriculum and innovative approaches to EMS fellowships.

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Does the Removal of Textbook Reading from Emergency Medicine Resident Education Negatively Affect In-Service Scores?

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Introduction: In-service exam scores are used by residency programs as a marker for progress and success on board exams. Conference curriculum helps residents prepare for these exams. At our institution, due to resident feedback a change in curriculum was initiated. Our objective was to determine whether assigned Evidence-Based Medicine (EBM) articles and Rosh Review questions were non-inferior to Tintinalli textbook readings. We further hypothesized that the non-textbook assigned curriculum would lead to higher resident satisfaction, greater utilization, and a preference over the old curriculum.

Methods: We collected scores from both the allopathic In-training Examination (ITE) and osteopathic Emergency Medicine Residency In-service Exam (RISE) scores taken by our program's residents from both the 2015-2016 and 2016-2017 residency years. We compared scores pre-curriculum change (pre-CC) to scores post-curriculum change (post-CC). A five-question survey was sent to the residents regarding their satisfaction, preference, and utilization of the two curricula.

Results: Resident scores post-CC were shown to be non-inferior to their scores pre-CC for both exams. There was also no significant difference when we compared scores from each class post-CC to their respective class year pre-CC for both exams. Our survey showed significantly more satisfaction, utilization, and preference for this new curriculum among residents.

Conclusion: We found question-based learning and Evidence-Based Medicine articles non-inferior to textbook readings. This study provides evidence to support a move away from textbook readings without sacrificing scores on examinations. [West J Emerg Med. 2020;21(2)434-440.]

INTRODUCTION

Each year residents across the country take in-service examinations as a part of their training and preparation for board certification examinations taken at the end of their residency. Specifically, emergency medicine (EM) allopathic residents take the In-training Examination (ITE) and osteopathic residents take a similar test, the EM Residency In-service Examination (RISE). These examinations are used by programs to determine the progress of their residents. Strong correlations exist between these training exam scores and scores on the allopathic Written Qualifying Examination and the osteopathic EM Written (Part I) Exam.[1,2] A plethora of resources are available for the preparation for these examinations including study guides, review books, and online question banks.

Due to resident feedback in the 2015-2016 program year, faculty from the EM residency program at St. Joseph's University Medical Center in Paterson, New Jersey, met with the incoming academic chiefs to discuss ways to improve the core curriculum. Through an open forum discussion, it became clear that residents were not enjoying the current textbook reading and many times admitted to skipping the assigned reading. It was known that residencies in the surrounding area were using alternative means of learning including *Evidence-Based Medicine (EBM)* articles. Therefore, we made the decision to move away from assigned chapter readings in *Tintinalli's Emergency Medicine: A Comprehensive Study Guide*.[3] Instead, the curriculum was

changed to *EBM* articles and assigned Rosh Review questions.[4,5]

The *EBM* articles served as short, evidence-based reviews of broader concepts to complement the question-based learning from Rosh Review questions. Although cost was not a factor in the decision to change the curriculum, residents in the program had free online access to *Tintinalli's* through the hospital library. While there was no additional cost to provide access to *EBM* articles, the program paid $3,696 to provide Rosh Review for 24 residents in the 2016-2017 academic year. We believed that the in-service scores would be at least as good after the change as they were before (non-inferior). Secondly, we hypothesized that resident satisfaction would be higher with the change because we believed residents would enjoy non-textbook sources.

Population Health Research Capsule

What do we already know about this issue?
Strong correlations exist between residency training exam scores and scores on the allopathic and osteopathic emergency medicine (EM) board exams.

What was the research question?
Is a non-textbook reading curriculum non-inferior to traditional textbook readings in preparing EM residents for in-service training exams?

What was the major finding of the study?
The new curriculum was non-inferior to the traditional curriculum. Residents were more satisfied with the new curriculum, used it more, and preferred it.

How does this improve population health?
The more effectively we train emergency physicians, the better equipped they will be to care for patients. We must regularly reassess our teaching methods.

METHODS

We collected scores from both the allopathic ITE and the osteopathic RISE taken by our program's residents in the 2015-2016 and 2016-2017 academic years. Names corresponding to each score were removed by the residency director to protect resident confidentiality. We obtained national averages for both examinations during these years to serve as a comparison. We then compared scores pre-curriculum change (pre-CC) to those post-curriculum change (post-CC). The post-CC began July 1, 2016.

The original curriculum included monthly chapter assignments from *Tintinalli's* with a variable number of chapters assigned each time in an effort to cover the textbook in its entirety throughout the course of residency. Senior residents, who were overseen by an assigned core faculty member, were assigned each month to write a 15-question quiz as well as develop an hour-long lecture based on the assigned readings. Although the quiz and lecture were administered to the residents during the last conference of the block, compliance was otherwise not formally monitored. The new curriculum was based on monthly subject content.

Rosh Review questions were chosen at random along with *EBM* articles based on the subject to be covered that block. Answers to quizzes found within the *EBM* articles were submitted to the chief residents by email, and the assigned Rosh questions were due at the end of each block and monitored by the assistant program director. Although Rosh Review was available to residents to be used during the 2015-2016 academic year, there were no assigned questions and its use was not monitored.

A five-question survey created by the authors was sent to the residents regarding their satisfaction, preference, and utilization of the two curricula. The six postgraduate year (PGY)1 residents who had not experienced the curriculum prior to the change were not surveyed. Answers were collected electronically and were kept anonymous. Satisfaction with the curriculum was based on a 0-10 scale with 0 being "not satisfied," 5 being "neutral," and 10 being "very satisfied." Use of either curriculum was also scored based on a similar 0-10 scale with 0 being "never utilized," 5 being "sometimes utilized," and 10 being "always utilized." The survey questions are shown in Table 1.

The primary outcome of this study was to determine whether the average scores in each residency class from the exams taken post-CC were non-inferior to the exams taken pre-CC. The secondary outcomes were resident satisfaction with the old vs new curriculum, overall utilization of one curriculum compared to the other and, finally, resident preference for one curriculum over the other. This study was approved by the hospital's institutional review board.

In 2016 the St. Joseph's University Medical Center EM residency shifted from dual accreditation by the American Osteopathic Association and the Accreditation Committee on Gradual Medical Education (ACGME), to accreditation solely by the ACGME. Therefore, some of our residents took just the osteopathic or allopathic in-service training exams and some of our residents took both. We compared osteopathic and allopathic scores in two separate analyses.

Data Analysis

We analyzed osteopathic and allopathic scores separately. Two sample t-tests were used to analyze the scores of different residents whereas we used paired t-tests to analyze scores comparing individual residents in different years. We conducted a one sample t-test to compare the residency's mean scores to the national mean values. P-values of all of our test results were reported. A standard p-value of <0.05 was considered significant. We performed all tests using R data

Table 1. Survey questions.

How satisfied were you with the Tintinalli readings assigned as part of the 2015-2016 educational curriculum?
How satisfied are you with the current Rosh/Evidence-Based Medicine (EBM) curriculum?
How often did you utilize Tintinalli during the course of the 2015-2016 year?
How often did you utilize Rosh/EBM during the course of the 2016-2017 year?
If you had to choose between the two, would you prefer to have assigned Tintinalli readings or Rosh/EBM?

analysis software (R Foundation for Statistical Computing, Auckland, New Zealand).[6]

RESULTS

Osteopathic

We evaluated only the 13 residents who took the osteopathic RISE pre-CC and post-CC. As seen in the two osteopathic columns in Table 2, the residents' individual scores from the year post-CC were compared directly to the scores they received the year pre-CC.

When comparing the PGY-4 scores post-CC to their own respective scores obtained during their third year pre-CC, we found no significant difference (p=0.2). There was no significant difference in individual PGY-3 scores when compared to their respective scores in their second year (p=0.23). The same was concluded of the PGY-2 scores compared to the scores they obtained in their first year (p=0.1). Comparison of each class's scores post-CC was made to the respective class year pre-CC (Table 3).

For example, when comparing PGY-3 resident scores in the 2016-2017 year post-CC to the PGY-3 resident scores in the 2015-2016 year pre-CC, we found no difference (p =0.54). The same comparison made for the PGY-2 residents yielded no difference as well (p = 0.89) . We compared the average score obtained by all of the residents post-CC to the average score rre-CC. Both the post-CC 2016-2017 and pre-CC 2015-2016 residency averages were compared to the national averages in these years as well (Table 4).

Compared to the average osteopathic resident score pre-CC (209.2), the average resident score post-CC (218.3) was significantly higher (p = 0.009). The national average pre-CC in the 2015-2016 year was 200.7. The national average post-CC was 204.9. Our residency average was greater than the national average both pre-CC (p = 0.016) and post-CC (p<0.001). Although we scored higher than the national average both years, the largest increase above the national average occurred in the post-CC time period.

Allopathic

A total of 11 allopathic residents took the ITE in both the pre-CC 2015-2016 and the post-CC 2016-2017 examination years. Of those 11, five residents were in their third year during the post-CC 2016-2017 residency year and six were in their second year. We directly compared the individual scores from the post-CC examination year to the scores the residents received during the pre-CC examination year the same way we did with the osteopathic scores (Table 2). When comparing the third-year scores post-CC to their own scores during their second year pre-CC, we found no significant difference (p = 0.09). However, when comparing second-year scores post-CC to their respective scores as first year's pre-CC, we found that they had performed better (p<0.012).

Comparisons of class-year scores post-CC were made to the same residency level in the pre-CC time period in the same manner as was done with the osteopathic residents (Table 3). When comparing PGY-2 scores post-CC to a different group of PGY-2 scores in the pre-CC 2015-2016 year, we found no difference (p=0.85). The same comparison was made for the PGY-1residents and yielded no difference as well (p=0.46).

We compared the average scores obtained by the residents from the allopathic exam in the post-CC 2016-2017 examination year to the average score obtained pre-CC the year prior, and both post-CC and pre-CC residency averages were compared to the national averages in these years (Table 4). Compared to the average resident score pre-CC, 71.7, the average resident score post-CC, 74.8, showed a positive trend but no significant difference (p=0.15). Meanwhile, the national average held fairly constant during this time period with the pre-CC national average being 75.5 and the post-CC national average being 74.6.

Satisfaction, Utilization, Preference

A total of 15/18 residents (83.3%) responded to the survey questions. The figure shows the survey results regarding the satisfaction and utilization of the *Tintinalli* curriculum versus the Rosh/*EBM* curriculum.

Overall, residents were more satisfied with the new curriculum compared to the prior curriculum (p = 0.0006). The average satisfaction score with the *Tintinalli* readings was 4.13 compared to 7.12 with Rosh Review and EBM in the new curriculum. Residents used the new curriculum more than the former curriculum (p = 0.002). The average utilization score for the old curriculum was 5.13 compared to 7.6 with the new curriculum. Based on the survey results, residents also preferred the new curriculum, with 80% preferring the new curriculum to the old curriculum.

DISCUSSION

A correlation has been established between scores achieved

Table 2. Individual scores for both osteopathic and allopathic residents who participated in the in-service examinations during the 2015-2016 examination year (Pre-CC) and the 2016-2017 examination year (Post-CC).

	Osteopathic in-service score as 3rd year (pre-CC)	Osteopathic in-service score as 4th year (post-CC)	Allopathic in-service score as 3rd year	Allopathic in-service score as 4th year
Resident A	217	224		
Resident B	215	226		
Resident C	211	223		
Resident D	218	226		
Resident E	222	207		
Resident F	212	229		
	Osteopathic in-service score as 2nd year (pre-CC)	Osteopathic in-service score as 3rd year (post-CC)	Allopathic in-service score as 2nd year (pre-CC)	Allopathic in-service score as 3rd year (post-CC)
Resident G	210	215		
Resident H	199	218	79	83
Resident I			75	69
Resident J	204	215	70	81
Resident K	226	221	78	71
Resident L			75	70
	Osteopathic in-service score as 1st year (pre-CC)	Osteopathic in-service score as 2nd year (post-CC)	Allopathic in-service score as 1st year (pre-CC)	Allopathic in-service score as 2nd year (post-CC)
Resident M			75	83
Resident N	202	223	75	79
Resident O	188	193	63	68
Resident P			65	75
Resident Q	196	218	75	75
Resident R			59	69

Pre-CC, pre-curriculum change; *Post-CC,* post-curriculum change.

by residents on their in-service exams during residency training and their scores on board certification exams.[1,2] The correlation between in-training exam scores and performance on board examinations has been well-documented in a number of different specialties including EM. Levy et al looked specifically at the correlation between scores on the RISE and on the osteopathic Emergency Medicine Written (Part I) Examination.[1] Using scores from over 400 residents over a four-year period, they were able to establish that the rate of passing on the board exam increased with higher scores on the in-service exam. Therefore, it is paramount that programs train their residents to do well on in-service exams.

Preparation for these exams is an integral part of the educational curriculum for residency programs, but there is no consensus on the optimal strategy. Educational curricula differ vastly between residency programs, and we believe most have some textbook readings to help build core knowledge. Our program moved away from textbook readings in the 2016-2017 residency year with the hypothesis that residents would likely be more satisfied and training scores would not suffer. Many theories have been developed with respect to medical education, and some are specific to adult learners. Most influential and well known are the principles of Malcolm Knowles and his theory of andragogy.[7] Although it was not a reason for the change in curriculum, it can be argued that moving away from assigned textbook readings to the new curriculum allowed the residents to become more autonomous and self-directed learners. Having Rosh questions and *EBM* articles with content based on cases as well as relatable examples honed in on the residents' prior clinical experiences, allowing for contextual learning.

Our study demonstrates a significant increase in our average osteopathic scores from pre-CC to post-CC and, comparatively, our residents improved their scores more than the national osteopathic average. Scores rose from 209.2 to 218.3 while the national average went from 200.7 to 204.9. It would be expected that a resident would improve his or her score from one year of residency to the next. However, we could find no data in the literature quantifying the expected improvement in scores in the absence of any change in curriculum. Our findings show a significant increase in scores post-CC, but it remains unknown whether it is more than expected from an additional year of residency training. After analysis of the allopathic exam scores, results mainly showed no significant statistical difference in most comparisons. The only comparison that achieved statistical

Table 3. Class scores for osteopathic and allopathic residents who took the in-service examinations during the 2015-2016 exam year (pre-curriculum change) and the 2016-2017 exam year (post-curriculum change).

	Osteopathic in-service score as 3rd year (pre-CC)	Osteopathic in-service score as 3rd year (post-CC)	Allopathic in-service score as 3rd year (pre-CC)	Allopathic in-service score as 3rd year (post-CC)
Resident A, G	217	215		
Resident B, H	215	218		83
Resident C, I	211			69
Resident D, J	218	215		81
Resident E, K	222	221		71
Resident F, L	212			70
	Osteopathic in-service score as 2nd year (pre-CC)	Osteopathic in-service score as 2nd year (post-CC)	Allopathic in-service score as 2nd year (pre-CC)	Allopathic in-service score as 2nd year (post-CC)
Resident G, M	210			83
Resident H, N	199	223	79	79
Resident I, O		193	75	68
Resident J, P	204		70	75
Resident K, Q	226	218	78	75
Resident L, R			75	69
	Osteopathic in-service score as 1st year (pre-CC)	Osteopathic in-service score as 1st year (post-CC)	Allopathic in-service score as 1st year (pre-CC)	Allopathic in-service score as 1st year (post-CC)
Resident M,S			75	65
Resident N, T			75	57
Resident O, U			63	76
Resident P, V			65	67
Resident Q, W			75	63
Resident R, X			59	66

Pre-CC, pre-curriculum change; *Post-CC,* post-curriculum change.

significance was the comparison of the PGY-2 class scores post-CC to their respective scores as first years' pre-CC. This finding does not undermine our conclusion of non-inferiority of the change in curriculum.

Overall, our study findings suggest a non-inferiority component to the scores obtained without textbook readings to those obtained with textbook readings. This demonstrates that by removing dedicated textbook readings the scores held constant. Although this may not seem of great value, this observation has many implications. For one, the survey demonstrated that residents were more satisfied with the curriculum change. Therefore, satisfaction improved without ultimately lowering scores and failing to prepare residents for the board exam. Our study is in line with findings from Easton and Bernard who found

that residents prefer question-based learning over text-based learning when preparing for the boards.[8] Removing textbook reading and adding an online question bank such as Rosh Review seemed to be well liked and thus was used more often, as shown in the survey.

There has been a recent trend with question-based preparation gaining popularity over textbook chapter readings. This can be explained by a number of reasons. EM residents may prefer the practicality and portability of using question-bank learning along with being able to familiarize themselves with the format and time constraints associated with the in-service and board certification exams. Our study found a similar preference in test preparation. When looking at the satisfaction of *Tintinalli's* chapter readings vs the Rosh Review with *EBM* curriculum, residents were more satisfied with the latter. This led to residents using the new curriculum more and ultimately preferring it to the old curriculum.

LIMITATIONS

This study was limited to the in-service scores of a single residency program. Furthermore, not all residents took the training exam both years; thus, there were a limited number of residents who could be studied for the purposes of this research. Therefore, it is unclear whether the data obtained can be applied widely across all residencies or across specialties. This study did not control for the fact that Rosh Review questions were available for residents in both of the years studied. Additionally, the surveys were subject to recall bias as there was no objective measure of compliance.

Another limitation is that the new curriculum demonstrated no improvement over the old curriculum and, therefore, calls into question the necessity of either curriculum. For instance, residents informally admitted to inconsistently reading the assigned textbook reading in the old curriculum and with the addition of the new curriculum performed the same. However, we believe

Table 4. Average residency scores for both osteopathic and allopathic in-service exams in the pre-curriculum change 2015-2016 and post-curiculum change 2016-2017 years. National averages on both osteopathic and allopathic in-service exams in those years.

	2015-2016 average resident score pre-CC	2015-2016 national average pre-CC	2016-2017 average resident score post-CC	2016-2017 national average post-CC
Osteopathic Score	209.23	200.7	218.31	204.9
Allopathic Score	71.73	75.5	74.8	74.6

Pre-CC, pre-curriculum change; *Post-CC,* post-curriculum change.

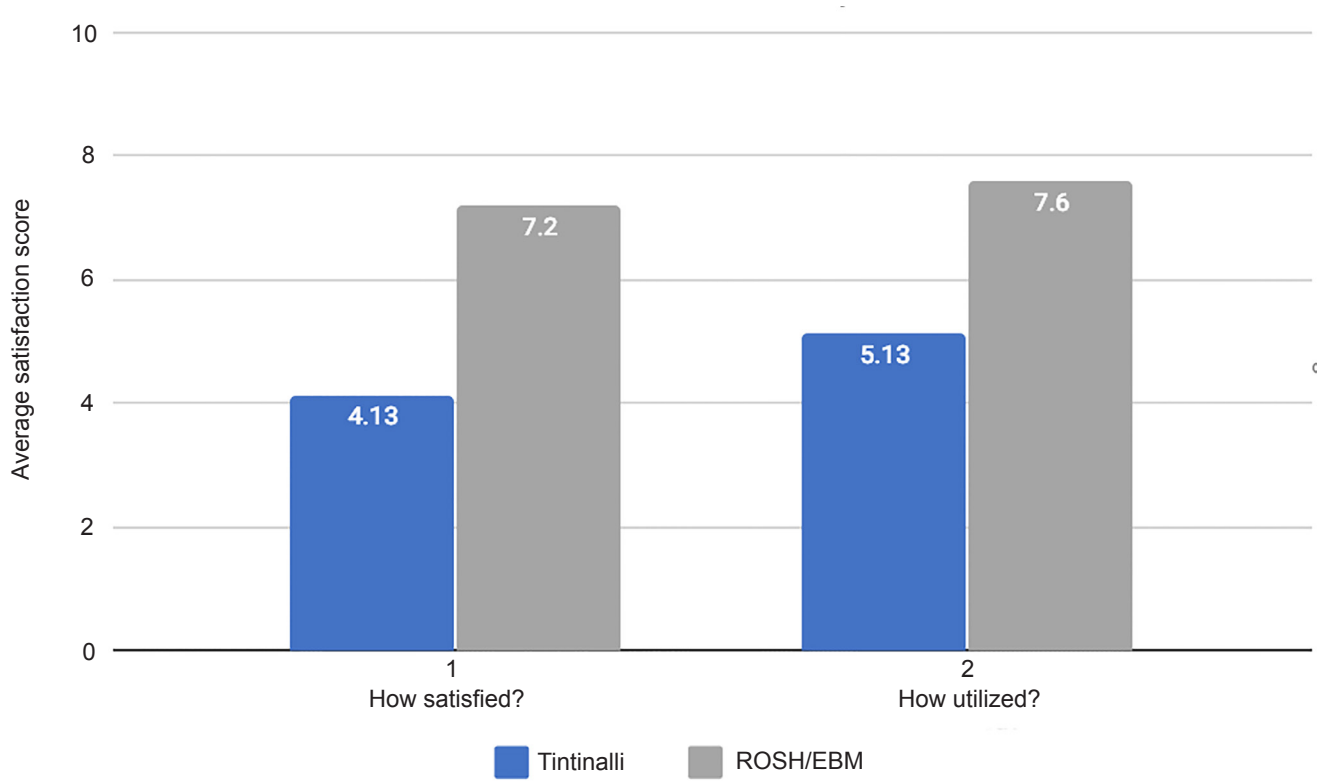

Figure. Satisfaction and utilization of the Tintinalli curriculum versus Rosh Review and Evidence-Based Medicine (EBM) curriculum based on survey results.

there to be value in the new curriculum because some residents did partake in the textbook reading of the pre-CC and now used the post-CC more and were more satisfied. A final limitation is that the study looked specifically at in-service scores but did not look at clinical outcome measures.

CONCLUSION

The new curriculum without dedicated textbook readings demonstrated to be non-inferior to the curriculum containing textbook readings. Residents were significantly more satisfied, used it more, and largely preferred it over the prior curriculum.

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Challenges Related to the Implementation of an EMS-Administered, Large Vessel Occlusion Stroke Score

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Introduction: There is considerable interest in triaging victims of large vessel occlusion (LVO) strokes to comprehensive stroke centers. Timely access to interventional therapy has been linked to improved stroke outcomes. Accurate triage depends upon the use of a validated screening tool in addition to several emergency medical system (EMS)-specific factors. This study examines the integration of a modified Rapid Arterial oCcclusion Evaluation (mRACE) score into an existing stroke treatment protocol.

Methods: We performed a retrospective review of EMS and hospital charts of patients transported to a single comprehensive stroke center. Adult patients with an EMS provider impression of "stroke/TIA," "CVA," or "neurological problem" were included for analysis. EMS protocols mandated the use of the Cincinnati Prehospital Stroke Score (CPSS). The novel protocol authorized the use of the mRACE score to identify candidates for triage directly to the comprehensive stroke center. We calculated specificity and sensitivity for various stroke screens (CPSS and a mRACE exam) for the detection of LVO stroke. The score's metrics were evaluated as a surrogate marker for a successful EMS triage protocol.

Results: We included 312 prehospital charts in the final analysis. The CPSS score exhibited reliable sensitivity at 85%. Specificity of CPSS for an LVO was calculated at 73%. For an mRACE score of five or greater, the sensitivity was 25%. Specificity for mRACE was calculated at 75%. The positive predictive value of the mRACE score for an LVO was estimated at 12.50%.

Conclusion: In this retrospective study of patients triaged to a single comprehensive stroke center, the addition of an LVO-specific screening tool failed to improve accuracy. Reliable triage of LVO strokes in the prehospital setting is a challenging task. In addition to statistical performance of a particular stroke score, a successful EMS protocol should consider system-based factors such as provider education and training. Study limitations can inform future iterations of LVO triage protocols. [West J Emerg Med. 2020;21(2)441-448].

INTRODUCTION

Emergency medical services (EMS) systems are regularly tasked with the delivery of time-sensitive care. Similar to ST-elevation myocardial infarctions, burns, and traumatic emergencies, a major component of stroke-centric care involves the transport of eligible patients to designated centers. The 2018 American Heart Association and American Stroke Association guidelines for acute ischemic stroke recommend a regional system of stroke care that involves rapid identification, diagnostic protocols, thrombolytic medications, and mechanical clot retrieval.[1] Recently, there has been significant interest with respect to the early identification of large vessel occlusion (LVO) strokes.[2-4] The ability to reliably identify LVO in the prehospital setting would permit EMS providers to preferentially transport patients to comprehensive stroke centers capable of interventional procedures.

Benefits associated with this type of triage strategy include a reduction in secondary transfers and a reduced time to groin puncture when endovascular treatment is pursued.[5] Current literature suggests that the window of opportunity for interventional stroke therapy may extend well beyond the window for systemic thrombolysis.[6,7] However, there is controversy over how EMS systems operationalize the identification of an LVO. Complicating the situation further, prehospital providers must make this determination rapidly in a chaotic and uncontrolled environment with missing or incomplete information. The goal of identifying LVO strokes is a laudable one, but it assumes that the EMS system can reliably differentiate the patient experiencing an LVO from other stroke syndromes, mimics, or imminent life threats.[8]

In 2016, the Pennsylvania Bureau of EMS approved an optional prehospital protocol that permits providers to use a modified Rapid Arterial oCclusion Evaluation (mRACE) score for the triage of potential LVO patients (Appendix 1). Patients who screened positive would be triaged to a comprehensive stroke center. This retrospective analysis examines the new protocol's ability to accurately identify patients with suspected LVO stroke and to triage them appropriately to a comprehensive stroke center. Specifically, it was thought that the inclusion of a validated, LVO-specific stroke triage score would improve the prehospital triage process and more accurately identify patients experiencing an LVO. The evaluation of a statewide protocol represents a holistic assessment of a system's ability to render condition-specific care and involves controversies and challenges beyond the clinical performance of any singular stroke scoring system. Lessons learned from the application of regionalized EMS protocols can inform future efforts and optimize the triage process.

Population Health Research Capsule

What do we already know about this issue?
Timely and accurate triage of patients with a suspected large vessel occlusion stroke represents a significant diagnostic challenge for EMS providers.

What was the research question?
Does the addition of a modified Rapid Arterial Occlusion Evaluation (mRACE) score to an EMS stroke protocol improve triage accuracy?

What was the major finding of the study?
Implementation of the mRACE score did not contribute to improved triage accuracy of large vessel occlusion strokes.

How does this improve population health?
The study highlights important questions related to systems-based stroke triage. Hopefully, the results will inform future EMS protocols and improve stroke assessment.

METHODS

In 2016, the Pennsylvania Bureau of EMS authorized EMS agencies to include an additional stroke assessment into the stroke treatment protocol. The new stroke assessment was applied to patients who screened positive after application of the Cincinnati Prehospital Stroke Score (CPSS). The Pennsylvania mRACE scale was adapted from the original RACE instrument published by Perez de la Ossa in 2014.[4] Agencies electing to use mRACE had to complete a single, state-approved training module that was delivered via a hybridized (online and didactic) instruction process. Although the class could have been delivered by approved instructors, the EMS bureau authorized a singular curriculum consisting of slides and handouts. Advanced Life Support (ALS) providers, credentialed as a prehospital registered nurse, paramedic, or critical care provider, were authorized to conduct the mRACE examination. Basic Life Support providers could perform the initial stroke screen and request ALS assistance, if appropriate.

A retrospective review of EMS transports to a single comprehensive stroke center in Pennsylvania was performed to identify patients eligible for inclusion. Research assistants from the emergency department performed the first round of chart abstraction. The research coordinator and a chief neurology resident on the stroke service reviewed all charts for agreement with respect to the final diagnosis of LVO. Although mRACE did not appear in the official protocol document until 2017, several EMS agencies were authorized by the bureau of EMS to triage patients in accordance with mRACE guidelines.

Patients transported between November 1, 2016–June 30, 2017 were included in the initial evaluation period. We

retrospectively analyzed prehospital charts to search for either a provider impression of stroke or a dispatch category consistent with stroke. Provider impressions included in the analysis consisted of "stroke/TIA," "CVA," or "neurological problem." The retrospective analysis was completed through review and abstraction of the EMSCharts electronic EMS medical health record (emsCharts, Inc; Warrendale, PA) Only patients between the ages of 18-90 with an authorized prehospital stroke score (CPSS or mRACE) were included in the final analysis. Other abstracted data points included the following: EMS call category; patient age and gender; glucose level; electrocardiogram reading; Glasgow Coma Scale (GCS); and vital signs (heart rate, blood pressure, respiratory rate, oxygen saturation). We also collected the final hospital discharge diagnosis for each subject from the discharge summary. The state-approved stroke protocol is available for review in Appendix 1.

The stroke protocol instructs EMS providers to perform a general assessment and then perform the CPSS. Approved providers then conduct the mRACE examination on those patients who tested positive on the initial CPSS. Patients who are assigned an mRACE score of 5 or greater were considered candidates for transport to a comprehensive stroke center. The cutoff score was mandated by the EMS bureau and extrapolated from previous studies involving the original RACE score derivation.[4,9]

We compared CPSS and RACE scores to the discharge diagnosis listed in the patient discharge summary. Based on these comparisons we were able to determine the number of patients who falsely tested positive and negative for stroke by EMS providers for both CPSS and mRACE. We also determined the number of patients who were found to be true positive (CPSS- or mRACE-positive with a discharge diagnosis of LVO) and negative (CPSS- or mRACE-negative with a discharge diagnosis other than LVO). Written discharge summaries did not include specific *International Classification of Diseases*, 10th edition, codes. Therefore, the diagnosis of "LVO" was established by the presence of any of the following: 1) anterior cerebral circulation ischemic stroke from a blockage in the anterior cerebral artery, the middle cerebral artery or carotid terminus; 2) posterior cerebral circulation ischemic stroke from a blockage in the posterior cerebral artery or vertebral basilar artery stroke; or 3) endovascular thrombectomy or other interventional radiology procedure targeted at treating a suspected LVO ischemic stroke.

We used these figures to calculate the sensitivity, specificity, positive predictive value, and negative predictive value for each score. "True negative" referred to those individuals who did not have a diagnosis related to acute stroke or LVO upon review of their hospital medical record and discharge summary. We examined secondary variables, including GCS score, vital signs, glucose level, and electrocardiogram findings, for possible trends that could potentially impact the accuracy of CPSS and RACE to identify LVOs in the prehospital setting. Characteristics of the respective stroke scores were used as a surrogate marker for the EMS protocol's effectiveness. This study was approved by the Allegheny Health Network's Institutional Review Board.

RESULTS

The search strategy yielded 380 prehospital charts. Of these, 67 were excluded due to missing or incomplete data leaving 312 for analysis. CPSS was used during 255 patient encounters, mRACE was used on 29 patients, and "other" stroke scales were used on 28 patients encounters. "Other" stroke scales were those not specifically mentioned in the Pennsylvania State EMS protocol. Out of 132 patients who were CPSS positive, 28 false positives were present resulting in a sensitivity of 82% (95% confidence interval [CI], 74.08-88.16). There were 123 CPSS-negative patients including those labeled inconclusive. Twenty-three false negatives occurred in the CPSS group for a calculated specificity of 78%. The positive likelihood ratio for CPSS was calculated at 3.74 (95%CI, 2.67-5.25).

The mRACE score was the second most widely used EMS stroke assessment. The sensitivity of an mRACE score of 5 or greater for LVO was 25% (5% CI, 0.63-80.59). Specificity of the mRACE score for an LVO was calculated at 75% (95% CI, 50.61-87.93). The positive predictive value of mRACE was 12.50 (95% CI, 2.28%-46.61%) and eight out of 29 patients had a positive mRACE score, but only four patients had an LVO. Therefore, the negative predictive value of mRACE > or = to 5 for a LVO was 85.71 (95% CI, 76.41-91.74). EMS providers recorded a blood glucose measurement in a majority (over 73%) of stroke encounters. When provider impression was compared with the initial diagnosis, the most frequently encountered stroke mimic appeared to be seizure or seizure-like activity of various etiologies. Results are summarized in Tables 1 and 2.

DISCUSSION

Our study represented an initial assessment of a novel, statewide stroke protocol aimed at triaging LVO patients to a comprehensive stroke center. The mRACE score was touted as a valuable tool for the identification of patients who might be appropriate for referral to a regional comprehensive stroke center. State EMS triage protocols instruct prehospital providers to use a single score (mRACE) to make determinations about the presence of an LVO. Because the addition of mRACE into existing treatment protocols represents an evolving process, study authors also examined the ability of the CPSS to identify patients with an LVO. Prior to the rollout of the Pennsylvania mRACE score, the CPSS was the sole instrument used by the region's EMS providers to confirm a prehospital impression of stroke. Interestingly, the less-discriminatory scale (CPSS) displayed superior sensitivity and specificity for the detection of LVO. Existing literature is replete with various stroke scoring schemes, and system medical directors, managers, and EMS clinicians are tasked with applying the tool that is most appropriate for their system. The challenges associated with prehospital diagnosis paired with the imperative for a rapid, accurate prehospital impression make it exceedingly difficult to come up with a

Table 1. Sensitivity and specificity of the Cincinatti Prehospital Stroke Scale and modified Rapid Arterial oCclusion Evaluation.

		Discharge Diagnosis		
		LVO	Not LVO	Total
CPSS	Positive	104	28	132
	Negative	23	100	123
	Total	127	128	255
mRACE	Positive	3	21	24
	Negative	1	4	5
	Total	4	25	29

LVO, large vessel occlusion; *CPSS,* Cincinnati Prehospital Stroke Score; *mRACE,* modified Rapid Arterial oCclusion Evaluation.

Table 2. Calculated sensitivity and specificity for large vessel occlusion.

	N	Sensitivity	Specificity
CPSS	255	82%	78%
mRACE	29	75%	16%

CPSS, Cincinnati Prehospital Stroke Score; *mRACE,* modified Rapid Arterial oCclusion Evaluation.

reliable triage algorithm.

Accurate prehospital identification is a crucial step in the appropriate and comprehensive management of acute ischemic stroke. Prehospital providers face many challenges in this task, including limited information and a chaotic and uncontrolled environment, as well as time and resource constraints. Our study shows that the CPSS is the most common prehospital stroke screening tool used within our region. Interestingly, while not specifically validated as an LVO screening tool the CPSS displayed a sensitivity of 88% for the detection of LVO. When EMS providers applied the mRACE tool, we found a 25% sensitivity for LVO. In this preliminary assessment of the stroke triage protocol, the addition of an mRACE score failed to reliably identify those who may benefit from primary transport to a comprehensive stroke center capable of delivering appropriate, interventional-based therapies.

Revolutionary stroke trials starting with MR CLEAN, ESCAPE, REVASCAT, and recently DAWN and DEFUSE-3, have shed light on the utility of extended mechanical thrombectomy for LVO strokes.[10-14] There is increased interest in triaging appropriate patients to centers capable of intervention due to the possibility of improved neurological outcomes and functional recovery. Indeed, a regionalized system of stroke care, which emphasizes validated triage tools and routes patients to centers capable of providing definitive stroke therapy, is essential to achieving the improved outcomes touted in the recent interventional stroke trials.

One of the most important functions of an EMS system is to deliver the patient to the right place, at the right time, and via the correct vehicle. Stroke presents a challenge to EMS providers in that there are many "mimics" that can confound the initial presentation and diagnosis.[2,15] This can make accurate triage of patients experiencing such symptoms challenging. The importance of identifying strokes within a brief time window adds additional pressure to the initial prehospital assessment. Endovascular therapy represents a promising modality for patients suffering from a LVO stroke, and the benefits are proportional to time of therapy delivery.

To reduce the incidence of overtriage, several stroke scoring systems have been developed to assist EMS providers with accurate diagnosis.[16,17] Existing literature affirms that the ideal tool has yet to emerge.[3,18] The Smith (2018) et al. meta-analysis demonstrated that LVO-specific triage schemes failed to perform better than less-selective tools. The Turc (2016) et al. paper examined 13 clinical scores for their ability to predict LVO and observed similar shortcomings with respect to scale accuracy and false positive rates.[18] EMS systems across the country have experimented with checklists, telemedicine, and other strategies targeted at stroke evaluation.[19,20] Despite a lack of consensus with respect to an optimized stroke triage protocol, current guidelines suggest that EMS systems consider bypassing a primary stroke center in favor of a comprehensive stroke center when LVO is suspected.[1] However, the added benefits apply only if the EMS system in question can 1) articulate a consistent, accurate protocol for stroke triage, and 2) reliably identify the presence of an LVO.

The literature is replete with analyses of multiple prehospital triage scores. A singular stroke score's "specificity" or "sensitivity" is a misleading outcome when reported in the absence of a comprehensive and regionalized stroke triage protocol. In other words, the EMS system performing the score is just as important as the score's accuracy and structure. Apart from a designation of ALS, BLS, or first response, there may be little to no similarity between any two EMS systems. The Pennsylvania Department of Health Bureau of EMS presented EMS agencies with the option of implementing a mRACE score to facilitate accurate triage and transport. The initial rollout of the mRACE score occurred at the discretion of individual medical directors and was predicated upon a review of existing scoring systems. Variabilities in provider familiarity and provider level of education likely contributed to the inconsistent application of mRACE. Despite being designated as the only state-approved scoring system for LVO, the mRACE score was only applied in a small percent of cases.

Since the initial submission of this article, one EMS agency published its "long-term" experience with RACE-based prehospital triage of stroke.[21] The study included 492 "RACE Alert" patients and boasted a 77% sensitivity for the detection of LVO for scores ≥ to 5. Intracerebral hemorrhage, as opposed to seizure, was the most common stroke mimic found in the intervention group. Paramedics applied the RACE exam to patients scoring positive on CPSS. The study's promising results highlight important points about protocol formulation and execution. First, the study involved a single EMS agency that benefited from collaboration between medical directors and stroke neurologists. The neurologists were from a single comprehensive stroke center, and all EMS providers in the study were "licensed as paramedics." RACE training was consistent and uniform; all paramedics had to successfully complete a "four hour module" and undergo annual retraining. The ability to route education and training through one agency likely contributed to the study's favorable conclusions. In addition, the study's protocol was restricted to a single group of ALS providers.[21]

Accordingly, the varied composition of our study's EMS system might also have contributed to the results. EMS agencies in the western Pennsylvania area incorporate volunteer, part-time, and career positions. It logically follows that frequency of exposure to LVO and its clinical manifestations would result in a more nuanced understanding of how to integrate and score clinical findings. Furthermore, the particular EMS region under study does not use a consistent paradigm for medical command. Referring EMS agencies employ a wide range of physician oversight strategies that incorporate anything from episodic physician call review to a more robust physician presence at designated skills-demonstration sessions. Future studies might consider implementing a stroke-scoring scheme within a system that embraces a more consistent mode of physician oversight with respect to both education and quality improvement.

There is a significant disconnect between the specificity and reliability of an LVO triage scheme and its utility within a larger EMS system. Deciding how to operationalize an LVO score into an EMS system requires careful consideration of system-specific factors. Apart from a designated educational program, it is vitally important to identify discrepancies in how the score is applied. EMS provider training and experience may play a significant role in the ability to reliably perform more complex neurological assessments and integrate those findings into an often-undifferentiated clinical picture.[22] It is hoped that analyses such as this one, although limited in its retrospective approach and single-center design, can shed light on the difficulties implicit in a systemwide application of a stroke triage scheme.

A tried and time-tested scale such as the CPSS holds promise in that it can accurately identify strokes and suggest the presence of LVO.[23] Richards (2018), et al. examined consecutively enrolled acute stroke patients arriving at a single comprehensive stroke receiving center from 2012-2014. A CPSS score of 3 predicted acute ischemic stroke with a specificity of 88% and a sensitivity of 41%. The unadjusted odds ratio of CPSS for LVO was calculated at 5.1 The authors posited that CPSS could therefore be used as a "screen" for LVO. Reportedly, 72.7% of patients with a CPSS score of 3 were ultimately found to have an LVO. The CPSS score has some significant advantages over other triage scores. Specifically, it is easy to use, requires little to no additional education, and is reproducible between EMS providers.[22,24] Results from this cohort of patients supports the premise of using a high CPSS score as a possible LVO screen.

Although prospectively validated, the RACE score's generalizability to other EMS systems remains uncertain.[4] The score was applied to a cohort of patients transferred from a community hospital to a referral center. These patients do not resemble the more-undifferentiated population encountered by United States EMS counterparts, and the score in question was usually discussed with a stroke neurologist following arrival at the comprehensive stroke center. Although derived from the "gold standard" National Institutes of Health Stroke Severity Score, the authors acknowledged several important limitations. First, the study likely incorporated a significant amount of selection bias due to most patients being transferred from a community hospital. The RACE score was constructed from data largely obtained from patients experiencing an "anterior circulation" stroke. This component of the RACE score's design may impact accuracy when applied to patients with middle cerebral or posterior cerebral artery circulation.[4] The authors readily acknowledged the necessity of "larger validation studies." To date, there has not been another published study that prospectively validates the RACE score in the context of a less-differentiated prehospital population.

Perhaps a stroke triage paradigm that emphasizes basic tenets of stroke assessment while highlighting factors linked to LVO will incentivize paramedics to make accurate triage decisions. Any optimized stroke triage protocol should incorporate additional, system-specific considerations into a comprehensive triage strategy. Factors such as focused provider education, provider level of training, and the degree of medical command oversight likely contribute to a reliable stroke protocol and assure its appropriate application to the desired patient population.

LIMITATIONS

In this study, a statewide stroke triage protocol predicated upon a mRACE score demonstrated specificity and sensitivity inferior to previously described results. As a tool intended for the prehospital identification and triage of patients with LVO, the RACE score performed less reliably than its predecessor, the CPSS. Of course, the prehospital environment is itself somewhat chaotic, and the individual characteristics of any one system factor into the reliability of a specific triage scheme. Allegheny General Hospital provides medical oversight for numerous EMS systems within the study's geographic area. Although the RACE exam represents an acceptable tool for EMS utilization, its implementation has been less than uniform. Provider unfamiliarity with the RACE

score and the existence of different educational programs likely contribute to its variable performance.

Furthermore, providers of varied educational and certification levels (emergency medical technician [EMT], paramedic, advanced EMT) operate within the area's EMS system. Paramedic providers more familiar with the intricacies of the central nervous system may be better positioned to formulate a diagnostic impression of stroke when compared to their BLS colleagues. In this study, paramedics were credentialed to perform and interpret the mRACE exam. BLS providers were tasked with initial stroke triage and, in some cases, requested ALS for a suspected diagnosis of LVO. This contingency represents a potential source of referral bias given that EMT providers could request ALS or critical care assistance for the treatment and transport of a possible large vessel stroke.

The mode of educational delivery highlights additional limitations. Although a state-approved program served as the foundation for instructional content, various personnel were involved in the rollout of the curriculum. Even though the EMS bureau hosted an online training program complete with case studies and triage scenarios, service agencies could incorporate their own instructors and course material into an approved mRACE program. Therefore, variations in the method of instruction and instructor familiarity with mRACE may have contributed to the score's underperformance. Prior to the inception of the state's mRACE protocol, providers relied upon both their clinical impression and the CPSS to arrive at a diagnosis of stroke. The study also included a subset of patients undergoing interfacility transfer. Therefore, stroke scales from outside hospitals and EMS agencies were incorporated into the patient's medical record. Certainly, a pre-transfer diagnostic impression of stroke introduces an element of referral bias into the results. Since the protocol was an optional addition to the existing state protocols there was also relatively low penetrance among the regional EMS services.

EMS system structure varies in accordance with a system's needs and resources This fact must be considered when choosing one stroke triage scheme over another and will likely influence the accuracy of any approved protocol. Limitations associated with retrospective chart abstraction and selection bias also represent another significant limitation. Chart abstractors were not blinded to the study hypothesis. The study hospital is one of three designated comprehensive stroke centers within the region of interest. Providers may also be more inclined to transport patients to a comprehensive stroke center knowing that the receiving hospital could treat strokes of varying severity.

Despite the use of an electronic medical record, investigators reviewed several charts with missing and incomplete data. Matching prehospital records to the inpatient electronic medical record presented additional challenges. Referral bias is another limitation that is difficult to mitigate. While the diagnosis of LVO includes specific anatomic and physiologic criteria, the absence of a clot found upon neuroimaging should not indicate a failed or inaccurate EMS referral. Indeed, a certain degree of overtriage is accepted when identifying patients who may benefit from intervention. Existing methods for validation of stroke triage fail to capture the complexity of the diagnosis. For example, an EMS provider might correctly classify a patient with post-seizure paralysis as having a LVO stroke. The particular patient's mRACE score would be elevated due to aphasia and paralysis despite the absence of stroke-related pathology. "False positive" encounters have the potential to challenge the validity of the stroke assessment even though providers may have correctly applied the mRACE calculation. Furthermore, neurologists at comprehensive strike centers encourage transport to facilities capable of delivering the highest level of stroke care.

Distance to a comprehensive stroke center might factor into a provider's decision to triage a sicker patient to a closer, "primary stroke" hospital. Subtleties of paramedic medical decision-making are not likely captured in our retrospective data abstraction. The diagnostic challenge of stroke presents several barriers to the responding EMS provider. Unlike other time-sensitive diagnoses such as STEMI and trauma, the diagnosis of stroke is confounded by the existence of clinical conditions that mimic stroke. The degree of stroke severity, coupled with the wide-ranging patient presentations, heap additional challenges onto the prehospital determination of LVO. Despite the Pennsylvania Bureau of EMS designating a single scale and uniform educational program for LVO triage, the mRACE score was under-represented in patient transports to a regional comprehensive stroke center.

The intervention group's small sample size deserves mention as a significant limitation. Aside from an inability to formulate meaningful conclusions about the utility of the mRACE score, the small numbers call attention to challenges related to protocol implementation. Indeed, the process through which a "uniform" triage protocol is operationalized is exceedingly complex. Regional EMS authorities must work through problems related to provider education, training, and communications, prior to the issuance of a blanket triage protocol. Incorporation of a trial population into a stroke triage protocol might have mitigated difficulties relating to the early adoption of the mRACE score. Additional study is needed to highlight barriers to update and penetration of the LVO-specific mRACE score within the EMS system. Finally, the various stroke studies highlighted in this paper examine different clinical endpoints. It is, therefore, difficult to directly compare stroke scales since one may look exclusively at any stroke versus a LVO.

CONCLUSION

The implementation of a novel, statewide EMS protocol intended to identify and transport patients with suspected LVO strokes performed with less than expected results. The addition of a mRACE score into existing triage protocols did not increase the sensitivity or specificity for the detection of LVO. Within a regionalized EMS service area, EMS crews reported a higher sensitivity and specificity for CPSS than the reported average. The use of mRACE for triage of LVO patients to be transported

to comprehensive centers appears to perform less reliably than other prehospital triage scores such as the historically used CPSS. Prospectively oriented research is needed to better qualify the benefits of the mRACE score and other LVO- specific scores over more widely used methods. Further study is needed to identify obstacles to the prehospital detection of LVO and to inform the rollout of regional stroke triage protocols.

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Mistriaged Advanced Life Support Patients in a Two-Tiered, Suburban Emergency Medical Services System

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Introduction: Emergency medical services (EMS) systems exist to provide prehospital care in diverse environments throughout the world. Advanced Life Support (ALS) services can provide advanced care including 12-lead electrocardiogram (ECG), endotracheal intubation and parenteral medication administration. Basic Life Support (BLS) can provide basic care such as splinting, wound care and cardiopulmonary resuscitation. ALS can release patients to BLS for transport to the hospital, and this is an area of high risk. Our study examines patients who were triaged and admitted to a critical care location, including an intensive care unit (ICU), cardiac catheterization laboratory, or operating room (OR).

Methods: The analysis included data from 2007–2015 of all patients who were triaged. We evaluated demographics, admission diagnoses, and dispositions using descriptive statistics. Diagnoses were grouped into categories based on the system.

Results: We found that 372/17,639 (2%) of patients were mistriaged to BLS and admitted to a critical care location. The average age was 64. The most common diagnosis categories were neurological (24%), gastrointestinal (GI)/abdominal pain (15%), respiratory (12%), and cardiac (12%).

Conclusion: It is uncommon for patients triaged from ALS to BLS to be admitted to an ICU, catheterization lab or OR, with a rate of 2%. Neurological, GI, respiratory, and cardiac diagnoses were the most frequent categories of patient complaints that were mistriaged. This study should lead to further studies to examine this patient population. [West J Emerg Med. 2020;21(1)449-454.]

INTRODUCTION

Worldwide, many different emergency medical services (EMS) systems exist in order to serve diverse patient populations. One of the systems in the United States uses a two-tiered response comprised primarily of a Basic Life Support (BLS) transport ambulance staffed by emergency medical technicians (EMT) and Advanced Life Support (ALS) staffed by two paramedics. A tiered system has the advantage of spreading resources further by incorporating volunteer, public, and private BLS ambulances. With more ambulances available to respond to simultaneous patients in high-volume areas, response times to critical intervention such as cardiopulmonary resuscitation and stabilization of trauma patients may be decreased.[1] One challenge of EMS is determining which patients truly require ALS pre-hospital care. An emergency medical dispatch (EMD) protocol will automatically dispatch ALS units to high-acuity complaints, such as chest pain, shortness of breath, altered mental status, and trauma as specified by protocols. EMD protocols decrease inappropriate dispatches of ALS in cases where advanced medical procedures and interventions, such as intravenous (IV) access, fluid resuscitation, medications, or cardiac monitoring are not necessary.[2] ALS interventions have shown to provide some mortality benefit to patients

with acute myocardial infarction, in certain trauma patients, and for seizures.[3,4,5]

An ALS unit that is dispatched and responds to a scene may down-triage or "release" the patient to BLS if, after ALS assessment, the paramedics feel no ALS monitoring or interventions are warranted. This process is either done through standing protocols or consulting an emergency physician (EP) via online medical control. This is an accepted practice in EMS systems that operate in a tiered-response environment. To date, no studies have been conducted to evaluate this group of patients who are triaged to BLS and subsequently found to have a condition requiring admission to the operating room (OR), cardiac catheterization lab, or intensive care unit (ICU). These groups will be referred to as a critical care location. Cardiac monitoring is required for patients who are admitted to critical care locations; this would suggest there may be benefit to ALS monitoring, treatment, and transport to the hospital. This is a high-risk group that may warrant ALS intervention and represent an area of opportunity to improve.

In this study, we sought to characterize a sample of cases where mistriage from ALS to BLS occurred. We used a large, suburban, hospital-based EMS agency with consecutive patients using a protocolized, retrospective chart-based review.

Population Health Research Capsule

What do we already know about this issue?
In a two-tiered emergency medical services (EMS) system, many patients are often mistriaged despite having life threatening diagnoses. No studies have previously characterized this phenomenon.

What was the research question?
What are the characteristics, diagnoses, and dispositions of patients who were mistriaged from Advanced Life Support to Basic Life Support?

What was the major finding of the study?
The mistriage rate is 2%. Patients are often geriatric. Neurologic, gastrointestinal/abdominal, and sepsis diagnoses were most often missed.

How does this improve population health?
Focusing paramedic education on recognizing these frequently missed emergencies may lead to safer triages and management of prehospital patients in two-tiered EMS systems.

METHODS

The setting is a suburban, two-tiered EMS system in which ALS units evaluate approximately 14,000 patients per year. Patient charts are documented in EMSCharts (Zoll Medical, Chelmsford, MA), a commercially available electronic medical record (EMR) designed for prehospital care. Inclusion criteria were cases mistriaged – patients who were triaged from ALS to BLS and admitted to an ICU, cardiac catheterization lab, or operating room from the emergency department (ED) (critical care locations). For the analysis, we retrospectively reviewed data on all patients from 2007-2015 who were down-triaged to BLS, transported to an ED, and then were subsequently admitted to a critical care location. From this group, demographics, diagnosis category, and disposition were extracted via EMSCharts into a spreadsheet that was analyzed for descriptive statistics using Excel (Microsoft Corp, Redmond, WA). We calculated 95% confidence intervals when appropriate. We excluded from analysis patients who were triaged to BLS for transport and not admitted to an ICU, OR, or catheterization lab.

The disposition of patients was obtained by the individual paramedic, EMT, or supervisor and was documented in the patient chart. Diagnoses were recorded and subsequently classified into categories that were programmed into the EMR and selected by the individual who obtained follow-up information. This study was approved based on a universal institutional review board (IRB) approval for retrospective chart reviews of EMSCharts data granted by the IRB at Morristown Medical Center in Morristown, New Jersey.

RESULTS

Out of 17,639 patients from 2007-2015 who were evaluated by ALS and triaged to BLS, 372 patients (2%) were mistriaged to BLS. The average age was 64 years, and 52% were female. The most common mistriaged admission diagnosis category was neurological (24%), followed by gastrointestinal (GI)/abdominal emergencies (15%), respiratory (12%), cardiac (12%) sepsis (10%), and trauma (10%). Of patients who were admitted, 83% went to an ICU, 15% to the OR, and 2% to the catheterization lab. Please refer to Figures 1, 2A, 2B, and 3 for the full results.

DISCUSSION

This study, while limited, demonstrates several important concepts. Our study demonstrated that there was a 2% rate of mistriage to BLS. These are critically ill patients who require close monitoring and could potentially benefit from ALS interventions and support that cannot be provided by EMTs. In patients who are admitted to the OR, ICU, or catheterization lab, cardiac monitoring is standard care. At the bare minimum, this data demonstrates a missed opportunity to closely monitor the patient for deterioration. In the state of New Jersey,

all cases of identified mistriage have to be reported to the Department of Health Office of Emergency Medical Services.

The average age of patients mistriaged was 64, and the median age was 70. The most frequently missed complaints included neurological and GI/abdominal complaints. Older patients with complaints of abdominal pain have more frequent and more serious diagnoses than younger cohorts.[6] Likewise, neurologic complaints were also frequently missed. Although the specific chief complaints were not analyzed, it is possible that patients may have presented with vague complaints, such as "dizziness, headache, fatigue or weakness." This knowledge could influence EMS education in that more caution should be taken when considering older patients for ALS transport with vague complaints who may become ill.

Patients admitted to the OR represent a significant area for improvement; it is possible that ALS providers are not recognizing situations in which emergency surgery may be indicated. This has serious implications for prehospital. It is possible that preoperative patients who may benefit from IV access, fluid resuscitation, pain and nausea medication may not be receiving it as a result of triaging to BLS providers. This is a group that requires further study, as patients may be admitted to the OR with non-critical diagnoses and straightforward surgeries that may not necessitate ALS care.

Lastly, 2% of patients were admitted directly to the catheterization lab. In the era of paramedic interpretation and 12-lead transmission of electrocardiograms (ECG) directly to the ED or to the catheterization lab, this is a population in which there should be few misses. However, it is possible that not all these patients met ST-elevation myocardial infarction (STEMI) criteria, and that some patients were taken to the catheterization lab based on dynamic ECG changes in the ED or for other reasons. It is also possible that the initial ECG may have had signs of a non-STEMI (NSTEMI) or STEMI and were simply misinterpreted. Either way, these were patients whose disposition implied they required a higher level of care than BLS and represent an area for improvement.

Our EMS agency had a protocol to guide paramedics in decision-making for down-triage to BLS providers for transport. However, it is possible that the protocols were not followed. In that case, education is required for the providers who violate them, but there is no ability to override their decision-making in real time.

LIMITATIONS

There are several limitations worth mentioning. This is a single EMS system study with a largely suburban response area in New Jersey. These results may not be generalizable to systems of dissimilar characteristics. The state of New Jersey operates a two-tiered system with BLS and ALS in separate ambulances, and ALS ambulances are staffed with two paramedics. Paramedics cannot transport in New Jersey under most circumstances and require BLS to transport the patient. This has the potential to influence decision- making.

We only examined data from patients who were admitted to critical care locations after ALS had triaged them to BLS. We did not compare this data with patients admitted to the respective units without triaging or patients treated by ALS and who were then admitted to these locations. Therefore, conclusions are limited to descriptions only. Disposition of the patient was determined by either in-person follow-up in the ED or by phone. It is possible patient's dispositions may have been missed. Likewise, patients in whom disposition was unable to be determined, or disposition was not investigated, were not included in this study. Disposition may have been mistaken. This may have skewed the results. Different hospitals may have different criteria for admission. This can also affect the results.

Individual paramedics may have variation in their rates of triage. This has important implications for the performance improvement process to identify special cause variation in individual departments. Lastly, due to our study design, we did not have a control group to make statistical determinations nor did we have patient outcome data, such as disposition status from the hospital. This also limits the conclusions that can be made to descriptions of this population.

CONCLUSION

This is the first study to investigate mistriaged patients from ALS to BLS. The data may help guide system planning and direct future research efforts to improve clinical care regarding patient triages. Future studies should include reviewing the outcomes of mistriaged patients to determine which of these patients, if any, suffered poor outcomes potentially related to mistriage and include a control group. We believe that further research on this topic is important in order to make safe decisions for prehospital patients and continue to use resources in two-tiered EMS systems effectively.

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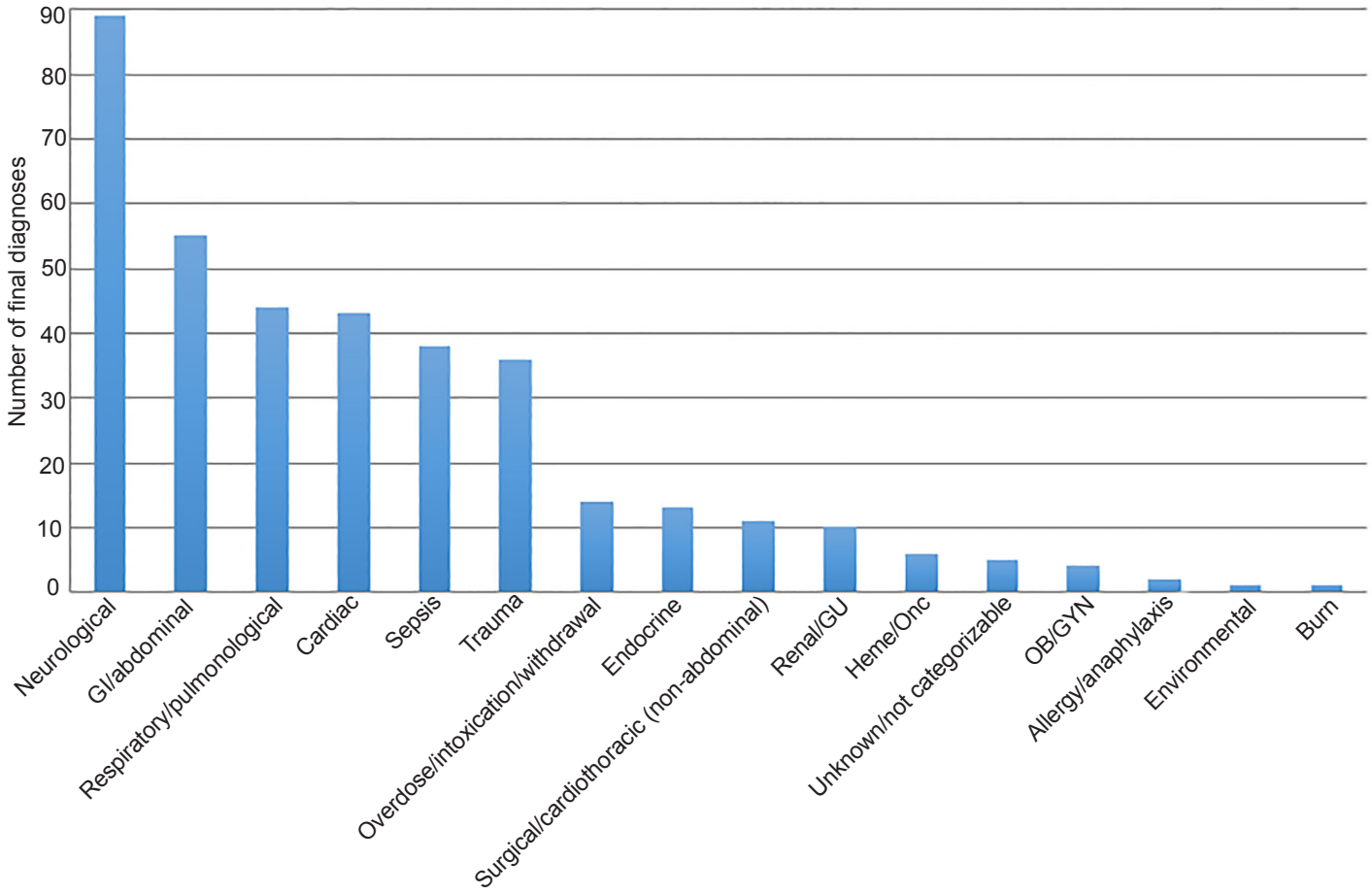

Figure 1. Number of admission diagnosis categories for patients triaged to basic life support and admitted to critical care location. *GI,* gastrointestinal; *GU,* genitourinary; *Heme/Onc,* hematology/oncology; *OB/GYN,* obstretics/gynecology.

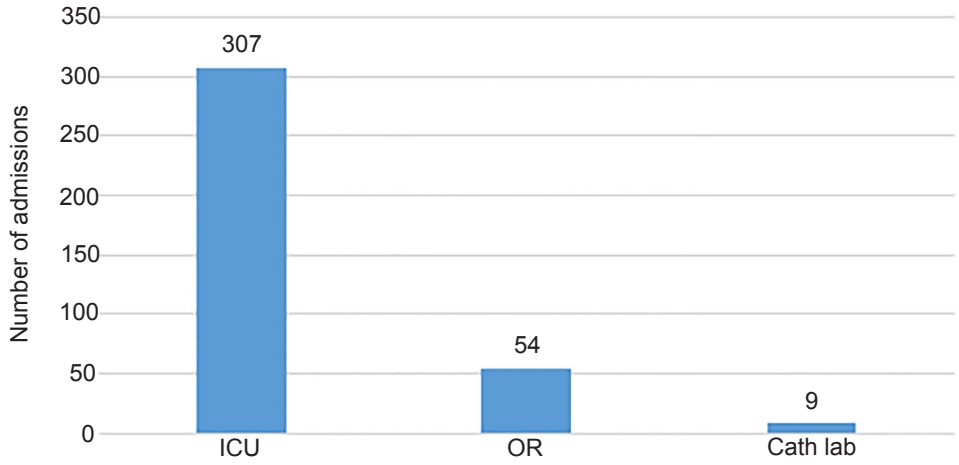

Figure 2A. Admission critical care location of mistriaged patients. *ICU,* intensive care unit; *OR,* operating room; *Cath Lab,* catheterization lab.

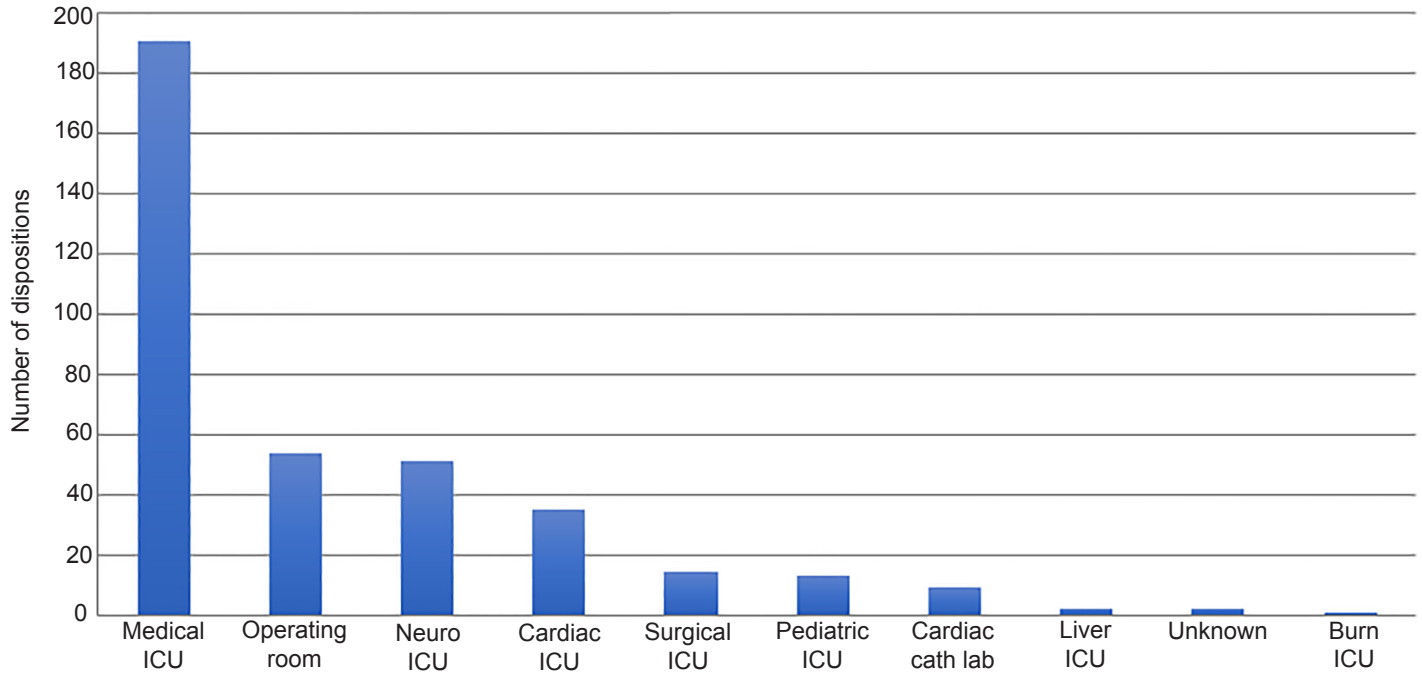

Figure 2B. Final disposition location of mistriaged patients.
ICU, intensive care unit.

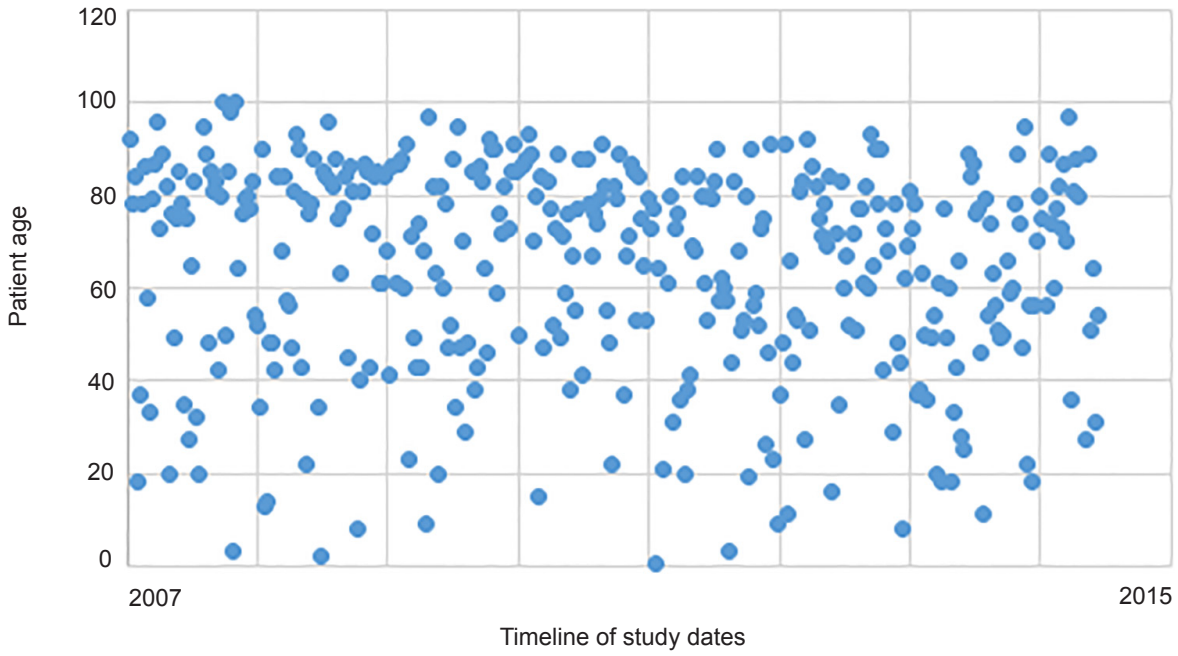

Figure 3. Scatter plot of ages of patients triaged to basic life support and admitted to critical care unit.

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Prehospital Trauma Scene and Transport Times for Pediatric and Adult Patients

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Introduction: Increased out-of-hospital time is associated with worse outcomes in trauma. Sparse literature exists comparing prehospital scene and transport time management intervals between adult and pediatric trauma patients. National Emergency Medical Services guidelines recommend that trauma scene time be less than 10 minutes. The objective of this study was to examine prehospital time intervals in adult and pediatric trauma patients.

Methods: We performed a retrospective cohort study of blunt and penetrating trauma patients in a five-county region in North Carolina using prehospital records. We included patients who were transported emergency traffic directly from the scene by ground ambulance to a Level I or Level II trauma center between 2013-2018. We defined pediatric patients as those less than 16 years old. Urbanicity was controlled for using the Centers for Medicare and Medicaid's Ambulance Fee Schedule. We performed descriptive statistics and linear mixed-effects regression modeling.

Results: A total of 2179 records met the study criteria, of which 2077 were used in the analysis. Mean scene time was 14.2 minutes (95% confidence interval [CI], 13.9-14.5) and 35.3% (n = 733) of encounters had a scene time of 10 minutes or less. Mean transport time was 17.5 minutes (95% CI, 17.0-17.9). Linear mixed-effects regression revealed that scene times were shorter for pediatric patients ($p<0.0001$), males ($p=0.0016$), penetrating injury ($p<0.0001$), and patients with blunt trauma in rural settings ($p=0.005$), and that transport times were shorter for males ($p = 0.02$), non-White patients ($p<0.0001$), and patients in urban areas ($p<0.0001$).

Conclusion: This study population largely missed the 10-minute scene time goal. Demographic and patient factors were associated with scene and transport times. Shorter scene times occurred with pediatric patients, males, and among those with penetrating trauma. Additionally, suffering blunt trauma while in a rural environment was associated with shorter scene time. Males, non-White patients, and patients in urban environments tended to have shorter transport times. Future studies with outcomes data are needed to identify factors that prolong out-of-hospital time and to assess the impact of out-of-hospital time on patient outcomes. [West J Emerg Med. 2020;21(2)455-462.]

INTRODUCTION

Trauma is the leading cause of death in the United States (US) for individuals under 45 years of age.[1,2] It accounts for 60% of deaths in patients less than 20 years old.[3,4] Owing to the significant burden of disease, the US maintains a robust trauma care infrastructure, including trauma centers, trauma prevention programs, and emergency medical services (EMS).[5,6] EMS is tasked with providing prehospital emergency care and with transporting patients to definitive care.[7,8]

In caring for trauma patients, out-of-hospital time is an important factor in patient outcomes.[7–11] The golden hour is well-known to EMS providers and directs them to deliver trauma patients to definitive care within 60 minutes of injury.[9,10] The golden hour concept is primarily attributed to R. Adams Cowley, the physician who founded Baltimore's Shock Trauma Institute. He wrote, albeit anecdotally at the time, that "the first hour after injury will largely determine a critically-injured person's chances for survival."[10] Multiple research studies support the concept that less time to definitive care results in better patient outcomes,[6,12–14] particularly with certain disease states, such as severe head injury,[15,16] abdominal injury,[17] and thoracic injury.[18,19]

Sampalis et al suggest that for each additional minute of prehospital time, the risk of dying increases by 5%.[12] Brown et al examined 164,000 trauma registry cases. In a logistic regression model, they found that prolonged scene time was associated with increased mortality among patients with hypotension, penetrating trauma, and flail chest.[20] In a separate study, Sampalis et al performed a case-control multivariable logistic regression analysis of 360 trauma patients. They found that out-of-hospital time in excess of 60 minutes was associated with a three-fold increase in mortality.[12] Feero et al examined nearly 1000 trauma registry cases in Oregon and concluded that less out-of-hospital time was associated with increased survival.[13] This body of literature supports the golden hour principle.

Owing to this, an emphasis on limiting prehospital time permeates EMS care systems.[7,8] Prehospital professionals are generally expected to keep trauma scene times under 10 minutes and may transport patients using emergency lights and sirens to reduce total out-of-hospital time.[7,8] While well studied in the adult population, the role of the golden hour in pediatric trauma is unclear. To date, no literature specifically compares prehospital time intervals of adult to pediatric trauma patients. The purpose of this study was to examine prehospital time patterns to better understand scene and transport time practices among patients with blunt or penetrating trauma.

Population Health Research Capsule

What do we already know about this issue?
Time to definitive care is an important consideration in prehospital (EMS) trauma care. EMS agencies are expected to keep scene time less than 10 minutes.

What was the research question?
To characterize EMS scene and transport time practices among trauma patients in pediatric and adult cohorts

What was the major finding of the study?
EMS largely misses the 10-minute scene time goal. Pediatrics, males, and penetrating trauma patients have shorter scene times.

How does this improve population health?
Prehospital agencies and medical directors can use these results to investigate their own performance and initiate quality improvement programs.

METHODS

Study Design

We performed a retrospective, regional, multijurisdictional cohort study of blunt and penetrating trauma patients in a five-county region in North Carolina (NC). We included patients who were transported directly from the scene by ground ambulance emergency traffic to a Level I or Level II trauma center between 2013 and 2018. The Wake Forest University Institutional Review Board approved this investigation and waived the requirement for informed consent. The STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines helped direct the research and publication process.[21]

Study Setting

This study was conducted across five counties with Advanced Life Support (ALS) EMS agencies over a five-year period (January 1, 2013-January 1, 2018) in a mixed urban and rural area of NC. Two of the five study counties have robust urban centers with approximately 250,000 people each, while the remaining three counties are largely suburban and rural communities. The EMS agencies serve a combined population of nearly 700,000 people and transport to two American College of Surgeons (ACS)-verified Level I trauma centers and one ACS-verified Level II trauma center. Each county operates its own single-tier, ALS-level EMS agency that receives medical direction from emergency physicians with subspecialty board certification in EMS.

Each agency uses the same prehospital electronic medical record system (ESO Solutions, Austin, TX,). An EMS agency

representative in each county extracted the data. These EMS representatives were blinded to the specific aims of the study. They were provided with a standardized, pilot-tested data extraction report to be run through their EMR system. The extractors did not alter the raw data. We collated each agency's data into a single report for analysis.

Participant Selection

We included blunt and penetrating trauma patients of all ages who were transported directly from the scene to a Level I or Level II trauma center by ground ambulance with emergency lights and sirens. These patients were identified based off a prehospital primary or secondary impression of trauma. In order to study the highest acuity trauma patients, we included only patients who were transported emergency traffic with lights and sirens. In the study region, <10% of trauma encounters are transported emergency traffic. The decision to transport emergency traffic is based on paramedic gestalt. Prisoners and patients who were declared dead in the field were excluded. We defined pediatric patients as being less than 16 years old and adult patients as being at least 16 years old. Interfacility transports were not included.

Outcomes

The primary outcomes of this study were scene time and transport time. Scene time was defined as the moment EMS arrived on scene to the moment transport was initiated to the trauma center. Transport time was defined as the time from scene departure to trauma center arrival. EMS providers recorded scene arrival, scene departure, and trauma center arrival times in the computer automated dispatch system by selecting the appropriate digital button in the ambulance-based mobile data terminal or by radioing dispatch command, which recorded the time.

Variables

Variables included the following: EMS agency; patient age, gender, race, and ethnicity; encounter year; primary and secondary impression; EMS on-scene time; EMS scene departure time; urbanicity defined either as urban or rural; and trauma center arrival time. Time from arrival on scene to "patient contact" was not reliably available. If patients were Hispanic or Latino, their race was considered "other." This resulted in a three-level variable for race/ethnicity, consisting of White, African American, and other.

We used the prehospital provider's primary and secondary impression to determine the mechanism of injury, which was defined as being either blunt or penetrating trauma. Blunt trauma included impressions of assault, bike accident, explosive incident, fall, motor vehicle accident, non-motorized vehicle accident, railway incident, and "being struck by an object." Penetrating trauma included impressions of gunshot wound, stabbing, cutting, and "being struck by a sharp object."

To account for urbanicity, we used the Centers for Medicare and Medicaid Services Ambulance Fee Schedule (AFS).[21] The AFS is a nationwide descriptor for urbanicity. Locales are described as "urban," "rural," or "super rural" based on zip code. Each encounter was linked to its respective AFS urbanicity descriptor. No encounters in the study region were associated with a super-rural descriptor.

Statistical Analysis

We used descriptive statistics and mixed effects modeling to characterize the sample. EMS agency, age, gender, race/ethnicity, mechanism of injury, and urbanicity were treated as categorical variables. Categorical variables were compared using Fisher's exact test. We treated scene time and transport time as continuous variables. If scene or transport time was missing, then we excluded the record from the analysis. Scene time outliers were defined as a scene time 1.5 times the interquartile range (IQR) above the upper quartile scene time. Transport time outliers were defined as a transport time 1.5 times the IQR above the agency-specific upper quartile transport time. Outliers were excluded from the analysis.

We performed linear mixed-effects regression modeling for scene time and transport time, controlling for age, mechanism of injury, EMS agency, gender, race/ethnicity, and urbanicity. EMS agency was treated as a group random-effect variable. The encounter year was assessed for association with scene time and transport time and was not significant in either. Encounter year was excluded from the model. We created biologically plausible interaction terms via the product method and tested in the model for significance (Appendix A). Only significant interaction terms were included and reported in the models. Otherwise, we reported the full models without stepwise reduction of terms. We considered statistical differences to be significant if the probability of a type 1 error was <5% ($p<0.05$). The sample size was fixed, so formal power calculations were not performed. However, given the number of observations relative to the number of degrees of freedom of the covariates in the model, the model did not risk being overfit. We used SAS University Edition (SAS Institute Inc., Cary, NC) to conduct statistical analyses.

RESULTS

Overview

A total of 2179 records met the study criteria, of which 2077 were used in the analysis (Figure 1). Of these, 92.4%% (n = 1919) were adult and 7.6% (n = 158) were pediatric. Blunt injury accounted for 80.6% (n = 1675) and penetrating injury 19.4% (n = 402). Males accounted for 68.8% (n = 1428) of the sample. White patients accounted for 62.2% (n = 1228) of the sample. Encounters occurred in rural environments 20.1% of the time (n = 416). Patient characteristics and the prevalence of the three most common mechanisms of injury are shown by age group in Table 1.

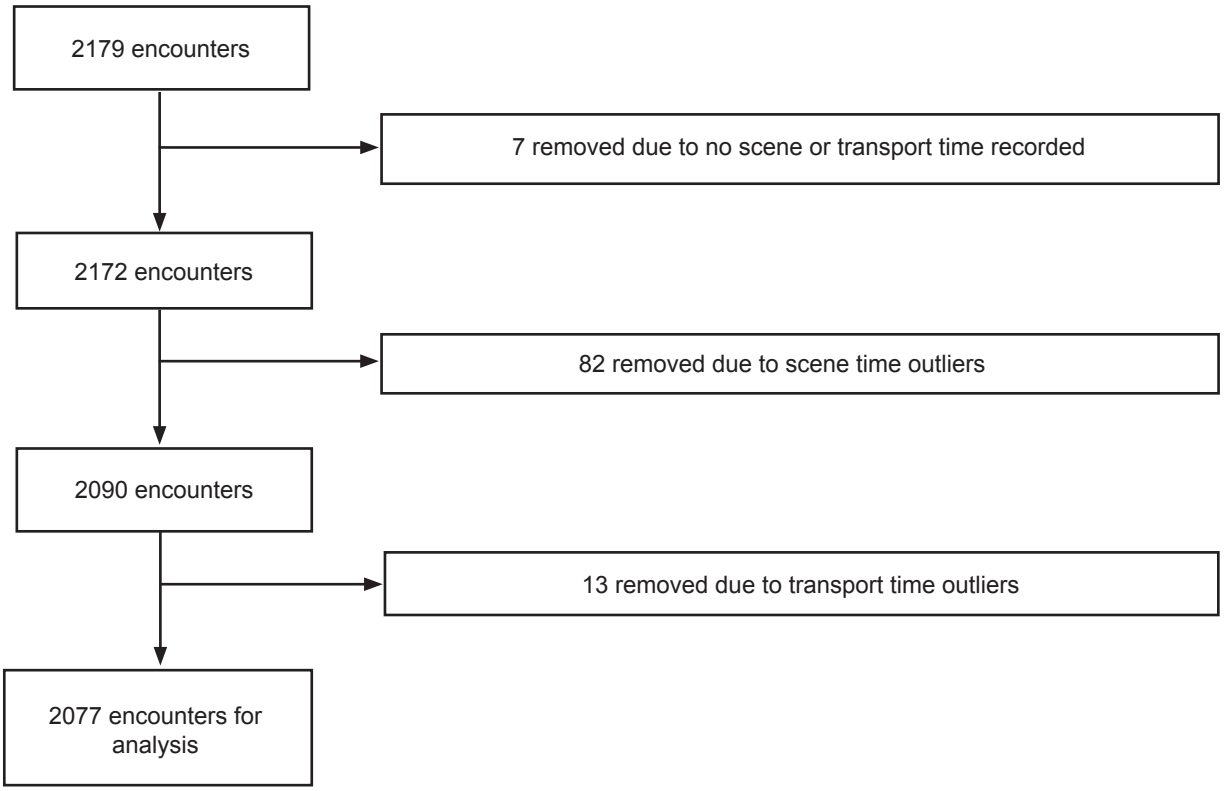

Figure 1. Case selection flow diagram.

Overall mean scene time was 14.2 minutes (95% confidence interval [CI], 13.9-14.5). The 90th percentile overall scene time was 25.0 minutes. Scene time was 10 minutes or less in 35.3% (n = 733) of encounters. Adult blunt trauma scene time (15.6 minutes, 95% CI, 15.3-16.0) was significantly greater than pediatric blunt trauma scene time (12.7 minutes, 95% CI, 11.6-13.7). Penetrating trauma scene time for adult patients (9.5 minutes, 95% CI, 9.0-10.0) was significantly greater than in pediatric patients (5.9 minutes, 95% CI, 4.6-7.2) (Figure 2).

Table 2 shows the linear mixed-effects regression model for scene time, which demonstrated that scene time was shorter for pediatric patients, penetrating injury, males, and victims of blunt trauma in rural settings. Urbanicity and race/ethnicity were not associated with scene time. The only interaction term with a significant effect on the model was the interaction of blunt mechanism with a rural location. A list of tested interaction terms is in Appendix A.

Overall mean transport time was 17.5 minutes (95% CI, 17.0-17.9). Adult blunt trauma transport time (18.4 minutes, 95% CI, 17.9-19.0) was comparable to pediatric blunt trauma transport time (17.9 minutes, 95% CI, 16.0-19.8). Adult penetrating trauma transport time (13.5 minutes, 95% CI, 12.7-14.4) was comparable to pediatric penetrating trauma transport time (12.1 minutes, 95% CI, 7.6-16.7) (Figure 2).

Table 3 shows the linear mixed-effects regression model for transport time, which demonstrated that being male or non-White and living in an urban area were associated with shorter transport times. Age and mechanism of injury were not associated with an effect on transport time. Interactions between race and urbanicity as well as gender and age were associated with a significant effect on transport time. A list of tested interaction terms is in Appendix A.

DISCUSSION

The primary findings of this novel prehospital study are that scene times are shorter for pediatric patients, males, victims of penetrating trauma, and patients with blunt trauma in rural settings, while transport times are shorter for males, non-White patients, and patients in urban areas. Importantly, we found that the 10-minute scene time goal is achieved in only about one-third of encounters. Identifying these variances in care may enable EMS medical directors and prehospital professionals to work toward more expeditious scene and transport times for all patients, perhaps improving outcomes.

There is limited research comparing prehospital trauma scene and transport management practices in children to adults. This is the first study to show that pediatric patients have less scene time than their adult counterparts. Although

Table 1. Descriptive statistics for the study population by age group with 95% confidence interval reported.

Characteristic	Adult (n = 1919)	Pediatric (n = 158)	Total (n = 2077)
Gender			
Male	69.2% (67.1-71.3) n = 1327	63.9% (56.4-71.4) n = 101	68.8% (66.8-70.8) n = 1428
Race			
White	63.4% (61.2-65.6) n = 1213	47.5% (39.7-55.3) n = 75	62.2% (60.1-64.3) n = 1288
African American	26.7% (24.7-28.7) n = 511	30.4% (23.2-37.6) n = 48	27.0% (25.1-28.9) n = 559
Other	9.9% (8.6-11.2) n = 190	22.2% (15.7-28.7) n = 35	10.9% (9.6-12.2) n = 225
Type of Trauma			
Blunt	79.8% (78.0-81.6%) n = 1532	90.5% (85.9-95.1) n = 143	80.6% (78.9-82.3) n = 1675
Urbanicity			
Rural	20.6% (18.8-22.5) n = 394	13.9% (9.0-20.3) n = 22	20.1% (18.4-21.9) n = 416
Mechanism of Injury			
MVC	55.0% (52.8-57.2) n = 1055	64.6% (57.1-72.1) n = 102	55.7% (53.6-57.8) n = 1157
Falls	16.9% (15.2-18.6) n = 325	16.5% (10.7-22.3) n = 26	16.9% (15.3-18.5) n = 351
GSW	13.9% (12.4-15.5) n = 267	7.6% (3.5-11.7) n = 12	13.4% (11.9-14.9) n = 279

MVC, motor vehicle collision; *GSW,* gunshot wound.

our study was not designed to understand why this difference exists, there are several plausible explanations. It is possible that providers are hesitant to perform invasive field interventions in children, leading to reduced scene time. It is also likely that children may be easier to extract from difficult situations due to smaller body habitus. Penetrating trauma patients have less scene time than blunt trauma patients, perhaps owing to the perceived critical status of a gunshot or stab wound. This difference might also be explained by the likely difficulty of safely extricating a blunt trauma patient, particularly from a motor vehicle accident, whereas penetrating trauma victims are more easily loaded into the ambulance, provided that the scene is safe.

Interaction term testing revealed that blunt trauma patients in rural environments have shorter scene times. This is likely because the extended response time for rural ambulances gives rural first responders more time to extricate and prepare patients for EMS transport.[22] Therefore, when EMS arrives on scene, the patient is closer to being ready for transport than they might otherwise be in an urban environment, thereby facilitating a shorter scene time. Regarding transport time, as expected, encounters in urban environments have shorter transport times. Similarly, non-White patients also have shorter transport times, likely due to this population's high urban density. These shorter transport times are reasonable given the close proximity of the trauma centers to the urban population clusters. Finally, it is unclear why scene and transport times are shorter for males than females. Future study will be needed to understand these important gender differences.

To improve mortality, prehospital professionals are expected to minimize trauma scene and transport times per national and the state of North Carolina EMS guidelines.[7,8] Both guidelines state that scene time should be 10 minutes or less.[7,8] Within our study, the mean scene time is 14.2 (95% CI, 13.9-14.5) minutes with a 90th percentile scene time of 25.0 minutes, which is nearly triple the guideline-recommended target. Only 35.3% of encounters achieve the 10-minute scene time goal. A recent analysis of over two million age-unspecified prehospital trauma encounters revealed a mean scene time of 18.1 ± 36.5 minutes for blunt trauma and 16.0 ± 45.3 minutes for penetrating trauma.[14] These studies indicate that we are not meeting our self-identified scene time goals. By identifying factors associated with prolonged scene times, EMS agencies may

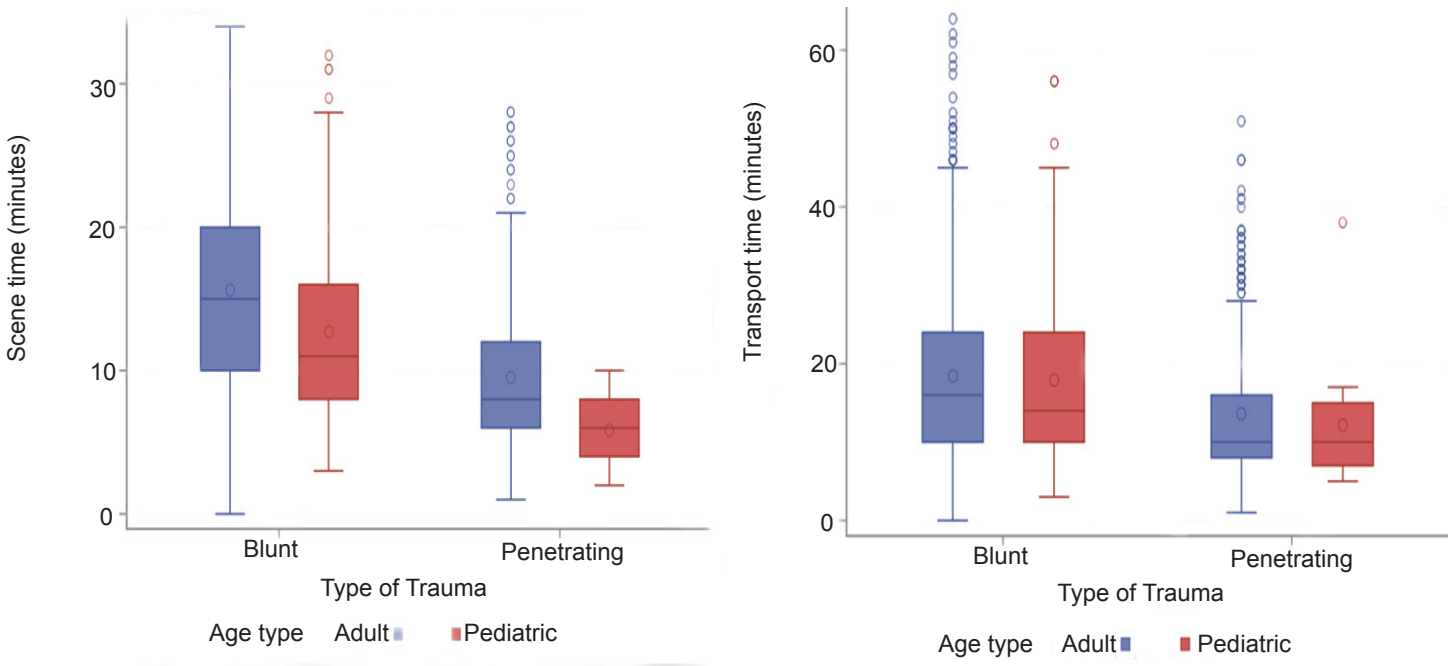

Figure 2. Box plots displaying scene time and transport time by mechanism of injury and age.

be able to implement quality improvement programs to reduce scene times.

A likely driver of prolonged prehospital scene times is prehospital procedures, such as intravenous access, spinal motion restriction procedures, advanced airway management, and other Advanced Life Support (ALS) interventions. Seamon et al found that for each prehospital procedure, trauma patients were 2.6 times more likely to die before hospital discharge.[23] These authors concluded that a "scoop and run" minimal prehospital intervention strategy is superior to a "stay and play" field intervention-heavy strategy.[23] Furthermore, EMS transport itself compared to privately owned vehicle (POV) transport has been associated with increased trauma mortality. In a large Pennsylvania retrospective trauma registry analysis of >90,000 encounters, patients who arrived by EMS had an odds ratio of 1.9 (95% CI, 1.5-2.4) for death compared to patients who arrived by POV.[24] The landmark Ontario Prehospital Advanced Life Support (OPALS) Major Trauma Study concluded that advanced life support ALS was not associated with improved survival compared to Basic Life Support and that patients with a Glasgow Coma Scale score of less than 9 who received ALS interventions had increased mortality.[25] These studies provide further evidence that limited out-of-hospital time is associated with better outcomes in trauma, even if it means that prehospital professionals employ a "scoop and run" strategy and minimize prehospital interventions.

Although prehospital time intervals have previously been emphasized in light of the "golden hour" principle, some research suggests that prehospital time may not significantly contribute to patient outcomes after all.[9,26,27] Newgard et al conducted one of the largest out-of-hospital time studies to date by examining 3656 trauma encounters from across 146 EMS agencies and 51 trauma centers. This study found no correlation between prehospital time and survival in adult patients.[26] Similarly, Lerner et al analyzed nearly 2000 trauma records. They found that age and injury severity were associated with mortality. However, out-of-hospital time was not associated with mortality.[27] While these studies argue against the golden hour concept, it is still possible that a cohort of patients benefits from decreased out-of-hospital time. It is especially important to remember that these studies include primarily adult patients and that pediatric-specific research is needed to clarify the role of the golden hour in pediatric trauma.

Additional studies should examine total scene time as well as scene time after making "patient contact." In select circumstances, such as a scene requiring rescue operations, an EMS provider may be delayed in making actual "patient contact" due to the nature of the accident. Therefore, the current data may unintentionally misrepresent some scene times as prolonged when they are in fact reasonable and unavoidable by the mere nature of the situation.

Future studies should attempt to delineate why particular demographics are associated with shorter scene and transport times. In these future studies, obtaining prehospital procedure and intervention data will prove important, as these are likely significant contributors to increased scene time. With a better understanding of why particular demographics have reduced scene and transport time, quality improvement measures may

Table 2. Linear mixed-effects regression model for scene time.

Variable	Variance components estimate (minutes)	P-value
Fixed effects		
Base point (Intercept)	8.6	
Age type		
Adult	2.7 (1.7 to 3.7)	<.0001
Gender		
Female	0.9 (0.4 to 1.5)	0.0016
Race/Ethnicity		
African American	-0.7 (-1.4 to 0.04)	0.06
Other	0.01 (-0.9 to 0.9)	1.0
White	Reference	
Type of trauma		
Blunt	5.5 (4.7 to 6.3)	<.0001
Urbanicity		
Rural	1.8 (-0.3 to 3.9)	0.09
Blunt *rural	-2.8 (-4.8 to -0.9)	0.005
Random effects		
County		
County A	-1.5 (-3.8 to 0.8)	0.21
County B	-2.4 (-4.7 to -0.2)	0.04
County C	-0.5 (-2.8 to 1.8)	0.7
County D	0.6 (-1.6 to 2.9)	0.6
County E	3.8 (1.4 to 6.1)	0.002

Table 3. Linear mixed-effects regression model for transport time.

Variable	Variance components estimate (minutes)	P-value
Fixed effects		
Base point (Intercept)	22.0	
Age type		
Adult	-0.4 (-1.6 to 0.8)	0.5
Gender		
Female	2.3 (0.4 to 4.3)	0.02
Race/Ethnicity		
African American	-2.8 (-3.5 to -2.1)	<.0001
Other	-2.1 (-3.0 to -1.1)	<.0001
White	Reference	
Type of trauma		
Blunt	0.6 (-0.07 to 1.3)	0.08
Urbanicity		
Rural	5.0 (3.8 to 6.1)	<.0001
Adult female *rural	-2.7 (-4.7 to -0.7)	0.009
African American *rural	6.4 (3.7 to 9.0)	<.0001
Random effects		
County		
County A	-6.0 (-12.5 to 0.6)	0.07
County B	-9.3 (-15.9 to -2.8)	0.005
County C	2.5 (-4.1 to 9.0)	0.5
County D	3.3 (-1.8 to 11.2)	0.2
County E	8.1 (1.6 to 14.7)	0.01

be implemented with the ultimate goal of improving patient outcomes by reducing out-of-hospital time.

LIMITATIONS

Our conclusions are limited by this being a retrospective and regional study, which opens it to bias and limits generalizability. While the time differences in this study are statistically significant, their clinical significance is unclear. As with most prehospital research, the EMS dataset is limited and unable to be linked with outcomes data. Additionally, the dataset did not include prehospital interventions. Due to these limitations, it is impossible to draw conclusions regarding out-of-hospital time and mortality, and we cannot examine the relationship between prehospital interventions and out-of-hospital time. Due to missing data and outliers, approximately 4.7% (n = 102) of the encounters were removed from the analysis, potentially opening the study to unintended selection bias. Of these, 93.1% (95/102) were outliers due to having prolonged scene or transport times. These were removed because the goal of this study was to better understand typical prehospital encounters, not substantive outliers.

It is important for readers to apply this study's conclusions in the context of their own regional trauma care systems. In the coming years, it is likely that robust health data exchange systems between prehospital services and hospitals will be developed. When this occurs, more conclusive outcomes-linked prehospital times studies will be possible.

CONCLUSION

This study population largely missed the 10-minute scene time goal. Scene time was shorter for pediatric patients, males, penetrating trauma, and patients with blunt trauma in rural settings. Transport time was shorter for males, non-White patients, and patients in urban areas. Future studies with outcomes data are needed to identify factors that prolong out-of-hospital time and to assess the impact of out-of-hospital time on patient outcomes. Prehospital agencies and medical directors should use this data to help investigate and improve their own agency's scene and transport times.

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Qualitative Research of Violent Incidents Toward Young Paramedics in the Czech Republic

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Introduction: Prehospital and emergency medical services (EMS) providers are usually the first to respond to an individual's urgent health needs, sometimes in emotionally charged circumstances. Because violence toward EMS providers in the Czech Republic is often overlooked and under-reported, we do not have a complete understanding of the extent of such violence, nor do we have recommendations from EMS professional organizations on how to resolve this problem in prehospital emergency medicine.

Methods: We conducted this study to explore the process of violence against EMS providers, using the Strauss/Corbin systematic approach of grounded theory to create a paradigm model. The participants in this research included personnel who had at least two years experience in the EMS systems of the city of Prague and the Central Bohemian Region, and who had been victims of violence. Our sample included 10 registered paramedics and 10 emergency medical technicians ages 23–33 (mean ± standard deviation: 27.7). The impact of communication during EMS delivery, in the context of violence from patients or their relatives, emerged as the core category and the main focus of our study. The five main groups of the paradigm model of violence against EMS personnel included causal, contextual and intervening conditions, strategies, and consequences.

Results: Of the 20 study participants, 18 reported experiencing an attack during the night shift. Ten participants experienced violence on the street, and 10 inside an ambulance. The perpetrators in all 18 cases were men. The behavior of EMS personnel plays a crucial role in how violent confrontations play out: nonprofessional behavior with drunken or addict patients increases the possibility of violence in 70% of cases.

Conclusion: We found that paramedics and EMTs were exposed to verbal abuse and physical violence. However, in 10 of the violent encounters reported by our 20 participants, the attack was perpetrated by otherwise-ordinary people (ie, individuals with strong family support and good jobs) who found themselves in a very stressful situation. Thanks to grounded theory we learned that for all 20 participants there was a potential opportunity to prevent the conflict. [West J Emerg Med. 2020;21(2)463-468.]

INTRODUCTION

Violence toward prehospital emergency professionals is an often-neglected topic. There is no complete understanding of the incidence of violence in the Czech Republic, nor are there recommendations for specific professional communities regarding the problem of violence and how to resolve it in prehospital emergency care.[1] Prehospital and emergency medical services (EMS) providers are the first to respond

to medical emergencies. A high prevalence of violence has been reported in a few studies, indicating the extent of the problem. It also seems that one factor contributing to inappropriate patient behavior may be the nonprofessional conduct of some prehospital emergency personnel.[2]

The rate of occupational injuries among paramedics and other EMS professionals is eight times higher than the national average for all workers and twice as high as the rate for police officers. It seems that there is no occupational group with a higher injury or fatality rate than paramedics and EMS providers.[3] The basic theories of violence include frustration, social learning, and a general pattern of violence, violence vs nonviolence, inequality, and subcultural and ecological theory. Theories of violence, including the state of "remaining marked for life," "direct correlation between organizational effects and creating a safe environment," EMS managers' self-awareness, and other contributing factors toward moderating violence must also be taken into account.[4] Although some safety measures are designed to reduce violence in emergency departments, few studies have focused on the prehospital emergency setting, with its unpredictable and unstructured environment.[5] Studies that explain the process of violence are yet to be carried out. Quantitative research cannot properly explore the real causes/roots of violence against paramedics and EMS providers; thus, we believe a qualitative approach is needed to understand the phenomenon and provide a basis for the promotion of safety, health and efficiency among EMS personnel.[6]

Population Health Research Capsule

What do we already know about this issue?
Violence toward emergency medical services (EMS) providers is an often-neglected topic.

What was the research question?
How does the behavior of EMS providers influence the occurrence of violent incidents with patients?

What was the major finding of the study?
While paramedics and emergency medical technicians were exposed to violence, we found that 50% of the time the acts were perpetrated by ordinary people under stress.

How does this improve population health?
Implementing training to improve the soft skills and communication styles of EMS staff would lessen violent encounters with patients in high-stress situations.

METHODS

Our main aim was to identify the impact of interpersonal communications in EMS delivery in the context of violence from patients or their relatives.

Study design

We conducted this study to explore the process of violence in EMS using the Strauss/Corbin systematic approach of grounded theory to provide a paradigm model. Such methods are often followed when there is no definitive theory that defines a social phenomenon (such as violence). The participants in this research included EMS providers with at least two years of work experience in the EMS systems of Prague or the Central Bohemian Region, who had been victims of violence. Our sample included 10 registered paramedics and 10 emergency medical technicians (EMT) between the ages of 23-33 (mean ± standard deviation [SD]: 27.7). The educational level of the participants included 11 with high school diplomas (EMTs), nine with bachelor's degrees (paramedics), and two with master's degrees (paramedics). The providers became victims of violence after they were deployed to a scene to provide emergency care to traumatic or non-traumatic patients.

Setting

The face-to-face interviews lasted from 20-50 minutes (mean±SD: 36.5) and were conducted in a location chosen by the participants. We collected data by means of a semi-structured interview, and all sessions were audio-recorded. We transcribed and analyzed the data using content analysis according to the Strauss/Corbin approach and constant comparative method to create a paradigm model of workplace violence (Figure 1). Our questions focused on the manner in which the violence occurred, how the EMS provider responded to the violence, and the consequences. In addition, we used observations and notes from documents and EMS medical records to document the following: circumstances of the event (eg, transporting the patient to the hospital); identification of the perpetrator's role (eg, patient, family member of the patient, etc); whether the victim knew the perpetrator prior to the event; whether the respondent reported the assault to his or her employer; and any other conditions (eg, the perpetrator was intoxicated); and finally how the violence might have been averted.[7]

RESULTS

In this study, the "impact of communication of emergency medical services delivery in the context of violence from patients or their relatives" emerged as the core category and the main focus. The five main groups of the paradigm model

of violence against EMS staff included causal, contextual, and intervening conditions, strategies, and consequences (Figure 1).[7]

Causal conditions

The main category of causal conditions was "triggers of violence," which included two groups: "event shock" and "delayed response time." Event shock refers to the prevalence of severe, unexpected events such as illness or trauma that may cause anxiety and agitation, resulting in unpredictable and uncontrollable behavior, such as violence: *"The father of the victim could no longer control himself and keep calm. His son had collapsed and he wanted to transport him quickly to the hospital. He verbally attacked the paramedics and couldn't keep calm" (Participant 7)*

The second potential trigger of violence was delayed response time (RT). One of the major causes of violence in EMS conditions is the delay in RT, which can be due to a delay in requesting help, an imagined delay, unrealistic expectations, or actual delays in the arrival of EMS. Further delays can be due to staff negligence or a lack of resources, including the availability of an ambulance: *"People want us to be there immediately after the accident. That's impossible. We arrived on the scene 10 minutes after the accident and the patient's relative was waiting for us in front of their home. He was very angry, threatened us with his fists and was very rude, because we were late." (Participant 5).*

Contextual Conditions

This category, entitled "context-makers of violence," includes four subgroups: unfamiliarity with EMS duties; insufficiencies of the EMS organization; challenges of inter-organizational cooperation; and disadvantaged socioeconomic and cultural conditions.

1. **Lack of familiarity.** The public's unfamiliarity with EMS duties and inadequate knowledge of how the EMS system functions is illustrated by how the following request to transfer a non-emergency patient to the hospital resulted in violence: *"An 85-year-old man called an ambulance for his hypertension. I checked his blood pressure and it was OK (130/75). The patient showed us his homemade monitor for blood pressure control. The monitor showed normal parameters (120/80, 130/80, 125/70 – this was the last measurement). I tried to explain to him that his blood pressure is normal and everything is OK. He called for his wife and wanted his stick. Then he started banging his stick on the table and shouting: 'You are only taxi drivers and I need to go to the hospital. Scoop me up and transfer me to the hospital!'"* (Participant 4)
2. **Insufficiencies of the EMS system**. One of the contextual factors of violence in the EMS resides in the insufficiencies of the EMS system itself, its regulations, and how providers are trained to manage

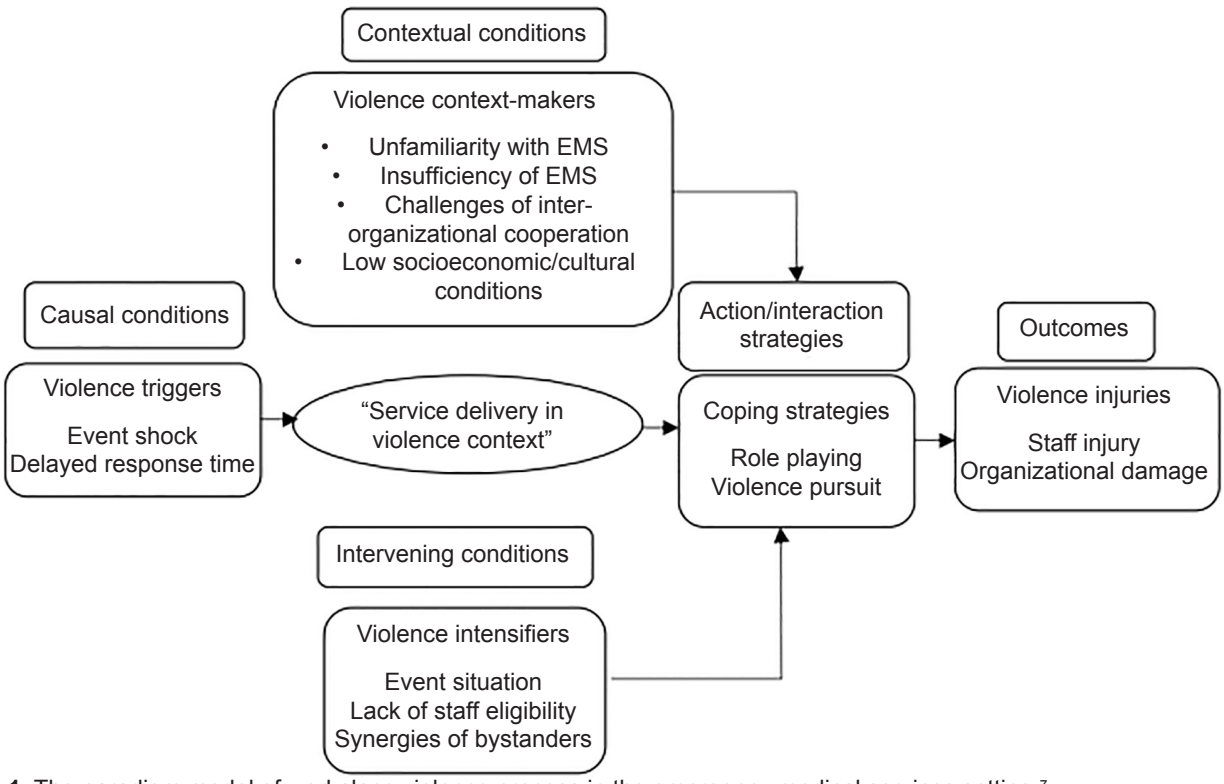

Figure 1. The paradigm model of workplace violence process in the emergency medical services setting.[7]
We encoded in each interview causal and contextual conditions, action/interaction strategies, and outcomes of every incident.
EMS, emergency medical services.

situations. Communication between ambulance personnel and the relevant receiving centers can cause violence (overload of staff in the ambulance). *"We cannot take care of people and their things. We were looking after a 36-year-old man who got drunk and fell. He was verbally abusive, but at last he agreed to be transported to the hospital. In the courtyard of the hospital he started to stand up [inside the ambulance] and wanted to take off his seatbelt. I asked him to stay calm. He took a knife out of his jacket and cut the seatbelt and went toward me. At this moment my colleague (EMT) stopped the ambulance; I opened the door of the ambulance and locked the man inside. Then we called the police."* (Participant 1)

3. **Challenge of inter-organizational cooperation**, and the performance of individuals from other organizations. The police are effective in ensuring the safety of EMS; however, in some scenarios we need the police to cooperate to calm the patient down*: "We wanted the help of the police, yes. But these policemen started to humiliate our patient and one of them wanted to hit him. We only wanted the police's help for our safety during the transport to the hospital. The presence of police sometimes contributes to more violence from patients."* (Participant 2)
4. **Poor socioeconomic and cultural conditions**. The incidence of violence is more prevalent in social environments with disadvantaged cultural, educational and socioeconomic status, and greater social malaise. Lack of interest on the part of the governmental health system in prevention of violence directed at EMS providers is another contributing factor. *"Most staff say – this is only part of the job, but I disagree. One 20-year-old man wanted to follow our ambulance in his car. I suspected he was drunk. I told him that if he followed us in his car I would call the police. Then he went over to me and hit me in the face."* (Participant 17)

Intervening conditions

Intervening conditions are a series of factors that impact violence strategies – time and place of the event, incompetence of EMS personnel, and involvement of bystanders.

1. **Time and place of the event**: Our goal was to determine when the prevalence of violence is the highest. Of the 20 respondents, 18 experienced the attack during the night shift (2–6 AM); 10 experienced violence in the street, and 10 inside the ambulance.
2. **Incompetence of EMS personnel**: In some cases, due to conditions on the ground and the anxiety of clients, we see inappropriate behavior by EMS providers. This is a significant contributing factor in the occurrence of violence perpetrated against them. Thanks On the basis of grounded theory we found that all 20 participants had some chance to prevent their conflicts.
3. **Involvement of bystanders**: Some studies have pointed to high-risk groups in the context of violence against EMS personnel, such as people with a history of drug abuse, users of alcohol and psychedelic agents, and aggressive and irresponsible individuals with criminal records who are involved in the escalation of violence.[8,9] On the other hand, we found that in 10 cases among our 20 participants the attack was instigated by ordinary people (ie, those with stable families and good jobs) who were under extreme stress.

Action/Interaction Strategies

In this study, we identified "coping strategies" as the main category with two groups: "role playing" and following up on violence."

1. **Role playing**: EMS staff focused on providing optimal services by ignoring violence against them, exhibiting self-control, and managing violence through various strategies including explaining, convincing, relaxing, using confidence and self-defense techniques, such as leaving the scene, keeping away, and building trust, accepting the client's demands, taking refuge, and seeking the cooperation of the perpetrator. Another strategy involves cooperation with the police, who play an important role at the scene to prevent violence or reduce injury: *"We heard the insults ('We're gonna kill you!'), but did not reply. We saw one man who tried to stand up and three people around him. We were still in the ambulance and the driver started to back up and then we went away and turned the corner. Then we called the police and cooperated with them"* (Participant 16)
2. **Following up on violence**: These strategies include reporting violence and protecting victims of violence. Especially in the case of EMS personnel who suffered physical injury, when they report violence to their supervisor they expect support, which depends on the sensitivity of the supervisor and the policy of their EMS organization. In some cases, violence is not reported for various reasons. The strategy of EMS management is to advise staff not to confront violence, and in the event of violence, to support the staff in their decision. Judicial support for victims of violence is another strategy used when following up on violence.

Outcomes

Exposure to physical violence and verbal abuse puts EMS staff and organizations at risk of significant consequences.[10]

***Staff injuries**:*

Injuries to EMS personnel result in a variety of physical and psychological after-effects:

"I am very careful now. One year after the incident (an unconscious man kicked me in the face when I tried to check him – I was knocked out for 10 minutes and out of duty for three months!); now when I am in contact with addicts during the night shift I remember it" (Participant 20)

"I wanted to call the police about a violent man and after I spoke he hit me in the face. He lives nearby our base. Whenever we go around there I remember this incident" (Participant 9)

DISCUSSION

In terms of "event shock" and "delayed response time," paramedics often witness unpredictable and uncontrollable behavior such as violence. Delayed response time is one of the major causes of stress for EMS personnel, which can occur due to a client's delay in requesting help, an imagined delay, unrealistic expectations, and actual delays in the arrival of EMS. Most studies on violence in healthcare have reported a close link between violence and stress. Once stress is intense and exceeds standard levels, it becomes a negative factor. A patient (but also a paramedic) who is unable to deal with stress can experience negative physical and mental responses (reduced self-control, unprofessional communication).[10]

Unfamiliarity with the role of EMS is another cause of conflicts, which can lead to disagreement with treatment interventions and refusal to accept services, and to the clients' perception that EMS providers failed to meet their expectations; these were reported as the contextual factors of violence in some studies.[12] On the other hand, we were witness to inappropriate communication from paramedics who seemed to devalue patients and their relatives.[13] It would be useful to increase public awareness regarding the structure, capabilities and nature of prehospital emergency tasks, perhaps via the educational system and the media as a means of reducing the incidence of violence against EMS providers.

The insufficiency of the EMS organization itself is another contextual factor contributing to violence. Communication between ambulance staff and the relevant receiving centers can result in violence. In this section and in various studies, educational levels, competence, and the ability to assist clients, as well as a shortage of specialized staff, lack of experience and professional training, and low self-esteem were reported as underlying causes of violence.[14] EMS managers must provide adequate and appropriate equipment/staff, create and maintain job satisfaction, and provide training on violence control as strategies to reduce workplace violence. In addition, measures must be taken to reduce violence and injury to health, while ensuring job satisfaction and providing equipment for the staff, teaching them self-defense, and cooperating with the police to protect EMS personnel as they provide service.[15] The management of the EMS systems of Prague and the Central Bohemian Region (Czech Republic) provide for the use of personal protective gear, self-defense by means of evasion and pepper spray, training in how to keep a distance and how to transfer an aggressive client, use of restrictive agents, EMS managers also should emphasize the need for police involvement in cases of violence in order to establish security.

Other factors triggering violence ranged from the challenges of inter-organizational cooperation and disadvantaged socioeconomic and cultural conditions, including insulting, humiliating or irresponsive behavior, or even aggressiveness toward EMS personnel, to errors made by EMS providers themselves or negligence in duties, and fatigue caused by too many missions. In both sections, we found that EMS teams must cooperate with the police. Sometimes there are positive and negative aspects of this cooperation. One potential solution would be the creation of joint training and conferences (police + EMS).

Involvement of bystanders and high-risk groups, which include people with a history of drug abuse or who use alcohol and psychedelic agents, as well as people with a history of criminal and aggressive behavior, are central to the upsurge in violence against EMS personnel. The role that high-risk groups play in fomenting violence has been emphasized in similar studies. From our point of view, we believe it is necessary to create a database of scenarios and high-risk groups in cooperation with the police.[16]

Violence decreases job satisfaction, causes burnout, high staff turnover, and feelings of inadequate support, reduces the organization's power, and ultimately impacts the performance and reputation of the EMS organization. Several related studies[17, 18, 19] highlight the serious personal, organizational and professional consequences, as well as inadequate job safety, as some of the costs of violence.[20, 21] Other related studies have mentioned minor and serious physical injury (eye and face injuries, bites, kicks, dislocations and fractures, bruises, and scratches) and psychological consequences such as stress irritability and headache, anxiety, depersonalization, depression, sleep disorders, irritability, fear of safety, and disturbing memories. Psychological injuries cause social consequences, including impact on social interactions, isolation, and personality changes in the workplace.[22]

LIMITATIONS

Our study has several limitations. First, it was carried out at two institutions in the Czech Republic; thus, the results cannot be taken to be representative of all EMS systems within the Czech Republic as a whole or in other nations. Nevertheless, we have provided detailed information about the qualitative results of violence toward young paramedics and EMS personnel under specific conditions. A further limitation is that we focused only on young paramedics and EMTs, all of whom were men.

CONCLUSION

Our study demonstrated that paramedics and EMTs were exposed to verbal abuse and physical violence. Of the 20 participants we interviewed, 18 reported being attacked during the night shift. Ten participants experienced violence in the street, and 10 inside the ambulance. In the 18 situations where EMS personnel encountered violence, all the perpetrators were men. We also found that the behavior of paramedics and EMTs plays a crucial role in escalating conflict. Specifically, nonprofessional behavior when confronted with drunk or drug-addicted patients increases the possibility of violence by 70%. On the other hand, we found that in 10 cases among our 20 participants the attack was caused by ordinary people under intense stress. Using the grounded theory approach we found that all 20 participants had some chance of preventing future conflicts from occurring.

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This Article Corrects: "Effectiveness of a Pediatric Emergency Medicine Curriculum in a Public Tanzanian Referral Hospital"

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Effectiveness of a Pediatric Emergency Medicine Curriculum in a Public Tanzanian Referral Hospital
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Abstract

Introduction: The World Health Organization recently recognized the importance of emergency and trauma care in reducing morbidity and mortality. Training programs are essential to improving emergency care in low-resource settings; however, a paucity of comprehensive curricula focusing specifically on pediatric emergency medicine (PEM) currently exists. The African Federation for Emergency Medicine (AFEM) developed a PEM curriculum that was pilot-tested in a non-randomized, controlled study to evaluate its effectiveness in nurses working in a public Tanzanian referral hospital.

Methods: Fifteen nurses were recruited to participate in a two-and-a-half-day curriculum of lectures, skill sessions, and simulation scenarios covering nine topics; they were matched with controls. Both groups completed pre- and post-training assessments of their knowledge (multiple-choice test), self-efficacy (Likert surveys), and behavior. Changes in behavior were assessed using a binary checklist of critical actions during observations of live pediatric resuscitations.

Results: Participant-rated pre-training self-efficacy and knowledge test scores were similar in both control and intervention groups. However, post-training, self-efficacy ratings in the intervention group increased by a median of 11.5 points (interquartile range [IQR]: 6-16) while unchanged in the control group. Knowledge test scores also increased by a median of three points (IQR: 0-4) in the nurses who received the training while the control group's results did not differ in the two periods. A total of 1192 pediatric resuscitation cases were observed post-training, with the intervention group demonstrating higher rates of performance of three of 27 critical actions.

Conclusion: This pilot study of the AFEM PEM curriculum for nurses has shown it to be an effective tool in knowledge acquisition and improved self-efficacy of pediatric emergencies. Further evaluation will be needed to assess whether it is currently effective in changing nurse behavior and patient outcomes or whether curricular modifications are needed.

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