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# *Western Journal of Emergency Medicine:*

## Integrating Emergency Care with Population Health

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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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# Barriers to Accessing Acute Care for Newly Arrived Refugees

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**Introduction:** Over the past decade, the number of refugees arriving in the United States (U.S.) has increased dramatically. Refugees arrive with unmet health needs and may face barriers when seeking care. However, little is known about how refugees perceive and access care when acutely ill. The goal of this study was to understand barriers to access of acute care by newly arrived refugees, and identify potential improvements from refugees and resettlement agencies.

**Methods:** This was an in-depth, qualitative interview study of refugees and employees from refugee resettlement and post-resettlement agencies in a city in the Northeast U.S. Interviews were audiotaped, transcribed, and coded independently by two investigators. Interviews were conducted until thematic saturation was reached. We analyzed transcripts using a modified grounded theory approach.

**Results:** Interviews were completed with 16 refugees and 12 employees from refugee resettlement/post-resettlement agencies. Participants reported several barriers to accessing acute care including challenges understanding the U.S. healthcare system, difficulty scheduling timely outpatient acute care visits, significant language barriers in all acute care settings, and confusion over the intricacies of health insurance. The novelty and complexity of the U.S. healthcare system drives refugees to resettlement agencies for assistance. Resettlement agency employees express concern with directing refugees to appropriate levels of care and report challenges obtaining timely access to sick visits. While receiving emergency department (ED) care, refugees experience communication barriers due to limitations in consistent interpretation services.

**Conclusion:** Refugees face multiple barriers when accessing acute care. Interventions in the ED, outpatient settings, and in resettlement agencies, have the potential to reduce barriers to care. Examples could include interpretation services that allow for clinic phone scheduling and easier access to interpreter services within the ED. Additionally, extending the Refugee Medical Assistance program may limit gaps in insurance coverage and avoid insurance-related barriers to seeking care. [West J Emerg Med. 2019;20(6)842-850.]

## INTRODUCTION

Over three million refugees have been resettled in the United States since Congress passed the Refugee Act of 1980.[1] In 2015, there were nearly 70,000 new refugee arrivals, representing 69 different countries.[1] Refugees undergo pre-departure health screening prior to arrival in the U.S., and are typically seen by a physician for an evaluation shortly after arrival.[2] Refugees are resettled in areas with designated resettlement agencies that assist them with time-limited cash assistance, enrollment in temporary health coverage, and employment options. Refugees are initially granted six to eight months of dedicated Refugee Medical Assistance, which is roughly equivalent to services provided by a state's Medicaid program.[3] Following this period, refugees are subject to the standard eligibility requirements of Medicaid.[3]

It is important to highlight the differences between a refugee, an asylum seeker and a migrant, as this study focuses specifically on refugees. A refugee is an individual who has been forced to leave his or her home country due to fear of persecution based on race, religion, nationality, membership in a social group, or policital opinion. Refugees undergo robust background checks and screening prior to receiving designated refugee status. They are relocated only after undergoing this screening process, and have legal protection under the Refugee Act of 1980 given their status as a refugee. An asylum seeker, on the other hand, is an individual who has fled his or her home country for similar reasons but has not received legal recognition prior to arrival in the U.S. and may only be granted legal recognition if the asylum claim is reviewed and granted. As a result, asylum seekers do not have access to services such as Refugee Medical Assistance, time-limited cash assistance, or similar employment opportunities. Migrant is a general term and refers to an individual who has left his or her home country for a variety of reasons.[4,5]

Prior studies have shown differences in utilization of the emergency department (ED) by refugees in comparison to native-born individuals.[6] In Australia, refugees from non-English speaking countries are more likely to use ambulance services, have longer lengths of stay in the ED, and are less likely to be admitted to the hospital.[6] A study conducted in the U.S. evaluated refugees one year post-resettlement and demonstrated that language, communication, and acculturation barriers continue to negatively affect their ability to obtain care. These data suggest that there may be unidentified opportunities for improving the acute care process for refugee populations; however, little is known about how refugees interface with acute care facilities. Therefore, the goal of this study was to use in-depth qualitative interviews to understand barriers to access of acute care by newly arrived refugees, and identify potential improvements from refugees and community resettlement agencies.

*Population Health Research Capsule*

What do we already know about this issue?
*There is limited data describing refugee use of and barriers to acute care services in the U.S.; however, studies outside the U.S. suggest that barriers exist.*

What was the research question?
*What barriers do newly arrived refugees face when accessing acute care in the U.S.?*

What was the major finding of the study?
*Refugees face multiple barriers when accessing acute care, but interventions in and outside the emergency department may reduce barriers to care.*

How does this improve population health?
*Understanding the barriers that refugees face and working with resettlement agencies to reduce barriers may improve their health status and health outcomes.*

## METHODS

### Study Design

Because the healthcare experience of refugees has not been well described and they cannot be reliably identified in administrative datasets,[7] we chose to conduct an in-depth interview study to identify the potential barriers and facilitators to accessing acute care as a newly arrived refugee. We included the following in the definition of acute care: sick visits, urgent appointments with the patient's primary care doctor, urgent follow-up with specialists and dentists, urgent care visits, and ED visits. Because our goal was to understand the range of experiences rather than the number of times an experience is identified, we chose in-depth interviews to obtain a detailed understanding of the perspective of each respondent. Interviews were conducted until thematic saturation was reached, when the data no longer identified new perspectives or themes.[8] We used purposive sampling to balance across gender to ensure that the fullest range of perspectives was included.[9]

### Study Setting and Population

We conducted the study at a refugee clinic and at resettlement and post-resettlement agencies. The refugee clinic was located at a tertiary care hospital in a city in the Northeast U.S. The clinic has been in operation for approximately five years and has cared for approximately 200 refugee patients yearly. At the time of the study, the clinic received referrals from one of the three resettlement agencies in the city. Refugee patients were seen within 30 days of arrival. Most refugees were seen for screening evaluations and transitioned to clinics near their homes after two

to three clinic visits. Refugee patients were eligible for this study if they were over 18 years of age, had capacity to consent, and had no hearing difficulties. We excluded refugees if they were deaf, unable to answer questions from an interpreter, or had acute medical or psychiatric illnesses.

In the city in which the study was performed, there are three main resettlement agencies and approximately three well-known post-resettlement agencies. Resettlement agencies are responsible for receiving new refugee arrivals and assisting individuals with support for three to six months after arrival. Resettlement employees assist refugees with establishing housing, employment, transportation, primary care, and language services. After three to six months, refugees are able to seek additional assistance at post-resettlement agencies. Post-resettlement agencies provide additional support in terms of support groups, language services, cultural activities, and case management. Employees were eligible for this study if they worked at a resettlement or post-resettlement agency, were over 18 years of age, and had no hearing difficulties.

**Study Protocol**

This was an in-depth interview study using semi-structured, open-ended interviews. Separate interview guides for refugees and resettlement agency employers were developed by all members of the study team. Study team members included the following: an emergency physician and investigator with expertise in qualitative methodology (MSK); an internal medicine physician with many years of experience working at the refugee clinic (AB); a third-year emergency medicine (EM) resident with three years of experience working bimonthly at the refugee clinic (AJZ); a second-year EM resident with no experience at the refugee clinic (UGK), an MD/PhD student with three years of experience working at the refugee clinic and content expert on refugee studies (MM); and an undergraduate student with two years of experience working at the refugee clinic (EJ). The study team composition allowed for a range of expertise with individuals who had experience working with refugees and those who did not. Questions were vetted among the all members of the study team and revised to ensure that content reflected the goals of the study. Prior to interviewing resettlement and post-resettlement employees, a resettlement/post-resettlement employee interview guide was developed using the same process. (See Appendix A for interview guides.)

Refugee interviews were conducted in person at a refugee clinic, and refugees were recruited during the study period when an interviewer was present during clinic hours. Refugees were asked to participate if a room and interpreter were available. If the aforementioned conditions were met, all refugees awaiting clinic appointments or available after their appointment were asked to participate. All of the refugees who were asked agreed to consent and participated. Interviews with refugees were conducted by two members of the study team (AJZ and EJ) using the Refugee Interview Guide (Appendix A) and lasted approximately 30 minutes. A phone interpreter was used for verbal consent prior to participation and for the interview. Demographic information was collected about each participant (see Appendix A). After interviews were completed for refugee patients, a second phase of semi-structured, open-ended, interviews were conducted in person at local resettlement and post-resettlement agencies in the region.

We obtained a list of employees involved in case management, health coordination, and program development for refugees/immigrants from resettlement healthcare teams. These employees were contacted via email with information regarding the study and consent form. Of 13 employees contacted, 12 participated. Employee interviews were conducted at their respective agencies, and verbal consent was obtained prior to participation. Interviews with resettlement employees were conducted by two members of the study team (AJZ and MM) using the Resettlement/Post-resettlement Employee Interview Guide (Appendix A) and lasted approximately 20 minutes. This study was approved by the institutional review board at the University of Pennsylvania.

**Data Analysis**

Each interview was recorded, professionally transcribed, and coded by three investigators (AJZ, EJ and UGK coded refugee interviews, and AJZ, UGK and MM coded resettlement interviews). The study team met regularly to design and refine a coding scheme for the refugee interviews. A separate coding scheme was developed for interviews with resettlement/post-resettlement agencies and similarly was refined regularly. All coding differences were resolved by consensus. (See Appendix A for codebook.) Interviews were conducted until consensus on thematic saturation was reached. The study team defined thematic saturation as the point when information obtained in interviews no longer revealed new information regarding barriers faced by refugees when accessing acute care.

## RESULTS

**Demographics**

A total of 16 interviews were completed (12 men, 4 women) with refugees. Participants had a mean age of 34 (range 20-48) and 50% had completed high school. Countries of origin were Syria (5), Bhutan (2), Democratic Republic of the Congo (2), Burma (2), Sudan (2), Iraq (1), Iran (1) and the Central African Republic (1). Most refugees seen at this refugee clinic undergo medical screening within one to two months of arrival. A few of the patients remained at the clinic for long-term follow-up. All refugees required an interpreter and all interpretation was done with phone interpreters. A total of 12 interviews were completed for resettlement and post-resettlement agencies. Resettlement employees interviewed represented two resettlement agencies and two post-resettlement agencies.

We identified several barriers to access of acute care facilities by newly arrived refugees (Table 1). The process by which refugees seek care and barriers at each step can be visualized in Figure 1.

**Table 1.** Themes & Illustrative Quotes.

| Theme | Illustrative quotes |
|---|---|
| Pre-acute care expectations | **[Resettlement Employee]** "At the beginning they will be confused between can we call 911 in these situation because they are used to in their countries to go – to show up doctor office any time and without an appointment and the doctor will see them."<br>**[Refugee]** "I think the only place to go is the hospital when I get sick or one of my family get sick. Because I don't know doctors. I don't know private clinics."<br>**[Refugee]** "But it's very difficult to get medication, because in [my home country] it's a very different way to get medication. You can just go to the pharmacy and you can get any medication. But here, it must be a prescription."<br>**[Resettlement Employee]** "I receive many questions about the prescription, how can we fill it. How can we go to the pharmacist and ask them to. This is a challenging thing." |
| Reliance on resettlement agencies | **[Refugee]** "If I became sick, I'll still go back to them [resettlement employee] and ask them for help, because they are the only ones that I know. So I'll still go and ask them how I can go about it and how I can manage to see a doctor."<br>**[Resettlement Employee]** "If I get a call and someone says, I can't breathe – and it could be their tonsils are swollen and it's hard for them to breathe, but because I'm not a medical professional, and when I get that call, I have to kinda – I talk it through, but the safest thing for me is to say, yes, go [to the ED]." |
| Barriers to acute outpatient care | **[Resettlement Employee]** "For non-native English speakers, that is an increased barrier because they don't know how to get through the automated phone system."<br>**[Resettlement Employee]** "I think specifically for follow-up visits, I feel like it's a little on the slower side. I feel like some of our clients, it takes over a week sometimes, just because the clinics are so busy."<br>**[Resettlement Employee]** "We've had several issues when – seeing the dentist, they need deep cleaning. It's not covered by insurance. It's like $200.00. So they can't afford that."<br>**[Resettlement Employee]** "There's just such a shortage of mental health care providers that are either covered by insurance or who are able to accommodate for non-English speaking patients." |
| Barriers in the ED | **[Refugee]** "I felt that my sugar level was down, so I went to the dentist […] they examined my sugar level, they referred me to the hospital. They did some bloodwork for me. But they did not tell me about the results. I would like to know about the results at least."<br>**[Resettlement Employee]** "I have a 60-year-old client; I think she's having panic attacks, going to the ER. I took her one time […] when they said they're going to discharge at midnight but didn't provide transportation. A 60-year-old, no language, where she's gonna go? So she was told to sit in a lobby until in the morning to go home. Next time, I asked them, I said, what's the plan of discharge? Is she gonna have transportation or an ambulance taking her back? I wanna know if she's gonna get a taxi."<br>**[Resettlement Employee]** "The idea of navigating the sort of westernized healthcare System […] people think oh, I just have to go the emergency room and they'll sit there for hours.They're gonna give me a pill. I'm gonna get this huge bill. And it's just gonna mask the pain." |
| Health insurance barriers | **[Resettlement Employee]** "I don't blame them because in their countries, they don't have the health insurance. Sometimes you don't need it because it's free health system."<br>**[Resettlement Employee]** "I had an incident where a woman was having a miscarriage and experiencing heavy bleeding. And she was calling me and another coworker at 10:00 at night. She had been at work and didn't know what to do because she was experiencing this heavy bleeding, but didn't want to leave work early because she was afraid about losing her job and she didn't think that her Medicaid would pay for the ambulance ride. But that's an example of people just having misconceptions about how their health insurance works and how the system works." |

*ED*, emergency department.

**Pre-Acute Care Expectations**

Prior to seeking care, refugees are influenced by their past experience with health systems, which vary considerably depending upon the country/countries where they lived previously. The ED is often a new healthcare setting for refugees that differs significantly from those in their country of birth or origin. Additionally, many refugees report that they are unaware of hospitals or clinics close to their house but do know how to call 911.

*"They [refugees] are not aware where they should go [when sick]. One of the clients had a high fever. So they ran to the emergency department. They're not used to the United States healthcare system because in their culture they just go to the hospital, which might not be just for emergencies." (Resettlement Employee)*

*"I do not know [where to go if I'm sick] because I'm new here in the United States. I only know one thing. If my condition worsens a lot, then I can just dial 911." (Refugee)*

**Reliance on Resettlement Agencies**

The uncertainty and unfamiliarity of the new healthcare system drives many refugees to the resettlement agency. Refugees reported relying on resettlement agencies for their needs and healthcare information. Refugees reported seeking advice from resettlement agencies prior to seeking care, often treating the resettlement agency as a triage center. Resettlement agency employees often have non-medical backgrounds and reported concern when providing medical advice to refugees, often referring to the ED depending upon the perceived severity of illness.

*"We refer refugees to the ER all the time. We do not have licensed medical staff who are able to diagnose and treat patients in the office. So if they come in with anything life threatening or if they come in with something that they feel is an emergent issue, chest pain or something along those lines, we refer to the emergency department." (Resettlement Employee)*

**Barriers to Acute Outpatient Care**

For those refugees who attempt to schedule outpatient care when sick, they experience significant difficulty with scheduling sick visits due to availability of same-day or next-day visits and language barriers with automated telephone services. As a result, they often rely on resettlement agencies for scheduling sick visits. Resettlement agency employees reported frequently scheduling appointments for patients because of language barriers. However, both resettlement agency employees and refugees reported that obtaining timely appointments for sick visits was challenging.

*"I called to get an appointment for my son. He was not feeling good. He has asthma. And they told me they didn't have an appointment until June [many months away]. I had to take him at 3:00 in the morning to the hospital." (Refugee)*

Aside from difficulties with scheduling, other common challenges included finding primary care clinics that accept Refugee Medical Assistance, offer interpreter services, and are geographically convenient. Resettlement agency employees also reported significant difficulty in finding specialists, mental health providers, and dentists who care for refugees, as they often do not accept Refugee Medical Assistance and may have less-robust interpretation services available. Notably, resettlement agency employees commented more on these challenges than refugees. Resettlement agency employees reported scheduling appointments for refugees regularly due to language barriers.

*"But mostly, for example, in the northeast part of the city or somewhere else with private or small clinics they are not familiar with the interpretation services or they rely on family members, even kids, to help them to interpret which is really – I always advise my clients not to depend on that. And even the parents, sometimes they don't feel comfortable sharing their medical concerns with their kids [as interpreters]." (Resettlement Employee)*

**Barriers in the ED**

When refugees do seek care in the ED, they report challenges obtaining interpretation throughout the entire ED process and limited explanation of the process including timeline and results.

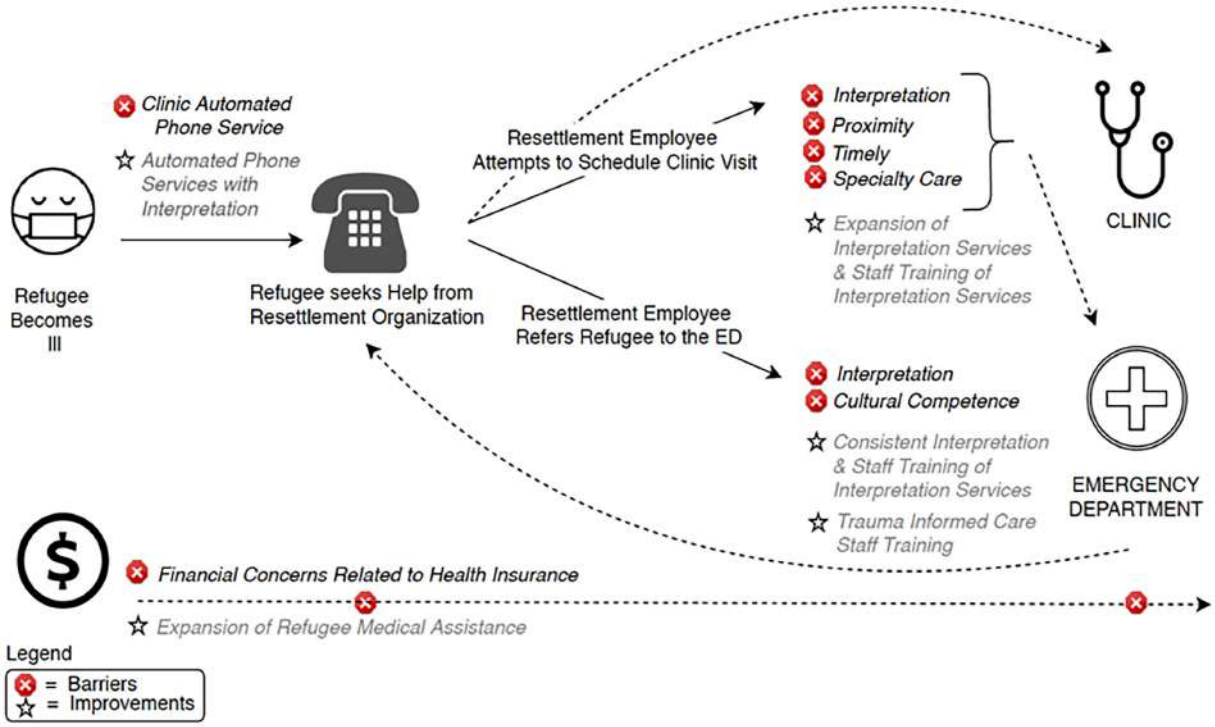


**Figure 1.** Process of seeking acute care for newly arrived refugees: barriers and potential solutions.

*"I went with one woman [to the ER] who spoke French because she wanted someone to accompany her. And the ER was expecting me to be the interpreter. I was like you know, you guys need to call an interpreter. I'm not trained to do this." (Resettlement Employee)*

Resettlement employees reported the desire for more culturally competent care in the ED, specifically citing trauma-informed care. Resettlement employees felt that refugees may present with somatic complaints resulting from their history of torture, trauma, and the stress of resettlement. These symptoms can be difficult to triage, diagnose, and treat both for resettlement employees and for medical teams alike.

*"I see a lot of people saying they have a heart problem. And when you ask them – were you diagnosed with a heart problem before? They say no but I feel my heart is beating out of control. I'm not a healthcare provider, but it seems like a panic attack or anxiety." (Resettlement Employee)*

**Complexity of Health Insurance**

Finally, refugees and resettlement employees reported confusion regarding the concept and complexity of health insurance, a barrier that is present at each point of access in the healthcare system. Most countries where refugees were born or lived prior to arrival do not have health insurance or have systems that differ significantly from the insurance structure in the U.S. Resettlement employees observed that refugees have many misperceptions of the insurance system and were often overwhelmed about paying for medical care and insurance.

*"I get tons of bills from emergency departments because the clients either didn't know to give them the [insurance] card or they thought they were uninsured – assumed they were uninsured." (Resettlement Employee)*

When refugees were asked if they knew what health insurance was, the responses were varied:

*"Life insurance?"*
*"Something for free? Provides meds and treatment that the state provides to the people."*
*"A paper from the hospital?"*
*"Eight months of coverage, could be extended, but will eventually expire."*
*"Covers fees for getting sick, gives access to a doctor. Necessary to make preventative appointments."*
*"Something that lasts for eight months, then I have to pay out of pocket which will be very, very expensive."*

**Recommendations from Resettlement Employees**

A majority of resettlement employees suggested interventions to reduce barriers and improve how refugees interface with the healthcare system. Outside of the ED, recommendations largely focused on improving access and resources for dedicated outpatient care and providers for refugees. For ED providers, resettlement employees stressed the importance of using trained interpreters and educating providers on how to provide culturally competent care. They also recommended educating refugees on appropriate ED utilization (Table 2).

## DISCUSSION

Our principal findings identify barriers throughout the process of accessing acute care for newly arrived refugees. Overall, refugees face uncertainty when accessing acute care services because of prior experiences in their home countries and limited understanding of the complex U.S. healthcare system. The unfamiliarity with the U.S. healthcare system drives refugees to rely heavily on resettlement employees as an initial point of triage or, if they are very sick, to call 911. At the resettlement agency, employees express concern about identifying the appropriate level of care to which to send a refugee client. They report challenges obtaining timely access to sick visits with primary care doctors and urgent visits with specialists and dentists.

Additional barriers that make obtaining unscheduled care challenging include identifying clinics that offer comprehensive interpretation services, accept Refugee Medical Assistance, and are geographically convenient. Scheduling appointments over the phone, specifically automated services, is particularly challenging for refugees with limited English proficiency. On arrival to the ED, the same language barriers create challenges to understanding care received. In addition, the lack of trauma-informed care can hinder the appropriate workup and treatment of symptoms. Finally, after obtaining care in any acute care setting, refugees face significant financial risk due to limited understanding of the health insurance system.

It is important to highlight that some of the aforementioned barriers to acute outpatient care reported exist among U.S.-born individuals, including geographical and insurance barriers, and difficulty accessing mental and dental services. However, these challenges are exacerbated for refugees due to language and cultural barriers. The U.S. healthcare system is new and often quite different from health systems refugees have used in the past, adding an extra layer of complexity to understand. The lack of interpretation services limits already limited resources such as appointments with specialists, dentists, and mental health providers. Additionally, refugees have unique mental healthcare needs given their history of trauma that adds an additional challenge when identifying appropriate mental health services.

There is limited existing data on the utilization of acute care services by refugees in the U. S. In Australia a study evaluating the use of emergency services by refugees suggested that some refugees know how to call for emergency help, yet have significant fear of calling for help because of security implications faced previously in their home countries.[10] In our study, refugees identified knowing how to call 911 if they were ill but did not express fear as a barrier to using this service. It is possible that

**Table 2.** Recommendations from Resettlement Employees.

| Location | Recommendation |
|---|---|
| Outpatient | At dedicated refugee clinics, increase availability and timeliness of appointments, dedicate specific times weekly for refugee appointments, ensure consistency of medical providers and provide one central number patients and resettlement employees can call when medical questions arise.<br>Develop a paid community health worker certification program to provide care navigation to refugees including accompaniment to the pharmacy, medical appointments, and for assistance with health insurance questions. Include and train social workers in this process if available.<br>Provide basic medical training for refugee resettlement employees so they can better assist with triaging patients. |
| ED | Provide cultural competency training to providers to improve comfort with taking care of populations with different cultural backgrounds and implementing dedicated training on use of both in person and phone interpreters.<br>Educate patients on the process of going to the pharmacy and filling prescriptions as pharmacies do not have interpreters.<br>Develop a protocol for refugees regarding when to go the ED and educate refugees on how to use the protocol. |

*ED*, emergency department.

the study population perceived less fear because the resettlement employees recommended the use of 911.

A qualitative study in the U.S. evaluating healthcare barriers of refugees one year post resettlement also identified individual and structural barriers to accessing health services. Barriers included challenges with language, acculturation processes, and cultural beliefs.[11] Similarly, our study found that language and acculturation were significant barriers when accessing health services. Our study differed in that we were specifically focusing on barriers to acute care access and that we identified additional barriers related to health insurance and perceived poor access to prompt outpatient clinic options. Additionally, our results identified the important role of resettlement agencies in addressing these barriers. Notably, our study occurred early in the resettlement process, a time when resettlement agencies are typically more involved, as opposed to one year after resettlement.

Respondents identified several areas for improvement to reduce barriers to accessing  care for newly arrived refugees (Figure 1). Areas for improvement within the acute care system include establishing partnerships with resettlement/post-resettlement agencies to assist with triage of refugees with acute conditions, and developing specific protocols that may help resettlement employees direct patients to appropriate levels of care. Finally, respondents recommended incorporating cultural competency and trauma-informed care training for providers. Trauma-informed care is based on the premise that past exposure to trauma can have long-lasting effects on the physical and mental health of patients. Thus, providers and organizations can respond by adopting trauma-informed models of care.

A trauma-informed organization acknowledges that trauma is pervasive, recognizes the signs and symptoms of trauma, and integrates knowledge about trauma into policies, procedures and practices with the goal of avoiding retraumatization.[12] While it is challenging to accurately estimate the number of refugees who have experienced trauma prior to resettlement, estimates suggest that the prevalence rate may be as high as 35%.[13,14] This does not account for trauma associated with the resettlement process. ED-specific approaches of trauma-informed care have been suggested for violently injured patients who have been injured due to violence and are treated in the ED; and some components may be applicable to refugee populations.[15] While more research is needed to establish trauma-informed models of care for refugees in the ED, providers should acknowledge a patient's history of trauma, ongoing signs and symptoms, and avoid practices that may result in retraumatization.

A major theme in our interviews was the importance of interpretation services. Refugees and resettlement employees describe challenges at all points of acute care access due to language barriers and a lack of appropriate interpretation services. Revisions to the Affordable Care Act in 2016 mandated that healthcare facilities must offer qualified interpreters to limited English proficient (LEP) patients[16] and the 2010 Joint Commission standards also require qualified interpreter services in hospital settings.[17] However, patients with LEP have worse clinical outcomes and receive a lower quality of care.[18] In the ED formal interpretation should be offered to all patients who do not identify English as their primary language, and operation teams should ensure interpretation services are embedded throughout a refugee's ED course, and that all members of the ED team are routinely trained on how to use in-person and phone interpreters. Similarly, clinic teams can ensure that interpretation services are available during clinic visits, but also when refugees call to schedule appointments or ask questions.

Another common barrier reported by resettlement employees and refugees is that refugees struggle to understand health insurance, which is also supported in prior studies.[19] More education for refugees was suggested as a potential intervention

to address this concern, and may be useful. However, additional policy changes may be required to avoid insurance-related barriers to accessing care. For example, refugees who live in states without Medicaid expansion have a much smaller chance of enrolling in health insurance once Refugee Medical Assistance ceases.[20] Additionally, it has been reported that in states where Medicaid requires reapplication annually, refugees often have a gap in insurance coverage.[19]

A study evaluating health coverage for immigrants suggests that expanding universal coverage may actually reduce net costs for LEP patients by increasing access to primary prevention and reducing emergency care for preventable conditions.[21] For refugees, the cessation of Refugee Medical Assistance after eight months occurs at a difficult time of transition. At six to eight months, cash assistance from the government typically ends as does support from the resettlement agency based on the expectation that refugees are self-sufficient after six to eight months of support.[2,3] A study evaluating unmet needs of refugees demonstrated that refugees in the U.S. for a longer period of time are more likely to report a lack of health insurance coverage and a delay in seeing a healthcare provider.[22] Policymakers should consider extending Refugee Medical Assistance beyond the first eight months as an additional strategy to improve access to health insurance and ensure stable access to care.

Finally, additional research is needed to understand networks of care for refugees. In order to understand ED utilization by refugees and barriers to acute care, future studies should focus on prospectively following refugees after arrival to identify patterns of use and integration long term. This would then help guide types of interventions at locations where refugees most frequently seek acute care. Systematic identification of refugees in national datasets would assist with understanding variations in patterns of utilization between different regions and identifying areas of particular importance.

## LIMITATIONS

We obtained the data from this study from one city. This limits the generalizability as results may be specific to the refugee experience in this location and healthcare system. However, our sample engaged refugees from a variety of countries, representing the current distribution of refugees resettled to locations throughout the country. This study did not specifically evaluate differences in access to acute care barriers for refugees based on country of origin, gender, educational, cultural, or economic background; however, all of these factors may influence experiences and are important to consider in future studies. Interviews with refugees occurred at a refugee clinic affiliated with a local resettlement agency and did not include refugees without acces to care and services. Similarly, resettlement agency employees were recruited by the study team, largely consisting of physicians.

Interviews with refugees were conducted mostly within three months of their arrival, thus only targeting newly arrived refugees. Barriers to access may differ at different stages of the resettlement process. However, this early period is likely to be the most vulnerable time with significant language, acculturation, and financial challenges. In addition, refugees typically see a physician within 30 days of arrival in the U.S. Many resettlement agencies work with specific clinics to meet this goal, making this the optimal time to capture a diverse population receiving care at one location.

Some members of the study team had significant experience working at the refugee clinic and may have been influenced by potential biases from previous work with refugees, specifically when identifying themes. To counter these potential biases, members of the study team included individuals who did not work at the refugee clinic. Transcripts were double coded by both a clinic and non-clinic investigator and reviewed by a non-clinic investigator.

Additionally, the use of interpreters may have altered responses from refugee patients. In some languages, a direct translation for specific words or meanings may not exist and as a result may be translated in a meaning that is different than what was intended. Finally, as with all qualitative studies, results generate hypotheses from the experience of the participants rather than testing or measuring a hypothesis.

## CONCLUSION

Our data demonstrate that there are multiple barriers refugees face when accessing acute care. Participants described barriers to timely outpatient care and significant challenges accessing ED care and understanding the complexities of health insurance. These results offer patient and stakeholder data to support implementation and evaluation of novel interventions focused on expansion of insurance coverage, enhanced access to quality interpretation, and targeted research efforts that will improve care provided to refugees.

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# Time Cost of Standardized Nursing Screens in the Emergency Department

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**Introduction:** Various policies require that screening questions be asked of all patients who present to the emergency department (ED). No studies have previously examined the potential time costs of standardized screens. Our objective was to analyze the time nursing spent conducting standardized nursing screens and calculate the corresponding time cost.

**Methods:** This was a prospective observational study of ED registered nurses (RN) performing triage assessments on adults presenting to the ED. A study author timed nurses while the RN asked five pre-selected questions from their current triage protocol. The time cost of each question was determined by multiplying the length of time spent asking the question each year by the mean hourly wage of RNs at the study hospital. (T/3,600) x V x S; T = mean time per question (in seconds); V = annual patient volume; S = mean hourly RN wage.

**Results:** We observed 200 triage assessments. During the triage assessments, 130 patients (65%) were asked about pneumococcal vaccine status; 161 (80.5%) about tetanus vaccine status; 184 (92%) about medication allergies; 172 (86%) about influenza vaccine; and 73 (36.5%) about recent travel. The mean time spent per question ranged from 4.37-6.26 seconds. The estimated annual time used to ask the five questions in the study ED is 590.73 hours, which equates to $20,675.50 in nursing costs per year.

**Conclusion:** There are potential monetary and time costs of standardized screening questions in the ED. The values heavily impact time and cost efficiency in the ED and could be redirected to more pertinent patient care. The required screening questions often have an unclear utility on the care that the patient receives in the ED. Further studies are needed to determine cost effectiveness of required ED screenings. [West J Emerg Med. 2019;20(6)851–854.]

## INTRODUCTION

The Joint Commission, other medical governing agencies, and various hospital policies mandate that certain screening questions be asked of all patients who come through the emergency department (ED) for evaluation. Before a patient has even seen a physician, they have likely been asked dozens of screening questions as part of the triage or nursing assessment. Screening questions are often implemented with good intentions and some questions serve as public health screening where the ED acts as a safety net.[1-3]

The downstream consequences of adding on numerous questions to the ED stay are often not considered. There is the potential for a significant amount of nursing time to be used administering assessments. Additionally, the purpose of triage is to identify and prioritize patients who require immediate treatment over those who do not. The required screening questions often have an unclear benefit on determining triage acuity and on the care that the patient

receives in the ED. In many instances the addition of screening questions is based on rudimentary studies that do not examine clinical outcomes or costs.[4]

Screening questions can add time to the triage process and ED wait time, and take nurses away from performing more direct patient care. While any individual question may not take long to ask, when you multiply it by the tens of thousands of patients who pass through the ED and the expanding number of screening questions, it quickly adds up to a significant amount of time. Our objective was to analyze the time nursing spent conducting standardized nursing screens and calculate the corresponding time cost.

## METHODS

This was a prospective observational study of ED RNs performing triage assessments on adults presenting to the ED for medical care in a single academic hospital in the United States. Institutional review board (IRB) approval for this study was obtained from the Augusta University IRB Office. Augusta University Medical Center (AUMC) is an academic, urban hospital with an ED with 83,860 visits during fiscal year (FY) 2018. The mean RN salary at AUMC during FY18 was $35 per hour ($35/hr); this represents the mean for all RNs in the hospital, including ED nurses.

The triage process was observed for all adult patients (age ≥ 18 years) presenting to the ED for treatment. To be included, patients had to go through triage (ie, not directly brought back to room by emergency medical services or to a critical room). Patients were excluded if they were discussing sensitive information (human immunodeficiency virus status, psychiatric complaint) or if they were unable to answer triage and nurse screening questions. Patients and triage nurses were provided an information sheet explaining that the study authors were conducting an observation study of nursing procedures. Verbal consent was obtained from nurses and patients. Patients and nurses were given the opportunity to opt out of being observed. All data collected was anonymous and no personal information was collected.

After reviewing the triage and in-room nurse screening questions asked at AUMC, we selected five questions to be timed.

1. Have you received a pneumococcal vaccine?
2. Have you had a tetanus shot within the last five years?
3. What are your allergies?
4. Have you received a flu shot this year?
5. Any recent travel?

These five questions were selected because they did not impact the patients' acuity level and all five questions were included in the triage questionnaire. Additional triage questions, such as medical history and history of present illness, were not included in the study because of their potential to impact acuity level.

From July 2018 – January 2019, a total of 200 triage assessments were observed. The study authors would select times throughout the day to observe the triage process and collect data. During the triage assessment, the study authors observed triage nurses as they asked the five pre-selected questions. The nurses were not pre-selected and data was collected on whichever nurse was assigned to work in triage. Not all questions were asked of every triaged patient. The questions asked were at the nurses' discretion and the data collectors did not interfere with the triage process.

Time was calculated using a stop clock timer. The timer was started as soon as the nurse began asking the question and stopped when the patient completely answered the question and the topic was changed. We calculated the time cost for each question by multiplying the time spent addressing the question each year by the mean hourly wage of AUMC ED RNs. (T/3,600) x V x S, where T = mean time per question (in seconds), V = annual patient volume at AUMC, S = mean hourly RN wage. We used Google Sheets (Google LLC, Mountain View, CA) for all calculations and statistical analysis.

## RESULTS

In total, we observed 200 triage assessments during the study period. During the triage assessments, 130 patients (65%) were asked about pneumococcal vaccine status, 161 (80.5%) about tetanus vaccine status, 184 (92%) about medication allergies, 172 about influenza vaccine (86%), and 73 (36.5%) about recent travel. The mean time spent per question ranged from 4.37-6.26 seconds (Table 1). The estimated annual time used to ask the five questions in the AUMC ED was 590.73 hrs. At a salary of $35/hr, this equates to $20,675.50 in nursing costs per year.

## DISCUSSION

This is a cursory look at the potential monetary and time costs of standardized screening questions in the ED. The

**Table 1.** Time to obtain answers to give preselected nursing triage questions and monetary cost to the emergency department.

| | Mean Time/ Question(s) ± SD | Hours/Year[1] | Annual Nursing Cost (Dollars)[2] |
|---|---|---|---|
| Pneumococcal[a] | 4.37±1.39 | 101.68 | 3,558.97 |
| Tetanus[b] | 4.61±1.42 | 107.33 | 3,756.68 |
| Allergies[c] | 6.26±2.83 | 145.76 | 5,101.53 |
| Influenza[d] | 4.57±1.42 | 106.47 | 3,726.44 |
| Travel[e] | 5.56±2.71 | 129.48 | 4,531.88 |
| Total | 25.36 | 590.73 | 20,675.50 |

[1]Based on 83,860 ED patient visits in FY18; [2]Based on mean AUMC RN salary of $35/hr; [a]Pneumococcal vaccination status, n=130; [b]Tetanus vaccination status, n=161; [c]Medication allergies, n=184; [d]Influenza vaccination status, n=172; [e]Recent travel in last 4 weeks, n=73.

calculated values directly affect time and cost efficiency in the ED process and could potentially be redirected to more direct patient care. For just the five observed triage questions alone, we estimated the nursing time cost to our institution to be $20,675.50. This time cost would be significantly increased if we examined additional triage and nurse screening questions. Furthermore, this is just the time spent in a single ED. If all 136.9 million adult ED visits in the U.S. included the five studied questions the screening would take 964,354 hours to complete.[5] This equates to $33.8 million in nursing costs annually.

The required screening questions are often unrelated to the patient's chief complaint and have a debatable impact on the medical management in the ED. Questions that may impact care, such as medication allergies, are typically asked by multiple medical providers during the ED visit, and redundancy leads to additional wasted time and cost. It is unclear whether the standardized questions are suitable for triage where the goal is to identify and prioritize patients who require immediate treatment over those who do not. Previous work has shown that triage assessments can have poor inter-rater and intra-rater agreement.[6] Additional research could evaluate whether the additional screening questions distract the triage nurse from his or her primary goal of assessing acuity and contribute to inconsistency in triage assessments.

If nurses were liberated from the mandated questions, they could potentially have more time for one-on-one patient care and other aspects of patient care, such as medication administration and lab draws. Although we suspect that reducing the number of required questions would free nurses to spend more time on direct patient care and improve efficiency of ED throughput, additional research will be required to study this hypothesis.

Studies evaluating ED screening questions often praise their ability to detect at-risk groups without looking at patient-oriented outcomes or cost. Cost-benefit analyses should be considered prior to mandating additional nurse screening questions as even a few seconds spent on a question adds up to a significant amount of time. A better research agenda is needed to assess the impact of triage questions on patient care.[7] There is significant potential for future research related to this topic. Further studies are needed to determine cost effectiveness of required ED screenings, including questions included as public health screens. Other potential timesaving measures, such as self-completed triage questionnaires on kiosks, could be researched as well.

## LIMITATIONS

Because this was a prospective observational study, we were unable to definitively state what the time saving would be if the five questions were eliminated. Future projects could implement a treatment group or trial period to evaluate the actual time saving and cost reduction that would occur with questions in the standardized nursing screens. Further, as this was a preliminary observational study, we had a limited sample size of only 200 assessments. Future research would benefit from a larger sample size to obtain more accurate time measurements. Additionally, we did not document the exact number of patients excluded.

Given the non-blinded nature of the study, the Hawthorne effect could have influenced our findings. It is possible that the nurses involved in the study may have subconsciously altered their triage process while being observed. Since they knew they were being observed, they may have been trying to be more efficient and get through their questions faster or conversely they could have been more thorough in their assessment and took longer than when they are not observed. Finally, this was just a limited look at the time spent asking five pre-selected triage questions. Future work needs to be done to analyze the time spent asking additional screening questions, such as fall risk, suicidality, domestic abuse/ "safe at home," and alcohol abuse risk.

## CONCLUSION

Significant ED nursing time is spent asking triage and nurse screening questions. The evidence is unclear as to whether screening questions improve the care that patients receive in the ED. Our data suggest that there is a significant time cost for asking standardized questions, and further cost-benefit analysis must be conducted to determine the usefulness of including these standardized questions as a part of the ED visit.

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# Another Perspective on Cannabis and Emergency Medicine in Colorado

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This editorial is written in response to Roberts BA. Legalized Cannabis in Colorado Emergency Departments: A Cautionary Review of Negative Health and Safety Effects. *West J Emerg Med*. 2019;20(4):557-72. (https://escholarship.org/uc/item/6xb8q31x)

Dr. Roberts has delivered an excellent review of many medical aspects of cannabis use and the effect of cannabis legalization on emergency medicine in Colorado.[1] As emergency physician researchers in Colorado, we echo many of his concerns. As he notes, since legalization, we have identified an increase in accidental pediatric exposures (some of which resulted in severe effects)[2-4], an increase in emergency department visits for hyperemesis (most likely related to cannabinoid hyperemesis),[5] an increased number of visits attributable to cannabis edibles,[6] a disproportionate increase in adult[7] and adolescent[8] mental health visits related to cannabis, and an increased number of visits for cannabis toxicity (greater in tourists than locals).[9] These effects are measurable, and while the direct attribution of these changes to cannabis legalization are limited to observational data that is subject to temporal trends, selection bias, and confounding, we believe the links between these changes and cannabis legalization are plausible, consistent and relevant.

While much of the focus in Colorado has been on recreational cannabis, it is important to note that many of the issues identified began before recreational cannabis was available in 2014. In Colorado, medical cannabis was legalized in 2000 and has been widely available since 2009. In Colorado, the qualifying medical conditions for cannabis use include the following: cancer, glaucoma HIV, severe pain, seizures, nausea, muscle spasm, post-traumatic stress disorder (PTSD), autism spectrum disorder, and cachexia.[10] As of June 2019, almost 84,000 patients have an active medical marijuana registration, 337 (0.4%) less than 18 years of age.[11] As with any therapy, the adverse effects we have identified must be balanced against the potential benefits to patients and society. However, there are few high-quality evidenced based studies to support these recommendations. Without clinical trials the measurement of the positive effects of cannabis remain largely anecdotal. There are additional concerns for reported cannabinoid content and claims on treatment for disease. The United States Food and Drug Administration (FDA) has issued numerous warning letters to various cannabidiol manufacturers for false claims in relation to disease diagnosis and treatment.[13] The medical utility of cannabis is further limited by insufficient training provided to medical professionals and trainees, in addition to the reliance of many users on non-medical providers to guide therapeutic choices. For example, many dispensaries will recommend cannabis to pregnant women despite various national guidelines cautioning against this practice.[12] The medical benefits of cannabis should have been evaluated using accepted clinical standards prior to providing legal status as medical treatments.

Recreational use has no demonstrated inherent health benefit. While some have suggested that it may increase relaxation and reduce stress, there are no clinical studies to support those claims. One plausible health benefit is the substitution of cannabis for other more dangerous recreational drugs; however, this is also not studied. Unfortunately, in Colorado we see that cannabis is also often combined with alcohol and other drugs and the relative increase in adverse effects may outweigh this potential benefit. Despite the observed increase in cannabis related driving fatalities in Colorado, 55% of cannabis users believed it was safe to drive under the influence of cannabis.[14] There have been mixed results on how

marijuana legalization has affected medical and nonmedical opioid use and prescribing.[15-16]

The discussion around the impact of cannabis on the healthcare system is (as with many issues) not absolute. When we speak to cannabis supporters we often hear the justification that it is safer than alternatives, and there are no real adverse effects. We believe our work has clearly demonstrated that cannabis legalization has measurably impacted the delivery of emergency care in Colorado. However, it is important to put the magnitude of this impact in perspective. Since 2006, more than 2000 Coloradans have died from opioid overdose, and tobacco use-associated healthcare costs in Colorado are almost 2 billion dollars per year. While it is disingenuous to say that cannabis legalization has not impacted emergency medicine in Colorado, it is important to recognize that there are many greater threats to public health and to provide appropriate focus to each of these conditions. A legitimate discussion around the health effects of cannabis in Colorado requires a fair assessment of the risks and benefits by advocates and critics alike.

Continued surveillance on both the positive and negative effects on marijuana legalization, and evidence-based research is needed as more states continue to pass medical and recreational marijuana. The long-term effects of increased availability of high-THC-cannabis are still to be determined. It is critical for public health officials, healthcare providers and legislators, in conjunction with advocates and industry representatives, to work toward regulations aimed at minimizing the public health impact of cannabis legalization on society.

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# Musculoskeletal Injuries and Outcomes Pre- and Post-Emergency Medicine Training Program

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**Introduction:** Musculoskeletal injuries (MSI) comprise a large portion of the trauma burden in low- and middle-income countries (LMIC). Rwanda recently launched its first emergency medicine training program (EMTP) at the University Teaching Hospital-Kigali (UTH-K), which may help to treat such injuries; yet no current epidemiological data is available on MSI in Rwanda.

**Methods:** We conducted this pre-post study during two data collection periods at the UTH-K from November 2012 to July 2016. Data collection for MSI is limited and thus is specific to fractures. We included all patients with open, closed, or mixed fractures, hereafter referred to as MSI. Gathered information included demographics and outcomes including death, traumatic complications, and length of hospital stay, before and after the implementation of the EMTP.

**Results:** We collected data from 3609 patients. Of those records, 691 patients were treated for fractures, and 674 of them had sufficient EMTP data measured for inclusion in the analysis of results (279 from pre-EMTP and 375 from post-EMTP). Patient demographics demonstrate that a majority of MSI cases are male (71.6% male vs 28.4% female) and young (64.3% below 35 years of age). Among mechanisms of injury, major causes included road traffic accidents (48.1%), falls (34.2%), and assault (6.0%). There was also an observed association between EMTP and trends of the three primary outcomes: a reduction of death in the emergency department (ED) from those with MSI by 89.9%, from 2.51% to 0.25% ($p = 0.0077$); a reduction in traumatic complications for MSI patients by 71.7%, from 3.58% to 1.01% ($p = 0.0211$); and a reduction in duration of stay in the ED among those with MSI by 52.7% or 2.81 days on average, from 5.33 to 2.52 days ($p = 0.0437$).

**Conclusion:** This study reveals the current epidemiology of MSI morbidity and mortality for a major Rwandan teaching hospital and the potential impacts of EM training implementation among those with MSI. Residency training programs such as EMTP appear capable of reducing mortality, complications, and ED length of stay among those with MSI caused by fractures. Such findings underscore the efficacy and importance of investments in educating the next generation of health professionals to combat prevalent MSI within their communities. [West J Emerg Med. 2019;20(6)857-864.]

## INTRODUCTION

Musculoskeletal injuries (MSI) are a major cause of morbidity and mortality across the world that disproportionately affect those in low- and middle-income countries (LMIC), which often lack trained healthcare providers who can properly treat such conditions.[1,2] Approximately 90% of the five million annual deaths across the world due to injuries occur in LMICs such as Rwanda.[3,4] The literature lacks an updated fund of knowledge regarding the prevalence, etiology, and treatment for MSIs in Rwanda to supplement previous studies. The growing number of Rwandan healthcare providers may incorporate this knowledge into educational programs when approaching MSI.[1,2,3]

Injuries in Rwanda are associated with significant morbidity and mortality.[5,6] Past studies in Rwanda have shown that most trauma victims are young men.[5,6] Road traffic accidents (RTA), especially those involving motorcycles, were the most common mechanism for adults, while children were frequently injured as pedestrians.[3] Approximately one-quarter of injured patients suffered a fracture.[3] The overall mortality prevalence was 5.5% with approximately half of the hospital deaths occurring in the emergency department (ED).[7] Yet, these mortality figures do not paint a comprehensive picture of the burdens posed by MSIs and fractures in particular.

MSIs resulting from trauma are frequently undertreated, causing difficulty for patients to resume normal work and life activities.[8] This is related both to cost and a shortage of technology and supplies.[9] In addition to a dearth of supplies, achieving health outcome targets without securing the appropriate human resources is difficult.[10,11] One team in Namibia found that three out of the eight Millennium Development Goals concerning healthcare required appropriate human resources for success.[10] A recent interrupted time-series study found that building Rwanda's emergency medicine training program (EMTP) resulted in an absolute reduction of overall facilities-based mortality by 4% overall, which was twice as great a decline as the national trend.[12] Such investments are vital to improving health in this region. While Africa contains approximately one-quarter of the world's burden of diseases, it possesses 4% of its health staff.[11,13]

A recent systematic review found that of 59 LMIC emergency care programs, very few incorporated specialist emergency care training. [14] The largest share of facilities was staffed either by physicians-in-training or by physicians whose level of training was unspecified. Data showed high patient loads and mortality, specifically in Africa where a substantial proportion of total deaths occurred in EDs. Compared to other LMIC regions, ED mortality is highest in Africa, with a median mortality rate of 3.4% compared to the average of 1.8% across all studied LMICs.[14,15] A minority of LMIC EDs incorporate specialty-trained emergency physicians into the staffing paradigm, but availability is limited.[14] The high volume and urgency of treatment make emergency care an important area of focus for interventions aimed at reducing mortality in these settings.

Within a short period of time, Rwanda has made significant improvements to its healthcare system. Rwanda's transformation of its health sector since the 1990s has helped to raise life expectancy from 27 years to 63 years of age, and nearly all Rwandans have health insurance.[16,17] Although there have been significant improvements, Rwanda has just 0.84 health providers per 1000 population, the majority of whom are generalists. This number falls below the minimum 2.3 providers per 1000 population set forth by the World Health Organization.[13]. In 2011, the Rwandan Ministry of Health began a seven-year partnership with a U.S. academic consortium to train Rwandan providers to become future educators through medical residencies, creating the Human Resources for Health (HRH) Program.

Among the new medical residencies is the first EMTP in Rwanda.[16] These trainees have introduced new emergency skills, such as triage and resuscitation, along with improvements to local protocols and systems.[12] The training curriculum was in line with the American Board of Emergency Medicine (East Lansing, Michigan) 2013 Model of the Clinical Practice of Emergency Medicine.[17] International faculty practicing EM were hired to implement EM training through the HRH program, a collaboration between academic medical centers in the U.S. and the Rwandan Ministry of Health (MOH).[12] Within the EMTP curriculum, specific longitudinal educational trainings on the diagnosis and treatments of MSI and fractures were provided through lectures and workshops.

*Population Health Research Capsule*

What do we already know about this issue?
*Past studies in Rwanda have detailed the epidemiology of musculoskeletal injuries (MSI), such as the demographics and etiology of these cases.*

What was the research question?
*What is the effect of an emergency medicine training program (EMTP) on mortality, complications, and emergency department (ED) length of stay among those with MSI?*

What was the major finding of the study?
*The EMTP in Rwanda reduced mortality, complications, and ED length of stay among those with MSI caused by fractures.*

How does this improve population health?
*Determining MSI epidemiology and effects of an EMTP on a major health burden in Rwanda demonstrates one approach to improve health outcomes on a population level.*

Research studies regarding the epidemiology of injuries and the impact of emergency training on patient outcomes have been conducted, although specific epidemiology regarding fractures and the impact of training on patient outcomes is lacking.[14,16] The purpose of our research was twofold: 1) to understand the epidemiology of MSI fractures in Rwanda; and 2) to evaluate the progress of the country's first EM residency program in treating MSI-related injuries by assessing ED mortality rates, length of stay, and complication rates.

## METHODS

### Study design and setting

This was a pre-post study examining the characteristics and outcomes of MSIs before and after implementation of an EMTP at the University Teaching Hospital of Kigali (UTH-K) in Kigali, Rwanda. UTH-K is an urban referral and tertiary-care teaching hospital with approximately 560 inpatient beds and 40 ED beds. UTH-K contains a 24-hour Accident and Emergency Department (A&E) that serves adult patients with acute complaints, as well as pediatric and obstetric trauma patients. Resources at UTH-K include 24-hour surgical coverage, 24-hour access to radiologic services including radiograph, ultrasound, and computed tomography, as well as continuous access to general surgery, orthopedic and neurological specialists.[7,18]

The A&E department is covered by general practice physicians (GP) and EM residents. An EM post-graduate diploma program was initiated on November 1, 2013, and most physicians enrolled subsequently participated in the official EM residency, which began in September 2015. Both programs are herein formally referred to as the EMTP. Prior to initiation of these training programs, care was provided exclusively by GPs. Since initiation of EMTP, ED care has been provided jointly by GPs and EM resident-trainees who have oversight by board-certified emergency physicians.

All patients who presented at UTH-K during the two data collection periods, from November 2012- October 2013 and August 2015-July 2016, were eligible for inclusion. These pre- and post-time periods for data collection were chosen to correspond with the absence of an EMTP and implementation of an EMTP, respectively. We identified cases and queried data from institutional records via protocolled methods, as previously described in prior studies.[7,18,19,20] Briefly, using a multipoint composite index generated from an electronic hospital database, we identified all cases during each month of the accruement periods. Subsequently, all cases were coded with a unique identification number and were sampled at random until a sufficient number of records meeting inclusion criteria were identified (range: 135–165 records per month). We then narrowed the dataset to those with MSI, either with open, closed, or mixed fractures. Next, we applied the following exclusion criteria: incomplete or erroneous evaluation documentation dates from the ED, comprising patients without admission dates, or patients with admission dates that preceded discharge dates.

Measured variables included age, sex, mechanism of injury, injury type, hospital vital signs, hospital admissions, surgical interventions, medical treatments, discharge date, and disposition. If more than one anatomical region was indicated as injured, each region was recorded.[8] We did not collect post-discharge outcomes, such as subsequent emergency visits, hospitalizations, or post-discharge death,.

### Ethical consideration

The research study was approved by the College of Medicine and Health Sciences University of Rwanda Institutional Review Board (IRB) No 310/CMHS IRB/ 2017 and Rhode Island Hospital (Lifespan) IRB (4144114; 45 CFR 46.110.5).

### Data management

Data were initially collected from medical records and then abstracted and entered into REDCap, a standardized, secured, web-based data collection instrument.[21] The database inputs were recorded by trained study personnel at UTH-K, verified by a trained physician, and then validated for any errors in order to meet inclusion and exclusion criteria.

### Data analysis

We performed analyses using Stata Statistical Software 14.2 (StataCorp, College Station, Texas). Continuous variables were summarized using medians with interquartile ranges or means with corresponding 95% confidence intervals. Categorical variables were reported as percentages using frequencies. Using two-sample t-tests with equal variance for patients treated before vs after implementation of EMTP, we compared outcomes for pre- and post-EMTP. Data were collected on information from the initial ED encounter and any subsequent hospitalization during the same stay.

## RESULTS

### Epidemiology

General MSI epidemiological findings in our 691 patients are outlined in supplements. A total of 17 patients were excluded for incomplete documentation. Of these records, 279 occurred before the start of the EMTP on November 1, 2013, while 395 occurred on or after the start of the program. Thus, patients were divided into pre-EMTP and post-EMTP groups resulting in 674 available patient records (see supplements). Patient demographics demonstrate that a majority of MSI cases were male (71.6%) and younger than 35 years of age (64.3%). Major mechanisms of trauma included RTAs (48.1%), falls (34.2%), and assault (6.0%). Of those involved in RTAs, a substantial proportion involved motorcycles (43.2%) while over one-quarter of accidents involved a pedestrian being struck (28.6%). The majority of patients were transported from another health facility (64.3%), while other patients were transported from the street (23.6%) or from home (9.0%).

Clinical characteristics of this cohort in Table 1 demonstrate approximately equal numbers of open and closed fractures (35.2% and 35.7%, respectively). The most common anatomical

regions of these fractures and injuries included the lower extremity (52.7%), upper extremity (30.0%), craniofacial (6.8%), abdomen-pelvis (4.2%), and thorax (3.9%). The most common abnormal vital signs included tachycardia (22.1%), hypotension (6.0%), and tachypnea (4.7%). Approximately 1 in 10 patients had a Glasgow Coma Scale (GCS) score of 12 or below, with 24 patients' scores ranging from 9-12 (5.2%) and 14 patient scores ranging from 3-8 (3.0%).

Care delivery metrics divided between ED outcomes and in-hospital outcomes are shown in Table 2. In the ED, a trauma intervention was performed for approximately three out of every four patients (76.0%). Most common trauma interventions included traction or splinting (52.2%), wound care (21.9%), and hemorrhage control (13.6%). Antibiotics and tetanus antitoxin were also commonly administered for fractures (84.4% and 26.4%, respectively), although they were more frequently given in the case of open fractures (86.6% and 54.3%, respectively).

Other common emergency procedures included analgesic medication (65.7%), intravenous liquid infusion (34.1%), and endotracheal intubation (28.1%), along with less common interventions such as transfusion of blood products (16.6%) and oxygen supplementation (9.2%). In over four out of every five cases, an emergency consultation was obtained (83.8%), most commonly from orthopedics (67.9%), acute care surgery (20.6%), and neurosurgery (10.0%). In a majority of cases, laboratory tests and imaging tests were ordered (62.8% and 82.5%, respectively). Nearly three of every four patients were admitted to the hospital (73.3%), with the most common admitting wards comprising orthopedics (65.6%), surgical (27.7%), and neurosurgery (5.1%).

As seen in Table 2, analysis of in-hospital care and outcomes showed that a majority of patients required operative management (88.1%). Most common procedures included open reduction (42.3%), wound debridement (22.7%), and closed reduction with external fixation (22.2%). A lesser percentage of the in-hospital patients required intensive care after admission (4.2%) or suffered from hospital complications (2.5%). Patient outcomes varied from discharges (89.6%) to transfers (7.3%) to deaths in hospital (2.4%).

**Table 1.** Clinical characteristics of musculoskeletal injuries.

| Characteristics | n (%)/median (IQR) |
|---|---|
| Fracture type | |
| Open | 243 (35.2) |
| Closed | 247 (35.7) |
| Mixed/Unknown | 201 (29.1) |
| Anatomical regions of fracture/injuries | |
| Craniofacial | 47 (6.8) |
| Thorax | 27 (3.9) |
| Abdomen-pelvis | 29 (4.2) |
| Spine | 11 (1.6) |
| Upper extremity | 207 (30.0) |
| Lower extremity | 364 (52.7) |
| Vital signs | |
| Heart rate, beats per minute | 88 (76-102) |
| Tachycardia, >100 beats per minute | 70 (22.1) |
| Respiratory rate, breaths per minute | 20 (18-20) |
| Tachypnea, >20 breaths per minute | 15 (4.7) |
| Systolic blood pressure, mmHg | 124 (113-137) |
| Hypotension, <100 mmHg | 19 (6.0) |
| Pain scale | 4 (3-6) |
| Neurological assessment | |
| Glasgow Coma Scale score | |
| 3–8 | 14 (3.0) |
| 9–12 | 24 (5.2) |
| 13–15 | 423 (91.8) |
| AVPU responsiveness scale | |
| Alert | 284 (89.6) |
| Verbal | 8 (2.5) |
| Pain | 2 (0.6) |
| Unresponsive | 5 (1.6) |

*IQR,* interquartile range; *mmHG*, millimeters of mercury.

**Impact of Emergency Medicine Training Program (EMTP)**

Baseline characteristics in Table 3 highlight the similarities and differences among the total of 674 patients seen prior to and following the implementation of the EMTP. Several patient characteristics did not differ between the pre-EMTP and post-EMTP cohorts, including age, gender, proportion of open fractures, proportion of RTAs, heart rate, and systolic blood pressure.

Overall, there was significant improvement in ED outcomes after the implementation of EM training at UTH-K. Results demonstrate improvement in the three outcomes of interest. Specifically, there was a decrease in the ED mortality prevalence in patients with MSI by 89.9%, from 2.51% to 0.25% ($p = 0.0077$). There was also a decrease in traumatic complications including wound infection, compartment syndrome, and associated shock from MSI by 71.7%, from 3.58% to 1.01% ($p = 0.0211$). Lastly, there was a reduction in the duration of stay in the ED by 52.7% or 2.81 days on average, from 5.33 to 2.52 days ($p=0.0437$) (Figure 1 and Table 4).

Similar measures, such as deaths and length of stay, did not significantly change in the in-hospital setting. There was a non-significant increase in the in-hospital mortality rate from 1.4% to 1.8% ($p = 0.7331$) and a non-significant decrease in in-hospital length of stay from 19.9 to 16.3 days ($p = 0.0529$) (Table 4). Several secondary outcomes in the ED setting also increased significantly, such as imaging requests (from 74.2% to 88.4%; $p = 0.0000$), laboratory exam requests (from 55.6% to

**Table 2.** Care delivery for musculoskeletal injuries.

| Characteristics | n (%)/median (IQR) | Characteristics | n (%)/median (IQR) |
|---|---|---|---|
| ED | | Cases with imaging test ordered | 570 (82.5) |
| Emergency procedures | | Admitted to the hospital | 452 (73.3) |
| Any trauma intervention | 486 (76.0) | Admission ward from ED | |
| Thoracostomy | 11 (1.6) | Surgical | 125 (27.7) |
| C-spine stabilization | 55 (8.0) | ICU | 6 (1.3) |
| Traction/splinting | 361 (52.2) | Pediatrics | 1 (0.2) |
| Hemorrhage control | 94 (13.6) | Neurosurgery | 23 (5.1) |
| Wound care | 151 (21.9) | Orthopedics | 296 (65.6) |
| IV fluid infusion | 218 (34.1) | In-hospital | |
| Blood products transfused | 36 (16.6) | Required operative management | 398 (88.1) |
| Antibiotics for all fractures | 265 (84.4) | Laparotomy | 12 (3.0) |
| Open fractures | 188 (86.6) | Craniotomy | 8 (2.0) |
| Tetanus shot for all fractures | 169 (26.4) | Closed reduction with external fixation | 88 (22.2) |
| Open fractures | 127 (54.3) | Open reduction | 168 (42.3) |
| Oxygen supplementation | 64 (9.2) | Wound debridement | 90 (22.7) |
| Endotracheal intubation | 18 (28.1) | Other | 31 (7.8) |
| Analgesic medication | 420 (65.7) | Required intensive care after admission | 19 (4.2) |
| Emergency consultations | | Hospital complications | 17 (2.5) |
| Total consults | 579 (83.8) | Patient outcome | |
| Acute care surgery | 119 (20.6) | Died in hospital | 11 (2.4) |
| Neurosurgery | 58 (10.0) | Transferred to a different health center | 33 (7.3) |
| Orthopedics | 393 (67.9) | Unknown | 3 (0.7) |
| Other | 9 (1.5) | Discharged | 405 (89.6) |
| Cases with laboratory test ordered | 433 (62.8) | | |

*IQR,* interquartile range; *ED,* emergency department, *IV,* intravenous; *ICU,* intensive care unit.

**Table 3.** Baseline Characteristics: Pre- and Post-EMPT.

| Characteristics | Pre-EMTP | Post-EMTP | p value |
|---|---|---|---|
| Age (years) | 32.0 (29.7 to 34.3) | 31.0 (29.1 to 32.9) | 0.5256 |
| Female | 29.0 (23.7 to 34.4) | 28.2 (23.7 to 32.6) | 0.8081 |
| Lowest GCS in ED (GCS scale) | 14.2 (13.9 to 14.5) | 14.6 (14.4 to 14.7) | *0.0159 |
| Open fractures | 33.0 (27.4 to 38.5) | 37.0 (32.2 to 41.7) | 0.2868 |
| Road traffic accidents | 46.6 (40.7 to 52.5) | 51.6 (46.7 to 56.6) | 0.197 |
| Vital signs | | | |
| Heart rate (beats per minute) | 91.4 (88.2 to 94.5) | 90.8 (88.2 to 93.3) | 0.7719 |
| Respiratory rate (breaths per minute) | 20.5 (19.9 to 21.2) | 19.5 (19.0 to 20.0) | *0.0115 |
| Systolic BP (mmHG) | 126.2 (123.4 to 129.1) | 123.4 (120.9 to 125.9) | 0.1437 |

p values: *<.05
Values represent mean percentages (95% confidence interval), unless noted.
*EMTP,* emergency medicine training program; *GCS,* Glasgow Coma Scale; *BP*, blood pressure; *mmHg,* millimeters of mercury.

69.0%; p = 0.0003), and administered tetanus antitoxin (from 15.1% to 34.3%; p = 0.0000). Additionally, ED exams were recorded more often, such as the GCS (from 62.9% to 74.7%; p = 0.0012), medical history (from 52.3% to 62.0%; p = 0.0120), and physical exam (from 98.2% to 99.7%; p = 0.0362).

## DISCUSSION

In the population of patients seeking emergency care for MSI, this study found significant improvements in mortality and complication rates, length of stay, and an array of secondary outcomes in association with the implementation of EMTP. The training curriculum taught by EM faculty is thought to have played a key role in the improvement of these outcomes. This curriculum included specific longitudinal educational trainings on the diagnosis and treatments of MSI provided through lectures and workshops that all residents completed. These findings help to demonstrate the potential importance of investing in the training of formal EM specialists to address the large burden of morbidity and mortality associated with MSI in LMICs.

It has been previously proposed that relatively simple interventions in areas such as emergency triage, communication, and education and supervision could lead to reductions in LMIC mortality in the ED, where up to 10-15% of all deaths occur.[14] The study demonstrates a temporal association between MSI outcomes in the ED and the inception of an EMTP, underlining the importance of developing such programs. While many LMIC governments do not list EM in their medical education priorities, they could consider doing so to tackle the treatment of such a high volume of patients with acute health problems.

The epidemiological results provide the first available data on MSI from a Rwandan hospital. Understanding the patient population, anatomical distribution of fractures, and mechanisms of injury could allow for more practical incorporation into the EMTP's future MSI curriculum. This understanding may also aid in proper diagnosis and treatment of the growing burden of MSI cases, a critical step for improving patient outcomes. Moreover, these epidemiological results, to an extent, confirm those of another research team that studied traumatic injuries in Rwanda's pre-hospital service, an epidemiological profile that showed nearly one-fourth (24%) of injured patients suffered from a fracture.[3]

Most importantly, the epidemiological patterns and EMTP results suggest the need for reducing MSI morbidity and mortality through expanding emergency care training programs. Although this evidence suggests an association with improved outcomes among patients with MSI with Rwanda's first EM residency program, further prospective evaluation of cases with MSI are needed to demonstrate reliability of these improvements over time. Moreover, similar epidemiological and training evaluation studies are needed in other African countries to effectively understand and develop scale MSI treatments.

## LIMITATIONS

Although we used formalized protocols, the design resulted

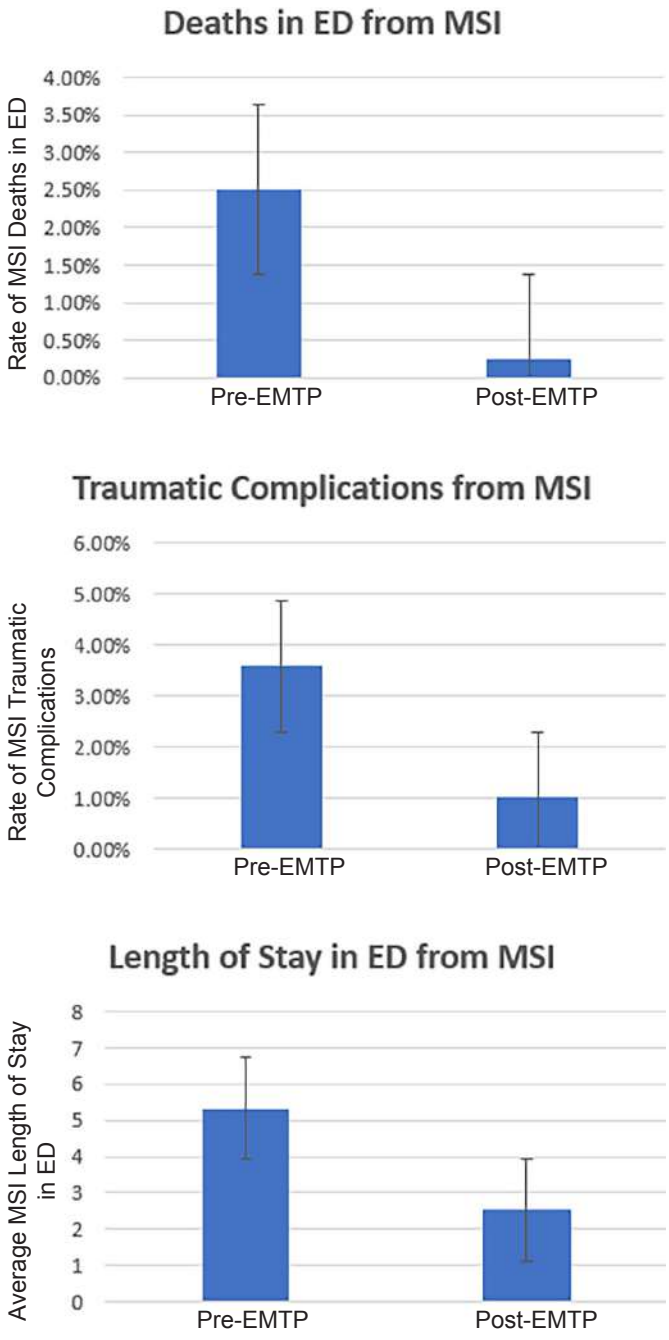


**Figure 1.** EM residency outcomes among MSI patients with musculoskeletal injuries show decreased death rate, complication rate, and duration of stay in emergency department. Using two-sample t-tests with equal variance for patients treated before vs after implementation of EMTP, results demonstrate a decrease and thus improvement in the three primary outcomes of interest. EMTP reduced the death rate in the ED from MSI by 89.9%, from 2.51% to .253% (p=0.0077). The program dropped traumatic complications from MSI by 71.7%, from 3.58% to 1.01% (p = .0211). Lastly, EMTP reduced duration of stay in the ED by 52.7% or 2.81 days on average, from 5.33 to 2.52 days (p = .0437). *Group 0 refers to pre-EMTP patients while group 1 refers to patients admitted during the EMTP program.
*MSI,* musculoskeletal; *ED,* emergency department; *EMTP*, emergency medicine training program.

in an inability to identify a proportion of cases due to incomplete medical records and some missing data among included cases, which could have biased the results. Overall, it appears that some intervention data was prioritized and thus better collected in comparison to other interventions. For example, the fact that oxygen supplementation was recorded as less used than intubation, demonstrates an inherent bias in recording interventions that are now more commonplace in the EM setting. In another example, although the GCS and vital signs in the pre-EMTP group are slightly different, it is worth noting that preliminary results show both GCS and vital signs were better recorded in the post-EMTP group vs pre-EMTP group (Table 4).

As better documentation practices were emphasized during EMTP implementation, this improvement demonstrates the inherent differences between provider training in each group, which may have led to more accurate GCS scores and vital signs in the post-EM group. The present study was performed at a single tertiary-care hospital, which may limit the generalizability of the findings to health delivery venues with less resource availability. Furthermore, due to lack of detailed information on prehospital and interfacility care provided for patients transported from various origins, controlling for prehospital interventions was not possible.

Future studies should attempt to account for such variables, especially given that a majority of patients presented from other facilities. Future studies should also attempt to differentiate patients based on varying levels of acuity, as this study's inclusion of transfer patients likely led to a higher-acuity patient population. Additionally, general medical, technological, and other secular advances over the course of the study cannot be

**Table 4.** Emergency medicine training program results.

| Results & Outcomes | Pre-EMTP | Post-EMTP | p value |
|---|---|---|---|
| | ED | | |
| Deaths^ | 2.5 (.6 to 4.3) | 0.3 (-.2 to .8) | ** 0.0077 |
| Traumatic complications^ | 3.6 (1.4 to 5.8) | 1.0 (0.0 to 2.0) | *0.0211 |
| Length of stay (days)^ | 5.3 (2.6 to 8.1) | 2.5 (1.3 to 3.7) | *0.0437 |
| Imaging requested | 74.2 (69.0 to 79.4) | 88.4 (85.2 to 91.5) | ***<0.0001 |
| Labs requested | 55.6 (49.7 to 61.4) | 69.0 (64.5 to 73.6) | ***0.0003 |
| Trauma intervention | 81.8 (77.0 to 86.5) | 72.4 (67.9 to 77.0) | **0.0067 |
| IV fluid/blood given | 33.1 (27.3 to 38.9) | 35.4 (30.5 to 40.3) | 0.5465 |
| Tetanus antitoxin given | 15.1 (10.7 to 19.5) | 34.3 (29.5 to 39.2) | ***<0.0001 |
| Antibiotics given | 83.1 (76.4 to 89.8) | 86.9 (81.9 to 91.8) | 0.3547 |
| Analgesics given | 67.3 (61.5 to 73.1) | 65.1 (60.3 to 70.0) | 0.5715 |
| Injuries examined | 98.9 (97.7 to 100.0) | 99.7 (99.2 to 100.0) | 0.1663 |
| Consult completed | 91.9 (88.4 to 95.4) | 94.7 (92.2 to 97.0) | 0.1853 |
| Endotracheal intubation | 34.3 (17.7 to 50.8) | 20.7 (5.0 to 36.4) | 0.2351 |
| ED protocols recorded | | | |
| GCS | 62.9 (57.0 to 68.7) | 74.7 (70.4 to 79.1) | **0.0012 |
| Vital signs | 65.2 (59.6 to 70.9) | 72.2 (67.7 to 76.6) | 0.0552 |
| Medical history | 52.3 (46.4 to 58.2) | 62.0 (57.2 to 66.8) | *0.0120 |
| Physical exam | 98.2 (96.6 to 99.8) | 99.7 (99.2 to 100.0) | *0.0362 |
| Patient Admitted | 70.4 (64.8 to 76.0) | 75.6 (71.0 to 80.1) | 0.1573 |
| | In-Hospital | | |
| Deaths | 1.4 (0.0 to 2.8) | 1.8 (0.5 to 3.1) | 0.7331 |
| Length of stay (days) | 19.9 (17.2 to 22.7) | 16.3 (13.9 to 18.7) | 0.0529 |
| Operative management | 90.6 (86.3 to 94.9) | 86.7 (82.6 to 90.8) | 0.2082 |
| ICU after admission | 2.8 (.4 to 5.2) | 4.9 (2.3 to 7.6) | 0.2533 |

p values: *<.05; **<.01; ***<.001

^ Indicates primary outcome.

Values represent mean percentages (95% confidence interval) unless otherwise noted.

*EMTP,* emergency medicine training program; *ED,* emergency department; *IV*, intravenous; *GCS*, Glasgow Coma Scale; *ICU,* intensive care unit.

ignored, as healthcare does not occur in a vacuum. Many advances in Rwanda's healthcare system have occurred in the last several years as previously noted, and the EMTP's impact cannot be isolated due to the observational nature of this study.[16, 17] However, it is worth noting from the results that changes to patient outcomes in the ED setting outperformed those same outcomes in the in-hospital setting over the same course of years, minimizing the role that technological advances played in improving outcomes. Lastly, the inclusion of patients with life-threatening injuries who also have fractures had the potential to confound results. Future research might exclude patients who require operative intervention for indications external to musculoskeletal trauma.

## CONCLUSION

This study reveals the current epidemiological foundations of MSI morbidity and mortality from a large referral center in Rwanda and the potential impacts of trained emergency physicians to properly treat those afflicted with MSI. Residency training programs such as the EMTP may be capable of helping to reduce mortality, complications, and ED length of stay among those with MSI. Such findings underscore both the efficacy and importance of investments toward educating the next generation of health professionals to treat prevalent MSI within their communities.

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# Predicting Emergency Department "Bouncebacks": A Retrospective Cohort Analysis

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**Introduction:** The short-term return visit rate among patients discharged from emergency departments (ED) is a quality metric and target for interventions. The ability to accurately identify which patients are more likely to revisit the ED could allow EDs and health systems to develop more focused interventions, but efforts to reduce revisits have not yet found success. Whether patients with a high number of ED visits are at increased risk of a return visit remains underexplored.

**Methods:** This was a population-based, retrospective, cohort study using administrative data from a large physician partnership. We included patients discharged from EDs from 80 hospitals in seven states from July 2014 – June 2016. We performed multivariable logistic regression of short-term return visits on patient, visit, hospital, and community characteristics. The primary outcome was the proportion of patients who had a return visit within 14 days of an index ED visit.

**Results:** Among 6,699,717 index visits, the overall risk of 14-day revisit was 12.6%. Frequent visitors accounted for 18.7% of all visits and 40.2% of all 14-day revisits. Frequent visitor status was associated with the highest odds of a revisit (odds ratio [OR] 3.06; 95% confidence interval [CI], 3.041 – 3.073). Other predictors of revisits were cellulitis (OR 2.131; 95% CI, 2.106 – 2.156), alcohol-related disorders (OR 1.579; 95%CI, 1.548 – 1.610), congestive heart failure (OR 1.175; 95% CI, 1.126 – 1.226), and public insurance (Medicaid OR 1.514; 95% CI, 1.501 – 1.528; Medicare OR 1.601; 95% CI, 1.583 – 1.620).

**Conclusion:** Previous ED use – even a single previous visit – was a stronger predictor of a return visit than any other patient, hospital, or community characteristic. Clinicians should consider previous ED use when considering treatment decisions and risk of return visit, as should stakeholders targeting patients at risk of a return visit.[West J Emerg Med. 2019;20(6)865-874.]

## INTRODUCTION

Short-term outcomes – including return emergency department (ED) visits – after discharge from the ED are used as internal quality metrics, as short-term revisits might represent medical errors or failures in care.[1-3] Although interventions to reduce return visits have largely been unsuccessful,[4] it is possible that these efforts did not adequately target high-risk patients. Related literature is focused on patients who have a pattern of repeat ED use; however, surprisingly, the degree to which these frequent users contribute to short-term revisits remains unknown.

The ability to accurately identify which patients are more likely to revisit the ED could improve treatment and disposition decisions, and also allow EDs and health systems to develop more focused interventions. Previous work has identified some predictors of return visits,[5-7] although these studies are limited by investigating only a subset of patients,[8–11] restriction to one

or few sites,[12–15] focus on non-U.S. hospitals,[16-18] reliance on complicated instruments,[19–22] focus on medical errors,[23] focus on admissions,[24,25] or use of overly-broad definition of discharge failure.[26]

We used a unique dataset with encounter-level data to evaluate the predictors of return visits. Our goal was to identify which patient demographics and medical conditions were most associated with short-term revisits. In addition, we hypothesized that frequency of recent previous visits – specifically, number of visits within the previous six months – would have a stronger association with return visits than other patient characteristics (including initial diagnosis), and that this pattern would be observed even after controlling for hospital and community characteristics.

*Population Health Research Capsule*

What do we already know about this issue?
*Short-term revisits to emergency departments (ED) and frequent ED utilization have each been studied, but the relationship between the two remains underexplored.*

What was the research question?
*To identify which patient characteristics, including recent frequent use, were most associated with short-term revisits.*

What was the major finding of the study?
*Recent frequent use was a stronger predictor of a revisit than other patient, hospital, and community characteristics.*

How does this improve population health?
*Clinicians should consider previous ED use when considering treatment decisions and risk of return visit, as should stakeholders targeting these high-risk patients.*

## METHODS

### Design

We conducted a retrospective study of patients visiting 80 hospitals in seven states from July 1, 2014 – June 30, 2016. In addition, we included data for six months prior and 30 days after the start and end dates, respectively, in order to observe activity around the index visit, giving a total range from January 1, 2014 – July 30, 2016. Encounter data were obtained from Vituity, a multistate physician partnership that contracts with hospitals to provide ED provider staffing. During the study period, Vituity (then known as California Emergency Physicians [CEP] America) provided staffing for 121 EDs in 13 states. Only sites with full contracts and data availability for the entire study period were included. The study received institutional review board approval.

### Study setting and population

All patient encounters were eligible for inclusion. We excluded encounters as potential index visits if patients eloped (left prior to discharge from the ED), died while in the ED, or were transferred to another facility.

### Methods and measurements

Data were recorded in the medical record at each hospital. Vituity collects this data through monthly electronic data feeds by its medical billing company, MedAmerica Billing Systems, Inc, which stores records in Application System / 400 and PostgreSQL. Patient visits were linked through Medical Person Identification number – a unique patient identifier derived by an algorithm taking into consideration patient name, date of birth, Social Security number, and address. This methodology allowed for linkage across sites, although visits at non-Vituity sites were not observable. Any visit had the potential to be defined as an index visit.

Patient characteristics included age, sex, insurance type (Medicare, Medicaid, commercial, or other), and the number of ED visits they had in the six months prior to the index visit. We reduced previous ED visits to an indicator variable for two or more previous visits in order to identify a characteristic that was easily observed and easy to apply to patients in real time.

Visit characteristics included acuity level, primary diagnosis, and Charlson comorbidity index. Primary diagnoses were categorized using *International Classification of Disea*ses, 9th and 10th revisions (ICD-9 and 10 codes according to Agency for Health Care Research and Quality (AHRQ) Clinical Categorization Software (CCS) categories. These categories were developed and defined by the Healthcare Cost and Utilization Project (HCUP), under the AHRQ, and this scheme has been used in a number of studies.[27,28] Because of the large number of categories, we further restricted diagnoses to the diagnoses that had at least 10,000 observations and were associated with 14-day revisits in bivariate analysis; among these, we included the five most common diagnoses for index visits and for revisits. Charlson comorbidity index was calculated for all visits based on up to 12 separate ICD codes per visit (Appendix A and B; Tables S1, S2).[29,30]

Hospital characteristics included size (volume for 2015), and turnaround time to discharge (TAT-D) for 2015. TAT-D is a quality metric measuring the median time between patient arrival and discharge at the hospital level for a given year. Volume was broken into four categories as defined by the Centers for Medicare & Medicaid Services: fewer than 20,000 encounters = low volume; 20,000 – 39,999 encounters = medium volume; 40,000 – 59,999 encounters = high volume; and greater than or

equal to 60,000 encounters = very high volume.

Community characteristics were comprised of zip code and county-level characteristics: median household income for zip code, number of hospitals per 1000 population in the county, and county. Zip code median household income was broken into quartiles based on the following: less than or equal to $44,168 = low income; $44,169 – $53,647 = medium income; $53,648 – $66,275 = high income; and greater than or equal to $66,276 = very high income.[31]

Physician characteristics included provider type: doctor (MD or DO) or advanced practice provider (APP; ie, physician assistant or nurse practitioner). We excluded from the study providers working for the firm for fewer than 60 days within the study period or accounting for fewer than 60 encounters. To test whether there was a different likelihood in return visit according to acuity level, we included interaction terms between MD/DO and acuity level; given the difference in scope of practice for APP, interactions between APP and acuity level were not modeled.

**Outcomes**

The primary outcome was the proportion of patients who had a return visit within 14 days of an index ED visit. Secondary outcomes included proportion of patients with a revisit within 3, 7, and 30 days of discharge; and likelihood of revisit according to number of visits in the six months prior to the index visit. We selected these time horizons due to use of each of these in the literature and their policy implications.[32]

**Analysis**

The primary outcome was the risk of return visit within 14 days. We calculated the proportion of patients who returned to the ED within 3, 7, 14, and 30 days after the index visit. We performed a multivariable logistic regression, regressing return visit on patient, physician, hospital, and community characteristics. Hospitals and counties were estimated to have random effects. Standard errors were clustered at the physician, hospital, and county levels. In sensitivity analyses, we estimated the model each of three ways: i) for a subset of the data that excluded patients aged <18 years; ii) using different thresholds for frequent visitor (one or more and three or more visits in the previous six months); and iii) using different time horizons for repeat visit (3, 7, and 30 days); we also conducted analyses for all combinations of frequent visitor threshold and time horizon. Analyses were conducted using SAS software, Version 9.4 (SAS Institute, Cary, NC) of the SAS System for Windows.

**RESULTS**

Over the study period, there were 8,334,885 index encounters. After excluding visits resulting in a disposition other than discharge and excluding visits with missing data, the total sample size was 6,699,717 (Figure 1). Table 1 shows the patient, visit, hospital, and physician characteristics at index visit for all encounters, and stratified by discharge vs admission. These descriptive statistics are also shown for encounters resulting in a 14-day return and for those who returned and were admitted to the hospital.

In the multivariate model including patient, hospital, and community characteristics (Table 2), the highest predictor of return visit within 14 days was whether or not the patient had two or more visits in the previous six months: OR = 3.06 (95% confidence interval [CI], 3.041 – 3.073). Men and patients with Medicare or Medicaid insurance were more likely to have 14-day revisits, as were patients with a primary diagnosis of alcohol-related disorder; complication of device, implant or graft; congestive heart failure; and schizophrenia and other psychotic disorders.

As a sensitivity analysis, we estimated the same model among adult patients only and found the results did not show any meaningful differences. Further, we repeated the analysis for each definition of frequent visitor definition (one or more and three or more previous visits) and time horizons (3-, 7-, and 30-day revisits), and each combination of frequent visitor and time horizon. Skin and subcutaneous tissue infections (SSTI) were the strongest predictor of three-day revisits for each of the definitions of frequent visitor, followed by frequent visitor as the next largest association. In all other specifications, frequent visitor was the factor with the strongest association with revisits.

There were 476,665 frequent visitors, who had a total of 1,251,082 visits, of which 340,381 were 14-day revisits. While frequent visitors represent 10.7% of all patients, they accounted for 18.7% of all encounters and 40.2% of all 14-day revisits. They were more likely to have a return visit at all times as compared to non-frequent visitors. Figure 2 demonstrates the percentage of patients revisiting the ED according to day after the index visit.

The blue line represents all patients and shows that revisits peak on days one and two, and steadily decline thereafter, with slight peaks at days 7 and 14. The red line shows the revisit rate for patients with no or one visit in the six months prior to the index visit; as with all patients, the revisit rate peaks on days 1-2 and declines thereafter, dropping to below 0.3% by day 14.

Patients defined as frequent visitors have revisits peaking on day 1 and decrease thereafter. The daily revisit rate for frequent visitors declines to a value of about 1.0% at 14 days, after which the revisit percentage decreases by less than 0.1% for each subsequent day. Encounters showing 0 days to first revisit reflect patients who returned to the ED on the same day as their index visit. Same day revisits represented 3.7% of the total encounters with an associated revisit. Frequent visitors had a significantly higher risk of a 14-day return visit resulting in admission than non-frequent visitors (OR 2.89; 95% CI, 2.86 – 2.93).

Table 3 shows the unadjusted proportion of encounters resulting in return at 3 and 14 days according to different thresholds defining frequent visitor. For each threshold number of visits in the preceding six months, the unadjusted risk of return visit was more than double among frequent visitors as compared to non-frequent visitors. The remainder of the analysis uses two or more previous visits as the threshold defining frequent visitor, unless otherwise specified.

## DISCUSSION

This retrospective analysis of almost seven million patient visits found that recent previous ED visits was the strongest predictor of an ED return visit. This finding held true across multiple cutoffs defining frequent use, and also under both univariate analysis and a multivariate model including patient, visit, hospital, and county characteristics. Along with recent frequent use, public insurance and three diagnoses (cellulitis, alcohol-related disorders, and congestive heart failure) were associated with an increased risk of a return visit. This suggests that our understanding of short-term revisits could be informed by considering frequency of ED use.

A parallel thread in the literature has investigated frequent users and interventions designed to decrease ED use.[25,33,34] Previous studies have evaluated predictors of ED revisit using patient-level data such as age, sex, race, insurance status, and diagnosis at initial ED visit, as well as hospital-level data. Surprisingly, the relationship between frequent ED use and risk of revisit after discharge is poorly characterized.[35] Further, there is no consensus on what defines "frequent," with definitions ranging from 2–12 visits per year.[36–41] We had the striking finding that even one previous visit increased risk of return by a clinically-significant margin. This finding held true even when accounting for patient, visit, hospital, and community characteristics. Our definition focused on visits within the previous six months because other work has shown that episodes of frequent ED use are usually self-limited,[42] which suggests that the recent past is more relevant to current health and risk of short-term return visit.

A second, related finding is that the threshold used to define frequent visitors is arbitrary with respect to risk of return visit. In the hope of informing the wide range in the literature on the number of visits or length of time used to define frequent users,[31,33] we considered our definition of frequent user in relation to risk of return visit. We had the surp finding that *any* number of previous visits used to define frequent vs non-frequent ED

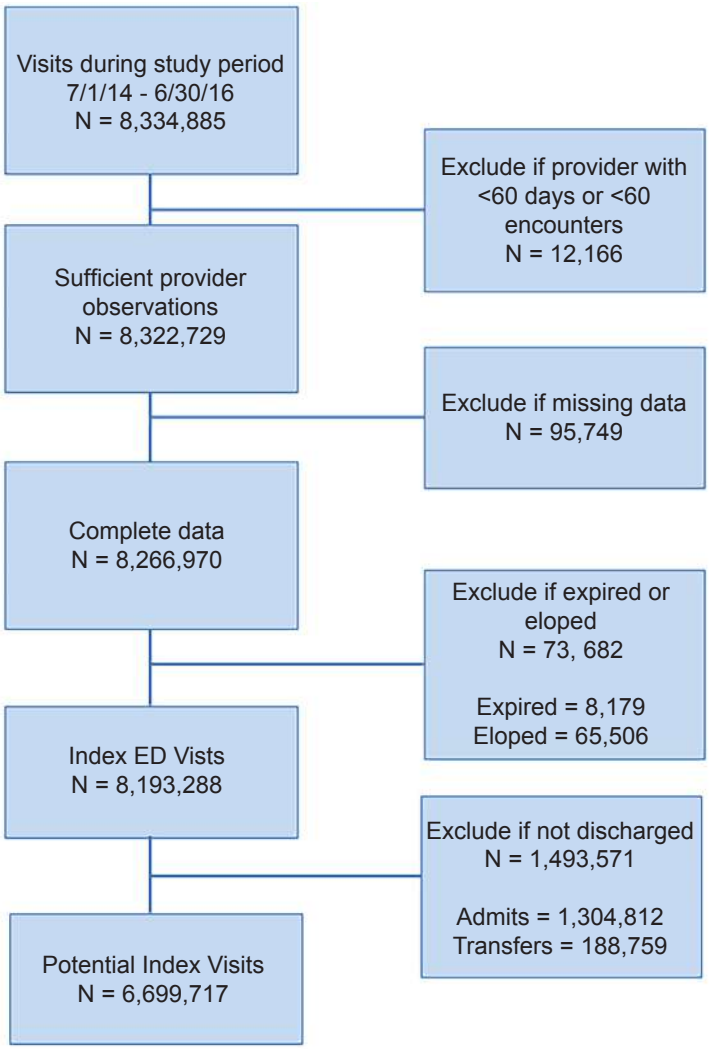


**Figure 1.** CONSORT-like flow diagram.
*ED*, emergency department.

**Table 1.** Patient, visit, hospital, and community characteristics.

| Characteristic | Index ED visit | Index discharge | Index admitted | Return visit | Return and admitted |
|---|---|---|---|---|---|
| Number of patients | 8,193,288 | 6,699,717 | 1,493,571 | 846,759 | 135,735 |
| Patient factors | | | | | |
| Age (median, IQR) | 39 (22-59) | 34 (20-53) | 62 (46-77) | 40 (25-58) | 56 (38-73) |
| Sex (female) | 55.4% | 56.3% | 51.7% | 55.3% | 54.3% |
| Insurance | | | | | |
| Commercial | 19.2% | 19.8% | 16.5% | 12.2% | 13.9% |
| Medicaid | 47.0% | 51.6% | 26.1% | 56.1% | 36.2% |
| Medicare | 23.8% | 17.5% | 51.9% | 24.3% | 45.5% |
| Other | 10.0% | 11.1% | 5.5% | 7.4% | 4.3% |
| Frequent visitor | 19.5% | 18.7% | 23.1% | 40.2% | 40.4% |
| Visit Factors | | | | | |
| E&M level | | | | | |
| 1 | 0.4% | 0.5% | 0.0% | 0.5% | 0.2% |
| 2 | 0.9% | 1.1% | 0.0% | 1.2% | 0.6% |
| 3 | 36.8% | 44.9% | 0.2% | 38.8% | 18.8% |
| 4 | 24.5% | 29.6% | 1.8% | 31.9% | 32.8% |
| 5 | 34.6% | 23.7% | 83.6% | 27.3% | 46.9% |
| Critical care | 2.8% | 0.3% | 14.4% | 0.3% | 0.7% |
| Primary Diagnosis | | | | | |
| Abdominal pain | 7.4% | 8.1% | 4.3% | 9.5% | 10.8% |
| Alcohol-related | 0.9% | 1.0% | 0.6% | 1.7% | 1.6% |
| Device or graft malfunction | 0.3% | 0.2% | 0.3% | 0.5% | 0.8% |
| Congestive heart failure | 0.8% | 0.2% | 3.3% | 0.4% | 1.2% |
| Schizophrenia | 0.5% | 0.3% | 1.7% | 0.5% | 0.8% |
| SSTI | 2.7% | 2.8% | 2.4% | 4.9% | 3.7% |
| Charlson comorbidity index | 12.0% | 7.0% | 32.0% | 10.0% | 19.0% |
| Advanced practice provider | 37.8% | 44.1% | 9.7% | 39.7% | 23.0% |
| Hospital | | | | | |
| ED volume (year) | | | | | |
| <20,000 | 2.3% | 2.4% | 1.9% | 2.5% | 2.2% |
| 20,000-39,999 | 16.9% | 17.3% | 15.3% | 17.5% | 15.8% |
| 40,000-59,999 | 19.3% | 19.4% | 19.1% | 20.0% | 20.3% |
| ≥60,000 | 61.4% | 60.9% | 63.7% | 60.1% | 61.7% |
| Time until discharge (low) | 82.8% | 83.6% | 79.3% | 84.8% | 81.9% |
| Community characteristics | | | | | |
| Median income for zip code, quartiles | | | | | |
| <$44,169 | 24.5% | 25.1% | 22.1% | 26.9% | 23.9% |
| $44,169 - $53,647 | 24.6% | 25.0% | 23.1% | 25.4% | 24.0% |
| $53,648 - $66,275 | 24.9% | 25.0% | 24.8% | 25.2% | 25.2% |
| >$66,275 | 25.9% | 25.0% | 30.0% | 22.5% | 27.0% |
| Hospitals per 1,000 persons (county) | 150.3 | 149.6 | 153.6 | 147.1 | 150.1 |

*IQR*, interquartile range; *ED*, emergency department; *E&M level,* Evaluation and Management CPT codes; 1 is lowest acuity, critical care is highest acuity; *SSTI*, skin and subcutaneous tissue infection.
Frequent visitor is defined as two or more visits in the previous six months. Time until discharge is an indicator for median time until discharge less than or equal to 200 minutes.

**Table 2.** Multivariable regression results: 14-day revisits.

| Effect | Odds ratio (95% confidence interval) |
|---|---|
| Patient characteristics | |
| Age | 1.035 (1.034 - 1.036) |
| $Age^2$ | 1.000 (0.999 - 1.000) |
| $Age^3$ | 1.000 (1.000 - 1.000) |
| Male | 1.12 (1.115 - 1.126) |
| Insurance Type (ref=other) | |
| Commercial | 0.94 (0.930 - 0.940) |
| Medicaid | 1.514 (1.501 - 1.528) |
| Medicare | 1.601 (1.583 - 1.62) |
| Frequent visitor | 3.057 (3.041 - 3.073) |
| Visit characteristics | |
| Primary Diagnosis (ref=other diagnosis) | |
| Abdominal pain | 1.162 (1.152 - 1.172) |
| Alcohol-related disorders | 1.579 (1.548 - 1.61) |
| Congestive heart failure | 1.175 (1.126 - 1.226) |
| Complication of device, implant, or graft | 1.576 (1.519 - 1.634) |
| Schizophrenia and other psychotic disorders | 1.62 (1.563 - 1.68) |
| Skin and subcutaneous tissue infections | 2.131 (2.106 - 2.156 |
| Evaluation & Management Level (ref=1) | |
| 2 | 1.194 (1.136 - 1.253) |
| 3 | 1.028 (0.987 - 1.071) |
| 4 | 1.152 (1.106 - 1.201) |
| 5 | 1.241 (1.190 - 1.295) |
| CC | 1.145 (0.893 - 1.467) |
| Charlson comorbidity index | 1.194 (1.092 - 1.108) |
| Hospital characteristics | |
| ED volume (ref=low) | |
| Medium | 1.027 (1.190 - 1.295) |
| High | 1.037 (0.893 - 1.467) |
| Very High | 1.035 (0.983 - 1.142) |
| Time to discharge (ref=low) | 0.939 (0.874 - 1.009) |
| Provider characteristics | |
| MD or DO provider type (ref = APP) | 1.187 (1.108 - 1.272) |
| Community characteristics | |
| Number of hospitals in county per 1,000 people | 0.999 (0.998 - 1.000) |
| Income category (ref=low) | |
| Medium | 0.994 (0.987 - 1.002) |
| High | 1.001 (0.993 - 1.008) |
| Very High | 0.947 (0.939 - 0.956) |

*CI,* confidence interval; Ref, reference; *ED,* emergency department; *MD,* medical doctor; *DO*, doctor of osteopathic medicine; *NP*, nurse practitioner; *PA*, physician assistant; *CC*, critical care; *APP*, advanced practice provider (NP or PA).

users predicted an increased risk of revisit. Given that the reason to label certain patients as frequent visitors is often in order to identify them for interventions, future work may consider an outcome-based definition of frequent users and define the term "frequent" with a qualifier – eg, with respect to propensity to revisit after a visit, risk of becoming a persistent frequent user, or risk of death.

As with existing literature, we transformed the number of previous visits from a continuous variable to a binary one. This has the disadvantage of losing some information, but is standard in the literature regarding frequent ED use, and can easily be applied in the midst of clinical practice.[31–39] Our sensitivity analysis demonstrated that any threshold was significantly associated with return visits, suggesting that knowing whether a patient had four vs three previous visits would provide marginally more information than simply knowing the patient had more than two previous ED visits.

As with the definition of frequent user, the time to return visit defining a return visit is somewhat arbitrary. While the risk of return visit is highest on the first day following the ED visit, the risk gradually decreases and, as found previously by Rising et al., there is no clear timeline that defines a return visit.[43] This finding may suggest something other than inadequate care at the index visit is the driving factor for most short-term revisits, and that both frequent use and revisits may simply be proxies for certain patients with increased healthcare-seeking behavior. Further complicating this issue is that patients may be instructed to return to the ED for a re-evaluation. Thus, an ED in a setting with limited outpatient resources might appear to give poor care as measured by revisits when in fact it serves to provide follow-up care that patients otherwise would not obtain.

Despite the variation in the literature and thus our broad range of models, we consistently found that the strongest predictor of a revisit is a high number of previous visits. This finding held true in our sensitivity analysis using different thresholds for number of previous visits and also days after index visit. The observation that previous visits predicts future visits may seem obvious or mechanical, but it does not necessarily follow that a patient with one or two visits in the prior six months would be at double the risk of a revisit within three days. Further, that this relationship was stronger than any other patient, hospital, or community characteristic is an important finding that has been overlooked in the literature regarding revisits. In fact, it appears that the literature on frequent visitors and the literature regarding revisits have to this point largely functioned in parallel and have not yet begun to inform each other.

Whether frequent users are merely frequently-ill people, and whether sicker patients are at increased risk of short-term revisits deserves future research. Likewise, future work should investigate the extent to which patients are frequent users because they received poor care or face limitations in their ability to obtain outpatient resources, the extent to which revisits are avoidable, and the degree to which frequent use persists over time. Understanding the extent to which follow-up with primary care, referrals to specialists, and ability to obtain further evaluation such as advanced imaging, cardiac stress test, or even a wound check is essential to understanding why patients return to the ED.

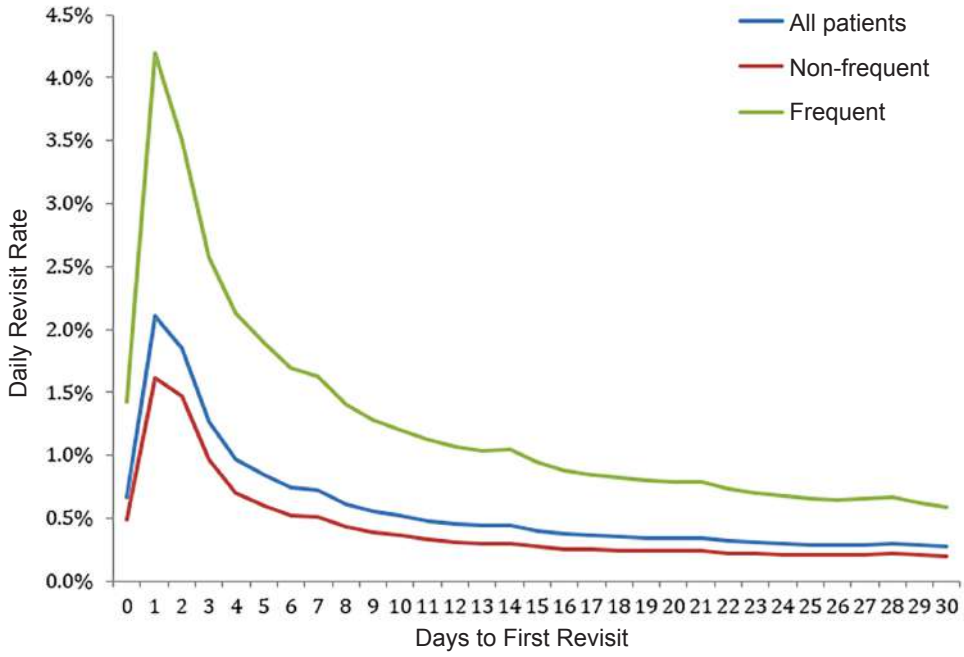


**Figure 2.** Percentage of patients with an emergency department revisit.
Percentage of patients revisiting the emergency department according to day after the index visit for all patients, and separately for each of frequent and non-frequent visitors.

## LIMITATIONS

The data for this study were obtained from a single multistate physician partnership and do not necessarily generalize to other providers or provider groups, or to other populations. However, the sample size was large and spans many cities and rural areas across several states, includes a broad set of hospital owner types, a large range of hospital sizes, and both teaching and non-teaching hospitals. This source of data may lead to a biased sample with respect to patient population, hospital characteristics, and provider characteristics. In particular, the income distribution is narrower than the distribution for the entire U.S., so the patient population could have a lower proportion of low- and high-income patients than typical for the U.S. We addressed these potential sources of bias by controlling for patient demographics, patient insurance, and local income; hospital characteristics including volume and a performance metric, and clinician degree.

Second, because not all hospitals within a region were observed, measures of frequent visitors and repeat visits may underestimate the actual numbers of frequent visitors and repeat visits, as patients may have gone to another ED either prior to or after the observed index visit. This limitation is typical of this research,[12-15] and in this dataset patients were linked across hospitals, although this was limited to the hospitals served by this company. Thus, it is unknown whether patients had an unobserved revisit at another ED, or whether what was considered an index visit actually represented a revisit after an initial visit at another ED. Next, we were unable to distinguish between planned and unplanned return visits. Thus, a patient who is instructed to return for a check over the weekend to ensure their illness is improving, for example, would appear to be a revisit, but this should not imply that their initial treatment was inadequate or inappropriate in any way. Research using administrative datasets, such as HCUP, likewise suffers from this limitation.

Finally, as with related research, this study does not identify the extent to which high rates of frequent visits and revisits are driven by patient factors, ED care, or non-ED healthcare resources. This analysis was limited in its ability to examine patient psychosocial attributes or local resources, which are likely to contribute to ED visits and revisits, although we did consider proxies for access to care: patient insurance and community-level factors such as income and number of hospitals in the county.

## CONCLUSION

In our study of 6.7 million patients across seven states from 2014 to 2016 we found that a high number of ED visits – as defined by *any* threshold – within the previous six months are not only a significant predictor of short-term ED revisits, but have a stronger association than any other observable variable assessed in this study. The number of recent visits is an easily-obtained value that can be used in real-time by physicians, social workers, and case managers, and the threshold number of recent visits can be chosen by any ED to optimize how it deploys resources to prevent short-term revisits. In addition, the result here suggests a relationship between two parallel threads of literature – that regarding frequent users and short-term revisits – that has thus far gone largely unnoticed and deserves further attention.

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**Table 3.** Risk of return according to previous visits.

| Frequent visitor threshold (# of visits in previous 6 months) | 3-day revisit | | 14-day revisit | |
|---|---|---|---|---|
| | Non-frequent | Frequent | Non-frequent | Frequent |
| 1 or more* | 4.10% | 8.81% | 8.11% | 20.09% |
| 2 or more* | 4.54% | 11.70% | 9.29% | 27.21% |
| 3 or more* | 4.82% | 14.69% | 10.05% | 34.18% |
| 4 or more* | 5.01% | 17.66% | 10.57% | 40.74% |

*The result from each z-test testing the proportion of non-frequent versus frequent patients with a 3-day or 14-day revisit was statistically significant at the $p < 0.001$ level for each of the eight pair-wise comparisons.

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# Diagnosis of Acute Heart Failure in the Emergency Department: An Evidence-Based Review

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Heart failure is a common presentation to the emergency department (ED), which can be confused with other clinical conditions. This review provides an evidence-based summary of the current ED evaluation of heart failure. Acute heart failure is the gradual or rapid decompensation of heart failure, resulting from either fluid overload or maldistribution. Typical symptoms can include dyspnea, orthopnea, or systemic edema. The physical examination may reveal pulmonary rales, an S3 heart sound, or extremity edema. However, physical examination findings are often not sensitive or specific. ED assessments may include electrocardiogram, complete blood count, basic metabolic profile, liver function tests, troponin, brain natriuretic peptide, and a chest radiograph. While often used, natriuretic peptides do not significantly change ED treatment, mortality, or readmission rates, although they may decrease hospital length of stay and total cost. Chest radiograph findings are not definitive, and several other conditions may mimic radiograph findings. A more reliable modality is point-of-care ultrasound, which can facilitate the diagnosis by assessing for B-lines, cardiac function, and inferior vena cava size. These modalities, combined with clinical assessment and gestalt, are recommended. [West J Emerg Med. 2019;20(6)875-884.]

## INTRODUCTION

Acute heart failure (AHF) is a gradual or rapid decompensation in heart failure (HF) requiring urgent management.[1-4] The condition covers a large spectrum of disease, ranging from mild exacerbations with gradual increases in edema to cardiogenic shock. HF affects close to six million people in the United States (U.S.) and increases in prevalence with age.[6-11] Currently, the emergency department (ED) initiates the evaluation and treatment of over 80% of patients with AHF in the U.S.[12-17] As the population ages, increasing numbers of patients with HF will present to the ED for evaluation and management. However, making the correct diagnosis can be challenging due to the broad differential diagnosis associated with presenting symptoms and variations in patient presentations.

Over one million patients are admitted for HF in the U.S. and Europe annually.[6-11,16-20] In the U.S. population, people have a 20% risk of developing HF by 40 years of age.[21-25] HF is more common in males until the age of 65, at which time males and females are equally affected.[25-28] Patients with HF average at least two hospital admissions per year.[25,29,30] Among patients who are admitted with AHF, over 80% have a prior history of HF, referred to as decompensated heart failure.[20-23] De novo HF is marked by no previous history of HF combined with symptom appearance after an acute event.[3,4,19,23] Mortality in patients with HF can be severe, with up to half of all patients dying within five years of disease diagnosis.[20,21,25] Other studies have found that post-hospitalization mortality rates at 30 days, one year, and five years are 10.4%, 22%, and 42.3%, respectively.[23-27] AHF expenditures approach $39 billion per year, which is expected to almost double by 2030.[31,32]

## METHODS

We searched PubMed and Google Scholar for articles using the keywords "heart failure" and "emergency." We included retrospective studies, prospective studies, systematic reviews and meta-analyses, clinical guidelines, and narrative

reviews focusing on diagnosis of HF including history and physical examination, biomarkers, electrocardiogram (ECG), and imaging. The literature search was restricted to studies published in English. Emergency physicians with experience in critical appraisal of the literature reviewed all of the articles and decided which studies to include for the review by consensus, with a focus on emergency medicine-relevant articles. A total of 124 articles were selected for inclusion in this review.

## DISCUSSION

### Anatomy and Pathophysiology

Normal cardiac physiology is dependent on appropriately functioning ventricular contraction, ventricular wall structural integrity, and valvular competence.[28,33,34] At normal functional status, a person's stroke volume (SV) is approximately one milliliter (mL) per kilogram for every heartbeat.[28,33-36] SV is dependent upon the preload (defined as the amount of myocardial muscle fiber stretch at the end of ventricular filling), afterload (defined as the amount of vascular resistance the ventricle must overcome), and contractility (defined as the strength of the myocardial contraction). In patients with HF, left ventricular (LV) dysfunction can be due to impaired LV contraction and ejection (systolic dysfunction), impaired relaxation and filling (diastolic dysfunction), or a combination of both.[28,33]

An alternate way of defining this would be by the effect on ejection fraction (EF). HF with preserved EF refers to patients with an EF > 50%, while HF with reduced EF refers to patients with an EF < 40%. Borderline preserved EF is defined by HF with an EF of 41-50%.[3,4,17,18,29] The most common form is HF with reduced EF, which is primarily related to a decrease in the functional myocardium (typically associated with ischemic disease or a prior myocardial infarction).[3,4,34] Additional causes include excessive pressure overload from hypertension, valvular incompetence, and cardiotoxic medications. HF with preserved EF occurs due to impaired ventricle relaxation and filling, which accounts for 30-45% of all HF cases.[22,23,33,37,38] This form of HF results in increased end-systolic and diastolic volumes and pressures and is most commonly associated with chronic hypertension, coronary artery disease, diabetes mellitus, cardiomyopathy, and valvular disease. Both systolic and diastolic HF can present with similar symptoms due to elevated, left-sided intracardiac pressures and pulmonary congestion.[25,28,33-36]

Right ventricular failure most commonly results from LV failure. As the right side of the heart fails, increased pressure in the vena caval system elevates pressure in the venous system of the gastrointestinal tract, liver, and extremities, resulting in edema, jugular venous distension, hepatomegaly, bloating, abdominal pain, and nausea.[25,28,33,34] High-output HF is associated with normal or greater-than-normal cardiac output and decreased systemic vascular resistance.[34-38] The associated decrease in afterload reduces arterial blood pressure and also activates neurohormones, which increase salt and water retention. Diseases that may result in high-output HF include anemia, large arteriovenous fistula or multiple small fistulas, severe hepatic or renal disease, hyperthyroidism, beriberi disease, and septic shock.[36-38]

In AHF, peripheral vascular flow and end-organ perfusion decrease, causing the body to compensate by neurohormonal activation (ie, the renin-angiotensin system), ventricular remodeling, and release of natriuretic peptides.[25,28,34,35] These mechanisms are chronically activated in HF, but worsen during acute exacerbations, resulting in hemodynamic abnormalities leading to further deterioration. Continued progression can result in a critical reduction to end-organ blood flow, leading to severe morbidity and mortality.[3,4,25,28,33-35]

### Heart Failure Classification

Patients with HF are classified into one of four classes, primarily determined by daily function, using the New York Heart Association, American College of Cardiology/American Heart Association, or European Society of Cardiology Guidelines (Table 1).[17,18,39-41] These systems help determine

**Table 1.** Heart failure classification systems.[17,18,39-41]

| NYHA | ACC/AHA | ESC guidelines |
|---|---|---|
| Class I: No symptoms with ordinary activity. | Stage A: Patient is at high risk for developing HF. | 1. Heart failure with reduced ejection fraction (< 40%). |
| Class II: Slight limitation with physical activity. No issues at rest, but physical activity can result in fatigue, palpitations, dyspnea, or angina. | Stage B: Patient has structural heart disorder but no symptoms of HF. | 2. Heart failure with mid-range ejection fraction (40-49%). |
| Class III: Severe limitation in physical activity. Comfortable at rest. However, less than normal physical activity results in fatigue, palpitations, dyspnea, or angina. | Stage C: Patient has past or current symptoms of HF with underlying structural heart disease. | 3. Heart failure with preserved ejection fraction (> 50%). |
| Class IV: Unable to perform physical activity without discomfort. Symptoms may be present at rest. | Stage D: Patient has end-stage disease and requires specialized treatment strategies. | |

*NYHA,* New York Heart Association; *ACC/AHA,* American College of Cardiology/American Heart Association; *ESC,* European Society of Cardiology; *HF,* heart failure.

the appropriate interventions to reduce the likelihood of developing severe LV dysfunction, thereby reducing the patient's potential morbidity and mortality.[3,4,17,18,34] Other means of classification depend on the presence of cardiomyopathy or acute coronary syndrome (ACS). The Nohria-Stevenson classification for decompensated HF in the setting of cardiomyopathy uses perfusion and congestion, while the Killip and Forrester classification systems evaluate AHF in the setting of ACS.[12,17,18,39-45] In general, short-term mortality is low for well-perfused groups and is higher in poorly-perfused patients.[12,17,18,39-45]

Unfortunately, these classification systems are not as useful for acute exacerbation of HF, thereby limiting their applicability in the ED setting. In the ED, classification is based upon the patient's hemodynamic status, perfusion, and blood pressure.[3,4,30,42] This differentiation can guide therapy and provides important prognostic information. Most patients are hypertensive or normotensive upon presentation.[16-22] The hypertensive form (associated with a systolic blood pressure > 140 millimeters of mercury (mmHg) is commonly associated with pulmonary edema, which may occur rapidly (ie, flash pulmonary edema).[46,47] In the normotensive progressive form, systemic edema is predominant.[16-22,30] Hypotensive AHF is associated with end-organ hypoperfusion, while systemic and pulmonary edema is minimal. ACS can occur simultaneously with or exacerbate HF and requires emergent coronary angiography.[48,49] Right-sided HF is associated with right ventricular dysfunction, leading to systemic venous congestion without pulmonary edema if the LV is not involved.[3,4,30]

**History and Physical Examination**

Due to the complex pathophysiology involved in HF and multiple phenotypes (eg, low- vs high-output, preserved vs reduced EF, left-sided vs right-sided), the history and physical examination may vary. Patients with HF are heterogeneous in terms of the cardiac structure and function, the etiology of their HF, the precipitant of the AHF exacerbation, comorbidities, and current medications. Early diagnosis is vital, as a delay or misdiagnosis has been associated with an increased risk of adverse outcomes and death.[50-52] Misdiagnosis occurs in up to one-third of patients upon initial presentation.[53-56] While no single historical factor or examination finding can significantly reduce the likelihood of HF in isolation, initial clinical gestalt has been shown to have a sensitivity of 61% and specificity of 86% for the diagnosis.[57,58]

Risk factors for HF include hypertension, renal disease, heart disease, diabetes, male gender, older age, and obesity.[58-61] In particular, advanced age, renal disease, and lower blood pressure are associated with increased mortality in AHF.[60,61] Precipitating factors for AHF exacerbation can include cardiac and non-cardiac causes.[63,64] Cardiac causes include uncontrolled hypertension, dietary or medication noncompliance, aortic dissection, dysrhythmias, and cardiac ischemia.[30,59,63,64] Non-cardiac causes include pulmonary disease, endocrine disease, infection, worsening renal function, anemia, and medication side effects.[3,4,30,59] Patients who are noncompliant with their diet and medications have been found to have a lower EF, higher brain-type natriuretic peptide (BNP) levels, and greater congestion when compared with their counterparts.[30,63,64] Dysrhythmias are another frequent precipitating cause. Among those, atrial fibrillation is the most common.[17,18,21,29] ACS is more commonly associated with de novo HF.[17,18,29] Components of the history such as weight gain, dyspnea, chest pain, peripheral edema, substance abuse, new medications, past complications, prior hospitalizations, diet changes (eg, salt or fluid intake), and medication compliance are vital to determine the underlying etiology, and an identifiable trigger can be found in approximately 60% of patients.[58-62]

Acutely, the most common symptoms associated with AHF include paroxysmal nocturnal dyspnea (PND), orthopnea, and edema.[16,29,30,57-59] The most common manifestation is dyspnea or edema from elevated LV filling pressures.[4,57-59] However, the classic symptoms such as PND, dyspnea, and orthopnea demonstrate poor sensitivity and specificity (Table 2).[59,65-67]

On examination, an S3 heart sound has the highest specificity, ranging from 97.7–99%, but it has only 12.7% sensitivity.[53,54,57-59] Additionally, an S3 heart sound can be difficult to detect in the ED setting, and inter-rater reliability can be poor.[3,4,59] Hepato-jugular reflux and jugular venous distension possess a specificity of 93.4% and 87% and sensitivity 14.1% and 37.2%, respectively, for HF.[57-59] Lung auscultation is also less reliable, as the presence of rales has a sensitivity of approximately 60% and a specificity approaching 70%.[57-59] Lower extremity edema has a sensitivity of 50% and specificity 78%.[57-59] A meta-analysis evaluating various signs and symptoms in patients with dyspnea found that no single sign or symptom was sufficiently able to rule out AHF, chronic obstructive pulmonary disease, asthma, or pulmonary embolism.[65] However, elevated jugular venous pressure, third heart sound, and lung crepitations were strongly suggestive of a diagnosis of AHF.[65]

**Laboratory Testing**

Laboratory assessment in the patient with suspected AHF can provide important diagnostic and prognostic information.[3,4,30,58,59] Testing should include a complete blood count, basic metabolic panel with renal function testing, liver function testing, troponin, and a BNP level.[30,48-50-47,55,56] Abnormalities in liver function are found in approximately 75% of patients with AHF and are associated with more severe disease.[30,69] If the right ventricle is involved, bilirubin and alkaline phosphatase levels may be elevated, while left-sided disease is more commonly associated with elevated transaminase levels.[30,69] Renal function is an important assessment, as it is a predictor of disease severity and mortality.[15-18,70] Decreased glomerular filtration rate (GFR) is associated with increased length of in-hospital stay, short-term mortality, and long-term mortality.[17,18,70-72] In patients with AHF,

**Table 2.** History and examination findings in acute heart failure.[59]

| Finding | Sensitivity (95% CI) | Specificity (95% CI) | +LR (95% CI) | -LR (95% CI) |
|---|---|---|---|---|
| Orthopnea | 52.1 (50.1–54.0) | 70.5 (68.8–72.1) | 1.9 (1.4–2.5) | 0.74 (0.64–0.85) |
| PND | 46.2 (43.7–48.6) | 73.9 (71.9–75.9) | 1.6 (1.2–2.1) | 0.79 (0.71–0.88) |
| Dyspnea at rest | 54.6 (51.2–58.0) | 49.6 (46.9–52.3) | 1.1 (0.9–1.4) | 0.88 (0.74–1.04) |
| No productive cough | 82.0 (79.6–84.4) | 25.8 (23.5–28.2) | 1.13 (1.02–1.26) | 0.6 (0.5–0.8) |
| History of CHF | 55.5 (53.9–57.1) | 80.2 (79.0–81.3) | 2.7 (2.0–3.7) | 0.58 (0.49–0.68) |
| History of MI | 31.8 (29.7–33.9) | 87.1 (85.8–88.3) | 2.1 (1.8–2.5) | 0.82 (0.76–0.89) |
| History of AF | 30.2 (27.4–33.2) | 85.3 (82.8–87.5) | 2.1 (1.6–2.9 | 0.82 (0.71–0.93) |
| History of CAD | 46.6 (44.5–48.7) | 76.2 (74.6–77.7) | 2.0 (1.7–2.4) | 0.71 (0.64–0.79) |
| History of DM | 28.8 (27.4–30.4) | 81.7 (80.4–82.8) | 1.5 (1.3–1.7) | 0.89 (0.84–0.94) |
| History of CRD | 32.0 (29.4–34.6) | 91.4 (90.0–92.7) | 3.4 (2.7–4.5) | 0.75 (0.71–0.80) |
| History of HTN | 66.9 (65.5–68.3) | 50.7 (49.4–52.1) | 1.3 (1.3–1.4) | 0.62 (0.53–0.73) |
| S3 | 12.7 (11.5–14.0) | 97.7 (97.2–98.2) | 4.0 (2.7–5.9) | 0.91 (0.88–0.95) |
| JVD | 37.2 (35.7–38.7) | 87.0 (85.9–88.0) | 2.8 (1.7–4.5) | 0.76 (0.69–0.84) |
| Hepato-jugular reflex | 14.1 (11.9–16.6) | 93.4 (91.2–95.2) | 2.2 (1.3–3.7) | 0.91 (0.88–0.94) |
| Leg edema | 51.9 (50.5- 53.4) | 75.2 (74.0–76.4) | 1.9 (1.6–2.3) | 0.68 (0.61–0.75) |
| Rales | 62.3 (60.8–63.7) | 68.1 (66.7–69.4) | 1.8 (1.5–2.1) | 0.60 (0.51–0.69) |
| Wheeze | 22.3 (20.9–23.8) | 64.0 (62.5–65.4) | 0.6 (0.5–0.8) | 1.19 (1.10–1.30) |
| No fever | 92.4 (90.9–93.8) | 20.6 (18.8–22.5) | 1.14 (1.02–1.27) | 0.4 (0.3–0.6) |
| Murmur | 27.8 (25.8–29.9) | 83.2 (81.6–84.8) | 1.9 (0.9–3.9) | 0.93 (0.79–1.08) |

*CI,* confidence interval; *PND*, paroxysmal nocturnal dyspnea; *CHF,* congestive heart failure; *MI,* myocardial infarction; *AF,* atrial fibrillation; *CAD,* coronary artery disease; *DM,* diabetes mellitus; *CRD*, chronic respiratory disease; *HTN,* hypertension; *JVD,* jugular venous distension.

every 10 mL/minute decrease in GFR is associated with an increase in mortality of 7%.[71,72]

Troponin testing can assist in prognostication and in the detection of underlying ischemia as a potential inciting event for AHF. Elevated troponin levels are associated with higher re-hospitalization rates and 90-day mortality.[17,18,48,49] Troponin elevation is common in AHF, as one study found elevated troponin levels in 98% of patients with diagnosed AHF, with 81% of the levels above the 99th percentile.[73] Other studies have suggested that this may be closer to 30-50%.[3,4,30] However, an elevated troponin is not specific for ACS and may be seen with a variety of other causes, including demand ischemia and renal dysfunction.[17,18,48-50]

Natriuretic peptides (ie, BNP and NT-proBNP) may be a valuable adjunct when the provider is unclear of the diagnosis.[57-59,74-77] BNP is produced by cardiac myocytes when exposed to significant myocardial stretch. Use of BNP and NT-proBNP may be sensitive, but not specific for the diagnosis of AHF. Levels less than 100 picograms (pg) per milliliter (mL) for BNP have demonstrated a sensitivity and specificity of 93.5% and 52.9%, respectively, with negative likelihood ratio (LR-) of 0.2.[57-59] Using a 300 pg/mL cut-off for NT-proBNP demonstrates a LR- of 0.09.[59] However, elevated levels only moderately increase the likelihood of AHF, as specificity improves to 72.9% with a value of 1550 pg/mL for NT-proBNP.[59,74-79] A BNP level > 400 pg/mL or a NT-proBNP level > 900 pg/mL is consistent with AHF; however, in patients over the age of 75 years, the NT-proBNP level should be increased to 1800 pg/mL.[3,4,30,74-77] Obesity can falsely lower the natriuretic peptides levels,[3,4,30,74-76,79] while renal disease may falsely elevate levels (especially with GFR < 60 mL/min).[74,75,80,81]

Other conditions associated with elevations in natriuretic peptide levels include pulmonary embolism, pulmonary hypertension, valvular heart disease, and acute respiratory distress syndrome. BNP levels of 100-400 pg/mL and NT-proBNP levels of 300-900 pg/mL are non-specific and may require further testing.[74-77,82-87] Although these biomarkers may assist in differentiation of other conditions, studies have not demonstrated improved patient-centered outcomes with use of natriuretic peptides .[86-88] Observational trial data suggest natriuretic peptides demonstrate sensitivity over 90%, but specificity is poor.[80,88-92] Data from randomized, controlled trials found that knowledge of the BNP levels did not significantly change the ED treatment, mortality, or readmission rates; however, it may decrease hospital length of stay and total cost.[76,93-99]

**Electrocardiogram**

An ECG should be rapidly obtained to evaluate for the etiology or precipitating factors (eg, ACS, atrial fibrillation with rapid ventricular response, ventricular dysrhythmia).[3,4,26,57,59]

An ECG is unlikely to diagnose or exclude AHF in isolation.[57,59,100,101] Prolonged QRS and junctional rhythms are associated with worse patient outcomes.[100,101] Table 3 demonstrates ECG findings in AHF.[57,100,101]

**Imaging**

Imaging is an important component in the patient with suspected heart failure. The most common modality used is the chest radiograph (CXR). Several findings suggest the diagnosis of heart failure on CXR, including cardiomegaly, central vascular congestion, and interstitial edema (Table 4).[17,18,41,102] However, a normal CXR should not be used to exclude the diagnosis of AHF, as up to 20% of CXRs may appear normal in AHF.[4,102-106] Studies evaluating physician accuracy with identifying AHF on CXR have demonstrated sensitivities of 59-74.5% and specificities of 86.3-96%.[59,103-105] While CXR should not be used to exclude AHF, it can be valuable for identifying alternate disease processes that may mimic AHF.[3,4,102-105]

Bedside ultrasound can be valuable for diagnosing AHF, with high specificity and positive likelihood ratios (Table 5). Ultrasound can be used to evaluate for B-lines, pleural effusions, inferior vena cava size and respiro-phasic variability, and cardiac contractility.[59,106-108] B-lines are vertical artifacts that result from sound wave reverberation through fluid-filled pulmonary interstitium. The presence of greater than three B-lines in two bilateral lung zones defines a positive lung ultrasound examination.[56,106-113] The number of lung zones examined varies in the literature, with eight thoracic lung zones used in the initial lung ultrasound protocols, while newer studies have used four or six lung zones. B-lines demonstrate high sensitivity and specificity for interstitial edema,[59,107,108] while the identification of pleural effusions is not as helpful.[59]

Assessment of EF on ultrasound may be assessed with visual assessment or quantitative measurements. Qualitative visual estimation is made by assessing the inward movement of the interventricular septum and inferior wall of the LV during systole.[59,106-113] E-point septal separation (EPSS) is a quantitative measurement assessing the distance between the anterior mitral valve leaflet and ventricular septum. An EPSS measurement > 7 mm is suggestive of an EF < 50%.[111-114] Ultrasound can also estimate intravascular volume through the measurement of inferior vena cava diameter and percentage change during the respiratory cycle. However, diagnostic performance is controversial, with many confounding factors and a wide range of sensitivities and specificities.[115-117] One study found that by using a combination of lung, cardiac, and inferior vena cava ultrasound, the authors were able to improve diagnostic accuracy by 20%.[118] Others have suggested that combining CXR with ultrasound may increase the sensitivity and specificity for diagnosing AHF.[103]

**Table 3.** Electrocardiogram findings in acute heart failure.[59]

| Finding | Sensitivity (95% CI) | Specificity (95% CI) | +LR (95% CI) | -LR (95% CI) |
|---|---|---|---|---|
| Ischemic changes | 34.0 (29.8–38.4) | 84.2 (81.2–86.9) | 2.9 (1.2–7.1) | 0.78 (0.73–0.84) |
| T-wave inversion | 10.0 (7.5–13.0) | 95.9 (92.3–98.1) | 2.4 (1.2–4.8) | 0.94 (0.90–0.98) |
| ST depression | 5.6 (3.9–7.7) | 96.5 (94.2–98.1) | 2.0 (1.0–3.8) | 0.97 (0.95–1.00) |
| ST elevation | 5.2 (2.1–10.5) | 91.8 (83.8–96.6) | 0.6 (0.2–1.7) | 1.03 (0.96–1.11) |
| Atrial fibrillation | 20.5 (18.3–22.9) | 89.9 (87.9–91.7) | 2.2 (1.4–3.5) | 0.88 (0.85–0.91) |
| Normal sinus rhythm | 55.4 (50.9–60.0) | 17.8 (15.1–20.8) | 0.7 (0.5–0.9) | 2.88 (1.26–6.57) |

*CI,* confidence interval; *LR,* likelihood ratio.

**Table 4.** Chest radiograph findings in acute heart failure.[59]

| Finding | Sensitivity (95% CI) | Specificity (95% CI) | +LR (95% CI) | -LR (95% CI) |
|---|---|---|---|---|
| Kerley B lines | 9.2 (6.5–12.5) | 98.8 (97.3–99.6) | 6.5 (2.6–16.2) | 0.88 (0.69–1.13) |
| Interstitial edema | 31.1 (28.2–34.2) | 95.1 (93.6–96.3) | 6.4 (3.4–12.2) | 0.73 (0.68–0.78) |
| Cephalization | 44.7 (41.1–48.4) | 94.6 (92.6–96.3) | 5.6 (2.9–10.4) | 0.53 (0.39–0.72) |
| Alveolar edema | 5.7 (4.7–6.9) | 98.9 (98.4–99.3) | 5.3 (3.3–8.5) | 0.95 (0.94–0.97) |
| Pulmonary edema | 56.9 (54.7–59.1) | 89.2 (87.9–90.4) | 4.8 (3.6–6.4) | 0.48 (0.39–0.58) |
| Pleural effusion | 16.3 (13.7–19.2) | 92.8 (90.4–94.7) | 2.4 (1.6–3.6) | 0.89 (0.80–0.99) |
| Cardiomegaly | 74.7 (72.9–76.5) | 61.7 (59.4–63.9) | 2.3 (1.6–3.4) | 0.43 (0.36–0.51) |

*CI,* confidence interval; *LR,* likelihood ratio.

**Table 5.** Bedside ultrasound findings in acute heart failure.[59,107]

| Finding | Sensitivity (95% CI) | Specificity (95% CI) | +LR (95% CI) | -LR (95% CI) |
|---|---|---|---|---|
| Positive B lines | 94.1 (81.3-98.3) | 92.7 (90.9–94.3) | 12.4 (5.7-26.8) | 0.06 (0.02–0.22) |
| Pleural effusion | 63.5 (50.4–75.3) | 71.7 (61.4–80.6) | 2.0 (1.4–2.8) | 0.49 (0.22–1.10) |
| Reduced EF | 80.6 (72.9–86.9) | 80.6 (74.3–86.0) | 4.1 (2.4–7.2) | 0.24 (0.17–0.35) |
| Increased LV end-diastolic dimension | 79.6 (65.7–89.7) | 68.6 (50.7–83.1) | 2.5 (1.5–4.2) | 0.30 (0.16–0.54) |
| Restrictive mitral pattern | 81.5 (68.6–90.7) | 90.1 (80.7–95.9) | 8.3 (4.0–16.9) | 0.21 (0.12–0.36) |

*CI,* confidence interval; *LR,* likelihood ratio; *EF,* ejection fraction; *LV*, left ventricular.

## Disposition

Due to the heterogenous nature of heart failure, disposition may be challenging. The majority of patients presenting to the ED in the U.S. with AHF are admitted.[12-14] Patients with hemodynamic instability or critical illness should be admitted to an intensive care unit, and patients with newly diagnosed HF may benefit from admission for further evaluation and management.[17,18,21,119] Other patients who may require admission include those with poor response to medical treatment or inability to obtain follow-up, significant electrolyte abnormalities, elevated blood urea nitrogen or creatinine, or ischemia on ECG or biomarker testing.[120] In those with prior history of HF and the absence of the aforementioned items, risk stratification tools such as the Emergency Heart Failure Mortality Risk Grade or the Ottawa Heart Failure Risk Score may be able to identify a select subset of low-risk patients, but these scoring systems require further validation.[120-124]

## CONCLUSION

Heart failure is a common presentation to the ED, which can be confused with other clinical conditions. Acute heart failure refers to the gradual or rapid decompensation of heart failure, resulting from either fluid overload or maldistribution. Typical symptoms can include dyspnea, orthopnea, or edema. The physical examination may reveal pulmonary rales, an S3 heart sound, or extremity edema. Laboratory studies should include an electrocardiogram, complete blood count, basic metabolic profile, coagulation studies, troponin, brain natriuretic peptide, and a chest radiograph. Point-of-care ultrasound can facilitate the diagnosis by assessing for B-lines, cardiac function, and inferior vena cava size. Understanding the diagnostic approach can improve the diagnostic accuracy and allow for more rapid initiation of the correct intervention.

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# Impact of Global Budget Revenue Policy on Emergency Department Efficiency in the State of Maryland

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**Introduction:** On January 1, 2014, the State of Maryland implemented the Global Budget Revenue (GBR) program. We investigate the impact of GBR on length of stay (LOS) for inpatients in emergency departments (ED) in Maryland.

**Methods:** We used the Hospital Compare data reports from the Centers for Medicare and Medicaid Services (CMS) and CMS Cost Reports Hospital Form 2552-10 from January 1, 2012–March 31, 2016, with GBR hospitals from Maryland and hospitals from West Virginia (WV), Delaware (DE), and Rhode Island (RI). We implemented difference-in-differences analysis and investigated the impact of GBR implementation on the LOS or ED1b scores of Maryland hospitals using a mixed-effects model with a state-level fixed effect, a hospital-level random effect, and state-level heterogeneity.

**Results:** The GBR impact estimator was 9.47 (95% confidence interval [CI], 7.06 to 11.87, p-value<0.001) for Maryland GBR hospitals, which implies, on average, that GBR implementation added 9.47 minutes per year to the time that hospital inpatients spent in the ED in the first two years after GBR implementation. The effect of the total number of hospital beds was 0.21 (95% CI, 0.089 to 0.330, p-value = 0 .001), which suggests that the bigger the hospital, the longer the ED1b score. The state-level fixed effects for WV were -106.96 (95% CI, -175.06 to -38.86, p-value = 0.002), for DE it was 6.51 (95% CI, -8.80 to 21.82, p-value=0.405), and for RI it was -54.48 (95% CI, -82.85 to -26.10, p-value<0.001).

**Conclusion:** Our results indicate that GBR implementation has had a statistically significant negative impact on the efficiency measure ED1b of Maryland hospital EDs from January 2014 to April 2016. We also found that the significant state-level fixed effect implies that the same inpatient might experience different ED processing times in each of the four states that we studied. [West J Emerg Med. 2019;20(6)885-892.]

## INTRODUCTION

The escalating cost of healthcare in the United States is unsustainable. In 2016 spending reached 17.9% of the gross domestic product, or $10,348 per person.[1] Many studies on healthcare reform in the U.S. focus on the factors driving the nation's high level of expenditure.[2-6] The payment system is the subject of one major stream of research.

### All-Payers Payment System and Total Patient Revenue

The State of Maryland is at the forefront of healthcare

reform in the U.S. The state is unique in its implementation of an all-payers payment system for hospitals. The system is governed by the Health Services Cost Review Commission (HSCRC), which sets hospital rates for all providers for both inpatient and outpatient services.[7] In 1977 the federal government granted the state a Medicare waiver that required government payers to abide by HSCRC hospital rates. Global Budget Revenue (GBR) is a revision of this waiver and was implemented in 2014. GBR drives a value-based healthcare service by setting global budgets for acute care hospitals, i.e., creating a capitated system for hospitals.

In 2011, Maryland implemented the Total Patient Revenue (TPR) program, a revenue constraint policy designed by the HSCRC. TPR was implemented as a pilot project in 12 Maryland hospitals located primarily in rural and geographically isolated parts of the state. Under TPR, these pilot hospitals were guaranteed a certain annual revenue calculated from a formula based on the prior year's revenue and reasonable annual adjustments. This structure provided an incentive to control costs by reducing unnecessary hospitalizations and inpatient resources. Communities were rewarded for the development of robust outpatient resources and improving the health of the population. Based on the success of TPR, the state and federal government moved forward with GBR on a statewide basis.

*Population Health Research Capsule*

What do we already know about this issue?
*In January 2014 Maryland began the Global Budget Revenue (GBR) program. Its goals include improving the health of communities and patient experience while lowering costs.*

What was the research question?
*What was the impact of GBR on emergency department performance and efficiency in Maryland?*

What was the major finding of the study?
*At the patient level, GBR implementation correlates with longer ED length of stay for admitted patients.*

How does this improve population health?
*Our results indicated that GBR implementation had a statistically significant negative impact on the efficiency performance of Maryland hospital EDs.*

**Global Budget Revenue**

On January 1, 2014, the State of Maryland began the GBR program with the main goals of improving the health of communities, improving the patient experience, and lowering the cost of healthcare services for all patients. In contrast to the 36-year-old waiver policy that preceded it, GBR guarantees a hospital's annual revenue by calculating global budget based on market share. Adjustments in global budgets are tied to changes in market share and the state's gross domestic product. In some ways, GBR is an extension of TPR. However, GBR is not a voluntary program; it requires every Maryland hospital to participate. The main difference is that TPR was implemented in geographically isolated areas of the state where catchment areas are clear. Hospitals under GBR operate in more competitive market environments.[7] In the online appendix, Table A1 lists the names of the Maryland hospitals that are under the GBR program.

In the past, hospital revenue was directly linked to the number of medical services that the hospital provided. In contrast, under GBR and TPR, each hospital's total annual revenue is defined by the HSCRC and known at the beginning of each fiscal year. The hospital margin is the difference between the global budget and annual cost. As a result, hospitals are motivated to control costs while maintaining or growing market share.[7-10]

**Medicaid Expansion**

Medicaid is a state and federal jointly-funded healthcare insurance program for low income Americans. The Medicaid program was expanded to individuals with annual incomes below 138% of the federal poverty level when the Patient Protection and Affordable Care Act (also referred to as the Affordable Care Act [ACA] or Obamacare) was passed. Maryland is one of 33 states that adopted the Medicaid expansion. This ACA provision was implemented on January 1, 2014, 10 days before GBR began.

**Emergency Department Efficiency**

Emergency departments (ED) have taken on an increasingly important role in the healthcare system and are often cited as a key contributor to rising costs.[8,11] The ED is an important hospital-based service; GBR, because of its focus on cost control, could have an impact on ED efficiency. We selected the length of stay (LOS) or ED1b (efficiency measure); see online appendix section A3) for admitted patients as our dependent variable. LOS is a Centers for Medicare and Medicaid Services (CMS) metric designed to measure the impact of hospital throughput on ED patients. Multiple studies document the deleterious effect of prolonged ED stays on quality of care.[12-14]

Our research focused on the impact of GBR on ED performance and efficiency in Maryland. Our study was confounded by the nearly simultaneous implementation of Medicaid expansion with GBR. To control for the effect of Medicaid expansion on Maryland's EDs, we compared our results with three geographically proximate states that had also adopted Medicaid expansion: West Virginia (WV), Delaware (DE), and Rhode Island (RI).

## METHODS

### Data

GBR was implemented on January 1, 2014. Our study period ran from January 1, 2012–March 31, 2016. We define January 1, 2012–September 30, 2013, as the pre-treatment period and April 1, 2014–March 31, 2016, as the post-treatment period. The six-month gap between September 2013 and April 2014 is omitted from our study and represents the transition period of GBR implementation and Medicaid expansion. As we used publicly available, administrative datasets that do not include data about individuals, institutional review board review was not sought.

### Data Sources

The overall data for our study combines three datasets. The first dataset uses data from the CMS Cost Reports Hospital Form 2552-10.[15] This form is generated by Medicare-certified institutional providers and is required in order to achieve settlement of costs (in total and for Medicare).[15] From the variables available in these reports, we chose TOTAL_HOSPITAL_BEDS, which is the total number of hospital beds during the fiscal year.

The second dataset is the CMS Hospital Compare data.[16] This dataset has a variety of reports about the quality of care delivered by hospitals. We used two of these reports: Emergency Department Throughput before July 17, 2014, and Timely and Effective Care after July 2014. These reports contain many measurement scores including ED1b. We used the hospital-level ED1b score as our main outcome variable and state-level annual reports to describe the trend among the four states studied. Table 1 presents the CMS Hospital Compare data reports that we used and their measurement periods.

GBR agreements were signed on July 1, 2013, and hospitals were able to extend the implementation deadline until October to make modifications. This means that hospitals could have implemented GBR at different times, so we designated a six-month window (October 1, 2013–March 31, 2014) as the treatment implementation period.

The third dataset is the Kaiser Family Foundation (KFF) database.[17] KFF is a non-profit organization focusing on national health issues that provides data for policy analysis and research. The data and reports that we used were the following:

**Table 1.** CMS Hospital Compare data report dates and measurement periods.

| Report ID | Measurement period |
|---|---|
| 20130701 | 1/1/2012-9/30/2012 (pre) |
| 20140717 | 10/1/2012-9/30/2013(pre) |
| 20151210 | 4/1/2014-3/31/2015 (post) |
| 20161219 | 4/1/2015-3/31/2016 (post) |

Hospital Beds per Thousand Population 2012-2015,[18-20] Hospital Emergency Room Visits per Thousand Population 2012-2015,[21] and Total Medicaid Managed Care Enrollment 2011-2015.[22] These data and reports all provide state-level information.

Merging the data gave us a total of 353 ED1b reports from Maryland, WV, RI, and DE from January 1, 2012–March 31, 2016. There are 24 reports from DE, 135 from Maryland, 44 from RI, and 150 from WV.

### Methodology

In this study, we used the difference-in-differences method (DID), which is widely used in healthcare management and policy analysis.[23-28] DID determines two differences and calculates the treatment or policy effect by determining the difference of the two differences. Examples of studies using DID include that work by Tiemann and Schreyogg on the impact of privatization on hospital efficiency in Germany.[27] Buchner et al. used DID to study the impact of health system entry on hospital efficiency and profitability.[28]

In our study, the first difference is the comparison of a GBR, hospital's performance before and after GBR implementation. The second difference is the comparison of scores from a group of control hospitals in the same time frame. Finally, we used the second difference from the control group to rule out the part of the first score difference that is not influenced by GBR. This allowed us to estimate the treatment effect within the treatment group. More precisely, GBR adoption was considered the treatment, the hospitals implementing GBR constituted the treatment group, and hospitals not implementing GBR but otherwise similar (in their adoption of Medicaid Expansion, for example) were considered the control group. This allowed us to identify the treatment effect due to the impact of GBR as opposed to Medicaid expansion or other industry-wide trends.

The treatment group was all Maryland hospitals that adopted GBR on January 1, 2014, but did not participate in the TPR program. According to the Annual Report on Selected Maryland General and Special Hospital Services Fiscal Year 2016,[10] Maryland has 46 EDs located in general hospitals. Of those 46 hospitals, 10 rural hospitals have participated in the TPR program since July 2010 and are, therefore, excluded from the analysis. The control group includes hospitals from WV, RI, and DE. These three states adopted the original Medicaid expansion on January 1, 2014, at the same time as Maryland, but did not implement the GBR or TPR programs. The main reason that we chose these three as our control group is that Medicaid expansion might have caused and been accompanied by some unmeasurable changes in patient behavior. For example, people who were newly eligible for Medicaid after the expansion would have had different strategies for choosing healthcare providers. We assumed that people from the four states exhibited similar patterns in their reactions to Medicaid expansion. The online appendix section A2 provides the logic behind the selection of the control group.

### Model and Setup

We formatted the final dataset into an unbalanced panel dataset and implemented a mixed-effects, linear regression model with a state-level fixed effect, a hospital-level random effect, and state-level heterogeneity to investigate the impact of GBR implementation on the ED1b scores of Maryland hospitals. The variables considered in our model are listed in Table 2 (see online appendix sections A4 and A5 for more details on our model).

### Sensitivity Analysis

We conducted three types of sensitivity analysis. The first analysis assessed whether our treatment effect estimates were sensitive to the length of the first report period. In our study, we used four CMS Hospital Compare data reports. The first report covers the nine-month period from January 1, 2012 –September 30, 2012, and the remaining three are 12-month period reports. Then, we introduced the report length into the model for the sensitivity analysis.

Second, to assess whether our estimates were sensitive to each state in the control group, we conducted three sensitivity analyses using three alternative control groups. In the first alternative control group, we removed the hospitals in WV counties with smaller populations (less than 45,000), since Maryland counties in our study have at least 45,000 residents. This left 18 WV hospitals in the control group. In the other two alternative control groups, we removed all hospitals from RI and then from DE. Third, we conducted a robustness check on the relationship between the number of hospital beds and resulting ED1b score by dropping hospitals with more than 500 beds.

**Table 2.** Variables considered in our model.

| Variables | Description |
|---|---|
| *ED1b* | Hospital's ED1b score |
| *ri* | Indicator variable for Rhode Island |
| *wv* | Indicator variable for West Virginia |
| *de* | Indicator variable for Delaware |
| *bed* | Number of beds in the hospital |
| *t* | Time |
| *period* | Indicator variable for post-treatment period |
| *tt* | GBR impact estimator |
| *medicaid* | Medicaid enrollment percentage of the population in each state |
| *edvperpop* | Hospital emergency department visits per thousand population of each state |
| *const* | Constant |

## RESULTS

### Model Results

Table 3 summarizes some general information about the four states involved in our study.

Table 4 shows the coefficient estimates under the panel data setting with mixed effects, clustered error on the state level using generalized least squares (GLS). The estimated coefficient of the variable *tt* (GBR impact estimator) was 9.466872 with a $p$-value<0.001, implying that GBR had a statistically significant impact on ED LOS (ED1b) in Maryland's GBR hospitals. On average, GBR implementation added 9.47 minutes per year to the time hospital inpatients spend in the ED after controlling other factors in the model. As shown in the results, WV (*wv coef.* = -106.9579, $p$-value = 0.002) had the best overall ED1b performance, and RI (*ri coef.*=-54.47875, $p$-value <0.001) performed the second best among the four states.

The significant $p$-values of variables *wv* and *ri*, which are state-level, fixed-effect variables, imply that patients admitted through EDs with similar medical problems and conditions from WV, RI, and Maryland might experience significantly different time in EDs. The effect of the total number of hospital beds (*bed coef.* = 0.2096206, $p$-value = 0.001), which is positively associated with ED1b scores as shown in Figure 1, provides strong evidence that the bigger the hospital, the longer the ED1b. The time variable (*t coef.* = 1.393201, $p$-value <0.001) implies that during our study period, the hospitals' ED1b performance, on average, became worse overall in all four states.

### Sensitivity Analyses

In the first sensitivity analysis, we introduced the report length into the model. The regression estimator for length (*length coef.* = -1.341053, $p$-value = 0.384) implies the shorter time period in the first report does not impact the ED1b score. (See online appendix, Table A9.) In the second sensitivity analysis, we introduced the total number of registered nurses per thousand population and the hospital beds per thousand population at the state level to describe the changes in available healthcare resources. Table 5 summarizes the sensitivity analysis estimates for the GBR effect. The regression results show that adding the two new variables or using the three alternative control groups is consistent with our main results. The incremental time estimate for each model in Table 5 is approximately nine minutes.

Fourth, after dropping hospitals with more than 500 beds, the number of hospital beds (*bed coef.* = 0.270943, $p$-value<0.001) is still positively associated with a hospital's ED1b score. Online appendix section A6 provides the details of the sensitivity analysis.

## DISCUSSION

At the patient level, GBR implementation correlates with longer ED LOS for patients being admitted to the hospital. We believe that this implies that GBR has fundamentally changed the way emergency physicians and hospital staff approach the hospitalization decision. The Evaluation of the Maryland All-

**Table 3.** Hospitals per 10,000 population.

| State | Number of hospitals* | Population (2013)** | Hospitals per 10,000 population |
|---|---|---|---|
| Maryland | 50 | 5,928,814 | 0.084 |
| West Virgina | 54 | 1,854,304 | 0.29 |
| Rhode Island | 11 | 1,051,511 | 0.10 |
| Delaware | 7 | 925,749 | 0.076 |

*1999-2015 American Hospital Association Survey.[19]
**Annual estimates of the resident population for states 2013.[18]

**Table 4.** Regression results from panel setting with mixed effects and state-level heterogeneity (GLS estimator).

| Variables | Coefficient Estimator | Confidence interval (95%) |
|---|---|---|
| *ri* | -54.47875** | (-82.85274, -26.10476) |
| *wv* | -106.9579* | (-175.0596, -38.85614) |
| *de* | 6.510064 | (-8.798204, 21.81833) |
| *t* | 1.393201** | (0.721995, 2.064408) |
| *tt* | 9.466872** | (7.062948, 11.8708) |
| *bed* | 0.2096206** | (0.0893118, 0.3299294) |
| *medicaid* | -0.6514587 | (-1.663111, 0.3601937) |
| *edvperpop* | -0.0064578 | (-0.2680708, 0.2551552) |
| *const* | 342.5963** | (239.5974, 445.5952) |

*p-value ≤0.01, **p-value ≤0.001
*GLS*, generalized least squares.

Payer Model Second Annual Report funded by CMS in 2017 emphasized that GBR targeted both healthcare cost and quality.[9] The model has encouraged more workup and interface with case managers in the ED; the objective is to ensure patient safety and high-quality care in the community in lieu of admission for appropriate patients. These changes were likely contributing factors to the increase in the total timespan for the care of an ED patient. Future work includes a study on whether and how Maryland hospital EDs adopted new strategies or modified their procedures for healthcare service delivery in response to the implementation of GBR. It remains to be seen if the changes in Maryland hospital EDs had or will have a substantial impact on Maryland's healthcare system.

We found significant differences among the three Medicaid expansion states to which Maryland was compared. WV and RI had significantly shorter ED1b scores for admitted patients than Maryland. Delaware's score was slightly longer. After applying sensitivity analysis using three alternative control groups, we found that the difference between Maryland's ED1b and those different control groups remained significant. GBR, a state policy, is correlated with longer LOS for admitted patients. In our study, the state-level fixed effect is significant. Nevertheless, there may well be unidentified confounders that influenced our results.

According to Benjamin C. Sun, professor of emergency medicine at Oregon Health and Science University in Portland, "It's not really fair to compare, say, a public teaching hospital in the middle of New York City that sees 120,000 patients with one that is in a rural area that sees 5,000 patients."[29] Similarly, it may not be fair to simply compare ED scores across states. Our comparison across states assumes similar demographics and disease burdens, both of which could affect hospital utilization. Also, we are assuming similar admission practices across states. More particularly, we assume the changes in Maryland inpatient census other than affected by the implementation of Medicaid expansion and GBR can be controlled by our control group. In February 2017, a news report stated that "Maryland ER wait times are the worst in the nation," a conclusion derived by simply comparing the ED scores published by CMS Hospital Compare.[30] Viewed in this light, interpreting the significant state-level fixed effect obtained in our study without clarifying factors that may be unique or particular to each state, might confuse, rather than clarify, perceptions of hospital ED performance.

## LIMITATIONS

We acknowledge several other limitations in our study. The GBR policy was adopted on January 1, 2014, 10 days after Maryland began Medicaid expansion. The control group hospitals then had to come from neighboring states that also implemented

traditional Medicaid expansion at the same time, thus, limiting our control group to WV, RI, and DE. Of these states, RI and DE have few hospitals. Another limitation was the incomplete report data. Overall, the reporting rate of the control group is 75%. According to KFF Total Hospital Reports,[31] there should be 290 Hospital Compare data reports from CMS. However, we found only 218 complete reports. It is possible that the missing data might have some impact on our results.

Another limitation is the possibility that unmeasured confounding factors may have affected ED LOS. Factors such as hospital closures, demographics, or shifts in access to care could have affected our results. To eliminate the effect of those possible confounding factors, the ideal measure would be the volume of each hospital's ED visits. CMS started to collect volume data on January 22, 2015. However, some states in our study only started to report this measure on November 10, 2016. Therefore, we selected features other than volume data and note that we might not have been able to eliminate all effects.

We were also limited in our choice of performance measure ED1b, which reflects the total time inpatients spend in the ED. Ideally our study would examine both ED1b and the corresponding outpatient measure, OP18. However, CMS only maintains Maryland State OP18 reports going back to January 1, 2014. As there is no data for the pre-treatment period, we cannot study the impact of GBR on the OP18 measure. Our design assumed that residents living in the four geographically close

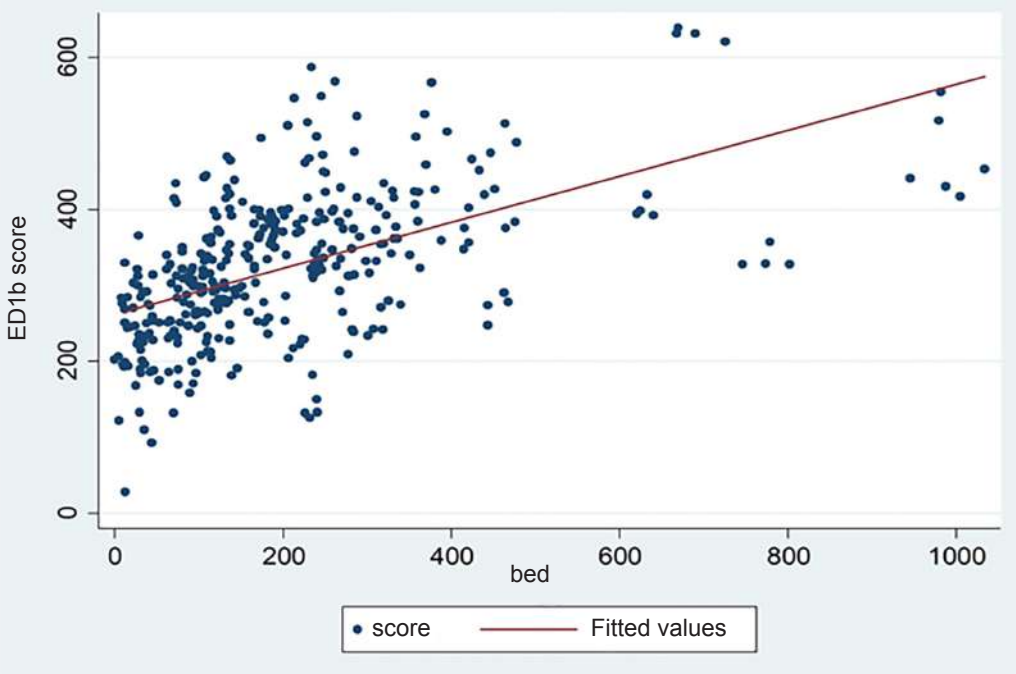


**Figure 1.** Scatter plot of ED1b scores vs total number of hospital beds.

**Table 5.** Summary of the sensitivity analysis.

| Model | GBR Effect Estimate | 95% Confidence Interval |
|---|---|---|
| Mixed model | 9.466872* | (7.062948, 11.8708) |
| Adding length of report period | 8.480697* | (7.851343, 9.110051) |
| Adding registered nurses per thousand population and hospital beds per thousand population | 8.825362* | (7.197024, 10.4537) |
| Control group with partial WV | 10.90678* | (6.785388, 15.02817) |
| Control group without DE | 9.85151* | (7.934328, 11.76869) |
| Control group without RI | 8.422524* | (7.44502, 9.400028) |

*p-value ≤0.001
*GBR,* Global Budget Revenue; *WV,* West Virginia; *DE,* Delaware; *RI,* Rhode Island.

states shared similar reaction patterns to the Medicaid expansion. Then, from an aggregate point of view at the hospital level, we assumed that our control group could rule out the impact of Medicaid expansion on Maryland ED LOS. It is possible that not every hospital was affected by Medicaid expansion at the same proportion, which might have affected the estimates. Also, our secondary finding, the significant difference in time spent in EDs across the four states, should be further investigated by analyzing data from the Nationwide Emergency Department Database.

## CONCLUSION

We conducted an empirical analysis of the impact of GBR implementation on Maryland ED efficiency measure ED1b from January 2014–April 2016. Our results indicated that GBR implementation had a statistically significant negative impact on the efficiency performance of Maryland hospital EDs. The mean 2014 ED1b score was 398.6 minutes, and our study showed an average increase of 2.4%, or 9.47 minutes per year, in the first two years after the implementation of GBR. We also found that the significant state-level fixed effect implies that the same inpatient might experience different ED processing times in each of the four states that we studied. Further research is indicated to explore the dynamics of GBR including the reasons for increasing ED length of stay.

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# Efficacy of a Short Role-Play Training on Breaking Bad News in the Emergency Department

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**Introduction:** Breaking bad news (BBN) in the emergency department (ED) represents a challenging and stressful situation for physicians. Many medical students and residents feel stressed and uncomfortable with such situations because of insufficient training. Our randomized controlled study aimed to assess the efficacy of a four-hour BBN simulation-based training on perceived self-efficacy, the BBN process, and communication skills.

**Methods:** Medical students and residents were randomized into a 160-hour ED clinical rotation without a formal BBN curriculum (control group [CG], n = 31) or a 156-hour ED clinical rotation and a four-hour BBN simulation-based training (training group [TG], n = 37). Both groups were assessed twice: once at the beginning of the rotation (pre-test) and again four weeks later. Assessments included a BBN evaluation via a simulation with two actors playing family members and the completion of a questionnaire on self-efficacy. Two blinded raters assessed the BBN process with the SPIKES (a delivery protocol for delivering bad news) competence form and communication skills with the modified BBN Assessment Schedule.

**Results:** Group-by-time effects adjusted by study year revealed a significant improvement in TG as compared with CG on self-efficacy ($P < 0.001$), the BBN process ($P < 0.001$), and communication skills ($P < 0.001$). TG showed a significant gain regarding the BBN process (+33.3%, $P < 0.001$). After the training, students with limited clinical experience prior to the rotation showed BBN performance skills equal to that of students in the CG who had greater clinical experience.

**Conclusion:** A short BBN simulation-based training can be added to standard clinical rotations. It has the potential to significantly improve self-efficacy, the BBN process, and communication skills. [West J Emerg Med. 2019;20(6)893-902.]

## INTRODUCTION

Breaking bad news (BBN) is considered to be one of the most important, stressful, and challenging responsibilities of a physician.[1-6] Trainees and experienced physicians alike report being uncomfortable with this task, notably due to a lack of prior training.[6-8] For patients, the acknowledgment of this information and their comprehension and perception are of paramount importance to facilitate their psychological adjustment and a long-term quality relationship with medical caregivers.[9-12]

The BBN process has changed drastically over the past decades, moving from a paternalistic medical approach to one of greater patient empowerment, which acknowledges the need for information[13-14] and results in a greater awareness and clearer understanding of their diagnosis and prognosis.[13] Patients prefer to receive individualized, comprehensive information communicated with warmth and honesty.[15-18] Patient and family expectations regarding the exact content of news have been shown to be highly variable,[13] making it difficult for healthcare professionals to tailor the information to suit each patient.[19]

Bad news in an emergency department (ED) may consist in announcing that a relative has been admitted to the ED or in sharing with patients or their families news concerning the need for hospitalization or conditions that might lead to a life-threatening situation sooner or later.[20] BBN in the ED is a particular challenge because the patient is generally meeting the emergency physician (EP) for the first time and neither of them enter into the relationship by choice. A recent survey[21] revealed that 78.1% of BBN occurred without previous contact between the patient and the physician. Moreover, history taking, diagnosis, and the acknowledgment of bad news are usually accomplished within a very short time frame[22] during which the physician is confronted with distractions, stress, or time constraints.[23]

EP training in communication skills to notify family members of a patient's death has been reported to be poor at best,[24] leading medical students, residents and young physicians to adopt inappropriate communication behaviors,[4,25] which in turn significantly increase their stress levels.[2] Inappropriate communication behavior does not take into account the needs of patients or their families. Several guidelines have been developed in oncology to help physicians deliver bad news.[4,26-31] One of the most widespread BBN protocols is the SPIKES (Setting, Perception, Invitation, Knowledge, Emotions and Summary) protocol.[28]

BBN training in the ED has scarcely been studied to date.[32] The studies undertaken have included a limited number of participants,[33-34] no validated assessment tools[35] or control group,[34,35] or were limited to death notification only.[21,24] In this study, we assessed the effects of incorporating a four-hour ED BBN simulation-based training (BBNSBT) on self-efficacy, the BBN process, and communication skills among medical students and junior residents who rotated in the ED. We hypothesized that BBNSBT has the potential to increase self-efficacy, the BBN process, and communication skills.

*Population Health Research Capsule*

What do we already know about this issue?
*A lack of training in breaking bad news (BBN) leads to inappropriate communication behaviors. BBN protocol has been developed to help physicians to deliver bad news.*

What was the research question?
*What are the effects of a role-play on the BBN process among students who rotated in the emergency department?*

What was the major finding of the study?
*A short BBN simulation-training has the potential to improve the BBN process and communication skills.*

How does this improve population health?
*A four-hour, simulation-based training is a good way for trainees to master BBN and better inform the patients and their families on diagnosis and prognosis*

## METHODS

The ethics committee approved the study (reference number 2015/235). Only authorized individuals had access to the data and materials. The researchers did not participate in the training program.

### Training Program

*Control Group*

The control group (CG) followed the traditional 160-hour ED rotation. Trainees cared for ED patients under the supervision of EPs. The CG did not receive any formal BBN training.

*Training Group*

The training group (TG) received a traditional 156-hour ED rotation and four hours of BBNSBT.

*BBNSBT*

Participants were split into small groups up to six members. The BBNSBT involved two components: 1) a one-hour theoretical course on BBN, SPIKES and communication skills with a 15-minute video illustrating SPIKES components; and 2) a three-hour simulation including six role-plays. Three participants were included in each role-play (one playing the physician and two playing family members) while the three other participants watched the simulation. Each one took 10-15 minutes plus 20-25 minutes for a debriefing. The debriefings followed the framework for Promoting Excellence and

Reflective Learning in Simulation, using the advocacy-inquiry technique.[36-40] The debriefings focused on the SPIKES protocol and effective communication behaviors.

The following steps ensured the consistency of the BBNSBT: 1) the International Nursing Association for Clinical and Simulation Learning (INACSL) Standards of Best Practice for Simulation[SM] [41,42] were used to design the BBNSBT; 2) six experts including psychologists, EPs, and simulation instructors validated the scenarios and simulation design; 3) the same facilitators, a psychologist and an EP trained in BBN and certified as basic simulation instructors conducted training; 4) PowerPoint slides with major theory points accompanied the theoretical part of the BBNSBT; and 5) prewritten scripts were used for the role-play explanations and the debriefings.

**Recruitment**

Medical students and first-year residents specializing in emergency medicine (EM) who had recently graduated were included in the study for one academic year, between September 2017–June 2018. A convenience sample was invited to participate in the study. It included medical students (n = 64) following a one-month ED internship and first-year EM residents (n = 9) beginning their first month of internship. Each participant gave his or her signed informed consent on a voluntary basis. Five students did not complete the rotation and were excluded from the study; therefore, a total of 68 participants were included. The TG and the CG had, respectively, 37 and 31 members.

**Study Design**

The feasibility study used cluster randomization to reduce contamination bias.[43] Each month, a group of 10 to 12 medical students and first-year EM residents was randomly assigned either to the TG or the CG. Demographic data such as gender, age, BBN experience, and study year were collected. During the first week of internship, participants underwent a pre-test of their ED BBN self-efficacy and skills. During the second week, participants assigned to the TG participated in the BBNSBT. Post-testing took place four weeks later and included a self-efficacy and ED BBN assessment (Figure 1).

**Assessment Tools**

*Self-efficacy*

We assessed the BBN self-efficacy of participants using a seven-item questionnaire (supplemental material 1 specifically developed for this study, corresponding to seven skills (eg, "To manage your nonverbal communication during the BBN"). Participants rated each item on a Likert scale from 1 ("not at all") to 5 ("entirely") in three separate areas: knowledge about the skill; ability to manage the skill; and applying the skill in practice. The experts placed the content validity index of the questionnaire at 0.92.[44]

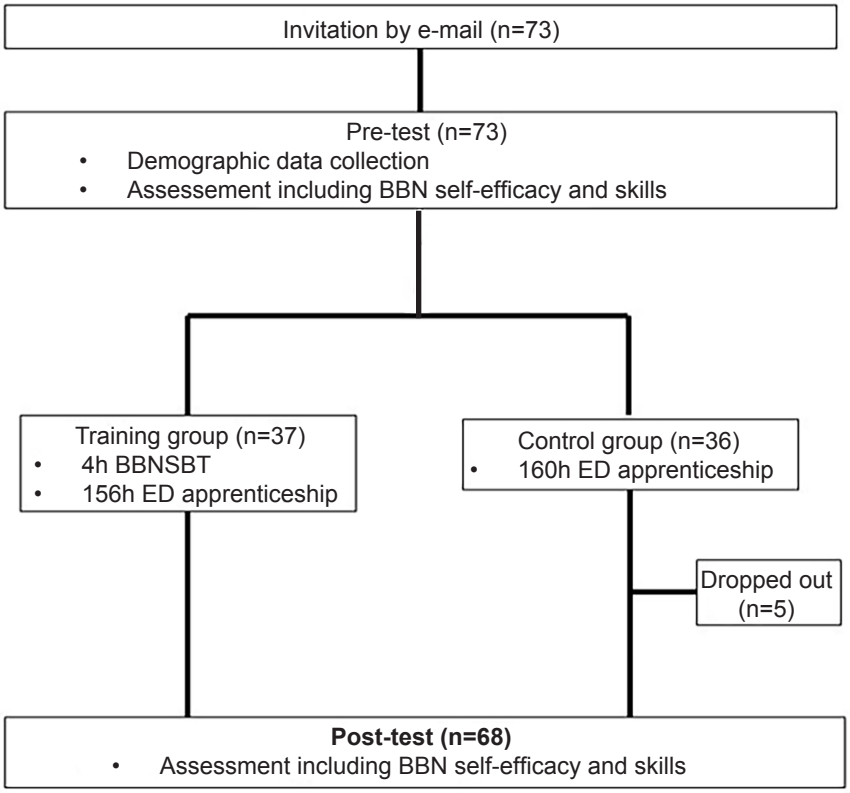


**Figure 1.** Flowchart of study examining the effect of simulation training on how trainees deliver bad news. *BBN,* breaking bad news; *BBNSBT,* BBN simulation-based training; *h,* hour; *ED*, emergency department.

*BBN Skills Assessment*

BBN skills were assessed in simulation exercises involving two standardized family members played by actors. A randomly selected BBN scenario was used to assess each participant in both pre- and post-test. The scenarios were as follows: 1) a life-threatening situation after a motorcycle accident; 2) a life-threatening cardiogenic shock; and 3) brain damage after a fight. Each trainee performed in one random scenario. The scenarios for the pre-test and the post-test were different in order to avoid memorization bias. The BBN skills assessments were video recorded and anonymized.

Two blinded raters assessed participants by using two assessment tools. The SPIKES competence form,[28] with 14 items, assessed the participants' compliance with the SPIKES protocol. Each item was scored as "yes" or "no," resulting in an overall score (range 0-14). The experts determined a cut-off score using the modified Angoff method.[45] A passing score was 11 and above, and a failing score was below 11. We used the modified Breaking Bad News Assessment Schedule (mBAS) to evaluate communication.[46] Rather than allocating points proportionally according to the results obtained, the mBAS is reversed, going from 1 (very good) to 5 (very poor). Overall scores ranged from 5-25. A passing score of 14 or lower was also set by the experts. A failing score was above 14.

Assessments were made in two rounds. In the first round, raters independently rated the video. If items were adjacent raw disagreements between raters (more than a one-point difference), they watched the video together, discussed it, and scored it again.

**Statistical Analysis**

The investigators entered the data collected into the R software, version 3.4.1 (the R Foundation). The statistician used SAS version 9.4 (Cary, NC). We compared the homogeneity of the CG and of the TG at pre-test with $\chi 2$ test and Fisher's exact test for qualitative variables and with the Mann-Whitney U test for quantitative parameters.

A generalized linear mixed model[47] (GLMM) measured changes before and after the BBNSBT in self-efficacy, the SPIKES competence form and the mBAS. We adjusted the effects of time, group, and group-by-time by the study year as a confounding factor. GLMMs were performed with a covariance matrix of the compound symmetry type.[48] We performed the McNemar's test to compare the proportion of students who passed the SPIKES competence form and the mBAS cut-offs between pre-test and post-test within the groups.

Furthermore, two further analyses were considered. First, we calculated the relative gains between pre-and post-test within the two groups by means of the following formula: [(post-test – pre-test) / pre-test]. A Mann-Withney U test was used to compare relative gains. Second, we tested whether the BBNSBT could help fill the performance gap between participants with limited clinical experience (less than one year) in the TG and participants with clinical experience (more than one year) in the CG by means of a Mann-Whitney U test. Results were considered statistically significant at the 5% critical level ($p< 0.05$).

**RESULTS**

**Participants' Sociodemographic Data**

Table 1 summarizes the sociodemographic parameters for gender, age, BBN experience, study year, training before BBN simulation training, and pre-test assessment scores. No statistically significant difference was found between the TG and the CG for gender ($p = 0.24$) and BBN experience ($p = 0.44$). No participants had attended a communication skills training workshop before the BBNSBT. A statistically significant difference was found for study years ($p<0.001$). In the CG, participants were predominantly in the third or fourth year of medical school whereas in the TG, they were predominantly in their second year. There was also a statistically significant difference in mean age ($p = 0.02$), although all students were between 22 and 26 years old.

**Pre-test Assessment**

Pre-test assessment results are reported in Table 1. We found no statistically significant difference between the TG and the CG with regard to self-efficacy ($p = 0.74$). However, at baseline the CG had better scores in the SPIKES Competence Form ($p = 0.03$) and for BBN skills according to the mBAS ($p = 0.02$).

**Post-test Assessment**

Table 2 presents the results at pre-test and post-test for each group, time effect, group effect, and group-by-time effect. These effects were adjusted by study year. There was a significant group-by-time effect of the training on participants' self-efficacy ($p<0.001$). Self-efficacy improved significantly over time, with a 55% enhancement for the TG ($p<0.001$), while it fell slightly in the CG (2.6% reduction; $p = 0.5$) (Table 3). The difference between these gains in the two groups was highly significant ($p<0.001$).

A significant group-by-time effect ($p<0.001$) of the training on the BBN process was also found for the SPIKES competence form. There was a 33.3% improvement ($p<0.001$) between pre-test and post-test in the TG while there was no significant gain for the CG. The difference between these gains in the groups was statistically significant ($p<0.001$). With regard to the measurement of communication skills with the mBAS during BBN, we found a significant group-by-time effect ($p<0.001$) of the training on communication skills. There was a 23.53% reduction in the non-effective communication skills of the TG participants, but 0% in the CG. The difference between the groups was statistically significant ($p<0.001$).

**Cut-off Scores**

Table 4 shows the proportion of students deemed competent when cut-off scores were applied to the SPIKES and the mBAS between groups at pre-test and post-test, as

**Table1.** Sociodemographic characteristics and pre-test assessment scores by group.

| Parameters | | Control group (n=31) | Training group (n=37) | P-value |
|---|---|---|---|---|
| Age (years) | Median (Q1-Q3) | 24 (23-26) | 23 (22-25) | 0.02[1] |
| BBN experiencxe | n (%) | | | 0.44[2] |
| None | | 23 (74.2%) | 31 (83.8%) | |
| Occasional (1-2 times a week) | | 7 (22.6%) | 6 (16.2%) | |
| Frequent (4-5 times a week) | | 1 (3.2%) | 0 | |
| Study year[3] | n (%) | | | < 0.001[2] |
| Second-year medical student | | 8 (25.8%) | 25 (67.6%) | |
| Third-year medical student | | 14 (45.2%) | 3 (8.1%) | |
| Fourth-year medical student | | 5 (16.1%) | 4 (10.8%) | |
| EM resident | | 4 (12.9%) | 5 (13.5%) | |
| Training before BBN | n (%) | | | |
| No | | 31 (100%) | 37 (100%) | |
| Self-efficacy | Median (Q1-Q3) | 1.50 (0.79-1.85) | 1.46 (0.96 – 2.00) | 0.74[1] |
| SPIKES competence form | Median (Q1-Q3) | 10 (9-12) | 8 (7-11) | 0.03[1] |
| mBAS | Median (Q1-Q3) | 15 (14-18) | 17 (16-18) | 0.02[1] |

*BBN,* breaking bad news; *mBAS,* modified Breaking Bad News Assessment Schedule: items are reversed, from 1 (very good) to 5 (very poor); *SPIKES,* Setting, Perception, Invitation, Knowledge, Emotions and Summary; *EM,* emergency medicine.
[1]Mann-Whitney U test; [2]Fisher's exact test; [3]Study year is classified by increasing order: the lowest level is second year and the highest is emergency medicine resident.

**Table 2.** Training effects on self-efficacy, the SPIKES competence form and the mBAS: time effect, group effect and group-by-time effect for the control group and the training group.

| Parameters | Pre-test | Post-test | Time effect p-value[1] | Group effect p-value[1] | Group-by-time effect p-value[1] |
|---|---|---|---|---|---|
| Self-efficacy | | | | | |
| CG (n=31) | 1.43±0.64 | 1.32±0.71 | 0.37 | 0.62 | < 0.001 |
| TG (n=37) | 1.51±0.66 | 2.40±0.60 | | | |
| SPIKES Competence Form | | | | | |
| CG (n=31) | 9.97±2.66 | 9.93±2.93 | < 0.001 | 0.8 | < 0.001 |
| TG (n=37) | 8.62±2.55 | 11.54±2.13 | | | |
| mBAS | | | | | |
| CG (n=31) | 15.58±2.95 | 15.42±2.88 | < 0.001 | 0.96 | < 0.001 |
| TG (n=37) | 17.24±2.42 | 13.7±2.77 | | | |

*mBAS,* modified Breaking Bad News Assessment Schedule: items are reversed, from 1 (very good) to 5 (very poor); *SPIKES,* Setting, Perception, Invitation, Knowledge, Emotions and Summary; *CG,* control group; *TG,* training group.
[1]Adjusted by study year.

well as between the times within the same group. There was no statistically significant difference at pre-test between the CG and TG for the level of either SPIKES-competent students (CG 15/31, 48.4%; and TG 11/39, 29.7%) or mBAS-competent students (CG 10/31, 32.3%; and TG 4/37, 10.8).

At post-test, we found a statistically significant (p = 0.02) difference for the SPIKES cut-off score: the TG had a higher number of participants passing the cut-off score (27 students passed; 73.0%) than the CG (14 passed; 45.2%). More TG students (23 of the 37; 62.2%) passed the mBAS cut-off score than CG students (11 of the 31; 35.5%), but without a statistically significant difference (p = 0.07). While there was a statistically significant improvement in pre- and post-test scores for the TG in SPIKES and the mBAS (p<0.001 for both), we didn't find a significant change in the CG scores (SPIKES: p = 0.92; mBAS: p=0.74).

**Clinically Inexperienced Participants Benefiting from Simulation Vs Clinically Experienced with No Simulation Sessions**

Further analysis compared participants with limited clinical experience (less than one year) in the TG (n=25) and participants with clinical experience (more than one year) in the CG (n=23) (Table 5). We found no statistically significant difference between subgroups with respect to perceived self-efficacy in pre-test (p=0.13). In post-test, the difference between the two subgroups was highly significant (p<0.001). The self-efficacy of students with limited clinical experience benefiting from simulation was higher than in the more experienced group. While BBN skills were statistically higher in students with clinical experience in the CG at pre-test, (p=0.049), we observed no differences post-test in the two subgroups (p=0.34). The results showed that participants with limited clinical experience made up the difference. Analyses showed the same for communication skills during BBN.

## DISCUSSION

Medical educators aim to identify the best methods to prepare students for clinical practice. Traditional training is the common pedagogical method for learning clinical skills.[49] Trainees rarely learn BBN in real clinical practice due to the paucity of opportunities[32,50] and the fact that clinical preceptors

**Table 3.** Relative gains between pre-test and post-test for the control group and the training group.

| Parameters | Median | IQR | P-value[1] |
|---|---|---|---|
| Self-efficacy | | | |
| CG (n=31) | - 2.6 | -36.5-9.22 | < 0.001 |
| TG (n=37) | 55.6 | 24.78-148.41 | |
| SPIKES Competence Form | | | |
| CG (n=31) | 0 | -22.5-28.64 | < 0.001 |
| TG (n=37) | 33.3 | 16.67-71.43 | |
| mBAS | | | |
| CG (n=31) | 0 | -14.17-15.76 | < 0.001 |
| TG (n=37) | -23.53 | -31.25—5.88 | |

*IQR,* interquartile range; *mBAS*, modified Breaking Bad News Assessment Schedule; *SPIKES*, Setting, Perception, Invitation, Knowledge, Emotions and Summary; *CG,* control group; *TG,* training group.
[1]Mann-Whitney U test.

**Table 4.** Cut-off scores for SPIKES and the mBAS for the control group and the training group, at pre-test and post-test.

| Parameters | CG (n=31) | TG (n=37) | P-value |
|---|---|---|---|
| SPIKES cut-off pre-test | | | |
| Failed | 16 (51.6%) | 26 (70.3%) | 0.11[1] |
| Passed | 15 (48.4%) | 11 (29.7%) | |
| SPIKES cut-off post-test | | | |
| Failed | 17 (54.8%) | 10 (27.0%) | 0.02[1] |
| Passed | 14 (45.2%) | 27 (73.0%) | |
| Comparison of the success rate within groups (P-value[3]) | 0.92 | < 0.001 | |
| mBAS cut-off pre-test | | | |
| Failed | 21 (67.7%) | 33 (89.2%) | 0.07[2] |
| Passed | 10 (32.3%) | 4 (10.8%) | |
| mBAS cut-off post-test | | | |
| Failed | 20 (64.5%) | 14 (37.8%) | 0.07[1] |
| Passed | 11 (35.5%) | 23 (62.2%) | |
| Comparison of the success rate within groups (P-value[3]) | 0.74 | < 0.001 | |

*mBAS,* modified Breaking Bad News Assessment Schedule; *SPIKES*, Setting, Perception, Invitation, Knowledge, Emotions and Summary; *CG,* control group; *TG,* training group.
[1]$X^2$ test; [2]Fisher's exact test; [3]McNemar test.

**Table 5.** Comparison of the results of students with limited clinical experience in the training group and students with more than one year of clinical experience in the control group.

| | Pre-test | | | Post-test | | |
|---|---|---|---|---|---|---|
| Parameters | Median | IQR | P-value[1] | Median | IQR | P-value[1] |
| Self-efficacy | | | | | | |
| Clinical apprenticeship > 1 year (n = 23) | 1.71 | 1.01-1.98 | 0.13 | 1.18 | 0.84-2.12 | 0.001 |
| Limited clinical apprenticeship (n = 25) | 1.29 | 0.83-1.67 | | 2.14 | 1.88-2.5 | |
| SPIKES | | | | | | |
| Clinical apprenticeship > 1 year (n = 23) | 10 | 9.5-12 | 0.049 | 11 | 8-13 | 0.34 |
| Limited clinical apprenticeship (n = 25) | 8 | 7-11 | | 12 | 10-13 | |
| mBAS | | | | | | |
| Clinical apprenticeship > 1 year (n = 23) | 15 | 13-18 | 0.02 | 15 | 13-17 | 0.4 |
| Limited clinical apprenticeship (n = 25) | 17 | 17-19 | | 14 | 12-16 | |

*IQR,* interquartile range; *SPIKES*, Setting, Perception, Invitation, Knowledge, Emotions and Summary; *mBAS,* modified Breaking Bad News Assessment Schedule.
[1]Mann-Whitney U test.

are rarely available to give feedback.[3,6,32,50] At pre-test, our study shows a low level of participant experience and a lack of BBN skills, especially in the TG. Chiniara et al.[51] define the "simulation zone" as areas in which simulation education may be better suited than other methods. BBN is an example of the HALO quadrant: high impact on the patient and low opportunity to practice.

This feasibility study assessed the impact of a four-hour ED BBNSBT compared to clinical internship. It was hypothesized that BBNSBT would have the potential to increase participant self-efficacy in BBN communication and management, adherence to BBN stages and processes, and to improve communication skills during BBN. Our results revealed that this training increased self-efficacy perception. Participants had a low level of self-efficacy in pre-test. After the BBNSBT, the TG reported being more confident about their knowledge and application of BBN and about their ability to perform BBN compared to the CG. This confirms the results of another, smaller study (n = 20), which showed an improvement in confidence and self-efficacy.[52]

These findings may be explained by Bandura's social cognitive theory,[53] which suggests four ways to enhance self-efficacy that we identify in the BBNSBT: 1) enactive attainment (performing the action during the role-play simulation); 2) vicarious experience (observing the video and watching other participants in the role-plays); 3) verbal persuasion (facilitators support the students during the debriefings); and 4) psychological safety during the simulations. Moreover, the perceived self-efficacy of students in the CG with more clinical experience decreased. This result could have different potential explanations, notably that the pre-test may have led to introspection and reflection about their BBN and communication skills.

Communication with patients and their families is one of the Accreditation Council for Graduate Medical Education Milestones for EM residents, specifically the fourth level of BBN.[54,55] Our research used two validated assessment tools that allow for standardization of the evaluation and training. The results demonstrate that BBNSBT using role-playing and debriefing enhances participant BBN learning and performance compared with the traditional learning paradigm and direct immersion in acute clinical situations. BBNSBT offers the opportunity to teach BBN and communication skills to students and young residents in a psychologically safe environment, preventing harm to patients and family members. It allows each participant to announce bad news and observe several BBN simulations with debriefings.

By contrast, in the traditional curriculum role modeling at the bedside could have a negative impact on patients and relatives when medical students or residents engage in inappropriate communication behaviors,[56,57] such as not keeping patients or family members adequately informed or using medical words they do not understand. More students in the TG reached the cut-off scores: 73% for SPIKES and 62.2% for the mBAS vs 45.2% and 35.5% in the CG. These results demonstrate the relevance of BBNSBT in communicating bad news in the ED. However, the difference between the groups for the mBAS cut-off score is not significant. BBNSBT probably focuses more on SPIKES than on communication behavior. It may be necessary to create an advanced course centered on communication skills rather than on SPIKES.

Despite this, BBNSBT offers experiential learning for participants. From the simulation experience, the debriefing process leads students to explore their frames, incorporate new frames such as SPIKES skills, and re-practice these new skills. This process allows knowledge to be acquired through experience.[56] Moreover, participants had access to ED BBN experts for four hours, which, unfortunately, is unlikely to happen in real clinical practice.

Additional data analyses allowed us to address a new question: Is BBNSBT more useful for students with less

than one year of clinical experience? We found a statistically significant difference in the pre-test. Students with limited clinical experience reached the same level of BBN skills as students with more clinical experience after the BBNSBT. The gap between these groups could be filled by simulation training, without the pitfalls of stress and discomfort of direct clinical exposure. No study has previously focused on this question. In fact, BBNSBT used a step–by-step process involving novice participants to bring them to a higher level. The first step involved theoretical explanations given via video, discussions, and lectures. Each simulation, and especially each debriefing, further enhanced the participants' skills.

One strength of the study is that we paid special attention to the theoretical background upon which the training and evaluation were based, using the widespread SPIKES[28] theoretical model and the INACSL Standards of Best Practice for Simulation[SM].[41,42] Moreover, the simulations were well designed, the debriefings were standardized, and the facilitators were trained and experienced. We believe that it is mandatory to meet the INACSL Standards of Best Practice, as well as work with simulation experts to obtain positive results with simulation training.

The next steps for research and pedagogical method improvement can be identified based on these results. Further research is needed to investigate the role of an advanced course in BBN. As BBN is not a required skill for EPs, it would be interesting to investigate whether BBNSBT is feasible and effective in other areas such as obstetrics, intensive care units, etc. Finally, we think that e-learning preparation before BBNSBT, as described for a training on managing low urine output,[58] could replace some of the in-person time.

## LIMITATIONS

According to Kirkpatrick's four-level training evaluation model,[59] the self-efficacy and skills assessment used in the simulation are categorized at level 2, which is a low level.[60] Moreover, we assessed the impact of BBNSBT just after training. Skills transfer to a real clinical setting is not guaranteed and does not allow for any definite conclusion with regard to the actual impact on patients or family members.[50] Future studies could assess the impact of this training in the workplace and on skills retention over time.[60] Despite these limitations, the results are very encouraging given that training is only four hours long, a significantly shorter period than other programs previously described.[25]

While the three scenarios used for the assessments share similarities, they were different before and after the training, as in real life. Cluster randomization resulted in an inequitable distribution of participants. Despite this heterogeneity, statistical analyses adjusted by study year seem to prove that BBN training has an impact on students. This study assessed the impact of a four-hour BBN training, but we cannot be sure that this duration would be more effective than two or six hours. Finally, we did not assess the emotional impact of BBNSBT and BBN assessment on trainees. It would be interesting to know whether BBNSBT elicits a different response than traditional internships.

## CONCLUSION

Training programs aspire to produce competent emergency physicians including excellence in the domains of professionalism and communication. According to the EM Milestones, the target for a trainee ready to graduate for "patient-centered communication (ICS1)" specifically includes being able to deliver bad news. The results of this study revealed that a short, simulation-based training with a debriefing session may improve the self-efficacy, BBN skills, and communication skills of medical students and young residents in the ED. Role-playing appears to be an effective and feasible way for trainees to master BBN and acquire patient-centered skills. Further studies should assess the transfer and retention of these skills as well as when to implement the simulation training in the curriculum.

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# Status of Emergency Signal Functions* in Myanmar Hospitals: A Cross-Sectional Survey

*key medical interventions that emergency units should be able to perform to treat common life-threatening conditions

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**Introduction:** Low- and middle-income countries (LMICs) have a large percentage of global mortality and morbidity rates from non-communicable diseases, including trauma. The establishment and development of emergency care systems is crucial for addressing this problem. Defining gaps in the resources and capacity to provide emergency healthcare in LMICs is essential for proper design and operation of ECS (emergency care services) reinforcement programs. Myanmar has particular challenges with road access for providing timely emergency medical care, and a shortage of trained health workers. To examine the ECS capacity in Myanmar, we used the Emergency Care Assessment Tool (ECAT), which features newly developed tools for assessing sentinel conditions and signal functions (key interventions to address morbidity and mortality) in emergency care facilities.

**Methods:** ECAT is composed of six emergent sentinel conditions and corresponding signal functions. We surveyed a total of nine hospitals in five states in Myanmar. A constructed survey sheet was delivered by e-mail, and follow-up interviews were conducted via messenger to clarify ambiguous answers.

**Results:** We categorized the nine participating institutions according to predefined criteria: four basic-level hospitals; four intermediate-level; and one advanced-level hospital. All basic hospitals were weak in trauma care, and two of 12 signal functions were unavailable. Half of the intermediate hospitals showed weakness in trauma care, as well as critical care such as shock management. Only half had a separate triage area for patients. In contrast, all signal functions and resources listed in ECAT were available in the advanced-level hospital.

**Conclusion:** Basic-level facilities in Myanmar were shown to be suboptimal in trauma management, with critical care also inadequate in intermediate facilities. To reinforce signal functions in Myanmar health facilities, stakeholders should consider expanding critical functions in selected lower-level health facilities. A larger scale survey would provide more comprehensive data to improve emergency care in Myanmar. [West J Emerg Med. 2019;20(6)903-909.]

## INTRODUCTION

Myanmar, formerly Burma, and now administratively designated the Republic of the Union of Myanmar, is a sovereign state in Southeast Asia. Myanmar has a diverse—135 different ethnic groups—population of 53 million according to the United Nations Population Division.[1] Recently, the military regime that long hampered the country's development was replaced by a civilian government.[2] Socioeconomic development in Myanmar lags far behind nearby countries, as does its healthcare system. There are shortcomings in maternal care, pediatric healthcare, and infectious disease treatment, as well as medical accessibility and quality.[3]

Strengthening medical systems by improving the standard of emergency care has been known to reduce the mortality and morbidity from both communicable and non-communicable diseases.[4,5] A large proportion of the global mortality and morbidity rate from various diseases is found in low- and middle-income countries (LMICs). Unfortunately, the emergency care systems required to address these shortcomings are not well established in most LMICs, including Myanmar.[6] Formal emergency care in Myanmar is only available in hospitals located in urban areas. Rural hospitals can provide only limited emergency care to patients.[7]

While preparing for an international sporting event, the Myanmar government started to formalize efforts to develop a formal emergency medicine (EM) training program.[8] Apart from the formal EM training program in the capital city, Nay Pyi Taw, frontline healthcare facilities across the country are not capable of providing life-saving emergency care. In most rural hospitals, the outpatient department usually covers emergencies; there is no separate area or facility for emergency treatment. Rural hospitals offer access to few medical specialties with minimal, if any, laboratory services. Public prehospital ambulance transportation service is virtually unavailable in rural areas.[9]

Several tools have been used to evaluate emergency care capability. Most focused primarily on the availability of hardware or infrastructure rather than functional aspects of emergency care.[10] Some researchers have tried to measure performance of EM practice in resource-limited settings, which has resulted in a demand for a comprehensive EM assessment tool for LMICs.[11,12,13] Recently, a novel approach based on work in the field of obstetrics, called sentinel condition and signal function, was adapted for EM by the African Federation for Emergency Medicine (AFEM).[14, 15]

Based on this concept, the AFEM developed a standard preliminary tool called the Emergency Care Assessment Tool (ECAT), which has been suggested to be more useful than previous evaluation tools in assessing EM systems.[10] Our study incorporated the concept of ECAT as a tool to analyze Myanmar's emergency care systems. We investigated the capability to deliver emergency care in different levels of hospitals located in several regions of Myanmar.

*Population Health Research Capsule*

What do we already know about this issue?
*The higher mortality and morbidity rates in hospitals in low-and middle-income countries often arise from suboptimal emergency care systems.*

What was the research question?
*Would implementation of a recently validated Emergency Care Assessment Tool effectively assess emergency care capacity in various levels of Myanmar hospitals?*

What was the major finding of the study?
*Basic-level facilities in Myanmar were suboptimal in trauma care, with critical care also inadequate in intermediate-levels hospitals.*

How does this improve population health?
*To reinforce signal functions in Myanmar health facilities, stakeholders should consider expanding critical functions in selected lower-level health facilities.*

## METHODS

This facility-based survey was conducted between February 7, 2018 –April 3, 2018. With the help of two Myanmar doctors and three nurses who were invited to Korea for training, survey sheets were distributed to the doctors in charge of emergency medical care at nine hospitals. Our primary criterion for selecting hospitals was access to e-mail and online messaging, at the time of survey, to allow for our interactions with them. The nine hospitals, including five at which our initial contacts were employed, were scattered in five states in Myanmar, and believed to partially represent both urban and rural regions (Figure 1). The nine hospitals were grouped into three levels, according to the bed capacity of the hospital (fewer than 100 beds, 100–1000 beds, over 1000 beds) and the number of physicians (fewer than five, 5–100, over 100).

Survey sheets were prepared in English using ECAT and delivered to responsible officers by e-mail. ECAT encompasses six sentinel conditions that threaten life (respiratory failure, shock, altered mental status, dangerous fever, severe pain, and trauma), and the related signal functions (key interventions) that alleviate them. The researchers explained the meaning of each question in the survey to the original five Myanmar contacts, and they, in turn, conveyed this information to the Myanmar doctors who took part in the study. In the case of any questions that were initially omitted on the completed surveys, clarification was provided, and the questions were then revisited and answered by the respondents.

The survey included questions about the general status

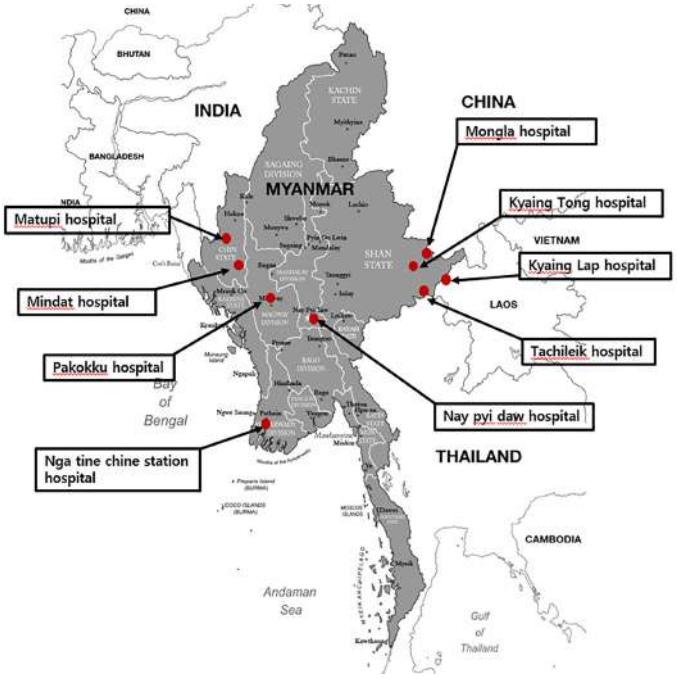


**Figure 1.** Geographical distribution of hospitals investigated.

of each hospital, such as the number of staff members, the number of hospital beds, and the annual patient load. The remaining questions addressed the performance of emergency signal functions, the products for signal functions (eg, airway management and defibrillation for resuscitation), and the availability of emergency facility infrastructures. We coded data using standard descriptive analyses with Microsoft Excel 2015 (Seattle, Washington, USA). Qualitative research methods involved thematic analysis of answers.

## RESULTS

All nine hospitals completed the survey sheet. Based on the predefined criteria, four hospitals were classified as basic level, four as intermediate, and one as advanced level, as shown in Table 1. We summarize results by the availability of performances/products/infrastructure in the Supplemental Tables 1-3. Table 2 shows the overall adherence rate to the signal functions.

### Basic-Level Hospitals

In performing signal functions for each of the sentinel conditions, basic-level hospitals were revealed to be weak in trauma care. Among the 12 signal functions related to trauma care that are deemed essential in basic-level hospitals, more than two functions were unavailable at all four hospitals. One hospital could not provide half of the trauma-related essential signal functions [Matupi Hospital–trauma protocol implementation (adult and paediatric), pelvic wrapping, cervical spine immobilization, basic fracture immobilisation (sling, splint, inline immobilisation for other spinal fracture), immediate cooling care for burns, fracture reduction]. None of the four basic-level hospitals had the resources to treat burn patients or provide pelvic wrapping. The survey questions regarding infrastructure revealed that none had a specialized resuscitation area for critical patients, and three of the hospitals did not have a triage area. There was neither trauma protocol nor a cervical immobilization device at any of the hospitals. Most signal functions for the other five sentinel conditions were generally available in these basic-level hospitals, with the exception of treatment for common toxidromes, which only half could provide.

**Table 1.** Overview of hospitals included in a survey of emergency medical care delivery in Myanmar.

| Name | Bed | Number of Doctors | Number of nurses | Location | Annual OPD visit number | Annual admissions |
|---|---|---|---|---|---|---|
| Basic | | | | | | |
| Kyaing Lap Station Hospital | 16 | 1 | 5 | Eastern Shan State | 3353 | 627 |
| Matupi General Hospital | 50 | 2 | 26 | Chin State | 10847 | 1997 |
| Mong La General Hospital | 50 | 2 | 21 | Eastern Shan State | 17375 | 1661 |
| Nga Tine Chine Station Hospital | 16 | 1 | 5 | Ayeyarwaddy region | 4609 | 2382 |
| Intermediate | | | | | | |
| MinDat General Hospital | 100 | 9 | 70 | Chin State | 16770 | 3100 |
| Kyaing Tong General Hospital | 200 | 30 | 199 | Eastern Shan State | 45954 | 11082 |
| Tachileik General Hospital | 100 | 23 | 78 | Eastern Shan State | 25826 | 8513 |
| Pakokku General Hospital | 200 | 72 | 182 | MaGway region | 34789 | 26919 |
| Advanced | | | | | | |
| Nay Pyi Daw General Hospital | 1000 | 238 | 402 | Nay Pyi Daw region | 208573 | 28819 |

*OPD,* outpatient department.

**Table 6.** Adherence rate to signal function for each sentinel condition in each category of hospitals.

| | Basic | Intermediate | Advanced |
|---|---|---|---|
| Performance analysis | | | |
| Respiratory failure | 92% | 91% | 100% |
| Shock | 92% | 92% | 100% |
| Altered mental status | 100% | 93% | 100% |
| Severe pain | 92% | 98% | 100% |
| Trauma | 71% | 83% | 100% |
| Dangerous fever | 81% | 100% | 100% |
| Product analysis | | | |
| General products | 98% | 100% | 100% |
| Respiratory failure products | 94% | 91% | 100% |
| Shock products | 100% | 75% | 93% |
| Altered mental status | 100% | 100% | 100% |
| Severe pain/trauma and burns | 75% | 100% | 100% |
| Dangerous fever | none | 100% | 100% |
| Infrastructure analysis | | | |
| Adherence rate of total infrastructure | 69% | 86% | 100% |

**Intermediate-Level Hospitals**

Two of the four intermediate-level hospitals indicated that they could provide all emergency signal functions. The other two hospitals, however, were found to provide a limited set of signal functions. They did not have a trauma protocol nor could they provide reduction for patients with bone fractures. Cervical immobilization, pelvic wrapping, burn care, and treatment of compartment syndrome were also unavailable. Moreover, one hospital could not perform defibrillation or mechanical ventilation support, nor administer intramuscular adrenaline, which is important for cardiopulmonary resuscitation. Two hospitals could insert central venous catheters and gain intraosseous access, which is important in shock management. In terms of resources, only two of the four had a separate triage area for emergency patients. All four hospitals had an isolation room, an obstetric/gynecologic area, and a decontamination room.

**Advanced-Level Hospital**

Nay Pyi Taw General Hospital was the only advanced-level hospital in the study. It was able to provide all emergency signal functions, and was equipped with all necessary hardware, with the exception of a fluid warmer for shock treatment.

**Explanation for Non-compliance with Signal Functions**

We surveyed hospitals on their reasons for non-compliance with signal functions, asking them to choose from among five possible causal factors. The first was training issues, taking the form of a lack of education. The second factor was related to the lack of availability of appropriate supplies, equipment, and/or drugs. The third pertained to management issues, such as the staff being unfamiliar with the functions, and cases where other equivalent procedures could have handled the conditions. The fourth factor was policy issues, referring to cases where the government or the facility itself does not allow for compliance with the signal functions. The fifth factor was designated as "no indication," meaning that there was no patient group who needed this function.

Supplemental Table 4 describes the reasons respondents provided on the survey for each unavailable signal function. Inappropriate supplies/equipment/drugs was the most common reason, as might be expected, and shortage of human resources was another causal factor. One intermediate hospital did not agree with the use of emergency signal functions for sentinel conditions, and answered "no indication" as their reason for non-compliance.

## DISCUSSION

It is widely recognized that there is a huge burden caused by trauma and non-communicable diseases in LMICs, where capability for emergency care is believed to be suboptimal.[16] Many studies have tried to assess the state of emergency care in the health facilities of LMICs. Due to the accessibility issue, most studies examined teaching hospitals located in urban areas. Assessment tools were not standardized and were usually developed by the researchers themselves. Domains for assessment were usually related to the availability of resources, and functional aspects were surveyed with qualitative measures, if any. To our knowledge, this study is

the first to survey urban and rural Myanmar hospitals using ECAT, the newly developed objective tool for assessing emergency care in health facilities.

Our study demonstrated that the performance of emergency signal functions in Myanmar hospitals is inadequate, especially in trauma care. Trauma care in LMICs has been regarded as a role for large hospitals, and direct referral to upper-level facilities is a common practice. Burke et al. found that lack of readily accessible equipment for trauma care and shortage of skilled staff were the main reasons for poor quality trauma care in lower-level health facilities in LMICs.[17] Another study pointed out the limited training opportunities for trauma management in LMICs.[18] We found similar obstacles to trauma care in Myanmar hospitals, including the unavailability of items necessary for signal functions.

Unlike other LMICs, Myanmar faces a singular geographic and demographic situation. Road conditions are poor. Almost 20 million people live in areas not connected by basic roads. The roads that do exist are unpaved and narrow, contributing to the overall lack of accessibility. The cause of this problem might be found in continuous armed conflicts. Since the independence of Myanmar in 1948, a continuing civil war has devastated the population and infrastructure of the rural areas, which has led to the deterioration of the health status of the country.

In areas dominated by violence, residential zones are located away from road access, and the level of medical care is behind the times. Financial support is also lacking.[19] For example, a referral and transport from Matupi Hospital to an adjacent upper-level facility takes as long as 16 hours during rainy seasons due to road damage (Figure 2). In this situation, timely management of patients in a critical condition is virtually impossible, and demands for higher levels of emergency care in basic-level facilities can be raised. Moreover, the results of our study show that some intermediate-level hospitals could not provide resuscitation for critical patients due to the lack of advanced airway management, mechanical ventilators, and defibrillation.

Imbalances in the quality of emergency care in both basic- and intermediate-level facilities should be addressed carefully. However, in Myanmar's special situation where highway infrastructure is lacking and there are problems with long transport times, the ability to administer emergency medical care at a large hospital should be established based on skilled labor and resources. Ouma et al. emphasized that all countries should reach the international benchmark of more than 80% of their populations living within a two-hour travel time to the nearest hospital.[20] Although it cannot be realized in the near future, measures to alleviate accessibility problems can be applied. Extension of critical signal functions for time-dependent conditions should be considered in selected basic-level facilities. Thorough gap analyses to address existing challenges in remote regions will be helpful for planning. In this regard, ECAT should be validated to include a time factor, such as the referral time to the nearest upper-level facility.

We identified the following urgent issues in need of remediation: 1) improvement of trauma-related signal functions in basic-level facilities; 2) improvement of trauma- and critical care-related signal functions in intermediate level facilities; and 3) implementation of a comprehensive nationwide survey to uncover emergency care deficiencies in rural areas, with emphasis on the time required for referral to higher-level facilities. Our suggestions to address the issues identified in our study can be summarized as relating to the reinforcement of infrastructure and human resources within each level of facility. In addition, prehospital care and

**Figure 2.** Common transportation method in rural area of Myanmar (photo taken near Matupi Hospital).

care during inter-facility transportation should receive special attention considering the unique context of Myanmar, with its dispersed residences and extremely long transport times.

There has been an effort to establish formal EM in Myanmar. In 2014, the Emergency Medicine Postgraduate Diploma course provided by Australia graduated 18 Myanmar medical officers.[8] These emergency providers will be an imperative asset to setting up a modern emergency medical care delivery system in Myanmar, although most of them will practice in advanced-level facilities. Measures to build the capacity to respond to medical emergencies in rural areas should be pursued in Myanmar. There have already been efforts to improve first-aid skills among local healthcare workers who have a high degree of understanding of the local context, and to employ them as community emergency responders.[21]

These local healthcare workers are well informed about the population, hygiene, disease distribution, and the geographical and cultural characteristics of the area; thus, they are able to provide essential first aid and find appropriate health facilities for referrals. This practice has been expanded to the concept of out-of-hospital emergency care (OHEC). It refers to a wide range of emergency treatments, from the process of recognizing an emergent care situation, to the initial emergency treatments outside the hospital, and transport to the hospital.[22] The establishment of OHEC has played a role particularly in LMICs by reducing mortality rates by 80%, especially in trauma cases.[23]

Since 2000, several organizations have implemented the trauma training course (TTC) program with non-physician clinicians (called health workers) in Eastern Myanmar.[24] The program comprises various skills for carrying out the initial treatment of trauma, taught through simple simulations and feedback. The findings indicated that survival rates improved significantly among major trauma patients following the implementation of this program. We recognize that some skills covered in the TTC, such as surgical airway management, would be relatively dangerous for health workers to perform in the field, and believe that development and implementation of a training program focused on the operation of emergency signal functions would be more practical for the rural context. Those who are trained in this program could act as prehospital emergency care providers, and also aid basic-level facilities to fill the functional gaps identified in this study.

In addition to the above suggestions, a national or provincial strategic plan for reinforcing emergency care in rural areas of Myanmar should be established and implemented. Following a thorough investigational survey, essential resources for each level of health facility should be supplemented. Public education to recognize emergency conditions is another area to be strengthened. In many LMICs, including Myanmar, folk remedies are still commonly attempted before people seek medical attention, especially in the field of obstetrics and gynecology.[25] Recognizing the need for emergency care is crucial because it is the first step leading the patient to the emergency medical care system. Community education should play an important role in preventing delays in the detection of emergency situations.[26] Traditional medicine providers have been the first to participate in this training thus far, and it has been reported to be effective.[27]

## LIMITATIONS

One limitation of the present study is the possibility of recall bias because we collected the data retrospectively. To minimize this bias, we selected five hospitals first, each of which had a key staff member whom we could contact frequently in a direct way. The other four hospitals were contacted via e-mail as a result of guidance we received from our initial five participants, who put us in direct contact with these additional research hospitals. Another limitation of our study is selection bias, given that the research hospitals taking part were not randomly selected. While the research hospitals were dispersed across various rural areas of Myanmar, they cannot be taken to represent each region,; however, they do provide a snapshot of the different levels of health facilities in Myanmar, and provide us with the basis for planning a more comprehensive survey on a larger scale in the future.

## CONCLUSION

Our study revealed that emergency signal functions in basic-level facilities in rural areas of Myanmar are suboptimal, specifically in trauma care. Additionally, critical care in intermediate-level facilities is also compromised, and should receive more attention. A survey at the provincial or national level is needed to address existing gaps in the functionality of emergency signal functions. Stakeholders related to the emergency medical care project should adopt the results of this survey and plan their project in such a way as to improve emergency signal functions within each level of facility. In particular, it is necessary to consider strengthening selected basic-level facilities in remote areas, to overcome unacceptably long transport times.

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# Identifying Emergency Department Symptom-Based Diagnoses with the Unified Medical Language System

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**Introduction:** Many patients who are discharged from the emergency department (ED) with a symptom-based discharge diagnosis (SBD) have post-discharge challenges related to lack of a definitive discharge diagnosis and follow-up plan. There is no well-defined method for identifying patients with a SBD without individual chart review. We describe a method for automated identification of SBDs from ICD-10 codes using the Unified Medical Language System (UMLS) Metathesaurus.

**Methods:** We mapped discharge diagnosis, with use of ICD-10 codes from a one-month period of ED discharges at an urban, academic ED to UMLS concepts and semantic types. Two physician reviewers independently manually identified all discharge diagnoses consistent with SBDs. We calculated inter-rater reliability for manual review and the sensitivity and specificity for our automated process for identifying SBDs against this "gold standard."

**Results:** We identified 3642 ED discharges with 1382 unique discharge diagnoses that corresponded to 875 unique ICD-10 codes and 10 UMLS semantic types. Over one third (37.5%, n = 1367) of ED discharges were assigned codes that mapped to the "Sign or Symptom" semantic type. Inter-rater reliability for manual review of SBDs was very good (0.87). Sensitivity and specificity of our automated process for identifying encounters with SBDs were 84.7% and 96.3%, respectively.

**Conclusion:** Use of our automated process to identify ICD-10 codes that classify into the UMLS "Sign or Symptom" semantic type identified the majority of patients with a SBD. While this method needs refinement to increase sensitivity of capture, it has potential to automate an otherwise highly time-consuming process. This novel use of informatics methods can facilitate future research specific to patients with SBDs. [West J Emerg Med. 2019;20(6)910-917.]

## INTRODUCTION

Patients are commonly discharged from the emergency department (ED) without a pathological diagnosis to explain their symptoms, with one study finding that over one third of patients leave the ED with a symptom-based diagnosis (SBD).[1] Studies exploring reasons for return ED visits have identified high levels of patient uncertainty related to lack of a definitive diagnosis as one cause for return.[2-4] These findings suggest the need for further research regarding the impact of and needs associated with receiving a SBD at the time of ED discharge and on patient transitions home from the ED. Research on this topic is challenging, however, because electronic health records (EHR) do not have a unique identifier for SBDs, and there is no agreed upon classification system for these conditions. This leaves manual chart review as the primary option for identifying these patients,[5] which is a highly subjective and

time-consuming process.

The Unified Medical Language System (UMLS) is a compilation of multiple biomedical vocabularies that facilitates interoperability between information systems.[6] The UMLS consists of three main components: the Metathesaurus; the Semantic Network; and the SPECIALIST Lexicon.[7] The UMLS Metathesaurus is a biomedical thesaurus that connects and organizes over 200 vocabularies into unique concepts, allowing varying terms for the same concept to be linked together so that relationships can be established between different concepts. For instance, the *International Statistical Classification of Diseases and Health Related Problems,* 10th edition (ICD-10)[8] code "R07.4 – Chest Pain" and Systematized Nomenclature of Medicine – Clinical Terms (SNOMED-CT)[9] code "29857009 – Chest Pain (finding)" both map to the UMLS concept unique identifier (CUI) "C0008031 – Chest Pain."

The Semantic Network is a series of semantic types that more broadly categorize concepts in the Metathesaurus and allow for relationships between these concepts.[7] For example, the UMLS concept for chest pain and headache (C0018681) both map to the semantic network identifier "T184 – Sign or Symptom."

Finally, the SPECIALIST Lexicon is a biomedical dictionary of English terms used for natural language processing (NLP). Each entry contains syntactic, morphological, and orthographic information for a term, as well as acronyms and abbreviations. This allows unification of different variations of the same term that would usually be documented in text in multiple forms (eg, "testing," "tested" and "test" are all treated as the same verb "test"). For instance, a term search for "chest pain" returns its base term, spelling variant (chest-pain), identification number, syntactic category (noun), and variants describing it as both a countable noun ("I'm having chest pains") and uncountable noun ("the most common complaint was chest pain"). A search for "CP" (a common acronym for "chest pain") returns multiple entries including the noun entry for "chest pain."

The UMLS has previously been used to facilitate ED-based research. Metzger et al. used it to develop an automated process to identify suicide attempts in the ED. For this process, they used NLP to assign codes from five different terminologies to medical terms written in natural language, and then used the Metathesaurus to identify similar concepts between the different terminologies.[10] Travers et al. evaluated the UMLS as a foundation for the generation of an ED chief complaint (CC) vocabulary.[11] Lu et al. used the UMLS to map ED CCs to UMLS concepts for the purpose of grouping CCs into syndromic categories to allow for automated monitoring of disease outbreaks.[12] Finally, Doan et al. used the UMLS to construct a lexicon of terms from ED documentation that identifies patients who should be considered for a diagnosis of Kawasaki disease.[13] To our knowledge, the UMLS has not yet been used to identify cohorts of patients based on categories of ED discharge diagnoses for use in research.

*Population Health Research Capsule*

What do we already know about this issue?
*Patients discharged from the emergency department with a symptom-based diagnosis (SBD) commonly experience post-discharge challenges. There is no automated process to identify SBDs.*

What was the research question?
*Can an automated and accurate process to identify SBDs be developed?*

What was the major finding of the study?
*Our automated process to identify SBDs had high sensitivity and specificity compared to the gold standard of manual review.*

How does this improve population health?
*Development of an automated, accurate process to identify SBDs would facilitate how we understand the primary needs and barriers of patients discharged with an SBD.*

In our current research, we sought to engage patients who had recently been discharged from the ED with a SBD via follow-up interviews. In previous work, these patients were identified manually. Here we describe the process by which we mapped patients' ED diagnoses to UMLS concepts to extract the semantic type for each diagnosis, thus generating a list of patients recently discharged from the ED with a likely SBD. The primary goal of this study was to compare this automated process of identifying SBDs to the "gold standard" of manual review.

## METHODS

### Study Design, Setting and Population

We performed a retrospective data analysis on data from the EHR at a single, urban, academic hospital. These methods were approved by the hospital institutional review board. The hospital had over 68,400 ED visits the year prior to this study with approximately 64% of patients being discharged from the ED. The process we designed was to identify all adult patients (18 years and older, non-pregnant) who were discharged from our ED with a SBD within a 30-day period. Exclusion criteria included any patient who did not receive an ED disposition of discharge (ie, left against medical advice, transfer, admission to inpatient or observation status), and any patient who did not have a discharge diagnosis assigned.

**Data Collection and Processing**

We first queried documentation from the hospital's EHR system Epic (Epic Systems Corporation, Verona, WI) via a third-party analytics software Qlik Sense (Qlik, Radnor, PA) to develop a list of all potentially eligible patients from May 2018. At the time of discharge, physicians enter a "clinical impression," which is derived from a local vocabulary linked with an ICD-10 based diagnosis code in the ED. We extracted the primary ICD-10 code and the associated "primary clinical impression" of the discharge diagnosis for each encounter to generate a list of potentially eligible patients. In cases for which there were multiple codes assigned, we used the first diagnosis code.

We downloaded the full release of the 2018AA UMLS[14] and created a custom subset of ICD-10 Clinical Modification via Metamorphosys,[7] the UMLS installation and customization program. Complete instructions on the installation of Metamorphosys are described by the U.S. National Library of Medicine.[15] We read the UMLS Rich Release Format (RRF) files for codes (MRCONSO.RRF) and the semantic types (MRSTY.RRF) into R statistical software v 3.3.2 (R Core Team, Vienna, Austria).

We then read into R the list of ICD-10 diagnosis codes and the associated discharge diagnosis associated with our study population. We used the package "data.table" v 1.11.4 (Matt Dowle and Arun Srinivasan) to map ICD-10 codes to their respective UMLS CUIs from MRCONSO (excluding term types deemed suppressible) and mapped the resulting CUIs to their appropriate semantic type from MRSTY. We isolated the unique relationships between ICD-10s, CUIs and semantic types, and linked these to each ICD-10 included in our study population.

This resulted in a table consisting of ICD-10 codes, associated discharge diagnoses, CUIs, and associated semantic types. For example, the ICD-10 "R68.2" is associated with the diagnosis of "Dry mouth" which mapped to the CUI: "C0478155 – Dry mouth, unspecified" which holds the semantic type "T184 – Sign or Symptom."

**Data Analysis**

For comparison, two authors (KLR and DMM) independently reviewed each discharge diagnosis and their respective ICD-10 code while blinded to the mapped semantic type, and categorized each diagnosis as either a SBD or non-SBD electronically in a spreadsheet. We calculated Cohen's kappa for inter-rater reliability. In the event of a disagreement, a third author (BHS) performed review to resolve the discrepancy.

The results of the manual categorization were linked to the output of the UMLS mapping. We calculated frequencies for each combination of ICD-10 code, discharge diagnosis, CUI, semantic type, and SBD category. Using the manual categorization as the "gold standard," we also calculated sensitivity and specificity of the UMLS mapping to the "Sign or Symptom" semantic type. We focused specifically on mapping to the semantic type "Sign or Symptom," as this was determined by the team to be the semantic type that should logically contain SBDs.

We calculated the statistical outcomes twice. The first analysis was conducted at the level of the patient encounter, which applies clinically to the question of whether each patient was discharged with a SBD. The second analysis was conducted at the level of the discharge diagnosis, thus assessing whether each unique diagnosis that was provided across one or more encounters was a SBD. We mapped all primary discharge diagnosis codes to CUIs in the Metathesaurus and their associated semantic types from the Semantic Network for each CUI. Our EHR uses a proprietary discharge diagnosis dictionary where multiple discharge diagnoses can be assigned the same ICD-10 code. Therefore, there are multiple synonyms within our discharge dictionary, and a high number of diagnoses could map to a small number of ICD-10 codes. For instance, "Seizure (CMS/HCC [Centers for Medicare and Medicaid Services/ hierarchical condition category])" and "Seizures (CMS/HCC)" are separate diagnoses in our dictionary that only differ in plurality, but are both associated with the same ICD-10 code "R56.9."

**RESULTS**

A total of 5705 patients visits occurred in our ED during the study period, out of which we identified 3879 (67.9%) that received an ED disposition of discharge. Of these, 237 (6.1% of discharges) met exclusion criteria resulting in 3642 (63.8 % of all visits) eligible ED discharge visits that were included in our patient encounter level analysis. Of these, 53.1% were for female patients with a median age of 41 years (interquartile range [IQR] 28-57 years) and 46.9% were for male patients with a median age of 43 year (IQR 31-56 years). These 3642 patient encounters received 1382 unique discharge diagnoses that we included in our discharge diagnosis-level analysis. These discharge diagnoses corresponded to 875 unique ICD-10 codes that mapped to 873 unique CUIs associated with 10 unique semantic types. Inter-rater reliability for the manual categorization of discharge diagnoses as SBD or non-SBD was very good at 0.87, with discrepancy in 73 (5.3%) diagnoses.

**Patient Encounter Level Results**

Of the 3642 patient encounters that resulted in discharges, there were 1367 encounters (37.5% of ED discharges) assigned a "Sign or Symptom" semantic type by our software (Table 1).

When applying the results of our manual review to the full dataset of discharge encounters, we identified 1288 patient encounters with a discharge diagnosis categorized as a SBD by manual review and assigned a semantic type of "Sign or Symptom." There were 79 encounters with discharge diagnoses not categorized as SBDs but assigned the semantic type of "Sign or Symptom." There were 2042 encounters with a discharge diagnosis code not assigned the semantic type of "Sign or Symptom" and also not categorized as SBDs. There

were 233 encounters that were not assigned the semantic type "Sign or Symptom" but categorized as SBDs in our manual review. Therefore, when examining all discharge encounters in our dataset (ie, examining the accuracy of our software for identifying SBDs on the level of the patient), our methods resulted in a sensitivity of 84.7% (95% confidence interval [CI], 82.8 – 86.5) and a specificity of 96.3% (95% CI, 95.4 – 97.0). Positive predictive value was 94.2% (95% CI, 92.9 – 95.3) and negative predictive value was 89.8% (95% CI, 88.6-90.8). These results are presented in Table 2. The top 10 diagnoses, ICD-10 codes, and frequencies for each grouping of semantic type assignment and SBD category at the encounter level are displayed in Tables 3-6.

**Discharge Diagnosis Level Results**

A total of 1382 unique discharge diagnoses were associated with the 3642 ED discharge encounters. Of these diagnoses, 314 (22.7%) were assigned the semantic type of "Sign or Symptom" by our software. With manual review, we identified 369 (26.7%) diagnoses as a SBD. When comparing the semantic types assigned by the software to those categorized as a SBD by manual review, 277 of the unique discharge diagnoses assigned "Sign or Symptom" were categorized as a SBD, while the other 37 assigned "Sign or Symptom" were not categorized as a SBD.

There were 976 unique discharge diagnosis codes not assigned the semantic type "Sign or Symptom" that were also not categorized as SBDs, and 92 diagnosis codes not assigned the semantic type "Sign or Symptom," but categorized as SBDs in our manual review. Therefore, when examining the accuracy of the software for identifying SBDs by classifying diagnoses to the semantic type of "Sign or Symptom," our methods resulted in sensitivity of 75.1% (95% CI, 70.3-79.4) and a specificity of 96.4% (95% CI, 95-97.4) with a positive predictive value of 88.2% (95% CI, 84.4 – 91.2) and a negative predictive value of 91.4% (95% CI 89.9 – 92.7). A 2 x 2 table of these results is presented in Table 7.

## DISCUSSION

We describe a novel automated electronic approach using the UMLS to identify groups of patients who have been discharged from the ED with a SBD (ie, "shortness of breath") instead of a disease-specific diagnosis (ie, asthma exacerbation). Using manual physician review as the "gold standard," we demonstrated a high sensitivity and specificity for the identification of SBDs using the UMLS semantic type of "Sign or Symptom."

The UMLS has been used in prior studies on ED EHR data for purposes including epidemiologic surveillance, constructing chief complaint dictionaries, and automated screening of rare conditions.[10-13] These applications typically use UMLS with NLP, where free text is analyzed (eg, provider notes) for concepts that were not otherwise captured in the EHR. Our work is different in that it was not intended for use with NLP or decision support, but rather was focused on automating the categorization of data fields that are not disease-specific for the purpose of identifying patients for research.

Our recent work suggests that many patients discharged from the ED with a SBD have struggles related to their lack of a definitive diagnosis, with further work needed to explore the challenges unique to this patient population.[3,4,16-18] Until now, there has not been a well-defined automated process for identifying these patients based upon their category of diagnosis (ie, "symptom-based") instead of a specific diagnosis name (eg, "myocardial infarction"). Our software was able to identify SBDs with a high sensitivity and specificity on the encounter level. False positives (assigned "Sign or Symptom" but not categorized as SBD) generally appeared to be pain or neurologic syndromes such as "seizure" and "musculoskeletal pain." Some of these diagnoses are inherently ambiguous, as there are both primary conditions and secondary causes for many of these diagnoses.

False negatives (not assigned "Sign or Symptom" but categorized as a SBD) appear from predominantly three

**Table 1.** Frequencies of semantic types among all included emergency department discharges (N = 3642).

| Semantic type | n | Percent |
|---|---|---|
| Sign or Symptom | 1367 | 37.5% |
| Disease or Syndrome | 916 | 25% |
| Injury or Poisoning | 643 | 17.6% |
| Finding | 358 | 9.8% |
| Mental or Behavioral Dysfunction | 163 | 4.5% |
| Pathologic Function | 155 | 4.2% |
| Acquired Abnormality | 20 | 0.5% |
| Neoplastic Process | 10 | 0.3% |
| Anatomical Abnormality | 9 | 0.2% |
| Body Substance | 1 | 0.03% |

**Table 2.** Patient encounter level statistics (N = 3642).

| Semantic type | SBD | Not SBD | Total | |
|---|---|---|---|---|
| Sign or Symptom | TP = 1288 | FP = 79 | 1367 | PPV = 0.942 |
| Not Sign or Symptom | FN = 233 | TN = 2042 | 2275 | NPV = 0.898 |
| Total | 1521 | 2121 | 3642 | |
| | Sn = 0.847 | Sp = 0.963 | | |

*SBD,* symptom-based diagnosis; *TP,* true positives; *FP, f*alse positives; *TN,* true negatives; *FN*, false negatives; *Sn*, sensitivity; *Sp,* specificity; *PPV,* positive predictive value; *NPV,* negative predictive value.

**Table 3.** Top 10 encounter-level diagnoses with associated ICD-10 codes and "Concept Unique Identifiers" classified as both "Sign or Symptom" semantic type and symptom-based diagnosis (N=3,642).

| ICD-10 code | Discharge diagnosis | CUI code | Semantic type | SBD | n |
|---|---|---|---|---|---|
| R07.9 | Chest pain, unspecified type | C0008031 | Sign or Symptom | Yes | 153 |
| R51 | Nonintractable headache, unspecified chronicity pattern, unspecified headache type | C0018681 | Sign or Symptom | Yes | 61 |
| R10.9 | Abdominal pain, unspecified abdominal location | C0000737 | Sign or Symptom | Yes | 43 |
| R10.84 | Generalized abdominal pain | C0344304 | Sign or Symptom | Yes | 38 |
| R51 | Acute nonintractable headache, unspecified headache type | C0018681 | Sign or Symptom | Yes | 37 |
| R06.02 | Shortness of breath | C0013404 | Sign or Symptom | Yes | 35 |
| R07.89 | Chest wall pain | C0029537 | Sign or Symptom | Yes | 28 |
| R42 | Dizziness | C0476206 | Sign or Symptom | Yes | 25 |
| R05 | Cough | C0010200 | Sign or Symptom | Yes | 23 |
| R21 | Rash | C0015230 | Sign or Symptom | Yes | 23 |

*ICD-10,* International Classification of Diseases, 10th ed; *SBD*, symptom-based diagnosis; *CUI,* concept unique identifier.

**Table 4.** Top 10 encounter-level diagnoses with associated ICD-10 codes and "Concept Unique Identifiers" classified as "Sign or Symptom" semantic type but not as symptom-based diagnosis (N = 3642).

| ICD-10 code | Discharge diagnosis | CUI code | Semantic type | SBD | n |
|---|---|---|---|---|---|
| R56.9 | Seizure (CMS/HCC) | C0036572 | Sign or Symptom | No | 16 |
| K59.00 | Constipation, unspecified constipation type | C0009806 | Sign or Symptom | No | 8 |
| M79.1 | Musculoskeletal pain | C0231528 | Sign or Symptom | No | 5 |
| R42 | Postural dizziness with presyncope | C0476206 | Sign or Symptom | No | 5 |
| G89.18 | Post-op pain | C2875361 | Sign or Symptom | No | 4 |
| R46.89 | Suicidal behavior without attempted self-injury | C0478141 | Sign or Symptom | No | 4 |
| M62.838 | Muscle spasm | C2895804 | Sign or Symptom | No | 3 |
| R55 | Vasovagal syncope | C0039070 | Sign or Symptom | No | 3 |
| G89.18 | Post-operative pain | C2875361 | Sign or Symptom | No | 2 |
| R56.9 | Seizures (CMS/HCC) | C0036572 | Sign or Symptom | No | 2 |

*ICD-10,* International Classification of Diseases, 10th ed; *SBD,* symptom-based diagnosis; *CUI,* concept unique identifier; *CMS/HCC,* Centers for Medicare and Medicaid Services/hierarchical condition category.

semantic types: "Finding," "Disease or Syndrome" and "Pathologic Function." Further refinement of our software may reduce the frequency of false negatives as we believe many of these diagnoses, such as "acute left ankle pain" or "vaginal discharge," could also be described as a "Sign or Symptom." However, it is important to note that the sensitivity of our analysis significantly improved (84.7% vs 75.1%) when examining our results on the more clinically-relevant patient encounter level, as opposed to the diagnosis level.

This work informs both future retrospective research that requires identification of this patient population, as well as potential future prospective work to identify and intervene on these patients in real time. Future integration of semantic types with ED discharge diagnoses could allow for automation of this process in real time, building the foundation for decision-support systems that guide providers to avoid SBDs or to provide additional assistance to patients discharged with a SBD.

## LIMITATIONS

Our analysis was limited to a single academic institution that uses a single EHR. Our implementation design includes ICD-10 codes associated with clinical diagnoses made in the ED; however, other hospital systems may use other medical terminologies or proprietary diagnosis dictionaries. The UMLS allows for various search modes, including various terminologies, ontologies and search terms; however, a comparison of these methods is needed to ensure reliable results.

In addition, even among institutions using similar EHRs

**Table 5.** Top 10 encounter-level diagnoses with associated ICD-10 codes and "Concept Unique Identifiers" classified as symptom-based diagnosis but not as "Sign or Symptom" semantic type (N = 3,642).

| ICD-10 code | Discharge diagnosis | CUI code | Semantic type | SBD | n |
|---|---|---|---|---|---|
| M25.571 | Acute right ankle pain | C3531698 | Finding | Yes | 17 |
| K08.89 | Pain, dental | C0029790 | Disease or Syndrome | Yes | 15 |
| R00.2 | Palpitations | C0030252 | Finding | Yes | 15 |
| R33.9 | Urinary retention | C0080274 | Finding | Yes | 14 |
| K62.5 | Rectal bleeding | C0019081 | Pathologic Function | Yes | 9 |
| R31.9 | Hematuria, unspecified type | C0018965 | Disease or Syndrome | Yes | 9 |
| M79.89 | Leg swelling | C0477668 | Disease or Syndrome | Yes | 8 |
| M25.572 | Acute left ankle pain | C3531697 | Finding | Yes | 7 |
| N93.9 | Vaginal bleeding | C0495117 | Pathologic Function | Yes | 7 |
| N89.8 | Vaginal discharge | C0029819 | Disease or Syndrome | Yes | 6 |

*ICD-10,* International Classification of Diseases, 10th ed*; SBD,* symptom-based diagnosis; *CUI,* concept unique identifier.

**Table 6.** Top 10 encounter-level diagnoses with associated ICD-10 codes and "Concept Unique Identifiers" not classified as either "Sign or Symptom" semantic type or symptom-based diagnosis (N = 3642).

| ICD-10 code | Discharge diagnosis | CUI code | Semantic type | SBD | n |
|---|---|---|---|---|---|
| W19.XXXA | Fall, initial encounter | C2904005 | Injury or Poisoning | No | 111 |
| F10.920 | Alcoholic intoxication without complication (CMS/HCC) | C2874406 | Mental or Behavioral Dysfunction | No | 59 |
| R45.851 | Suicidal ideation | C0424000 | Finding | No | 30 |
| L02.91 | Abscess | C2888089 | Pathologic Function | No | 20 |
| N12 | Pyelonephritis | C0477743 | Disease or Syndrome | No | 19 |
| N30.00 | Acute cystitis without hematuria | C2902964 | Disease or Syndrome | No | 19 |
| S09.90XA | Head injury, initial encounter | C2832842 | Injury or Poisoning | No | 19 |
| S61.219A | Finger laceration, initial encounter | C2849879 | Injury or Poisoning | No | 18 |
| Y09 | Assault | C0004063 | Injury or Poisoning | No | 17 |
| J06.9 | Upper respiratory tract infection, unspecified type | C0264222 | Disease or Syndrome | No | 16 |

*ICD-10,* International Classification of Diseases, 10th ed; *SBD,* symptom-based diagnosis; *CUI,* concept unique identifier; *CMS/HCC,* Centers for Medicare and Medicaid Services/hierarchical condition category.

and impressions mapped to ICD-10, there are likely to be health system and regional variation in practice patterns for the level of detail provided at the time of discharge (eg, gastroenteritis vs vomiting and dehydration), which may make these methods less reliable. For the purpose of this analysis we used the first diagnosis and associated ICD-10 code assigned to each patient encounter, which is defined as the "primary clinical impression" in our EHR. We presume that the "primary clinical impression" is the diagnosis made by the treating provider most closely associated with the patient's encounter.

The analysis of additional diagnoses assigned at the time of treatment and the development of a process to weigh the value of combinations of SBDs and non-SBDs were outside the scope of this research. It is possible that if a patient was assigned additional diagnoses that were not SBDs, their overall level of uncertainty could be lower or vice-versa. Further analysis will have to be performed to include additional diagnosis codes and develop a process to determine the level of uncertainty associated with combinations of SBDs and non-SBDs. Also, we mapped ICD-10 codes to the first CUI returned by the UMLS. It is possible that additional CUIs could be more appropriate in certain cases, although an analysis to compare various CUIs would deviate significantly from the simple methods described in this manuscript.

We used manual review and categorization of discharge diagnoses by two emergency physicians (with a third as an arbitrator) as the gold standard for SBDs. While our reviewers had high inter-rater reliability (0.87), they were not blinded

**Table 7.** Discharge diagnosis level statistics (N = 1382).

| Semantic type | SBD | Not SBD | Total | |
|---|---|---|---|---|
| Sign or Symptom | TP = 277 | FP = 37 | 314 | PPV = 0.882 |
| Not Sign or Symptom | FN = 92 | TN = 976 | 1068 | NPV = 0.914 |
| Total | 369 | 1013 | 1382 | |
| | Sn = 0.751 | Sp = 0.964 | | |

*SBD,* symptom-based diagnosis; *TP,* true positives; *FP, f*alse positives; *TN,* true negatives; *FN*, false negatives; *Sn*, sensitivity; *Sp,* specificity; *PPV,* positive predictive value; *NPV,* negative predictive value.

to the goals of the study, and may have been biased in their categorization of SBDs. Additionally, as noted above, some of these discharge diagnoses are inherently ambiguous. Our team of raters established the list of SBDs via consensus and in these ambiguous cases attempted to consider the case from the viewpoint of the patient. For example, if a patient presents with pain in a limb, they are often concerned about a fracture or sprain; in this case, receiving a diagnosis of musculoskeletal pain (while still ambiguous and less specific than "sprain" or "contusion") has more specificity than the presenting complaint of "leg pain." In contrast, when a patient presents unable to urinate and is discharged with a diagnosis of "urinary retention," they have gained no specificity beyond that with which they presented. It was this sort of rationale that informed our decision-making and why "musculoskeletal pain" is not considered a SBD, but "urinary retention" is.

However, despite our high inter-rater agreement, we acknowledge that others, including both patients and medical professionals, may disagree with our determination of SBD classification. Future work is needed to refine this method before routine use to identify complete cohorts of patients or to assess frequencies of occurrence. Further, by categorizing SBDs, we are not attempting to assign value to the SBD or encouraging emergency physicians to provide definitive diagnoses in all cases, as the physician's role is to rule out immediately dangerous conditions rather than provide a definitive diagnosis. Finally, per our research protocol we excluded pregnant and pediatric patients; however, these patients could also benefit from SBD research and future methods should consider including these populations.

## CONCLUSION

This study demonstrates an application of the UMLS to identify symptom-based diagnoses, with the semantic type of "Sign or Symptom" showing high sensitivity and specificity compared to manual review. Automation of this time-intensive process could facilitate large-scale studies on the effects of symptom-based diagnoses or other non-disease-based events associated with an episode of care.

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# Identifying and Overcoming Barriers to Resident Use of Point-of-Care Ultrasound

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**Introduction:** Emergency medicine residency programs have rigorous point-of-care ultrasound (POCUS) curricula. However, this training does not always readily translate to routine use in clinical decision-making. This study sought to identify and overcome barriers that could prevent resident physicians from performing POCUS during clinical shifts.

**Methods:** This was a two-step process improvement study. First, a survey was deployed to all residents of a three-year academic residency program to identify barriers to clinical use of POCUS. This survey identified the perceived lack of a uniform documenting protocol as the most important barrier to performing POCUS on shift. Second, as an intervention to overcome this barrier, a streamlined documentation protocol was developed and presented to residents. The primary outcome was the number of patients who had POCUS used in medical decision-making one year before and after intervention. Secondary outcomes were the level of training of residents performing exams and whether faculty overseeing exams were trained through an ultrasound fellowship program.

**Results:** POCUS use by residents increased from 82 to 223 patients before and after the intervention, respectively. Per resident, this translates to an absolute increase from 2.2 (95% confidence intervall [CI], 1.4, 3) to 5.8 (95% CI, 4, 7.6) or 3.6 (95% CI, 1.8, 5.4) exams/resident over the study period. We observed no significant difference in the proportions of scans attributable to the resident level of training ($\chi 2 = 0.5$, $p = 0.47$). The proportion of exams by non-ultrasound fellowship trained faculty increased significantly more compared to fellowship trained faculty ($\chi 2 = 19$, $p<0.0001$); however, both ultrasound fellowship trained and non-ultrasound fellowship trained faculty increased the absolute number of exams performed.

**Conclusion:** A key perceived barrier to resident-performed POCUS is unfamiliarity with documenting ultrasounds for medical decision-making. Educating residents in person about a POCUS documentation protocol may help overcome this barrier. Incorporating resident input and motivation into POCUS incentivization may increase utilization. Future studies in optimizing POCUS on shift will need to focus on streamlining documentation, addressing time constraints, and faculty support for resident-performed POCUS. [West J Emerg Med. 2019;20(6)918-925.]

## INTRODUCTION

Point-of-care ultrasound (POCUS) has emerged as an essential diagnostic tool in emergency medicine (EM).[1] Several studies have demonstrated that a structured curriculum is both feasible and effective in training emergency physicians (EP) to obtain and accurately interpret images with test characteristics approaching or even exceeding those of dedicated radiology-performed scans.[2–5] However, less is

known about the penetrance of POCUS into daily EP practice. The emergency department (ED) poses unique challenges to implementation of diagnostic POCUS not present in other specialties with broad adoption of POCUS such as cardiology, critical care, and obstetrics: 1) the time spent with an individual patient is limited compared to other specialties; 2) ED settings vary dramatically between academic, community, rural, and urban practices, and each environment has its own unique challenges with respect to availability of POCUS and training of clinicians in ultrasound;[6] and 3) the breadth of POCUS applications in the ED is considerably greater than in other specialties.

Guidelines from the American College of Emergency Physicians (ACEP) endorse 12 core applications. The degree of experience necessary to obtain competency in image acquisition and interpretation, while not clear, appears to be highly variable between these applications.[7,8] As a result, few EPs maintain competency in all 12 applications without further postgraduate fellowship training. This leads to a general reluctance to perform and rely on some POCUS exams, as EPs question the need to maintain competency in certain applications.[9] Indeed, a survey of EPs in California found that most EPs do not use POCUS, and that EPs in academic environments use POCUS more regularly than their community counterparts.[10]

The challenges posed above apply both to established EPs and residents in training who are establishing practice patterns. Despite near-universal incorporation of ultrasound into resident training,[11] a survey of recent residency graduates found limited use in daily clinical practice.[12] This suggests that dedicated ultrasound training in most EM residency programs in North America progresses residents to the intermediate level, where they are able to effectively acquire and interpret images, but not to the level of the expert who is able to seamlessly incorporate the procedural skill into practice. We hypothesized that a number of perceived barriers may be leading to a gap in deliberate, on-shift practice, which is preventing trainees from advancing to expert levels.

The goal of this study was to assess and address relevant barriers to POCUS performed on shift by residents at a single, three-year EM residency program. As such, the study had two phases. We first performed a voluntary residency-wide survey to address perceived attitudes and barriers to on-shift use of POCUS. Next we performed an intervention to address the primary barrier, namely the perceived lack of a proper charting and reporting policy.

*Population Health Research Capsule*

What do we already know about this issue?
*Ultrasound is an essential component of emergency medicine resident education, yet its use in emergency physicians' daily practice remains relatively low.*

What was the research question?
*What are the barriers to resident use of ultrasound in clinical practice?*

What was the major finding of the study?
*After an educational intervention on ultrasound documentation, ultrasound utilization increased.*

How does this improve population health?
*Addressing barriers to clinical ultrasound use allows emergency physicians to fully use the benefit of this imaging modality in the care of emergency patients.*

## METHODS

### Setting

We conducted the study at an ED with an annual volume of 65,000 patients, which hosts a three-year EM residency program. The residency trains a total of 36 residents, with 12 residents per year. The study site uses the HealthLink/EPIC electronic medical record (Epic Systems, Verona, WI), and all point-of-care ultrasounds are wirelessly uploaded to a middleware product (Q-Path, Telexy Health Systems, Seattle, WA). Quality assurance of all scans submitted for review is performed by ultrasound fellowship-trained EPs who rotate on a weekly basis.

At the time of study performance, ultrasound training consisted of a four-hour introductory ultrasound course at the start of residency training, a four-week mandatory ultrasound rotation during the first year, and quarterly didactics with simulation and hands-on training during regularly scheduled mandatory conference. In addition, ultrasound fellowship-trained faculty offered three-hour sessions, biweekly, which consisted of didactics, image review, and bedside scanning. These sessions were mandatory for the first-year resident who was on the dedicated POCUS rotation, as well as two second- and third-year residents who were on a dedicated month of community ED practice. The study was performed as part of ongoing quality improvement (QI) program, not requiring institutional review board review at the study institution.

### Workflow

At the beginning of the study, a departmental best-practice, systematic, ultrasound documentation workflow was disseminated to faculty attending physicians. This workflow included saving ultrasound examinations performed or supervised by a faculty member credentialed in the relevant application. The images were then transferred from Q-Path

to the hospital picture archiving and communication system (PACS) where they are visible to all hospital providers. Finally, the findings were documented under the "Procedures" section of the ED provider note, and referenced in the medical decision-making portion of the note as appropriate. Pre-established macros (smart-phrases) for documentation of each application were shared with all providers. All faculty were credentialed in accordance with ACEP guidelines. Under this policy, residents may perform the ultrasound exam under supervision of credentialed faculty and submit scans to count toward their own credentialing.

**Survey**

The survey was designed with input from interviews with faculty, including residency and QI leadership, and residents. The survey was sent out using the online SurveyMonkey tool. Paper print-outs of the survey were also made available to residents to facilitate compliance. The resident performing the study (NS) was excluded from this survey. Responses were weighted using a five-point Likert scale.

**Intervention**

Following collection of survey responses, a 15-minute presentation was given to the residents on January 7, 2016, outlining the new charting policy, by the resident organizer of the study (NS). The presentation outlined the workflow for using ultrasound in clinical management, including appropriate charting procedure. The results of the survey were also shared with faculty via email. These interventions were timed to coincide roughly with the middle of the academic year which spans the time period of July 2015–July 2016.

**Data Collection**

We collected data for all ultrasound exams used for clinical decision-making for one year pre- (January 7, 2015–January 7, 2016) and post-intervention (January 8, 2016–January 8, 2017). Only the residents who were part of the residency program at the time of the intervention were included in the study. Prior to data collection we set the primary outcome as the number of scans submitted to PACS. As secondary outcomes we analyzed the involvement of general compared to POCUS fellowship-trained faculty, and the level of training of the residents performing the scans.

## RESULTS

**Survey**

At the beginning of the study, we performed a qualitative needs assessment with a workgroup, including the authors of the study, residency leadership, QI leadership, and unstructured interviews with residents. We generated potential contributors to the observation that residents rarely use POCUS on shift and summarized them in a "fish-bone" diagram (Figure 1). Based on this list, we created a survey of residents to help further elucidate residents' attitude towards POCUS and the leading barriers to POCUS use on shift (Supplemental Appendix).

Participation in the survey was voluntary, and we received responses from 27/35 (77%) residents with comparable contribution from residents at all three levels of training. We found that 30% of all residents reported never using POCUS on shift, 52% reported using POCUS approximately once per shift, and 18% used POCUS more than once per shift. When asked about general attitudes toward ultrasound use and training, most residents somewhat agreed or strongly agreed that ultrasound is an important skill for residents to learn (96%) and practice in our ED (93%). Most residents also somewhat agreed or strongly agreed that POCUS will be important in their future practice (92%). However, responses were somewhat tempered in considering whether availability of POCUS would be important in their search for future employment: 63% somewhat or strongly agreed, while 7% somewhat disagreed (Table 1).

In assessing barriers to on-shift use of ultrasound we found that the "inability to use results in documentation" received the highest weighted average rating of 3.7 on a five-point Likert scale with 41% and 25% of residents, respectively, reporting that this was a significant and extreme barrier. Time barriers, including time to complete/optimize exams and time required to initiate an exam were also rated highly with weighted averages of 3.6 and 3.2. Barriers pertaining to tools and technology such as Q-Path navigation, inability to find the machine, space on the machine, and gel availability were generally ranked as only "slight barriers" with weighted average scores of 2.2, 2.1, 1.8, and 1.6, respectively (Table 2).

Finally, we attempted to assess potential incentives that would help residents overcome the barriers above. We found that increased attending support was the top perceived incentivizer for residents with a weighted average of 4. Residents also felt that clear guidelines on charting were likely to incentivize scanning (weighted average score of 3.8).

**Effects of Intervention**

Following completion of the survey, we designed an intervention aimed at addressing the highest-scoring barrier to on-shift POCUS, namely the perceived lack of the ability to document scans in medical-decision making. This intervention involved an in-person education session during resident conference on an established guideline for on-shift documentation. The guideline was also disseminated to residents and faculty via email. We found that significantly more patients received at least one POCUS exam performed on shift and used in medical decision-making in the year following the intervention (223) compared to prior to the intervention (82) (Figure 2A). Per resident, this corresponds to an absolute increase from 2.2 (95% confidence interval [CI], 1.4, 3) to 5.8 (95% CI, 4, 7.6) or 3.6 (95% CI, 1.8, 5.4) exams/resident over the study period ($p<0.0001$, Mann-Whitney U-test) (Figure 2B). We also looked at the number of patients scanned by each resident and found that the majority of residents (75%)

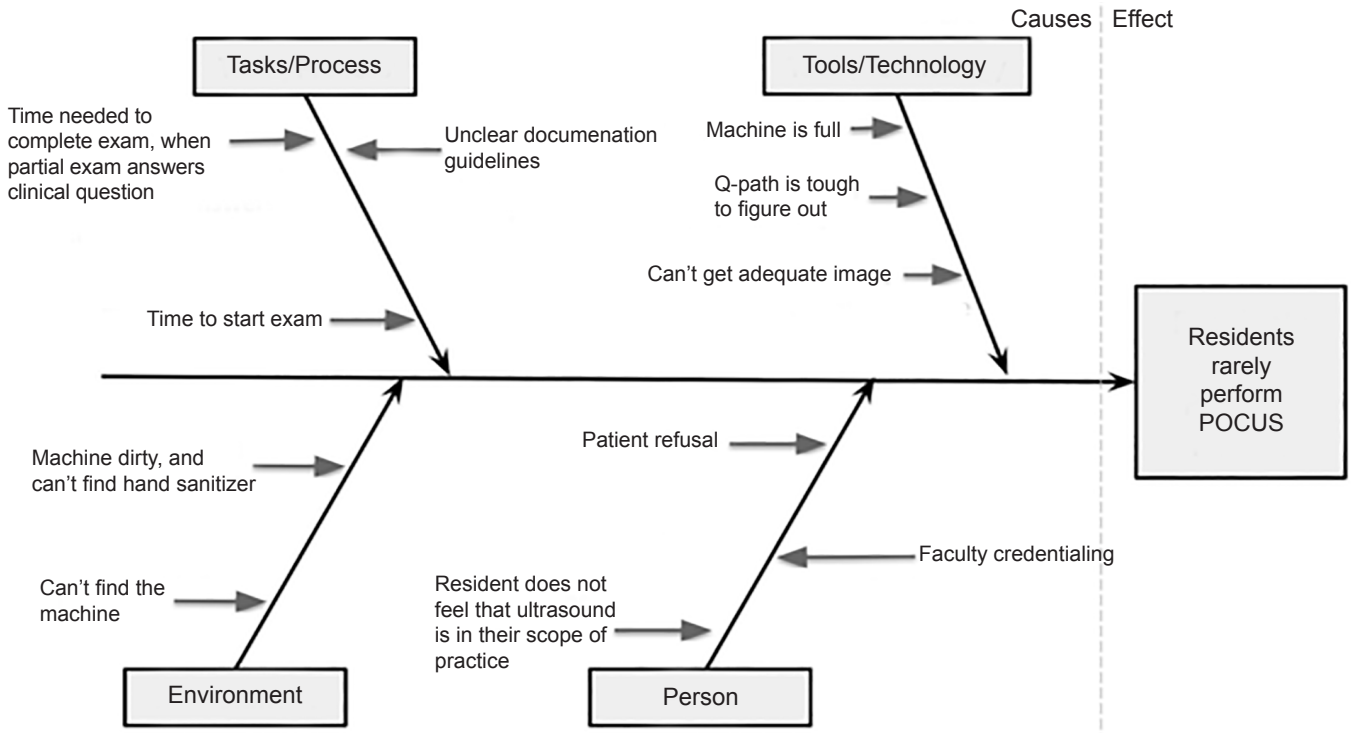



**Figure 1.** "Fish-bone" diagram derived from qualitative assessment of potential barriers to clinical use of point-of-care ultrasound (POCUS) by emergency medicine residents.

**Table 1.** Resident attitudes toward point-of-care ultrasound (POCUS) education and use.

| How do you feel about POCUS? | Strongly disagree | Somewhat disagree | Neutral | Somewhat agree | Strongly agree | Weighted average |
|---|---|---|---|---|---|---|
| Ultrasound is an important skill for residents to learn | 0 | 0 | 1 | 5 | 21 | 4.74 |
| Ultrasound is an important skill to practice in our emergency department | 0 | 0 | 1 | 12 | 14 | 4.48 |
| Ultrasound will be an important part of my future emergency medicine practice | 0 | 0 | 2 | 12 | 13 | 4.41 |
| Ultrasound availability will be important for me when I look for a job | 0 | 2 | 8 | 11 | 6 | 3.78 |

increased their scanning, while only 14% of residents decreased their scanning, suggesting that the effect size was not due solely to outlier residents (Figure 2C).

In assessing secondary outcomes, we found no significant difference in the proportion of scans performed by residents at various postgraduate year levels ($\chi 2=0.5$, $p=0.47$) (Figure 3A). In addition, while POCUS fellowship-trained faculty performed more scans than non-fellowship trained faculty both pre- and post-intervention, the total proportion of scans performed increased significantly more in the non-fellowship trained faculty cohort from 22% to 50% ($\chi 2=19$, $p<0.0001$) (Figure 3B).

## DISCUSSION

Ultrasound training is a core feature of EM residency training. However, there is a considerable variability in the form this training takes throughout residencies in the United States.[13] In order to characterize POCUS training of EM residents, Hayward et al. applied Ericsson's deliberate practice model of acquiring procedural proficiency. This model divides learners into novice, intermediate, expert, and advanced expert levels who are able to learn the basics, apply them efficiently, apply them intuitively, and apply advanced applications of the procedure respectively.[14]

**Table 2.** Perceived barriers to routine use of ultrasound in clinical practice.

| Potential Barriers | Not a Barrier | Slight Barrier | Moderate Barrier | Significant Barrier | Extreme Barrier | Weighted average |
|---|---|---|---|---|---|---|
| Inability to use the results in documentation | 0 | 6 | 3 | 11 | 7 | 3.7 |
| Time to complete/optimize a full exam | 0 | 5 | 5 | 12 | 5 | 3.63 |
| Available time to start an exam | 3 | 4 | 8 | 7 | 5 | 3.26 |
| Radiology ultrasound too readily available | 4 | 4 | 9 | 6 | 4 | 3.07 |
| Not knowing if your attending is credentialed | 4 | 4 | 14 | 4 | 1 | 2.78 |
| Difficult to figure out Q-Path | 8 | 9 | 6 | 4 | 0 | 2.22 |
| Can't find the ultrasound machine | 7 | 13 | 5 | 1 | 1 | 2.11 |
| The machine is out of space | 12 | 9 | 5 | 1 | 0 | 1.81 |
| Can't find gel | 13 | 11 | 2 | 0 | 0 | 1.58 |
| Patient refusal | 18 | 5 | 3 | 1 | 0 | 1.52 |
| You don't see it as within your scope of practice | 22 | 4 | 1 | 0 | 0 | 1.22 |

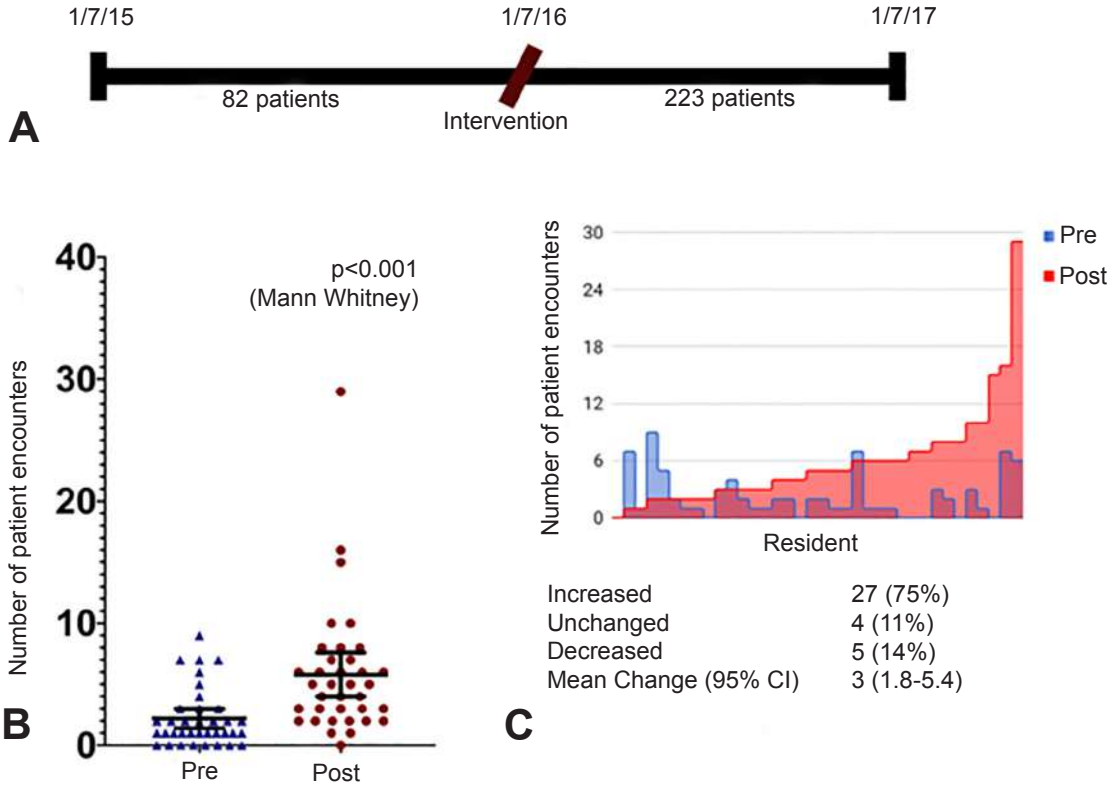
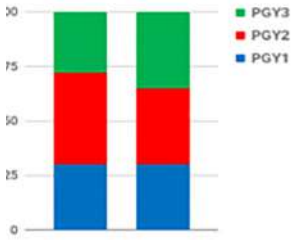



**Figure 2.** Implementation and education of an ultrasound documentation policy increases point-of-care ultrasound utilization by residents. A. Timeline of the study period and observed increase in billed scans from 82 to 223. B. Mean patients scanned per resident increased by an average 3.6 patients/resident. Error bars = 95% confidence intervals. Each data point represents individual residents C. Evaluation of number of patients scanned pre- and post-intervention by each individual resident (where each resident is represented by a vertical bar). The majority (75%) of residents increased their ultrasound use after intervention.
*CI*, confidence interval.

To advance trainees from intermediate sonographers (ie, ones who are competent in image acquisition and interpretation) to expert sonographers (ie, ones who seamlessly integrate POCUS into daily practice and patient care), one must have a detailed understanding of the barriers to such a transition. To the best of our knowledge, this study is the first attempt to systematically define and address these barriers in a resident population. Our data highlight a number of key findings, likely relevant to curriculum and POCUS workflow design:

| Post-graduate year (PGY) | Pre-intervention, n (%) | Post-intervention, n (%) |
|---|---|---|
| PGY1 | 25 (31%) | 67 (30%) |
| PGY2 | 34 (41%) | 78 (35%) |
| PGY3 | 23 (28%) | 78 (35%) |

**A**




| Faculty | Pre-intervention, n (%) | Post-intervention, n (%) |
|---|---|---|
| Fellowship trained | 64 (78%) | 122 (50%) |
| Non-felowship trained | 18 (22%) | 111 (50%) |

**B**

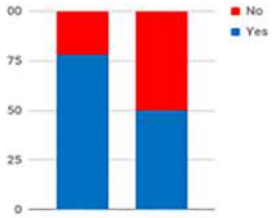



**Figure 3.** Secondary outcome analysis. A. Subgroup analysis of individual residency classes by postgraduate (PGY) year, showing no significant difference between PGY level and increase in point-of-care ultrasound utilization. B. Subgroup analysis of faculty. The non-ultrasound trained faculty demonstrated a significant increase in the total proportion of exams performed compared to the ultrasound trained faculty.

First, we found that residents' perception of ultrasound and its importance in modern EM training is overwhelmingly positive with 96% of residents believing that ultrasound is an important skill to learn during their training. Despite this, only 63% of residents believed that ultrasound availability would be an important feature for them in their future job search. This discrepancy likely underscores the larger problem posed above: While residents are enthusiastic and competent in image acquisition and interpretation, next level training in methods of integrating ultrasound into daily practice is lacking.

Second, we were somewhat surprised that the major barrier identified by residents at the time of our study was the perceived inability to use ultrasound for medical decision-making rather than conventional barriers of time available in the ED or equipment malfunction. However, when viewed through the lens of the deliberate practice model of transitioning from intermediate to advanced competency, it makes sense that our residents' grasp on how to use ultrasound in daily practice was the major perceived barrier.

Third, our finding that implementation and education of a documentation policy is associated with increased integration of ultrasound in clinical decision-making has significant implications for resident education and its integration into subsequent ED ultrasound billing workflows. Recent studies have demonstrated that a continuous workflow quality improvement efforts for all staff also significantly increased the proportion of reported and billed ultrasound studies.[15,16] Another recent study found that resident education of billing practices significantly increased RVU billable by resident encounters.[17] Taken together, this body of literature suggests that educational interventions such as ours can have a quantifiable effect on ED revenue and future EP documentation practices.

A potential confounder in the before-after design of our study was a concomitant push for faculty credentialing, which was underway in our department during the study period. To assess whether the increase in the patients scanned may have been due to this confounder we also analyzed the number of POCUS studies uploaded to PACS by faculty ***without*** resident involvement. We found that faculty uploaded 124 vs 138 studies, which were done without resident involvement, during the pre- and post-intervention phases of the study, an absolute increase of 6%, while resident scans uploaded to PACS increased by 78% ($p<0.0001$, Fischer's exact test). Thus, it appears that the increase in scans performed was primarily resident-driven.

Finally, while it is difficult to infer causation in this observational, before-after study, it does provide a suggestion that incentivization of residents and faculty might be linked. Our secondary outcome demonstrated that the resident-based intervention increased scanning among non-fellowship trained faculty, more so than among ultrasound fellowship-trained faculty. As methods of faculty credentialing and education continue to advance, it may be useful to integrate resident and faculty education. Future inquiry into the effect and interplay of faculty and resident incentivization may help make the transition from intermediate to advanced sonographer more robust and efficient.

## LIMITATIONS

This study was performed at a single academic center with an EM residency program, and as such may be limited in external applicability. However as mentioned earlier, our institution faces many of the same problems and barriers that have been reported by other institutions in the literature. These include the low rate of POCUS utilization, need for deliberate practice, implementation of intuitive documentation processes, and lack of time in a busy ED.[15]

While we did solicit feedback from residency leadership and residents, within the limitations of a single-center quality improvement study, we did not perform separate validation of the survey. The survey portion was also subject to sampling bias, since we had only a 77% response rate. However, we believe that voluntary and anonymous reporting on the survey provides a sufficient advantage. Our low sample size, given its single-center nature, is an important limitation as it limits the statistical power of the study, and it would be useful to repeat this study on a nationwide level. The survey itself includes closed-ended questions, which may introduce response bias; however, write-in, free-text responses were allowed.

In regard to our primary outcome, our study may be limited by the assumption that the number of exams uploaded to PACS is an accurate marker for the number of scans used in the medical decision-making process. Indeed, the survey responses suggest that 82% of residents used POCUS one or more times per shift, but even after the intervention there were only 5.8 scans documented per resident. This suggests that a large proportion of POCUS studies are never documented (a phenomenon often referred to as "scan and run" or "phantom scans"). In addition, this surrogate marker also relies on the cooperation of the appropriate attending, as residents did not have ability to upload images to PACS. However, the survey does identify lack of documentation ability as an important barrier, and documentation of POCUS studies is essential to appropriate medical decision-making and billing as laid out in ACEP's clinical guideline on POCUS use. Thus, our study's primary outcome is relevant to the key objective of the study (ie, facilitating POCUS use in clinical practice).

Another key limitation of our study is the before-after design, which introduces a number of confounders. During the study period faculty received ongoing reminders and were actively incentivized to increase clinical use of POCUS. It is unlikely that the increase in scans is due solely to our intervention; however, we found that the increase in resident-performed POCUS studies is disproportionate to the number of studies done by faculty alone, suggesting that resident involvement in POCUS documentation should be a key factor in improving the quality of POCUS use in clinical decision-making.

## CONCLUSION

This work demonstrates that residents in our program perceive POCUS as valuable to their practice of EM, but recognize a number of barriers to routine incorporation into clinical care. Unfamiliarity with documentation procedure was a key barrier to resident use of POCUS on shift, and addressing this barrier with in-person education helped improve the number of ultrasounds used in medical decision-making. Future work is warranted to establish user-friendly documentation procedures and evaluate the mechanisms of knowledge translation necessary to transition competent resident level sonographers into advanced attending level sonographers.

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# Vitamin D Deficiency and Long-Term Cognitive Impairment Among Older Adult Emergency Department Patients

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**Introduction:** Approximately 16% of acutely ill older adults develop new, long-term cognitive impairment (LTCI), many of whom initially seek care in the emergency department (ED). Currently, no effective interventions exist to prevent LTCI after an acute illness. Identifying early and modifiable risk factors for LTCI is the first step toward effective therapy. We hypothesized that Vitamin D deficiency at ED presentation was associated with LTCI in older adults.

**Methods:** This was an observational analysis of a prospective cohort study that enrolled ED patients ≥ 65 years old who were admitted to the hospital for an acute illness. All patients were enrolled within four hours of ED presentation. Serum Vitamin D was measured at enrollment and Vitamin D deficiency was defined as serum concentrations <20 mg/dL. We measured pre-illness and six-month cognition using the short form Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE), which ranges from 1 to 5 (severe cognitive impairment). Multiple linear regression was performed to determine whether Vitamin D deficiency was associated with poorer six-month cognition adjusted for pre-illness IQCODE and other confounders. We incorporated a two-factor interaction into the regression model to determine whether the relationship between Vitamin D deficiency and six-month cognition was modified by pre-illness cognition.

**Results:** We included a total of 134 older ED patients; the median (interquartile range [IQR]) age was 74 (69, 81) years old, 61 (46%) were female, and 14 (10%) were nonwhite race. The median (IQR) vitamin D level at enrollment was 25 (18, 33) milligrams per deciliter and 41 (31%) of enrolled patients met criteria for vitamin D deficiency. Seventy-seven patients survived and had a six-month IQCODE. In patients with intact pre-illness cognition (IQCODE of 3.13), Vitamin D deficiency was significantly associated with worsening six-month cognition (β-coefficient: 0.43, 95% CI, 0.07 to 0.78, p = 0.02) after adjusting for pre-illness IQCODE and other confounders. Among patients with pre-illness dementia (IQCODE of 4.31), no association with Vitamin D deficiency was observed (β-coefficient: -0.1;, 95% CI, [-0.50-0.27], p = 0.56).

**Conclusion:** Vitamin D deficiency was associated with poorer six-month cognition in acutely ill older adult ED patients who were cognitively intact at baseline. Future studies should determine whether early Vitamin D repletion in the ED improves cognitive outcomes in acutely ill older patients. [West J Emerg Med. 2019;20(6)926-930.]

## INTRODUCTION

Long-term cognitive impairment (LTCI), defined as new or worsening deficit in cognition that persists following acute illness, is a well described phenomenon occurring in an estimated 16% of older adults who are acutely ill.[1] This often leads to increased disability, loss of independence, and decreased quality of life. Currently no effective therapies, especially those that can be administered early in the acute illness course, exist to prevent or treat LTCI following acute illness.

While the mechanism of LTCI has not been fully elucidated, it is hypothesized that systemic proinflammatory cytokines, in response to an acute medical illness such as sepsis,[2] lead to increased central nervous system (CNS) inflammation, microglial activation, and neuronal injury and death.[2] Vitamin D is a pleotropic hormone that modulates systemic and CNS inflammatory responses.[3] Therefore, patients with Vitamin D deficiency may be particularly vulnerable to LTCI following an acute illness. Several observational studies have suggested that Vitamin D deficiency is associated with poorer long-term cognition among community-dwelling adults.[4] However, the relationship between Vitamin D deficiency in the setting of acute illness and subsequent development of LTCI remains unknown in acutely ill patients, especially in the emergency department (ED) setting. Therefore, we sought to determine whether serum Vitamin D at ED presentation was associated with poorer six-month cognition in acutely ill older adults.

## METHODS

This study was an observational secondary analysis within the DELINEATE prospective cohort study, which enrolled ED patients age 65 years and older who were subsequently admitted the hospital for an acute illness at a large, academic, tertiary care hospital.[5] This study enrolled patients from March 2012 – November 2014. The local institutional review board reviewed and approved this study.

Details and rationale of the selection of participants have been described previously.[5] Briefly, we included patients if they were 65 years or older and in the ED for less than four hours at the time of enrollment. Patients were excluded if they were non-English speaking; previously enrolled; deaf, comatose, non-verbal or unable to follow simple commands prior to their current illness; were considered unsuitable for enrollment by the treating physician or nurse; were unavailable for enrollment within the four-hour time limit secondary to clinical care (eg, procedures, radiologic testing, etc,); or were discharged home from the ED. Patients were included for this analysis if they had blood specimen available for Vitamin D measurement and had a surrogate available to complete a short form Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) obtained at enrollment to establish pre-illness cognition.

Pre-illness (baseline) and six-month cognition (primary outcome) were measured using the short form IQCODE in patients who had a surrogate in the ED who knew the patient for greater than 10 years. It ranges from 1 to 5 (severe cognitive impairment). This surrogate-based cognitive screen was used because patient-based measurements in the ED may not accurately reflect true baseline cognition especially in the setting of delirium.[6] The IQCODE is also a validated measure of cognition, which has been previously used to assess cognitive decline[5,7] At time of study enrollment, informants were asked to assess the patients' pre-illness cognition at two weeks prior to ED presentation, and follow-up assessment at six months over telephone with all attempts made to have the same person complete the IQCODE questionnaire as the individual who completed the pre-illness questionnaire.

The primary independent variable was serum Vitamin D measured at ED enrollment. We used Vitamin D level at ED presentation to identify patients with pre-existing Vitamin D deficiency prior to hospitalization for an acute illness. Vitamin D deficiency was defined as a serum Vitamin D concentration <20 milligrams per deciliter (mg/dL).[2] We collected blood in citrate anti-coagulated collection tubes immediately upon study enrollment. Tubes were placed on ice and centrifuged at 3000 g-force within one hour to isolate plasma. Samples were stored at -80C until batched Vitamin D measurements were performed using the Abbott Architect i2000 (Abbott Pharmaceuticals, Lake Bluff, IL).

We used the Charlson comorbidity index to quantify patient comorbid burden.[8] The Acute Physiology Score (APS) of the Acute Physiology and Chronic Health Evaluation II (APACHE II) score, including age, was used to quantify severity of illness.[9] The presence of a CNS diagnosis (meningitis, seizure, cerebrovascular accident, transient ischemic attack, intraparenchymal hemorrhage, epidural hematoma, subdural hematoma, subarachnoid hemorrhage, cerebral edema, meningitis, etc,) was determined by two physician reviewers via medical record review. Any disagreement was adjudicated by a third physician reviewer.

### Statistical Analysis

To determine whether Vitamin D was associated with poorer six-month cognition, we performed multiple linear regression with Vitamin D deficiency as a binary variable adjusting for covariates, IQCODE, the Charlson comorbidity index, APS, and presence of a CNS diagnosis, which were all defined a priori. Because we previously observed that pre-existing cognition may modify any associations and long-term cognition,[10] we incorporated a cross product of Vitamin D and pre-illness IQCODE in the linear regression model. If the interaction p-value was < 0.25, then it was retained in the multiple regression model. Because the IQCODE is a continuous variable, vitamin D's b-coefficients are reported at the 25th and 75th percentile values of the

pre-illness IQCODE to represent those who were cognitively intact and cognitively impaired at baseline, respectively. Another multivariable model was run where serum Vitamin D deficiency was the independent variable. We used SAS version 9.4 (SAS Institute, Cary, NC) for statistical analysis.

## RESULTS

Of the 228 patients enrolled in the DELINEATE cohort, 30 patients did not have a surrogate present to complete the pre-illness IQCODE and 64 did not have blood collected at enrollment leaving 134 participants available for this analysis. The patient characteristics stratified by Vitamin D deficiency status can be seen in the Table. The median (interquartile range) Vitamin D level at enrollment was 25 (18,33) mg/dL and 41 (31%) patients met criteria for Vitamin D deficiency.[11]

Of the 134 patients, 25 (18.7%) died prior to the six-month follow-up, four (3.0%) opted out of the follow-up at enrollment, 10 (7.5%) were lost to follow-up, and 18 (13.4%) were successfully followed-up but a surrogate was not readily available to complete the six-month IQCODE. A total of 77 patients survived and had a six-month IQCODE. The interaction term between Vitamin D deficiency and pre-illness IQCODE interaction's p-value was significant (p = 0.0111) indicating that the relationship between Vitamin D deficiency and six-month IQCODE was modified by the pre-illness IQCODE. The Figure displays the multivariable linear regression models between serum Vitamin D at ED enrollment and adjusted six-month cognition. Among patients with a pre-illness IQCODE of 3.13 (cognitively intact at baseline), for every 1 mg/dL decrease in serum Vitamin D, the six-month IQCODE score significantly increased by 0.18 points (95%CI: 0.00 to 0.031) after adjusting for pre-illness IQCODE and other potential confounders; this indicated that lower serum Vitamin D concentrations measured at ED enrollment was associated with poorer six-month cognition. Among those with an IQCODE of 4.313 (cognitively impaired at baseline), no association with Vitamin D deficiency was observed (β-coefficient: 0.00; 95% CI, -0.01 to 0.02). Similarly, Vitamin D deficiency was significantly associated with worsening six-month cognition (adjusted β-coefficient: 0.44; 95% CI, 0.09 to 0.79) among older adults cognitively intact at baseline (pre-illness IQCODE = 3.13). No association with Vitamin D deficiency was seen (β-coefficient: -0.10, 95% CI, -0.49 to 0.29) in those with pre-illness cognitive impairment (pre-illness IQCODE = 4.313).

## DISCUSSION

Our findings suggest that Vitamin D deficiency is common among older patients presenting to the ED with an acute medical illness, and Vitamin D deficiency is associated with increased risk for LTCI among older adults who are

**Table.** Patient characteristics and demographics.

| | Non-Vitamin D Deficient* | Vitamin D Deficient* |
|---|---|---|
| Median age (IQR) | 74 (69, 82) | 72 (67, 79) |
| Female gender | 51 (54.8%) | 22 (53.7%) |
| Non-white race | 6 (6.5%) | 8 (19.5%) |
| Median pre-illness IQCODE (IQR) | 3.56 (3.06, 4.13) | 3.19 (3.00, 4.00) |
| Median OARS ADL (IQR) | 22 (15, 27) | 25 (17, 27) |
| Median Charlson Comorbidity Index (IQR) | 4 (3, 6) | 4 (2, 5) |
| Median APS (IQR) | 13 (12, 15) | 15 (13, 18) |
| CNS diagnosis | 20 (21.5%) | 3 (7.3%) |
| ED chief complaint | | |
| Abdominal pain | 4 (4.4%) | 4 (10.3%) |
| Altered mental status | 16 (17.4%) | 7 (18.0%) |
| Chest pain | 6 (6.5%) | 5 (12.8%) |
| Generalized weakness | 9 (9.8%) | 2 (5.1%) |
| Nausea/vomiting | 5 (5.4%) | 0 (0.0%) |
| Shortness of breath | 10 (10.9%) | 5 (12.8%) |
| Syncope | 4 (4.4%) | 0 (0.0%) |

*IQR*, Interquartile range; *APS*, Acute Physiology Score; *IQCODE*, Informant Questionnaire on Cognitive Decline in the Elderly score; *OARS ADL,* Older American Services Activities of Daily Living; *CNS*, central nervous system.
The APS also incorporates age from the Acute Physiology and Chronic Health Evaluation II (APACHE II).
*Vitamin D deficiency was defined as a serum concentration of less than 20 ng/dL.

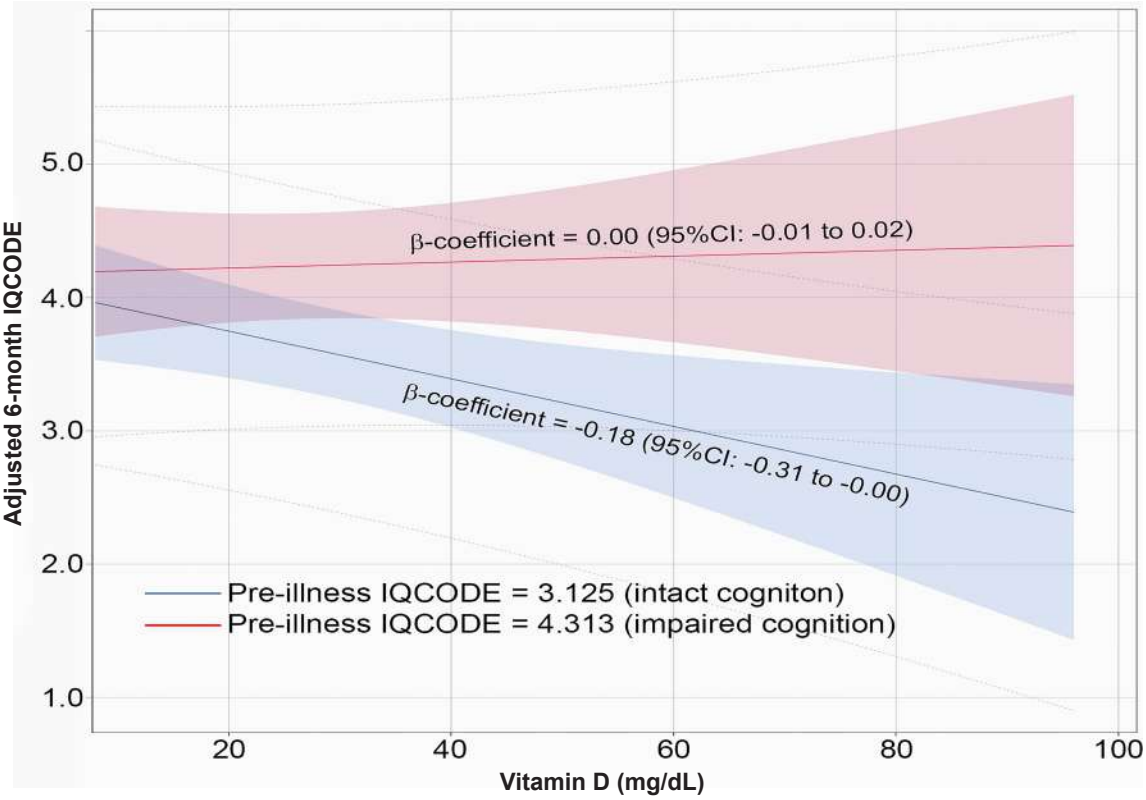


**Figure.** The relationship between serum Vitamin D concentrations measured at enrollment and 6-month cognition. Cognition was determined by the short Informant Questionnaire on Cognitive Decline in the Elderly (IQCODE) which ranged from 1 to 5 (severe cognitive impairment). The association between serum Vitamin D and 6-month cognition was modified by pre-illness cognition. In older adults with pre-illness cognitive impairment (higher IQCODE group, shown in RED), serum Vitamin D concentrations were not a predictor of adjusted 6-month cognition. In older adults who were cognitively intact at baseline (lower pre-illness IQCODE group, shown in BLUE), there was a statistically significant relationship between serum vitamin D concentrations and 6-month cognition after adjusting for confounders.

cognitively intact prior to an acute illness. Unfortunately, no intervention exists to preserve long-term cognition after an acute illness. The first step toward discovering an intervention is to identify modifiable risk factors early on in the course of an acute illness, and this is the impetus for our study. Future studies should determine if early Vitamin D repletion in the ED improves cognitive outcomes in acutely ill older patients.

We also observed that the association between serum Vitamin D concentrations and six-month cognition was more prominent in patients with intact cognition at baseline. It is possible that Vitamin D deficiency in the setting of acute illness may more profoundly affect those with intact cognition. It is also possible that patients with intact cognition at baseline are more at risk for cognitive decline following acute illness that is detectable with the measures currently available to assess cognition. Future studies should confirm this finding using more robust neuropsychiatric evaluations to quantify long-term cognition.

Our study builds upon the work conducted in the outpatient settings, which also reported that low- serum Vitamin D level is associated with the development of Alzheimer's disease.[4] Because systemic and CNS inflammation are the underpinning of LTCI pathophysiology, we hypothesize that Vitamin D treatment could potentially improve long-term cognition by attenuating systemic and CNS inflammatory responses. Vitamin D is a pleiotropic secosteroid hormone that modulates systemic and CNS inflammatory responses.[12] Inflammation in response to an acute illness plays a prominent role in LTCI pathogenesis.[13] Vitamin D down-regulates systemic inflammation by inhibiting the release of peripheral pro-inflammatory cytokines such as tumor necrosis factor-α (TNF-α), IL-6 and IL-12.[14,15] Additionally, Vitamin D also inhibits CNS inflammation by attenuating systemic inflammation and more directly by specifically targeting the brain. Based upon in-vitro models, Vitamin D further attenuates CNS inflammation by inhibiting microglial production of pro-inflammatory cytokines such as IL-6 and TNF-α.[14]

## LIMITATIONS

Our study has several limitations. First, the study was observational and thus was only able to assess association, not causation, between Vitamin D deficiency and long-term cognitive impairment. We used IQCODE to measure pre-

illness and six-month cognition. While it has been previously used to characterize cognitive decline, it is possible that misclassification could have occurred and may have biased our findings.

Second, selection bias may have been introduced by enrolling patients from a single site and only during weekdays and daytime hours. Our primary analysis was based on 57% of enrolled patients due to death during the study period or no six-month IQCODE available for analysis. Patients with missing six-month IQCODEs were similar in age, pre-illness OARS ADL, comorbidity burden, severity of illness, proportion with altered mental status as a chief complaint, and the proportion with CNS diagnosis compared those with accessible six-month IQCODEs (Supplemental Table). However, patients with missing six-month IQCODEs were more likely to be female, non-white race, and cognitively intact at baseline.

Furthermore, our study was limited to a single, academic, tertiary care hospital; thus, our findings may not be generalizable to other settings. Inherent to observational studies and limited by our sample size, unmeasured and residual confounding may exist.

## CONCLUSION

In older adults without pre-existing cognitive impairment (eg, dementia), Vitamin D deficiency at ED presentation was a risk factor for poorer six-month cognition. This relationship was present after adjusting for confounders chosen a priori such as other comorbidities, severity of illness, and the presence of pre-existing cognitive impairment and other CNS diagnoses. We found no such association with Vitamin D and LTCI among older adults with pre-illness cognitive impairment. This suggests that vitamin D deficiency among cognitively intact older adults at the time of ED presentation may be a potentially modifiable risk factor in the development of long-term cognitive impairment.

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# Risk Factors Associated with Emergency Department Recidivism in the Older Adult

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Our objective was to review risk factors predictive of older adult recidivism in the emergency department. Certain risk factors and themes commonly occurred in the literature. These recurring factors included increasing age, male gender, certain diagnoses (abdominal pain, traumatic injuries, and respiratory complaints), psychosocial factors (depression, anxiety, poor social support, and limited health literacy), and poor general health (cognitive health and physical functioning). Many of the identified risk factors are not easily modifiable posing a significant challenge in the quest to develop and implement effective intervention strategies. [West J Emerg Med. 2019;20(6)931-938.]

## INTRODUCTION

Emergency department (ED) overutilization costs the U.S. healthcare system nearly $38 billion annually.[1-5] ED recidivism (defined as ED returns after discharge from an index ED visit) by older adult patients is a substantial contributing factor to ED overutilization with estimated rates varying between nearly 20% to over 40%, depending on time elapsed since the index ED visit, 30 days to six months, respectively.[6, 7] Older adults have more comorbid conditions and complex medical histories as compared to younger adults, often necessitating more expensive and lengthy ED diagnostic testing.[2, 8, 9] Their utilization of the ED despite having health insurance and a primary care physician, suggests other contributors, such as poor health literacy, cognitive impairment, and lack of social support.[1,3,10-12]

Understanding the factors leading to ED recidivism in older adults is necessary to build prevention strategies to decrease unnecessary testing, overutilization of healthcare resources, and hospital admissions. High rates of recidivism coupled with the projected rise in the older adult population makes it critical that effective prevention strategies targeting older adults are developed.[13] This narrative review will discuss risk factors for ED recidivism in older adults.

## METHODS

We searched the PubMed database using the terms *emergency department*, *recidivism* or *return(s), and older adults* from 1985 to November 1, 2018. We identified a total of 185 articles. Studies excluded were those with the following charcteristics: 1) did not include community-dwelling older adults (defined as patients over age 55); 2) did not provide a separate sub-analysis of the older adult patients; and 3) included patients with scheduled ED returns. Various time intervals appear in the literature, including 2, 3, 7, 14, and 30 or more days post-index visit. Studies looking at ED returns within 12 months of the index ED visit were included in this review to ensure that all potential contributing factors were explored. After applying the above exclusion criteria, we performed a review of the cited references for the remaining publications to capture additional pertinent literature. Table 1 displays the characteristics of the 19 included studies.

## RISK FACTORS REPORTED IN THE LITERATURE

### Demographics

Age increases the odds of returns in older adults.[6, 12, 14] In a study of the general ED population within the United States (U.S.), patients over 65 years of age were three times more likely to return and be hospitalized within 72 hours of an ED visit compared to those under age 30. Additionally, risk for ED recidivism and hospitalization appears to increase with advanced age.[12, 15] An increase in age of one year above the age of 70 was found to be an independent predictor for 30-day ED returns in Dutch older adults.[15] However, this increased risk appears to decline after age 85.[14] Male gender was also found to increase odds of returns in U.S., Dutch and Canadian

older adult populations.[12, 15, 16] Other demographic data, such as ethnicity and insurance status, were not predictive of returns by older adults.[10, 12, 16]

**ED Diagnoses and Pain**

Several diagnoses in older adults are associated with ED returns (Table 2). Diagnoses most commonly reported as predictive of recidivism include those related to the respiratory system, traumatic injuries, and pain (particularly chest and abdominal pain). Respiratory diagnoses were found to be predictive not only of 30-day recidivism but of frequent recidivism (defined as three or more return visits; excluding index visit within six months).[6] It is possible that the association of respiratory diagnoses with ED recidivism may reflect the season in which the studies were conducted. Information regarding the time of year the studies were conducted or whether a large percentage of the study population were enrolled in the fall and winter months is not available. Another possibility is that patients with respiratory diagnoses may have underlying chronic respiratory conditions such as emphysema or asthma and that these patients represent a sicker population.

Common ED complaints in older adults include abdominal and chest pain. According to the National Health Statistics Reports of 2007, abdominal pain was the third most common reason for ED visits among all adults aged 65 years or older.[19] Many patients presenting to the ED with abdominal pain or chest pain often do not receive a definitive diagnosis for the cause of their complaint despite extensive diagnostic testing. While clinicians feel safe discharging a patient with negative test results, believing that testing did not reveal any cause for emergent treatment or admission, this news may produce the opposite effect in patients due to this diagnostic uncertainty and fear of the unknown cause of their complaints. This lack of diagnostic certainty may lead patients to return to the ED in the hope of finding an answer or out of fear if the symptoms return.[20-22] The psychological component experienced by patients during their ED encounters is often overlooked and is a potential area of focus for study and improvement.

All types of pain appear to increase the odds of ED returns in older adults. Furthermore, pain complaints may be predictive of *frequent* returns (more than five visits in one year), particularly in those discharged from the ED with a prescription opioid.[23-25] Patients discharged with prescription opioids who are properly educated on prescription opioid medications may be less likely to experience opioid-related adverse events, potentially minimizing ED recidivism.[23]

**Comorbid Conditions and Chronic Illness**

The presence of certain comorbid conditions such as depression, heart disease, diabetes, stroke, and cancer also increase ED recidivism in older adults.[6, 25] Poor mental health, depression, and diabetes were predictive not only of 30-day returns but of frequent returns.[6, 14, 26] A history of psychiatric disorders is a common risk factor identified in several studies with one reporting it as predictive of frequent ED visits (more than five visits in one year).[24, 27] In a study of low-income, homebound older adults with depression, a positive association was found between the Hamilton Rating Scale for Depression scores and frequency of ED visits.[25] Non-cardiac, non-traumatic body pain was the most common reason for recidivism in this older adult population suffering from depression, highlighting the well-established link between depression and pain.

While the literature suggests that specific comorbid conditions are associated with increased recidivism, overall co-morbidity burden, as measured by the Charlson Comorbidity Index, is not. Although intuitively it would seem that patients with high co-morbidity burden would be more likely to return to the ED, La Mantia et al. found no association between Charlson comorbidity scores and ED recidivism.[10] The presence of chronic illness in older adults returning, often frequently, to the ED suggests that at baseline these high-risk patients are sicker with a high burden of comorbidities requiring treatment with multiple medications. This likely explains the reporting of polypharmacy (taking three or more medications) as an independent predictor for 30-day ED returns in older adults.[6, 15] Additionally, recent hospitalization, an indicator of clinical illness severity, was also found to be an independent predictive factor for repeat and frequent ED visits in older adults.[6, 28]

Reasons for returning to the ED in this older adult population suffering with chronic illness may stem from the following: seeking reassurance regarding their condition; noncompliance with treatment plans leading to complications; compliance with

*Population Health Research Capsule*

What do we already know about this issue?
*ED overutilization is a significant burden on the healthcare system. ED recidivism by older adults is a substantial contributor to this overutilization.*

What was the research question?
*The objective of this report is to review risk factors predictive of older adult ED recidivism.*

What was the major finding of the study?
*Risk factors included age, male gender, certain diagnoses, and psychosocial factors. Many are not easily modifiable.*

How does this improve population health?
*Identifying risk factors and effective prevention strategies are essential given the expected population growth for this group.*

**Table 1.** Characteristics of included studies.[4-6, 10, 14-18, 23-26, 27, 28, 35-37, 41]

| Author (year) | Location | Study type | Study duration | Period of ED use | Sample size | Age of sample | Primary Outcome(s) |
|---|---|---|---|---|---|---|---|
| Hastings SN, et al. (2008) | U.S. | Retrospective review of Medicare Current Beneficiary Survey data | 01/2000 to 09/2002 | 90 days | 1851 | 65 years or older | ED return, hospital admission, nursing home admission or death |
| Hastings SN, et al. (2007) | U.S., VA medical center | Retrospective, cohort | 07-09/2003 | 90 days | 942 | 65 years or older | VA ED return, hospitalization, and/or death |
| McCusker J, et al. (2000) | Canada, 4 sites | Prospective observational cohort | 1996 (3 month period) | 6 months | 1122 | 65 years or older | Early returns (within 30 days of index visit) and frequent returns (3 or more return visits in six months) |
| LaMantia MA, et al (2010) | U.S., 1 site | Retrospective review | 2007 (1 year) | 30 days | 995 | 65 years or older | ED returns |
| de Gelder J, et al. (2018) | Netherlands, 3 sites | Prospective observational cohort | 3 months in 2014 and 2015 for two sites. Third site not specified | 30 days | 1093 | 70 years or older | ED return and 90-day functional decline or mortality |
| McCusker J, et al. (1997) | Canada, 1 site | Prospective observational cohort | 07-08/1994 | 90 days | 167 | 75 years or older | ED returns |
| Southerland LT et al. (2016) | U.S, 1 site | Retrospective review | 08/2011 to 02/2013 | 90 days | 263 | 65 years or older | ED returns after discharge for fall from standing |
| Southerland LT et al. (2014) | U.S., 1 site | Retrospective review | 08/2010 to 07/2011 | 72 hours | 315 | 65 years or older | ED returns in patients with new fracture diagnosis |
| Howard R, et al. (2014) | Australia, 1 site | Prospective observational cohort | 8 months | 30 days | 356 | 65 years or older | ED returns in patients discharged with pain |
| Brennan J, et al. (2017) | U.S. | Retrospective, review of non-public, visit-level data obtained from the California Office of Statewide Health Planning and Development | 2013 to 2014 (2 years) | 1 year | 71,449 | 65 years or older | Frequent ED users (defined as 6 or more visits in one year) |
| Choi NG et al. (2012) | U.S. | Randomized control trial | 2 years | 6 months | 121 | 50 years or older | Frequency of ED use |
| Friedmann PD, et al. (2001) | U.S/, 1 site | Prospective observational cohort | 10/1995 to 06/1996 | 90 days | 463 | 65 years or older | ED return, hospitalization, and/or death |
| Castillo EM, et al. (2017) | U.S., multicenter | Retrospective review | Not specified | 7 days | 871,558 | 65 years or older | ED returns |
| Naughton C, et al. (2010) | Ireland, 2 sites | Prospective observational cohort | 18 months | 6 months | 306 | 65 years or older | ED returns |
| Ostir GV, et al. (2016) | U.S., 1 site | Prospective observational cohort | 07- 11/2014 | 90 days | 110 | 65 years or older | ED returns and cognitive health |

*ED*, emergency department; *U.S.*, United States; *VA,* Veterans Administration.

**Table 1.** Continued.

| Author (year) | Location | Study type | Study duration | Period of ED use | Sample size | Age of sample | Primary Outcome(s) |
|---|---|---|---|---|---|---|---|
| LaMantia MA, et al. (2016) | U.S. | Retrospective review of local electronic medical record data, Medicare claims, Indiana Medicaid claims, resident-level Minimum Data Set (MDS), and Outcome and Assessment Information Set (OASIS) data | 11 years | 30 days | 32,697 | 65 years or older | ED use and returns |
| Lee J, et al. (2015) | Canada, 8 sites | Prospective observational study | 04/2009 to 04/2013 | 6 months | 1568 | 65-100 years of age | ED return or hospitalization after ED discharge with minor traumatic injury |
| Horney C, et al. (2012) | U.S, 1 site | Retrospective cohort | 06- 9/2007 | 90 days | 308 | 65 years or older | Healthcare use including ED returns or hospitalizations |

*ED*, emergency department; *U.S.*, United States; *VA,* Veterans Administration.

treatment plans but still developing complications from their condition; not understanding the course of their disease; or inadequate education regarding their discharge plan.

**Psychosocial Factors**

Several psychosocial factors are associated with returns visits in older adults. These include lack of social support, marital status, and anxiety.[6, 28] Divorced, separated, or widowed patients have more than double the increased odds for early returns within 30 days; conversely, patients who never married were significantly less likely to return.[6] An explanation proposed by McCusker et al. for this finding is that patients who never married are more self-sufficient and independent than those who are currently or have previously been married. Reporting a perceived lack of social support by the patient was predictive of both 30-day and frequent returns (three or more within six months).[6] Patients who are divorced, separated, or widowed may feel they have less social support than their married counterparts to assist in their healthcare needs.

Other psychosocial factors reported in the literature include anxiety and substance abuse such as daily alcohol use. Naughton et al. found a 13% increase in the risk of revisits per one unit increase in anxiety scores on the Hospital Anxiety and Depression Scale.[29] The association between anxiety and ED recidivism supported by the literature is not surprising, particularly when a patient may not receive a definitive cause for their symptoms. Patients may experience fear and uncertainty regarding their health leading to anxiety.[20, 21] This coupled with a perceived poor social support system may lead these patients to return to the ED when challenged with new healthcare issues or a perceived failure of current issues to resolve in a timely manner.

Daily alcohol use is associated with a *decrease* in risk of 30-day returns.[6] However, two large retrospective cohort studies of older adults reported that a general history of substance abuse was an independent predictor of frequent ED use (five or more visits in one year).[24, 27] Unfortunately, individual analyses for each of the substances of abuse that were included in these latter studies were not reported, making comparison of these disparate study conclusions difficult. Thus, it is unknown if daily alcohol use might confer a different risk compared to other substances of abuse.

**Health Literacy, Cognitive Health, and Physical Functioning**

The Institute of Medicine defines health literacy as "the degree to which individuals can obtain, process, and understand basic health information and services they need to make appropriate health decisions.[29] In older adults, low health literacy has been linked to decreased use of preventative services, higher utilization of acute care settings (such as the ED) and resources, and poorer health outcomes.[30-32] Over 70% of elderly patients are not questioned on their ability to care for themselves prior to discharge; 20% disclose that they do not understand their discharge instructions.[33, 34] This subset of the older adult population may have difficulty comprehending and following their discharge instructions. This may lead some patients to return when their initial complaints do not improve due to uncertainty and lack of comprehension regarding their discharge diagnoses, treatment, and follow-up plans.[22]

Several studies indicate poor cognitive health also is an important driver of ED returns.[6, 14, 15, 35, 36] Older-adult patients with cognitive and memory impairment were at an increased risk for 30-day returns, and several studies demonstrated it to be an

independent predictor for these returns.[6, 15, 37] However, Ostir et al. found that poor cognitive health and odds of 30-day revisits did *not* have a significant association. Although, Ostir et al. did find that *higher* cognitive health scores were linked to *lower* risk for unplanned ED revisits at 60- and 90-days post-index visit. The authors found that every one-point increase in cognitive score was associated with 24% and 21% decreased odds of 60-day and 90-day revisits to the ED, respectively.

The lack of significant association between poor cognitive health and increased 30-day returns by Ostir et al. may be explained by several differences in the study population, which was mostly female (70.9%), African American (73.6%), and with cognitive impairment (94.7%). The average cognitive score of these patients was 4.5 points below standardized norms for persons 65 years and older,[35] whereas 76.8% of the study population in the McCusker et al. study had no impairment or only mild cognitive impairment.[6] Only 18.7% of patients in the de Gelder et al. study were found to have cognitive impairement.[16] Since nearly all patients in the Ostir et al. study had cognitive impairment, their findings may be due to the lack of an adequate comparison group.

There are several possible explanations why patients with

**Table 2.** Reported frequency or odds of recidivism by diagnoses.[6,10,14-18]

| Diagnoses* | All ED returns regardless of disposition %, OR (CI, p-value) | ED discharge with subsequent ED recidivism %, OR (CI, p-value) | Admission with subsequent ED recidivism OR (CI, p-value) | ED discharge with subsequent admission (%) |
|---|---|---|---|---|
| Circulatory system | | 142 (12.6%) | | 17 (3.6%) |
| Chest pain | 343 (16.7%) | | 1.55 (1.14-2.12, 0.01) | |
| Foot/toe swelling | | 7.67 (1.78-33.04, 0.01) | | |
| Hypertension | 0.41 (0.16-1.02, 0.05) | | | |
| Respiratory system | | 81 (7.2%) | | 56 (12%) |
| Dyspnea | 68 (6.2%) | | 1.73 (1.09-2.75, 0.02) | |
| General viral infection | 9.37 (0.85-103.82, 0.07) | | | |
| Accidental injuries | 463 (42.4%) | 104 (9.2%); 1.48 (1.10-1.99, 0.01) | | 39 (8.3%) |
| Head trauma+ | 2.35 (1.06-5.2, 0.036) | | | |
| Leg/hip fracture | 0.27 (0.06-1.11, 0.07) | | | |
| Fracture | 1.24 (0.64-2.40, 0.518) | | | |
| Digestive | | 93 (8.2%) | | 35 (7.5%) |
| Abdominal pain | 107 (5.2%) | | | |
| Stomach/abdominal pain | 6.03 (1.34-27.12, 0.02) | 5.72 (1.09-29.90, 0.04) | | |
| Lower abdominal pain | | 4.18 (1.13-15.57, 0.03) | | |
| Abdominal distention | | | 12.23 (2.45-61.16, 0.00) | |
| Generalized weakness | 141 (12.9%) | | 1.57 (1.06-2.32, 0.03) | |
| Disorders of speech/ speech disturbance | | | 5.67 (1.25-25.80, 0.03) | |
| Allergy, NOS | | 5.44 (1.33-22.28, 0.02) | | |
| Epistaxis | | 3.39 (1.59-7.24, 0.00) | | |
| Symptoms referable to the lips | 10.26 (0.93-113.51) | | | |
| Urinary tract infection | | | 3.00 (1.18-7.66, 0.02) | |
| Infection of skin of hand, arm, or finger | | 6.37 (1.17-34.66, 0.03) | | |

*Diagnoses and body systems follow the International Classification of Diseases, 9th Revision, classification system as reported in the cited literature.
+Derived from retrospective chart reviews of ED recidivism in patients after a fall.
*ED*, emergency department; *OR,* odds ratio; *CI,* confidence interval; *NOS*, not otherwise specified.

poor cognitive health may be at increased risk for recidivism, including suffering from more complex comorbidities necessitating more frequent healthcare, decreased comprehension of ED discharge diagnoses and instructions, and decreased accuracy in reporting of presenting illness. Patients with delirium superimposed on dementia were found to have lower concordance with their surrogates regarding reason for ED presentation reported to ED staff.[38] This discordance between presenting complaints may lead to insufficient evaluation, missed diagnosis, and/or inappropriate discharge, particularly when the surrogate is not available during the ED evaluation.

In addition to cognitive health, poor physical function and poor general health also increase odds of returning within 30 days, and may be an independent predictor for ED recidivism.[6, 16, 26] As physical functioning is a well-established predictor of outcomes among elderly patients, these findings likely reflect the characteristics of a sicker aging population.

**Patient Perceptions of ED Care**

Several studies have shown that patients, despite access to care (insurance and a primary care physician), prefer to seek care in the ED compared to the outpatient setting.[39-41] Reasons include the following: accessibility/convenience; perceived urgency of complaints; inability to wait for scheduled primary care follow-up due to worsening of persistence of symptoms; expedited diagnostic testing; perceived availability of specialists; lack of transportation to primary care office; and wanting a second opinion, among other reasons. In a study of the general ED population, uninsured patients were not found to use the ED more than insured patients, but they use other types of care less. Interestingly, both the insured and uninsured visit the ED at similarly high rates for non-emergent complaints or complaints that can be treated in non-ED settings.[42]

As discussed previously, patient fear or uncertainty likely plays an important role in understanding why patients come (and return) to the ED. This sense of uncertainty regarding the cause of their symptoms is best illustrated by Castillo et al.'s findings of a rather high rate of older adults returning to the ED for the same primary diagnosis (23.2%) and many seeking care at a different facility (19.4%), perhaps in hopes of finding a different conclusion from their index ED visit.[27] In a qualitative study of 40 adult patients with chronic cardiovascular disease or diabetes, patient reported driving factors for ED returns included feeling a sense of fear or uncertainty (rather than relief) with negative test results and expecting a diagnosis for their symptoms. Many patients who did not receive a clear diagnosis for their symptoms reported needing to return until a diagnosis was found.[20, 21] In two studies of older adults, patients were less likely to consider that their complaint has been completely resolved and believed they would be less independent after discharge from the ED.[33, 43]

A survey of 15 older adults also linked patient perception of ED care with ED recidivism, including believing that the ED was their "only option" and that their symptoms required specialized care only provided in the ED.[22] Several patients also reported that they believed their primary care physician would have advised them to seek care in the ED for their symptoms. Others reported receiving ineffective treatments or instructions at the time of ED discharge. In some cases, this perception may stem from inadequate patient counseling regarding expectations and reasonable goals of care and that can be achieved during the ED visit.

**FUTURE DIRECTIONS**

The older adult population is a key and significant contributor to ED recidivism and is responsible for a disproportionate amount of healthcare costs. For this reason, older adults have received much attention and study to create interventions aimed at reducing ED recidivism. The unique characteristics of this patient group (complexity of medical issues, age and pathological-related changes in cognition and physical function) should be considered when developing strategies to minimize ED returns. The generation of a profile for elderly patients at increased risk for ED returns could identify potential targets for individualized education, counseling, and other interventions to reduce ED over-utilization.

Many of the study results discussed in this review were performed outside the U.S. and thus may not be fully generalizable to older adults residing in the U.S. due to different social and cultural influences and healthcare systems. However, when data was available for comparison, studies performed in the U.S. identified many similar risk factors for return visits in older adults as the non-U.S. studies. These similarities suggest that the underlying reasons for ED utilization by older adults may be influenced more by themes related to aging rather than the cultures or healthcare models of individual countries. However, it is important to note that these studies were all performed in highly developed countries with stable economies and well-established healthcare systems. Therefore, whether the identified risk factors would remain true in developing countries with fewer healthcare resources is unknown and deserves further study.

Numerous risk factors have been identified in the literature. Further study is needed to understand how each of these areas influences return visits, how they influence each other, and to resolve discrepancies in previously reported findings.

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# An Academic Relative Value Unit System: Do Transparency, Consensus, and Accountability Work?

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**Introduction:** Academic medicine continues to struggle in its efforts to compensate scholarly productivity. Academic achievements receive less recognition compared to clinical work, evidenced by a lack of reduced clinical hours or financial incentive. Core departmental education responsibilities are often distributed inequitably across academic departments. An approach using an incentive program, which emphasizes transparency, equity, and consensus may help academic departments share core education responsibilities and reward scholarly activity.

**Methods:** We launched a two-stage approach to confront the inequitable distribution of educational responsibilities and to recognize the scholarly work among our faculty. In the first stage, baseline education expectations were implemented for all faculty members, which included accountability procedures tied to a financial incentive. The second stage involved the creation of an aAcademic rRelative vValue uUnit (ARVU) system which contained additional activities that were derived and weighted based on stakeholder consensus. The points earned in the ARVU system were applied towards additional financial incentive at academic year-end. We compared education contributions before and after implementation as well as total points earned in the ARVU system.

**Results:** In the first year of implementing education expectations, 87% of faculty fulfilled requirements. Those with a heavier clinical load made up the majority of deficient faculty. Those who did not meet education expectations were notified and had their year-end incentive reduced to reflect this. Faculty conference attendance increased by 21% (P<.001) and the number of resident assessments completed increased by 30% (P<.001) compared to the previous year. To date, faculty across the department have logged a total of 1,240 academic activities in the database, which will be converted into financial bonus amounts at year-end.

**Conclusion:** We have seen significant increases in faculty participation in educational activities and learner assessments as well as documentation of activities in the ARVU system. A similar system using different specialty-specific activities may be generalizable and employed at other institutions. [West J Emerg Med. 2019;20(6)939-947.]

## INTRODUCTION

Academic medicine faces a challenge on how to balance the objectives of revenue production with compensation of scholarly achievement. Historically, "relative value units" have been used to incentivize physicians to improve clinical productivity, but these systems have neglected to recognize non-clinical achievements, such as those related to teaching, academic leadership roles, or other scholarly activity. Many non-clinical activities do not earn a reduction in clinical hours or financial incentive, which may result in decreased motivation to contribute academically as well as frustration and burnout. As faculty members work to advance in their professional careers, diminished scholarly output may create a barrier for promotion possibilities at traditional academic institutions. All of this

may result in less time devoted to teaching and diminished opportunities for mentorship and role modeling for learners.

To foster academic productivity and the retention of talented physicians, academic medicine must recognize and reward the effort that is necessary to thrive within it.[1] Models have been introduced over the past decade that focus on incentivizing non-clinical activities. Some of these models have focused solely on education and teaching commitments using a teaching or educational value unit system to weigh activities.[2-5] Others have cast a broader net encompassing all academic activities, including education, teaching, committee and administrative roles, and research, using a clinical or academic relative value unit (ARVU) model.[6-8]

Problems were identified in our department with regards to education and scholarly activity. The residency group and a small group of core faculty have traditionally carried much of the teaching effort, resulting in an unequal distribution of educational commitments across the department. In addition to education, many in the department participate in other scholarly work such as research projects earning grant funding, peer-previewed publications, lecturing engagements, and leadership or committee positions. Similar to other academic institutions, our department has experienced difficulty tracking faculty activities outside of clinical work. Faculty frustration has resulted from many of these activities not being compensated financially or rewarded with reduced clinical hours. Furthermore, junior faculty lacked an understanding of the importance of tracking academic activities as a way to monitor their progress and to focus on areas that required more attention in preparation for the promotion process.

We brainstormed ideas regarding how to expand faculty commitment to better align with our academic mission, to prepare faculty for promotion, and to create an improved infrastructure fostering resident and student mentoring. Our project had several objectives: 1) realign and redistribute the responsibility for meeting education needs equitably across the department; 2) create a system of accountability and transparency based on faculty consensus; 3) recognize and reward academic activities that go above minimum expectations; 4) align faculty academic productivity with institutional promotion procedures; 5) build a system that houses academic activities in a format consistent with institutional teaching portfolio expectations; 6) incentivize and increase departmental scholarly output; and 7) build a system capable of supporting an academic mentoring infrastructure for our learners.

In 2017 we initiated a two-stage project to redesign education expectations and to identify and recognize the full spectrum of academic activities among all faculty. Stage one involved the creation of a mandatory baseline educational participation process; stage two, implemented later, involved the creation of an ARVU points system with identified voluntary academic participation. Both stages of the project were tied to an academic financial incentive awarded at year-end. Our goal was to determine the effects of this project on faculty baseline participation in educational activities as well as monitor academic productivity and advancement within the department.

## METHODS

### Study Design and Setting

Institutional review board approval was not sought for this project because it was conducted for quality improvement purposes.

### Methods and Measurements

*Stage One: Baseline Education Expectations*

Stage one, initiated in July 2017, created minimum education expectations and accountability procedures, incorporating two related requirements. The first included attending a minimum number of resident conferences per year, inversely proportional to a faculty member's clinical load. The second element required participation in a module system, created by the residency, where each month represented one module (12 in total throughout the year) and focused on a particular topic. Each faculty member was required to sign up for and commit to specific dates during a module where they were responsible for taking part in teaching activities assigned by the residency or undergraduate medical education group. These activities included such things as giving a lecture, moderating a journal club, running a small group session, or teaching a procedural skills lab among others. The sign-up process afforded some flexibility and choice, as faculty could pick dates that worked for them and topics they were most interested in. Conference attendance required only the presence of faculty in the audience, but module participation required the active participation of faculty in specified activities.

Conference attendance and module participation were chosen as minimum expectations for two reasons: firstly, all faculty historically have been expected to participate in residency and student teaching as part of their academic appointment to the medical school; and secondly, these activities were considered to require the heaviest lift and were inequitably distributed among the faculty. These new expectations were required of faculty across the department and were tied to a newly created academic incentive awarded at fiscal year-end. The faculty who did not meet these new education expectations were not eligible for this financial incentive.

After soliciting feedback on these new expectations through faculty meeting discussions and offline conversations, most agreed that the new expectations were not overly burdensome. However, two main concerns surfaced. One was that the academic incentive was not reflective of other non-clinical activities valuable to the department's mission. A second concern brought forth by the residency leadership was that the expectations did not include resident assessments, which historically had a low response rate. Based on this feedback, the baseline education expectations were revised to include

completion of a percentage of resident post-shift assessments over the academic year, inversely proportional to a faculty member's clinical load. During the first year (academic year [AY] 2017-18), the requirements included only conference and module participation. The residency assessment requirement was subsequently enacted in the following year (AY 2018-19). Table 1 lists the final baseline education expectations required of faculty members. Before employing these education requirements, all faculty members were notified of the consequences of not fulfilling expectations, which included ineligibility for any academic incentive and an inability to participate in the voluntary ARVU system.

*Stage Two: Academic Relative Value Unit System*

In May 2018, stage two began, which involved the creation of an ARVU system to encompass all other academic activities. It was decided that the ARVU system would be voluntary, but to participate the baseline education expectations outlined in stage one had to be fulfilled. For the first step of this stage, the vice chair for education created a list of preliminary activities to be included in the ARVU system, such as teaching, lecturing, publications, grants, committee memberships, and leadership positions. These additional activities were ones in which faculty were already participating that aligned with the academic mission of the department, but had not been captured within the baseline education expectations, did not earn clinical hours reduction from the department or institution, or were not an implicit part of a faculty member's role based on his or her leadership position. The thought was that activities that earned a clinical reduction in hours were already being financially rewarded, and this system was designed to recognize activities not yet distinguished. An example includes fellowship activities, which were not included because fellowship directors have a reduction in clinical hours to support their leadership role.

After the initial list was assembled, it was shared with a select group of 11 leaders within the department, including residency leadership, undergraduate medical education leadership, fellowship directors, the research division, and the pediatric emergency medicine division. The participants were selected due to their various leadership roles in the department, their dedication to scholarly achievement in their own careers, and the high priority they placed on these activities within their respective divisions. These qualifications placed these faculty members in a prime position to help generate a comprehensive list of activities relevant to each division. After multiple discussions and written communications using a modified Delphi method, the group reached consensus on the activities that were to be included.

The unique part of this project was the third step, which included a survey that was created and analyzed using Qualtrics software (Provo, UT, and Seattle, WA) and distributed to a group of 60 faculty members across the department. These faculty members were chosen out of a total of 123 because they were identified as department members who regularly participated in the activity list created by the leadership group. Because these faculty members were the most active in these activities, they were in the best position to review the list and evaluate each activity to its fullest. Furthermore, because it was decided that the ARVU system would be voluntary, they were deemed the faculty most likely to be invested in and use this new system. Finally, one of the goals of this mission was to get faculty buy-in as they were the most important stakeholders in this endeavor, and this was achieved by allowing them a voice and to feel empowered in the final steps of this project.

The survey included all agreed-upon activities and asked faculty to rate each on a scale from one (minimal effort) to four (most effort) (Appendix 1). A short description of the activity in question was included to help faculty decide on the point values assigned. The 11 faculty members who contributed to the final list of activities created these descriptions. Effort was defined by the time needed to commit or prepare for a particular activity, the ongoing effort needed to sustain the activity if it involved a longer commitment than just one session, and whether the activity required a passive presence or more active participation. For example, activities that required a sustained effort included such things as grant involvement, committee membership, or a leadership position.

As expected, some subjectivity was involved in the voting for various reasons, such as the activity being one in which the responsive faculty member participated in himself or herself, or differing opinions regarding how much preparation time might be needed for such things as a lecture. To help reduce this bias, the survey was sent to many faculty members with different roles and responsibilities to obtain a consensus and to dilute

**Table 1.** Baseline education expectations for faculty.

| Faculty category | Conference attendance | Module requirement | Resident post-shift assessment completion |
|---|---|---|---|
| Full time ≤ 28 hours | 10 conferences/year | 2 modules/year (2 months) | 75% |
| Full time > 28 hours | 5 conferences/year | 1 module/year (1 month) | 50% |
| Overnight | 5 conferences/year | 1 module/year (1 month) | 50% |
| Part time or non-ACGME fellow | 5 conferences/year | 1 module/year (1 month) | 50% |

*ACGME*, Accreditation Council for Graduate Medical Education.

idiosyncratic points of view. Furthermore, the knowledge of and dedication to each activity that the chosen faculty members had and the descriptions provided helped to further reduce bias in the points system. The survey also included free-text fields where faculty could input additional activities that they felt should be added to the list.

Of the 60 faculty members surveyed, 49 (82%) responded and completed the survey in its entirety. The activities, ranked from highest to lowest based on the mean score including standard deviations, are presented in Table 2. The standard deviation was less than one for all activities included in the survey. The mean of each activity was translated into final points to be awarded in the ARVU system. Activities with higher means earned more points. Any activities that were similar in description and mean score were assigned the same number of final points. We introduced the final list and point system at a faculty meeting prior to implementing, and after this final feedback round, we launched the system in December 2018. The free-text responses were also reviewed, and these activities were added to the list and also voted on by the faculty group to create the final list with points.

The next steps for the project included creating a database where faculty could log their completed activities. We created a Google form that listed all activities in the ARVU system where faculty members could select the activity in which they participated (Figure 1). Each activity had an associated dropdown menu that asked for additional information, such as title, date, location, description, proof of activity, and an ability to upload documents. We then created a dashboard in the analytics platform Tableau (Seattle, WA), containing all activities. Statistics for the baseline educational expectations (conference attendance, module participation, and resident assessments) automatically loaded into the dashboard and could not be edited by faculty members.

The ARVU activities logged into the Google form also fed directly into the dashboard for display. The full dashboard displayed each faculty member's baseline education expectations, whether they had met requirements, the activities that they had entered into the ARVU point system, and total points earned to date (Figure 2). Final points were earned after academic leadership reviewed, approved, and signed off on each submitted activity. Each month, the system automatically e-mailed a link to each individual's dashboard notifying faculty how many points they had earned to date and of any participation deficiencies.

The medical school requires a teaching portfolio for faculty seeking promotion on the scholar track. This portfolio requires faculty to document their achievements in the following categories: teaching effort, mentoring and advising, administration and leadership, committees, and teaching awards. All ARVU activities were reviewed and categorized based on the elements of the teaching portfolio. These activities not only show up as itemized items with points, but they are also grouped into the appropriate portfolio category and are displayed on each individual faculty member's dashboard. This allowed each faculty member to see how much scholarship they had completed within each of the teaching portfolio categories and in which areas they were lacking that deserved more attention. This provided faculty with a readily accessible repository of activities that could be transferred directly into the correct category of their teaching portfolio, facilitating tracking of activities upon which one needed to focus for promotion.

**Outcomes and Analysis**

Compliance with baseline education expectations was determined by evaluating each individual faculty member's conference attendance, module participation and completion of resident assessments. We evaluated the effect of the expectations on conference attendance and resident assessments by using paired t-tests performed in Microsoft Excel 2016 and by tracking individual faculty member's compliance pre- and post-implementation. Faculty who were absent for prolonged periods of time and new faculty were not included in the analysis. The ARVU system was tracked since implementation to determine number and type of activities logged.

## RESULTS

A total of 123 faculty members were expected to participate in the baseline education expectations. At the end of the academic year in June 2018, 107 faculty (87%) had met requirements. Failure was defined as not attending the required number of conferences per year or not participating in the module system. Of the 16 who did not meet expectations, 94% signed up for conference modules to participate in specific activities, but none of them met overall required conference attendance. Of the deficient faculty, five worked full time at 28 or fewer hours, 10 were full time at more than 28 hours, and one was part time. Those who did not meet education expectations were notified and had their year-end AY 2017-18 financial incentive reduced to reflect this deficiency.

We compared an individual faculty member's conference attendance in AY 2016-17 and AY 2017-18 to determine any changes after implementing the new expectations. Overall, faculty attended 21% ($P<.001$) more conference days after expectations were implemented compared to the prior year. Preliminary data for the following AY 2018-19 reveals that conference attendance increased by 15% ($p = .096$). The number of resident assessments completed in AY 2017-18 among all faculty was 2837 compared to preliminary AY 2018-19 assessments of 4049, resulting in a 30% ($p<.001$) increase since expectations went into effect.

To date, faculty across the department have logged a total of 1240 academic activities in the database. The distribution of points across categories is highlighted in Table 3 with most points earned through teaching activities at the medical school or through other scholarly work that doesn't necessarily fit into the other categories of the teaching portfolio. Leadership will review each faculty member's individual records to determine

**Table 2.** Final academic relative value unit activities with mean points and standard deviations.

| Activity | Mean | Standard Deviation |
|---|---|---|
| Principal investigator (PI) on federal grant | 3.80 | 0.64 |
| Principal investigator (PI) on foundation grant | 3.71 | 0.67 |
| Principal investigator (PI) on industry grant | 3.65 | 0.69 |
| Course director of medical student selective course | 3.57 | 0.70 |
| First author peer-reviewed research manuscript | 3.55 | 0.70 |
| Primary textbook editor | 3.53 | 0.79 |
| Course director of medical student elective course | 3.49 | 0.70 |
| Principal investigator (PI) on internal school grant | 3.49 | 0.79 |
| Principal investigator (PI) on internal Department of EM grant | 3.43 | 0.81 |
| Residency module leader | 3.33 | 0.77 |
| Leader Scholarly Academy | 3.27 | 0.80 |
| Co-investigator on federal grant | 3.27 | 0.72 |
| Textbook chapter | 3.27 | 0.72 |
| Lecture at international, national or regional meeting | 3.24 | 0.72 |
| Co-investigator on foundation grant | 3.18 | 0.72 |
| Grand rounds lecture - external institution | 3.16 | 0.71 |
| First author non-research manuscript | 3.16 | 0.68 |
| Journal editor | 3.14 | 0.78 |
| Chair of national/regional education committee | 3.12 | 0.72 |
| Grand rounds lecture - internal | 3.08 | 0.78 |
| Lecture at resident conference | 3.00 | 0.53 |
| Lecture at PEM conference | 3.00 | 0.57 |
| Outside lecture or teaching session at another teaching institution | 2.98 | 0.71 |
| Leader at faculty development session | 2.94 | 0.79 |
| Content creator and/or editor of educational site/blog/podcast faculty | 2.92 | 0.85 |
| Participant/mentor CPC | 2.86 | 0.78 |
| Mentor resident scholarly project | 2.86 | 0.78 |
| Abstract presenter national meeting | 2.80 | 0.64 |
| Last author peer-reviewed research manuscript | 2.78 | 0.89 |
| Co-author peer-reviewed research manuscript | 2.73 | 0.69 |
| Abstract presenter regional/local meeting | 2.71 | 0.67 |
| Mentor of Medical Student International Health Program | 2.65 | 0.87 |
| Lecture at fellow core curriculum session | 2.65 | 0.69 |
| Preceptor of Medical Student Scholarly, Research Concentration | 2.61 | 0.72 |
| Project lecture in basic science course | 2.59 | 0.81 |
| Lecture to other NYU residents, faculty, students or staff | 2.57 | 0.70 |
| Journal reviewer | 2.57 | 0.76 |
| Last author non-research manuscript | 2.53 | 0.81 |
| Co-author non-research manuscript | 2.53 | 0.70 |
| First author on case report | 2.53 | 0.64 |
| Member of Residency Program Evaluation Committee | 2.47 | 0.93 |
| Preceptor for the Patient Longitudinal Ambulatory Clinical Experience | 2.43 | 0.73 |
| PEM joint conference liaison | 2.43 | 0.64 |
| Residency interviewer | 2.39 | 0.88 |

*EM,* emergency medicine; *PEM*, pediatric emergency medicine; *NYU*, New York University.

**Table 2.** Continued.

| Activity | Mean | Standard Deviation |
|---|---|---|
| Lecture at Toxicology Rotators Conference | 2.39 | 0.69 |
| Journal club moderator at resident conference | 2.37 | 0.63 |
| Lecture in medical school course for elective or selective | 2.37 | 0.77 |
| Member of NYUSoM educational committee | 2.37 | 0.80 |
| Co-author abstract national meeting | 2.33 | 0.71 |
| Co-author abstract regional meeting | 2.31 | 0.77 |
| Primary URiM Summer Fellowship Student faculty mentor | 2.29 | 0.76 |
| Preceptor morbidity and mortality conference | 2.27 | 0.69 |
| Member of Clinical Competency Committee | 2.27 | 0.69 |
| PEM conference journal club moderator | 2.27 | 0.60 |
| PEM journal update presenter | 2.27 | 0.60 |
| Member of national/regional education committee | 2.27 | 0.69 |
| Instructor at resident procedure, simulation or multi-modal workshop | 2.24 | 0.69 |
| Participant URiM Summer Fellowship | 2.24 | 0.74 |
| Instructor Inter-clerkship intensive (ICI) courses | 2.24 | 0.66 |
| Instructor in Practice of Medicine | 2.24 | 0.72 |
| Leader in-situ simulation session | 2.22 | 0.65 |
| Instructor medical student ultrasound workshops | 2.20 | 0.67 |
| Commentary/letter to editor | 2.20 | 0.70 |
| Co-author case report | 2.20 | 0.61 |
| Preceptor/Participant Sonolympics | 2.18 | 0.80 |
| EM Foundations Curriculum Faculty Facilitator | 2.18 | 0.80 |
| Instructor Transition to Residency Course | 2.16 | 0.58 |
| Instructor ATLS | 2.14 | 0.81 |
| Participation in First Night on Call for Interns | 2.14 | 0.67 |
| Preceptor/Participant EM Olympics | 2.12 | 0.82 |
| Instructor at PEM procedure or simulation workshop | 2.10 | 0.61 |
| Preceptor of toxicology bedside rounds | 2.08 | 0.75 |
| Primary medical student faculty mentor | 2.06 | 0.65 |
| PEP talks to students | 2.04 | 0.67 |
| Primary mentor on resident lecture | 2.02 | 0.65 |
| Small groups facilitator at resident conference | 2.02 | 0.68 |
| Preceptor of toxicology fellow rounds | 2.02 | 0.71 |
| Medical school interviews | 2.00 | 0.70 |
| Participation in oral boards preparation | 1.98 | 0.59 |
| PALS instructor | 1.98 | 0.65 |
| Ultrasound scanning shifts with residents | 1.96 | 0.60 |
| Ultrasound scanning shifts with medical students | 1.96 | 0.60 |
| Participate in NYCPCC afternoon rounds | 1.94 | 0.79 |
| Instructor in student simulation or workshop sessions | 1.88 | 0.59 |
| Participation in Emergency Medicine Interest Group | 1.86 | 0.61 |
| Preceptor of medical student ultrasound OSCE | 1.80 | 0.61 |
| Medical student case session for EM selective or elective | 1.76 | 0.77 |

*NYUSoM*, New York University School of Medicine; *URiM*, Underrepresented Minorities in Medicine; *PEM*, pediatric emergency medicine; *ATLS*, Advanced Trauma Life Support; *EM*, emergency medicine; *PEP*, The Prevention and Education Partnership; *PALS*, Pediatric Advanced Life Support; *NYCPCC*, New York City Poision Control Center; *OSCE*, Objective Structured Clinical Exam.

**Table 2.** Continued.

| Activity | Mean | Standard Deviation |
|---|---|---|
| Participation in Standardized Direct Observation Assessment Tool | 1.61 | 0.66 |
| Participation in EM/PEM conference | 1.59 | 0.67 |
| Attendance at Ultrasound Conference | 1.49 | 0.61 |
| Attendance at Education Journal Club | 1.47 | 0.58 |
| Attendance at Toxicology Journal Club | 1.43 | 0.57 |
| Attendance at PSQI Journal Club | 1.41 | 0.57 |
| Attendance at Scholarly Academy | 1.35 | 0.52 |
| Attendance at Toxicology Consultants' Conference | 1.31 | 0.54 |
| Resident advisor | 1.30 | 0.51 |
| Attendance at faculty development session | 1.29 | 0.49 |
| Morning report attendance | 1.22 | 0.46 |

*EM,* emergency medicine; *PEM*, pediatric emergency medicine; *PSQI,* Patient Safety and Quality Improvement.

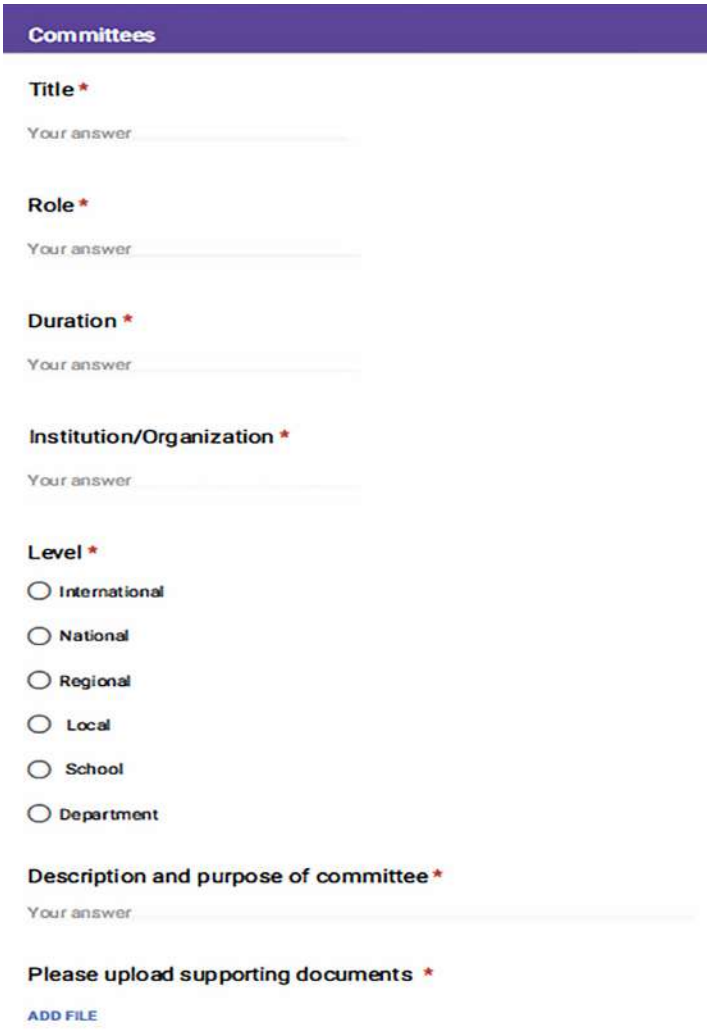


**Figure 1.** Google document used to document faculty's academic relative value unit activities.

if they have met baseline education expectations. The faculty who meet expectations will receive the set baseline incentive and have the potential to earn more financial incentive based on the number of points they have earned in the ARVU system. Once all the data is analyzed, the points will be converted into financial bonus amounts based on the number of faculty who are eligible and the amount of funds available.

## DISCUSSION

This project has resulted in preliminary positive effects on both education and documentation of scholarly work within our department. The first stage resulted in an overall increase in conference attendance and participation even prior to implementing the ARVU system. It is possible that these positive findings were a result of the academic incentive being dependent on meeting education expectations. However, in offline discussions with multiple faculty members, it appears that there was a shame factor that also contributed to improved attendance. Multiple faculty expressed their relief that many were being called out on their low attendance and participation and that faculty who had historically carried much of the teaching responsibility were now being recognized. In the same vein, resident assessments increased in the second year by a considerable amount, without any other changes being made to the system, and therefore were likely a result of the new expectations. The increase in assessments does not necessarily mean better quality, and this will need to be evaluated going forward to determine full impact. The improved participation in educational activities as a result of financial incentives or other measures is consistent with reports from other institutions and existing literature.

There is a clear correlation between faculty documentation of scholarly output and the ARVU system, as there was no system in place prior that allowed tracking of activities.

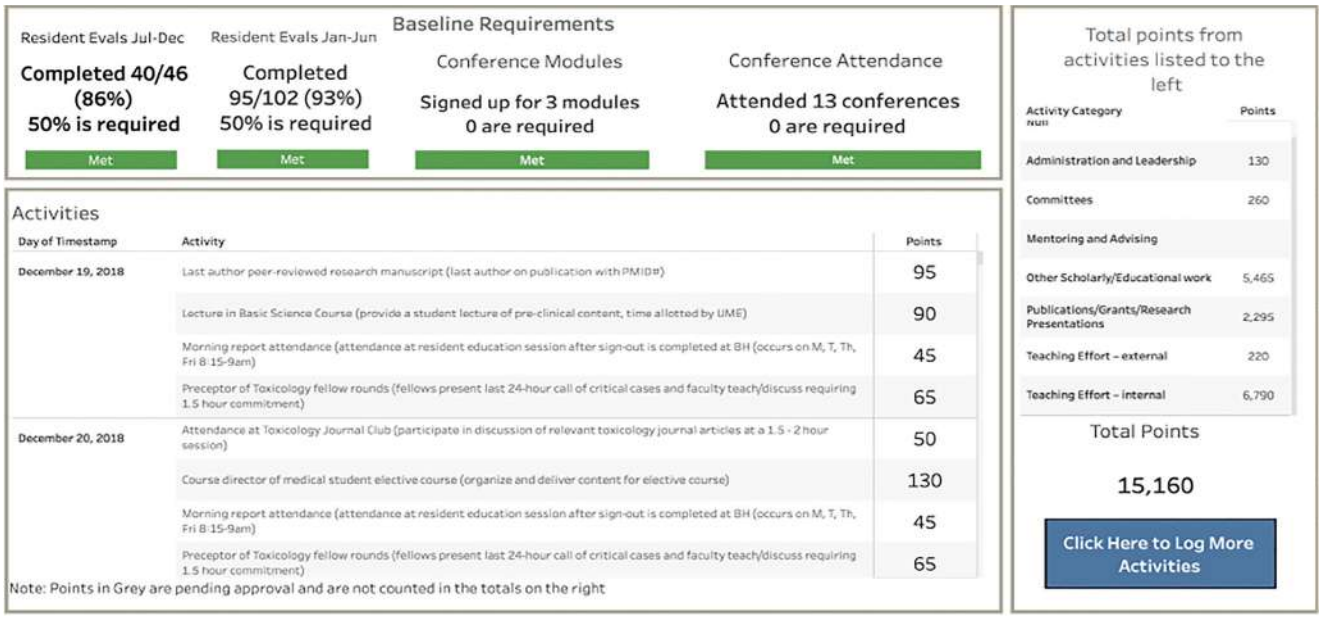


**Figure 2.** Dashboard with education expectations, academic relative value unit activities, points, and portfolio categories.

**Table 3.** Total activities, points, and categories logged to date.

| Activity Category | Points |
|---|---|
| Administration and leadership | 260 |
| Awards | 180 |
| Committees | 825 |
| Mentoring and advising | 755 |
| Other scholarly/educational work | 29,050 |
| Publications/grants/research presentations | 5,355 |
| Teaching effort - external | 2,245 |
| Teaching effort - internal | 22,500 |
| Total points | 61,170 |

The increase in activities and documentation will need to be followed from year to year to draw conclusions on overall scholarly activity among individual faculty members and throughout the department. Unlike previous literature describing ARVU systems, our project has emphasized the ability to house activities in one place that can be transferred into a faculty member's teaching portfolio, thereby further incentivizing the use of this system outside of financial rewards.

We will continue to track baseline education expectations and the ARVU system across the department as well as continuously seek feedback from faculty and make changes as needed. This process will continue to be refined over time based on faculty feedback and departmental and institutional priorities. The majority of faculty who did not qualify for the academic bonus last year worked more than 28 clinical hours per week, and thus time issues may have affected compliance. To further probe this finding and facilitate educational commitments, we will solicit additional feedback from this group of faculty members to explore participation barriers that may be addressed in the future.

We hope to follow the scholarly output of the department over time using the ARVU system as an estimate of faculty productivity. Our longer-term goals will be to see the effects of this system on the promotion process within the department with an expectation that more junior faculty will become eligible for advancement. These effects will be evaluated by tracking the progress and content of junior faculty teaching portfolios compared to previous years and time to successful promotion. With a bottom-heavy young faculty group, our expectation is that this system will better prepare people for promotion as they can track their activities and determine where they need to place more effort to enhance their portfolio. Finally, this system will be used to improve the mentorship infrastructure within the department. Assigned faculty mentors will use the ARVU dashboard to mentor junior faculty on their progress for promotion. This dashboard will provide another data point for mentors to advise junior faculty where they need to focus their efforts in order to progress professionally.

## LIMITATIONS

There was likely subjectivity and bias in faculty assigning points to activities based on effort. Faculty may have ranked certain activities higher than others due to their own participation in the activity in question. In addition, faculty have different opinions on what type of effort may go into an activity; for example, a lecture may be easily prepared by some

and take a lot of effort for others. We attempted to remove some of this subjectivity and bias by including faculty in this process who are the most committed to academics in our department. Many of these faculty participate in these activities on a regular basis and, therefore, we believed they were most committed to creating a fair transparent system to reward achievements. Furthermore, the standard deviation for each activity was not large enough to have created significant discrepancies in where a particular activity was ranked.

This was a project initiated at a single site, which may limit its generalizability to other institutions. However, similar methods could be used to create site-specific prioritized activities that may enhance its use at other institutions. Finally, it is possible that the increase in conference attendance and resident assessments was confounded by other factors. The changes could have been simply due to faculty feeling the need to attend more conferences or better evaluate our learners, but the effects coinciding with the implementation of new expectations is unlikely to be coincidental.

## CONCLUSION

Although other institutions in a similar fashion have developed ARVU systems, using consensus-type methods, none of these systems have engaged a large faculty group to rank activities and assign final points. The methods we used to derive this system were iterative, transparent, and collaborative. This process was unique because it included multiple faculty stakeholders who had different roles and priorities within our department to create the system. The selected activities were inclusive and respectful of all efforts.

We have already seen significant increases in faculty participation in learner teaching activities and assessments. In addition, for the first time in the department's history, we have taken steps to recognize all of the other academic activities that don't receive funding or reduced clinical time. A similar system, using the same methods outlined above, but with different specialty-specific activities, may be generalizable and employed at other institutions.

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# The Standardized Letter of Evaluation Narrative: Differences in Language Use by Gender

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**Introduction:** Prior research demonstrates gender differences in language used in letters of recommendation. The emergency medicine (EM) Standardized Letter of Evaluation (SLOE) format limits word count and provides detailed instructions for writers. The objective of this study is to examine differences in language used to describe men and women applicants within the SLOE narrative.

**Methods:** All applicants to a four-year academic EM residency program within a single application year with a first rotation SLOE available were included in the sample. We used the Linguistic Inquiry and Word Count (LIWC) program to analyze word frequency within 16 categories. Descriptive statistics, chi-squared, and t-tests were used to describe the sample; gender differences in word frequency were tested for using Mann-Whitney U tests.

**Results:** Of 1117 applicants to the residency program, 822 (82%) first-rotation SLOEs were available; 64% were men, and 36% were women. We did not find a difference in baseline characteristics including age (mean 27 years), top 25 schools (22.5%), Alpha Omega Alpha Honor Medical Society rates (13%), and having earned advanced degrees (10%). The median word count per SLOE narrative for men was 171 and for women was 180 ($p = 0.15$). After adjusting for letter length, word frequency differences between genders were only present in two categories: social words (women: 23 words/letter; men: 21 words/letter, $p = 0.02$) and ability words (women: 2 words/letter; men: 1 word/letter, $p = 0.04$). We were unable to detect a statistical difference between men and women applicants in the remaining categories, including words representing communal traits, agentic traits, standout adjectives, grindstone traits, teaching words, and research words.

**Conclusion:** The small wording differences between genders noted in two categories were statistically significant, but of unclear real-world significance. Future work is planned to evaluate how the SLOE format may contribute to this relative lack of bias compared to other fields and formats. [West J Emerg Med. 2019;20(6)948-956.]

## INTRODUCTION

Gender disparities exist in academic medicine. Women in academic medicine are less likely to achieve the rank of professor or hold senior leadership positions compared to men, even after adjusting for age, experience, specialty, and research productivity.[1,2] Previous studies in other professional fields have shown that there are differences in language used in describing men and women in letters of recommendation.[3-5] Additional studies have shown that evaluations of women medical students are more likely to describe women as "caring," "compassionate,"

and "empathetic," in addition to "bright" and "organized," than male medical students.[6-8] In addition, women are more often portrayed as teachers and students, and less often portrayed as researchers or professionals compared to men.[9]

Within emergency medicine (EM) the letter of recommendation, including both standardized letters and traditional letters, has been cited as one of the top four most important factors in selecting applicants to residency, along with EM rotation grade, interview, and clinical grades.[10] More specifically, the letter of recommendation has been cited as the most important factor in selecting applicants to interview.[11] Historically, in EM, letters of recommendation were written without guidelines or restrictions. In 1996, the Council of Residency Directors in Emergency Medicine (CORD) implemented the standardized letter of recommendation (SLOR), which was renamed the standardized letter of evaluation (SLOE) in 2013. The SLOE contains both a quantitative evaluation of an applicant and a narrative portion of 250 words or less.[12-14] The SLOE narrative provides a focused assessment of the non-cognitive attributes of potential residency candidates.[15]

The standardized format and universal instructions make the SLOE a good text sample to study for variation in language by gender. Additionally, while there are several studies analyzing traditional letters of recommendation for language variation between genders, there is a gap in the current literature in analyzing standardized letters of recommendation. Previously, our research team published a study in *Academic Emergency Medicine Education and Training* that showed minimal differences in language use between genders in evaluating 237 SLOEs from applicants invited to interview to a single academic EM residency for the 2015-2016 application cycle.[16] The small dataset, and potential for a homogeneous sample (as only the SLOEs of applicants invited to interview were included), prompted the current investigation with a goal of confirming or refuting the original results with a larger dataset.

The choice to include all applicants was made with a goal of potentially increasing the variability in the language used within the SLOE (e.g., word frequency in one word category may be equal across genders for the strongest applicants invited to interview, as in our first study, but a gender gap may be unveiled in a larger sample of all applicants). The aim of this study was to compare differences in language within specific word categories to describe men and women applicants in the SLOE narrative for all applicants to a single academic EM residency program for the 2016-2017 application cycle. We secondarily sought to determine whether there was an association between word categories' differences and invitation to interview, regardless of gender, in order to better contextualize the possible importance of wording differences.

*Population Health Research Capsule*

What do we already know about this issue?
*Prior research demonstrates that there are gender differences in the language used to describe women and men applicants in letters of recommendation.*

What was the research question?
*Within the emergency medicine (EM) SLOE narrative, are there differences in language used to describe women and men applicants.*

What was the major finding of the study?
*Small wording differences exist in SLOE narratives between genders in two of sixteen word categories.*

How does this improve population health?
*The standardized format of the EM SLOE may limit gender bias within the letter of recommendation relative to other fields and formats.*

## METHODS

### Study Design

This was a cross-sectional descriptive study employing a linguistic analysis to describe features of the words used in the narrative portion of the SLOE for all applicants during one application cycle. This study was reviewed by the institutional review board at Northwestern University and deemed exempt.

### Study Setting and Population

Northwestern University McGaw Medical Center EM residency is a four-year, urban, academic residency program with 60 total residents. Applications to the residency program are accepted through the Electronic Residency Application Service (ERAS), which transmits applications, letters of recommendation, medical student performance evaluations, and transcripts to residency programs. Applicants must participate in the National Resident Matching Program (NRMP) to be eligible for selection to the residency.

### Study Protocol

SLOE narratives for all applicants to the residency for the application cycle 2016-2017 were downloaded from ERAS by the program coordinators and converted to Microsoft Word format. We included the narrative portion of the SLOE in analysis. The narrative is limited to 250 words and asks the writer to "Please concisely summarize this applicant's candidacy including… (1) Areas that will require attention, (2) Any low rankings from the SLOE, and (3) Any relevant noncognitive attributes such as leadership, compassion, positive attitude, professionalism, maturity, self-motivation, likelihood to go above and beyond, altruism, recognition of limits, conscientiousness, etc."[15] If applicants submitted more

than one SLOE, the SLOE from the first chronological clinical EM rotation was included in analysis. We analyzed first-rotation SLOEs, as opposed to all SLOEs, to provide a uniform evaluation of student performance and limit word differences based on varying experiences in time. Additionally, not every applicant had more than one SLOE. Exclusion criteria included applicants from non-Liaison Committee on Medical Education (LCME) schools, as well as applicants with a first-rotation SLOE that was not available to be downloaded from ERAS. Analysis began after all NRMP decisions had been made and finalized and did not affect an applicant's invitation to interview or placement on the rank list.

Prior to analysis, each letter was read by two reviewers who screened for "stock" language. These "stock" or standardized sentences were not related to applicant characteristics. They included statements in certain categories such as statements regarding waiving rights to see the letter ("The student has waived his or her right to see this letter"); stock opening statements ("This is a composite letter"); stock closing statements ("Please contact me if you have any questions"); descriptors of the rotation ("The student rotated at a site with 110,000 visits of year…"); descriptors of grade calculation ("We calculate a numerical grade for each of the following 5 areas..."); and descriptors of the letter writer ("As department chair…"). Any letter-writer signatures and titles were deleted prior to analysis to avoid introducing bias. Pronouns were not made pleural (eg, his/her) or deidentified prior to analysis.

**Measures**

Measures obtained from the ERAS application for use in describing the sample included the following: age at time of application; gender; Alpha Omega Alpha (AOA) Honor Medical Society designation at the time of application; and advanced degrees. Medical school rank was obtained from the 2016 *US News and World Report* rankings for medical schools in the research category. [17] We did not use class rank as it is not a standardized measure across medical schools.

The analysis approach was the same as that taken in our prior study.[16] In short, the Linguistic Inquiry and Word Count (LIWC)[18] is a text analysis dictionary composed of 80 word categories with 4500 words and word stems. We employed the LIWC program in our study to provide word counts and ratios of words per SLOE for each individual SLOE text file. Within the 80 word categories we selected 16 word categories for comparison based on prior research that has evaluated gendered language in professional letters of recommendation.[3,4,8] These word categories have also been used in the medical literature.[8] In other studies within the medical literature that do not use the LIWC categories, similar words and word categories overlapped with the LIWC word categories selected.[6,7]

These 16 categories included nine taken from the default LIWC 2015 dictionary: positive emotion (eg, nice); negative emotion (eg, nasty); social words (eg, friend); cognitive processes (eg, knowledge); affiliation words (eg, social); achievement words (eg, success); power words (eg, superior); reward words (eg, benefit); and risk words (eg, doubt). The remaining seven categories were "user-defined dictionaries," which have been previously generated for studies of gender and letters of recommendation.[3-5, 9, 22] These categories include "grindstone" traits (eg, diligent); ability traits (eg, talented); standout adjectives (eg, exceptional); research terms (eg, project); teaching terms (eg, teach); communal traits (eg, kind, caring); and agentic characteristics (eg, ambitious, confident). The LIWC software reports word counts and ratios of words per SLOE for all 16 word categories.

To validate the LIWC tool and dictionaries, independent judges rated hundreds of text samples, and then their ratings were compared to computerized LIWC ratings of the same text.[19-21] The communal and agentic word dictionaries were validated by Madera and colleagues by having independent judges rate the letters as a whole on a scale of 1-9 for the "degree to which the applicant is described as communal/agentic" and subsequently evaluated for correlation of those scores to the LIWC word-count frequencies.[3] The additional five word dictionaries have not been externally validated.

**Data Analysis**

We used descriptive statistics to report the applicants' characteristics and assessed for differences in baseline characteristics by gender using t-tests and chi-squared tests, as appropriate. Median word counts for the identified 16 categories of interest (nine LIWC default categories, seven user-defined dictionaries) were reported. For the primary outcome of interest, we assessed differences by gender in word counts after adjusting for letter length using Mann-Whitney U tests. In secondary analysis, the analyses were repeated for differences in word categories by invitation to interview. We used multivariable logistic regression to identify word categories associated with receiving an invitation to interview. Covariates in this model were selected via a predetermined inclusion threshold of $\alpha = 0.10$. We performed all analyses using Stata 13.1 (College Station, TX).

Additionally, for any of the seven user-defined word categories in which a difference was noted, a further analysis was conducted evaluating the use of each individual word in the dictionary to assess if the difference for the category was driven by the use of a single word (eg, talented, bright), or by the use of multiple descriptors within the category. For this analysis, the proportion of SLOEs with each word included was compared by gender using Fisher's exact test. This analysis was not conducted for any differences in the LIWC defined categories due to the size of the word dictionaries (eg, >700 social words in LIWC dictionary vs 15-40 words in user-defined dictionaries).

**RESULTS**

There were 1117 applicants to the residency in the single application cycle of study (2016-2017) of whom 1001 were graduates from LCME schools (Figure 1). We included in this

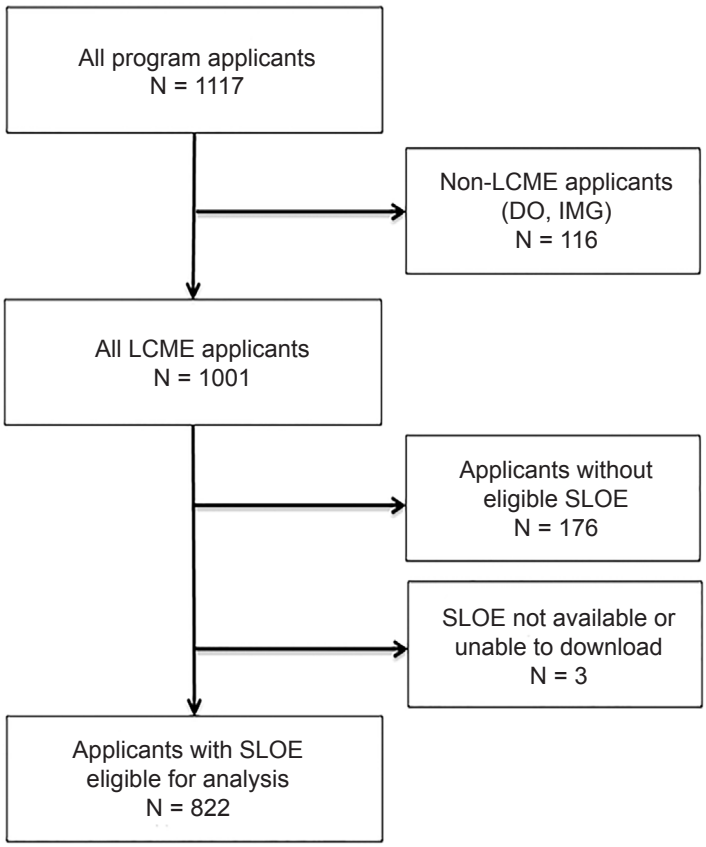


**Figure 1.** Selection of Standardized Letter of Evaluation (SLOE) for inclusion in analysis.
*DO,* doctor of osteopathic medicine; *IMG,* international medicine graduate; *LCME,* Liaison Committee on Medical Education.

study the 822 applicants (82%) who had a first-rotation SLOE available for analysis. Of these, 64% of applicants were men, and 36% were women. Comparing men and women applicants, we found no differences detected between genders for baseline characteristics including age (mean 27 years); top 25 schools (22.5%); AOA rates (13%); and having earned advanced degrees (10%) (Table 1).

The median word count per SLOE narrative for men was 171 (interquartile range [IQR] 127-224) and for women was 180 (IQR 133-225), which was not statistically different ($p = 0.15$). Within the 16 word categories investigated, after adjusting for letter length, word frequency differences between genders were only present in two categories: social words (women: 23 words/letter; men: 21 words/letter, $p = 0.02$) and ability words (women: 2 words/letter; men: 1 word/letter, $p = 0.04$) (Table 2).

The remaining categories, including words representing communal or agentic traits, standout adjectives, grindstone traits, and teaching and research words were also not statistically different between men and women applicants. Among ability words, there were no significant differences in the number of SLOEs for men or women using specific words within the ability word dictionary (see Appendix 1).

In a secondary analysis comparing applicants invited to interview and those not invited to interview, regardless of gender, invited applicants had slightly longer SLOEs (median 17 words longer) with significantly more standout, ability, power, and research words. The differences in all word categories were small (Table 3).

Notably, invited applicants had fewer reward words than non-invited applicants. In adjusted analysis, letters with standout words were associated with the highest odds of receiving a request to interview (OR [odds ratio[ 1.15, 95% confidence interval [CI],1.05-1.26), and letters with reward words had the lowest odds of receiving a request to interview (OR 0.89, 95% CI, 0.82-0.95). Other word categories were no longer significantly associated with higher or lower odds of receiving an interview after adjustment.

## DISCUSSION

This analysis found small but quantifiable differences in word frequency between genders in the language used in the SLOE. In this study, differences between genders were present in two categories: social words and ability words, with women having higher word frequency in both categories. Our prior investigation found differences of similar magnitude (eg, one

word differences per letter) in affiliation words and ability words, with letters for women applicants having higher word frequency in both categories. For both studies, the differences in word frequency were statistically significant, but it is difficult to comment or draw conclusions about the significance of these small wording differences on application or educational outcomes. What is perhaps more notable than the presence of differences in two categories is the lack of difference in the remaining 14 categories.

When looking specifically at the categories that had gender differences, our finding of ability words being used to describe women applicants more frequently than men applicants is in contrast to previous studies, while our other research finding, that women are more frequently described with social words than men, is in alignment with previous studies. In the medical literature, letters of recommendation for men applying for faculty positions contain more ability attributes such as standout adjectives and research descriptors than letters for women,[9] and letters for women in medical school applying for residency positions are more frequently described by non-ability attributes such as being caring, compassionate, empathetic, bright, and organized.[6]

Looking specifically at ability words, this word category had statistically significant differences in both this investigation and our prior study, with ability words occurring more frequently for women than men. Ability words include descriptors such as talented, skilled, brilliant, proficient, adept, intelligent, and competent. This consistency of findings between

**Table 1.** Applicant information Standardized Letter of Evaluation.

| Variable | Total n = 822<br>n (%) | Male n = 526<br>n (%) | Female n = 296<br>n (%) | P-value |
|---|---|---|---|---|
| Age, mean (SD) | 27 (2.9) | 27 (3.0) | 27 (2.8) | 0.60 |
| Top 25 Ranked Med School | 185 (22.5%) | 122 (23.2%) | 63 (21.3%) | 0.53 |
| AOA | 104 (12.7%) | 68 (13%) | 36 (12.2%) | 0.31 |
| Advanced Degree | 82 (10%) | 55 (10.5%) | 27 (9.1%) | 0.54 |

*SD*, standard deviation; *AOA,* Alpha Omega Alpha.

**Table 2.** Select Linguistic Inquiry and Word Count output variables and word categories of the Standardized Letter of Evaluation, comparing male and female applicants.

| Variable | Total n = 822<br>median (IQR) | Male n = 526<br>median (IQR) | Female n = 296<br>median (IQR) | P-value |
|---|---|---|---|---|
| Word count | 173 (129-224) | 171 (127-224) | 180 (133-225) | 0.15 |
| Words per sentence | 15 (13-18) | 15 (13-18) | 15 (13-18) | 0.17 |
| Positive emotion | 10 (8-14) | 10 (8-13) | 11 (8-14) | 0.26 |
| Negative emotion | 1 (0-2) | 1 (0-2) | 1 (0-2) | 0.77 |
| Social | 21 (16-28) | 21 (15-27) | 23 (17-28) | 0.02 |
| Cognitive processes | 14 (9-19) | 13 (9-18) | 14 (10-19) | 0.12 |
| Affiliation | 4 (3-6) | 4 (2-6) | 4 (3-7) | 0.38 |
| Achievement | 8 (6-11) | 8 (6-11) | 8 (6-11) | 0.07 |
| Power | 6 (4-8) | 6 (4-8) | 6 (4-8) | 0.82 |
| Reward | 4 (3-6) | 4 (3-6) | 4 (3-6) | 0.42 |
| Risk | 0 (0-1) | 0 (0-1) | 0 (0-1) | 0.50 |
| Standout | 1 (0-2) | 1 (0-2) | 1 (0-2) | 0.17 |
| Ability | 1 (1-3) | 1 (0-3) | 2 (1-3) | 0.04 |
| Grindstone | 2 (1-3) | 2 (1-3) | 2 (1-3) | 0.55 |
| Teaching | 2 (1-4) | 2 (1-4) | 2 (1-4) | 0.27 |
| Research | 0 (0-1) | 1 (0-1) | 0 (0-1) | 0.88 |
| Communal | 1 (0-2) | 1 (0-2) | 1 (0-2) | 0.36 |
| Agency | 1 (1-2) | 1 (0-2) | 2 (1-3) | 0.08 |

*IQR,* interquartile range.

the two samples suggests that letter writers employ multiple descriptors within the ability category to convey proficiency of women applicants. However, the reason for this difference is unclear. Notably, the word "bright" is one of the ability words for which there was no gender difference found, counter to findings from prior research wherein women applicants were more often described as bright.[6,18] While the descriptor "bright" is often considered a compliment, it has also been suggested that its use "subtly undermines the recipient of the praise in ways that pertain to youth and, often, gender" stemming from its association with the phrase "bright young thing." [23]

The finding that women were more frequently described with social words (two words more frequently than men) aligns with previous studies of letters of recommendations. Studies in letters of recommendation for psychology and chemistry faculty positions have shown that women are often described as communal (eg, warm, kind), while men are described as agentic (eg, dominant, confident) and have more standout adjectives (eg, exceptional).[3,9] Other studies have found women to be described as more communicative.[6]

We employed a secondary analysis with respect to the invitation to interview to determine if small differences in word categories were associated with invitation to interview. The adjusted analysis showed an association between more standout words and invitation to interview; however, this analysis did not account for other factors that may influence invitations to interview (eg, school rank, grades). Although these findings represent an association and not causation, they help to contextualize the potential importance of small differences in word use, although this is not conclusive. Notably, neither social words nor ability words (the categories in which there were gender differences) influenced the choice to interview, and there was an equitable frequency of standout words between genders.

Despite the small word differences in the categories of social and ability words, we did not find a difference in the 14 other word categories queried. There are several possible explanations for this lack of a finding. It is possible that the sample was underpowered to detect small wording differences in the 14 word categories. Another explanation is that the SLOE format itself may be driving the lack of a difference. The short word format of the SLOE (limiting to 250 words) and specific, detailed instructions as noted above may reduce bias. Other explanations include the increasing use of group authorship, which may introduce less bias than individual authorship. In 2012, a sampling of three EM residencies calculated that 34.9% of SLORs were created by groups.[24] In 2014, 60% of EM program directors (PD) participated in group SLORs, 85.3% of departments

**Table 3.** Select Linguistic Inquiry and Word Count output variables and word categories of the Standardized Letter of Evaluation, comparing applicants invited to interview and applicants not invited to interview.

| Variable | Total n = 822 median (IQR) | Invited n = 202 median (IQR) | Not invited n = 620 median (IQR) | P-value |
|---|---|---|---|---|
| Word count | 173 (129-224) | 186 (135-228) | 169 (127-223) | 0.03 |
| Words per sentence | 15 (13-18) | 16 (14-18) | 15 (13-18) | 0.42 |
| Positive emotion | 10 (8-14) | 10 (8-13) | 10 (8-14) | 0.07 |
| Negative emotion | 1 (0-2) | 1 (0-1) | 1 (0-2) | 0.89 |
| Social | 21 (16-28) | 23 (17-28) | 21 (15-27) | 0.34 |
| Cognitive processes | 14 (9-19) | 15 (10-20) | 13 (9-18) | 0.61 |
| Affiliation | 4 (3-6) | 5 (3-7) | 4 (2-6) | 0.21 |
| Achievement | 8 (6-11) | 9 (6-11) | 8 (6-11) | 0.75 |
| Power | 6 (4-8) | 6 (4-9) | 6 (3-8) | 0.02 |
| Reward | 4 (3-6) | 4 (2-6) | 4 (3-6) | 0.001 |
| Risk | 0 (0-1) | 0 (0-1) | 0 (0-1) | 0.96 |
| Standout | 1 (0-2) | 2 (1-3) | 1 (0-2) | <0.0001 |
| Ability | 1 (1-3) | 2 (1-3) | 1 (0-2) | 0.005 |
| Grindstone | 2 (1-3) | 2 (1-4) | 2 (1-3) | 0.62 |
| Teaching | 2 (1-4) | 2 (1-4) | 2 (1-4) | 0.41 |
| Research | 0 (0-1) | 1 (0-2) | 0 (0-1) | 0.03 |
| Communal | 1 (0-2) | 1 (0-2) | 1 (0-2) | 0.47 |
| Agency | 1 (1-2) | 2 (1-3) | 1 (0-2) | 0.46 |

*IQR,* interquartile range.

provided a group SLOR, and 84.7% of PDs preferred a group SLOR.[11] Although the sample size and lack of a standard comparator (eg, SLOE and full-length letter on each candidate from the same author) limit the ability to determine why we did not find a difference for the majority of word categories, we hypothesize that it is related to the format and hope to further support that hypothesis through future work examining paired SLOE and full-length letters for candidates.

A recently published study by Friedman and colleagues in the otolaryngology literature has been the only study, in addition to our own, to our knowledge that evaluates a standardized letter for gender bias. In this 2017 study, the SLOR and more traditional NLOR (Narrative Letter of Recommendation) in otolaryngology residency applications were compared by gender, concluding that the SLOR format reduced bias compared to the traditional NLOR format. Although in both letter formats some differences persisted (eg, women more frequently described as "team players"), the SLOR format resulted in less frequent mention of women's appearance and more frequent descriptions of women as "bright."[22] Although their analysis strategy differed from the one we used in this study, their findings parallel ours in that there are minimal differences by gender in a restricted letter format and highlight the need for further study of the how the question stem and word limitations may be intentionally built to minimize bias.

Lastly, of note, our study focused specifically on differences in language use in the SLOE. This study does not evaluate the presence or absence of gender bias in the quantitative aspects of the SLOE, nor does our multivariable model include other factors that would influence the invitation to interview such as rotation grades, test scores, school rank, or AOA status. Such analyses were beyond the scope of our study, which was focused on the SLOE narrative itself. Other studies have evaluated this but have not evaluated the narrative portion of the SLOE.[25]

Additionally, there remain many other forms of evaluation, numerical and narrative, in medical training, in addition to the SLOE that have analyzed gender bias. Recent studies have suggested that bias persists in other forms of evaluation. Specifically, Dayal and colleagues' recent publication notes lower scores for women residents in EM Milestones ratings compared to male peers as they progress through residency.[26] Evaluations of narrative comments from shift evaluations are another area of interest, of which we are aware of two current investigations underway in EM programs. Additionally, a study of evaluations of medical faculty by physician trainees by Heath and colleagues also showed gender disparities.[27] As this body of literature continues to grow and interventions are developed to minimize bias in all narrative performance evaluations, we believe it will be important to think carefully about the question stems and response length allowed. Unfortunately, limiting space may also limit the room for positive evaluation and strings of praising adjectives.[22] However, while implicit bias exists, employing limits in response format may rein in the manifestation of implicit bias by focusing the writer.

## LIMITATIONS

This was a single center study; only SLOE narratives from applicants who applied to interview at a single, academic EM residency program were included in analysis, and applicants from non-LCME schools were excluded, limiting generalizability. The man to woman applicant ratio in this study reflects the national trend for the 2017 match, which may contribute to generalizability.[28] ERAS does not allow an individual program to access SLOEs for applicants who have not selected that program; therefore, a full national sample of all applicants in a single year to ERAS was not feasible.

Our analysis used the LIWC linguistic software and focused on individual words. Other approaches, such as qualitative content analysis or focusing on phrases (eg, leadership potential) or searching for specific words (eg, bright) as was done by Friedman and colleagues in the study discussed above may have yielded different findings. Additionally, the LIWC contains pre-established word lists. While these lists have been used in medical literature,[8] it is possible that there may be a set of words for EM that is more applicable.

Our analysis used word frequency as a measurement of biased language and did not evaluate context of the words in the letters, limiting the study. Words in different contexts can have different meaning. For instance, the word "aggressive" can have both a positive or negative connotation based on context when describing and applicant as "aggressive in picking up patients" vs "aggressive with consultants." A qualitative analysis of the SLOEs would better delineate the context of word phrases and provide a more in-depth analysis.

Although it is a limitation that we did not evaluate word context, word frequency software applied to a large sample gives generalizability that a small qualitative analysis may not be able to achieve. In these rare instances of context misinterpretation for positive and negative emotion categories (ie, as stated in the previous example with the word "aggressive," which would be interpreted in the software as a negative emotion word category), this may be of little overall consequence as there is such a large margin between median positive vs negative words within these word categories (median 10 vs median 1, Table 2). Additionally, the subtle differences between word phrases such as "we strongly recommend this student" vs "we will be recruiting this student" would not be picked up by the software.

This was an exploratory study and as such was not

powered to a specific outcome; however, we estimated that with our sample size of 822 (allocation 1.5 male/female) that we would have 80% power to detect a difference of 0.2 mean words within a single word category with a 5% type I error (based on estimated baseline word frequency per category of three words). Additionally, it is possible that the sample was underpowered to detect small wording differences among the 16 word categories, which could represent a type II error. The analysis for differences in 16 categories raises the question of the multiple comparisons problem.

We did not replicate the findings of our previous study with regard to differences in the same word categories, further adding to this concern. However, we are equally interested in the lack of a difference as we are in detecting differences. Although negative findings are often highlighted less than positive ones, this analysis did not find a difference in the majority of word categories (a finding that is similar to the prior study). Finally, as the majority of letters do not denote letter-writer gender and most were composed by a group of authors, this group composition did not allow for any evaluation of the relationships between author gender and applicant gender with respect to language used in the SLOE.

## CONCLUSION

This study expanded upon our prior work by employing a larger dataset–all applicants to a single residency program–rather than only the highest achieving applicants invited to interview. Within this larger study population, minimal differences were detected in word frequency between genders for 16 categories of words. The wording differences noted in two categories were statistically significant, with one to two word differences between genders. Future work will evaluate how the SLOE format may contribute to this relative lack of bias compared to other fields and formats, including a comparison of the SLOE and traditional letters of recommendation submitted for individual EM residency applicants.

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# Safety of Tiered-Dispatch for 911 Calls for Abdominal Pain

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**Introduction:** Many dispatch systems send Advanced Life Support (ALS) resources to patients complaining of abdominal pain even though the majority of these incidents require only Basic Life Support (BLS). With increasing 911-call volume, resource utilization has become more important to ensure that ALS resources are available for time-critical emergencies. In 2015, a large, urban fire department implemented an internally developed, tiered-dispatch system. Under this system, patients reporting a chief complaint of abdominal pain received the closest BLS ambulance dispatched alone emergency if located within three miles of the incident. The objective of this study was to determine the safety of BLS-only dispatch to abdominal pain by determining the frequency of time-sensitive events.

**Methods:** This was a retrospective review of electronic health records of one emergency medical service provider agency from May 2015-2018. Inclusion criteria were a chief complaint of abdominal pain from a first- or second-party caller, age over 15, and the patient was reported to be alert and breathing normally. The primary outcome was the prevalence of time-sensitive events, including cardiopulmonary resuscitation (CPR), defibrillation, or airway management. Secondary outcomes were hypotension (systolic blood pressure < 90 mmHg); or a prehospital 12 lead-electrocardiogram (ECG) demonstrating ST-elevation myocardial infarction (STEMI) criteria or a wide complex arrhythmia. Descriptive statistics were used.

**Results:** During the study period, there were 1,220,820 EMS incidents, of which 33,267 (2.72%) met inclusion criteria. The mean age was 49.9 years (range 16-111, standard deviation [SD] 19.6); 14,556 patients (56.2%) were female. Time-sensitive events occurred in seven cases (0.021%), mean age was 75.3 years (range 30-86, SD18.7); 85.7% were female. Airway management was required in seven cases (0.021%), CPR in six cases (0.018%), and defibrillation in one case (0.003%). Two of the seven (28.6%) cases involved dispatch protocol deviations. Hypotension was present in 240 (0.72%) cases; six (0.018%) cases had 12-lead ECGs meeting STEMI criteria; and no cases demonstrated wide complex arrhythmia.

**Conclusion:** Among adult 911 patients with a dispatch chief complaint of abdominal pain, time-sensitive events were exceedingly rare. Dispatching a BLS ambulance alone appears to be safe. [West J Emerg Med. 2019;20(6)957-961.]

## INTRODUCTION

In the 1970s, priority emergency medical services (EMS) dispatch systems were introduced to help triage 911 calls and resources. Since then, multiple versions of dispatch triage, including criteria-based dispatch, medical priority dispatch systems, and locally developed protocols have been used. However, most dispatch systems have a high rate of overtriage, leading to increased costs, increased utilization of limited resources, and increased use of lights and sirens, all without clear evidence of outcomes that suggest improved patient care.[1] Many studies suggest that priority dispatch systems lead to overtriage of Advanced Life Support (ALS) units with <1%

of low-acuity calls requiring ALS resources.[1-6] For this reason, multiple large cities with accelerating EMS call volumes are re-evaluating their current dispatch systems.

Multiple studies have attempted to identify low-acuity chief complaints and triage criteria at the 911-dispatch level to better optimize allocation of resources.[6,7] Although abdominal pain is one of the most common reasons 911 is activated, few studies have specifically examined dispatch protocols for abdominal pain. The few studies that have been published suggest overtriage and overutilization of ALS resources for abdominal pain with a range from 10-51%.[8,9] Other retrospective reviews found that 84-98% of abdominal pain calls are low acuity and that less than 6-8% were considered true emergencies.[4,9,10] Of note, most ALS care was pulse oximetry and/or an intravenous (IV) placement, and when the analysis was restricted to IV fluid bolus, medication, intubation or defibrillation, the majority (19/28) received ALS <10% of time.[7]

Although more than 85% of 911 incidents for abdominal pain require only Basic Life Support (BLS) transport to the emergency department (ED),[8] many dispatch systems continue to send ALS resources, sometimes in addition to the closest first responder units. In 2015, the Los Angeles Fire Department (LAFD) implemented an internally developed tiered dispatch system (LA-TDS). Under LA-TDS, patients reporting a chief complaint of abdominal pain received the closest BLS ambulance dispatched alone emergency (ie, with lights and sirens) if located within three miles of the incident. If no BLS ambulance was available within three miles, then a closer paramedic ambulance was dispatched, and if no ambulance was available within three miles, a BLS fire company responded emergency along with the closest ambulance non-emergency.

The purpose of this study was to evaluate the safety of this dispatch algorithm by determining the prevalence of 911 patients with abdominal pain and a documented time-sensitive event.

*Population Health Research Capsule*

What do we already know about this issue?
*Abdominal pain is one of the most common reasons 911 is activated. While most of these calls are low acuity, ALS resources are commonly dispatched.*

What was the research question?
*What is the prevalence of time-sensitive events in patients who call 911 for abdominal pain? Is it safe to send a BLS ambulance alone?*

What was the major finding of the study?
*Time-sensitive events were rare (0.021%). Dispatching a BLS ambulance alone appears safe.*

How does this improve population health?
*By demonstrating that BLS alone appears safe, alternative dispatch protocols may be implemented, reserving limited ALS resources for true, time-sensitive emergencies.*

## METHODS

### Setting

The LAFD is a tiered, fire-based EMS provider system, and it is the sole provider of 911-EMS response for the City of Los Angeles. The department covers 480 square miles and serves a population of 4.2 million people. All 911-call takers are sworn members of the LAFD and are either firefighter/paramedics or firefighter/emergency medicine technicians (EMT) who are certified as emergency medical dispatchers. A resource is dispatched to all calls, and there is mandatory offer of ambulance transport to an ED.

LAFD-TDS is a homegrown dispatch system that was implemented in 2015 with the goal of improving call processing times, cardiac arrest recognition, resource availability and response times. Under LAFD-TDS, patients reporting a chief complaint of abdominal pain receive the closest BLS ambulance dispatched alone emergency (ie, with lights and sirens) if located within three miles of the incident. While the dispatch protocol calls for a BLS ambulance, the dispatch protocol dictates that an ALS ambulance responds if no BLS ambulances are available within three miles. Of note, in this system, only ALS providers can perform prehospital electrocardiograms (ECG). However, given that ALS providers may be dispatched to these calls, ECGs are occasionally performed on patients with non-traumatic abdominal pain who met our study inclusion criteria.

### Study Design

This was a retrospective review of electronic health records for 911 incidents dispatched as non-traumatic abdominal pain from May 2015–May 2018. Cases were included if the patient's chief complaint was abdominal pain, the patient was the caller or was in close proximity to the caller (ie, a first- or second-party call), the patient was over age 15, and the patient was awake and breathing normally. All calls that met this inclusion criteria regardless of resource dispatched or transport to an ED were included in the study.

The primary outcome was the prevalence of documented, time-sensitive prehospital events that require emergent life-saving interventions, defined as cardiopulmonary resuscitation (CPR), defibrillation, or airway management (including use of bag-valve-mask, supraglottic airway, or endotracheal intubation in a non-ventilator dependent patient). Secondary outcomes were incidents that could potentially benefit from ALS resources and included the presence of hypotension (defined as initial systolic blood pressure < 90 millimeters of mercury [mmHg]) or a prehospital 12-lead ECG that was read

as ST-elevated myocardial infarction (STEMI) or wide complex arrhythmia by computer software. ECGs that were marked as STEMI or wide complex arrhythmia were reviewed and interpreted by the authors (TA, ME). Descriptive statistics are presented, including frequencies. We excluded all incidents that were the result of trauma.

Audios from the 911 calls for cases involving CPR, defibrillation, or airway management were reviewed. We used qualitative analysis to identify any themes or key words in the calls. Additionally, dispatch protocol adherence was evaluated. This study was approved by the institutional review board of the University of Southern California (HS-18-00649).

## RESULTS

During the study period, there were 1,220,820 EMS incidents. Of all incidents 9,999 (0.82%) met this study's definition of time-sensitive events. Study inclusion criteria was met by 33,267 (2.72%) incidents (Figure 1).

Of the cases that met study inclusion criteria, the mean age was 49.9 years (range 16-111, standard deviation [SD] 19.6) with 7,281 (21.9%) over the age of 65 years; 14,556 patients (43.8%) were male. The mean response time for all included cases was 7.05 minutes (median 6.55, SD 11.52). A BLS ambulance responded alone to 24,248 (72.9%) of the included cases with a mean response time of eight minutes (median 7.43, SD 2.43). In 9,019 (27.1%) calls, a BLS ambulance was not the initial resource dispatched to the scene due to not being available within three miles of the incident. In these cases, a paramedic-staffed engine and/or ALS ambulance were first on scene, and the mean response time was 7.66 minutes (median 7.08, SD 2.32). Transport times were also similar among these groups with BLS-only responses having a mean transport time of 10.34 minutes (median 9.76, SD 3.73) and non-BLS responses having a mean transport time of 9.42 minutes (median 8, SD 3.42).

### Primary outcome

Time-sensitive events were documented in seven patients (0.021%), with a mean age of 75.3 years (range 30-86, SD 18.7), of whom six (85.7%) were over age 65, and 85.7% were female. For calls with time-sensitive events, the mean response time was 6.93 minutes (median 5.52, SD 4.05). Cardiopulmonary resuscitation was required in six cases (0.018%), defibrillation in one case (0.003%), and airway management in seven cases (0.021%). In patients requiring time-critical interventions, including CPR or airway management, the mean age was 75.3 (range 30-86, SD 18.7). Of note, the 30-year-old patient was an outlier who had cancer and was on hospice. Characteristics of each outcome were further analyzed (Table 1).

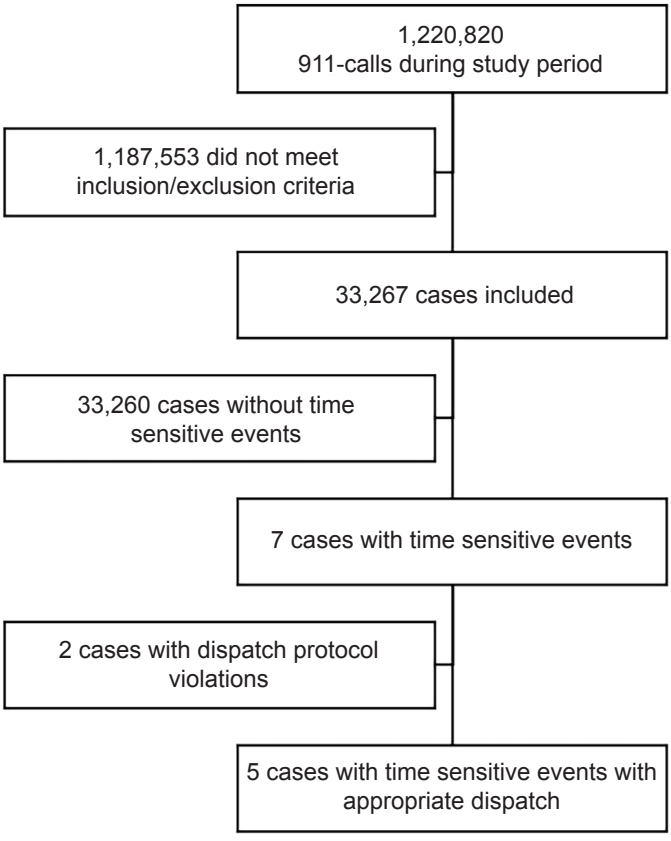


**Figure 1.** Study flow chart.

We reviewed dispatch audios from the seven 911 calls where time-sensitive event occurred. All were made by second-party callers. In two cases, the dispatch algorithm was not adhered to since the callers described the patient as having irregular breathing, which should have prompted an emergent ALS dispatch. Other phrases during the calls that indicated the severity of the patient's conditions included mention of skin pallor (1); excruciating or terrible pain (2); difficulty or abnormal breathing (2); and mention of chronic medical conditions (2). Details of these calls are included in Table 2.

**Secondary Outcomes**

Hypotension, defined as systolic blood pressure less than 90 mmHg, was present on arrival in 0.72% of all included calls. The average age of those with hypotension was 57.4 years (range 16-96, SD 20.6), and 64.2% were female. The mean response time for patients who had documented hypotension was 6.9 minutes (median 6.5, SD 3.2).

A 12-lead ECG was obtained in 2,213 (6.7%) abdominal pain dispatches. In six cases (0.018%), the ECGs met STEMI criteria according to the cardiac monitor software algorithm. Patients with ECGs that met STEMI criteria had a mean age of 61.67 years, and 83.3% were female. There were no cases of wide complex tachycardia captured on 12-lead EKGs. Only three (50%) of six ECGS that were documented as STEMI actually met STEMI criteria when manually reviewed. The inter-rater relatability of reviewers was 1.0. The mean response times for this group was 8.94 minutes (median 6.5, SD 3.2).

## DISCUSSION

Abdominal pain is a common medical reason for 911 activation. In an environment with limited resources and increasing 911-call volumes, minimizing overtriage is essential to ensure ALS resources are available for true, time-critical emergencies. By introducing a tiered-dispatch system that dispatches a BLS ambulance alone for non-traumatic abdominal pain in patients who are awake and breathing normally, there is a potential opportunity to free up more ALS and first-responder resources to respond to true, time-critical calls.

Time-sensitive events were identified in only 0.021% of all cases meeting inclusion criteria, which is considerably lower than LAFD's overall rate of 0.82% for time-sensitive events for all EMS 911 calls during the study period. The need for airway management or CPR was extraordinarily rare among the 33,000 abdominal pain dispatches under study. Furthermore, in two of the seven cases, if dispatch protocol had been followed correctly, ALS resources would have been deployed, decreasing the frequency from 0.021% to 0.015%, ie, 1.5 in 10,000 patient

**Table 1.** Characteristics of time-sensitive events.

| Event | Proportion of time sensitive cases (n=7) | Mean age (years) | Median age (years) | Over age 65 (%) | Sex (% female) | Dispatch protocol adherance (%) |
|---|---|---|---|---|---|---|
| CPR | 6/7 | 73.5(30-86) | 81.5 | 83.3% | 83.3% | 83.3% |
| Airway | 7/7 | 75.3 (30-86) | 83 | 85.7% | 85.7% | 71.4% |
| Defibrillation | 1/7 | 77 | 77 | 100% | 100% | 100% |
| All | | 75.3 (30-86) | 83 | 85.7% | 85.7% | 71.4% |

*CPR,* cardiopulmonary resuscitation.

**Table 2.** Dispatch evaluation of time-sensitive events.

| Case # | Time Sensitive Events (s) | Age (Years) | Sex | Dispatch protocol compliance (y/n) | Dispatch Audio |
|---|---|---|---|---|---|
| 1 | Airway | 86 | Female | No | "her breathing," "I don't think she is conscious" |
| 2 | Airway, CPR | 85 | Female | yes | "my mom needs to go to the hospital," "she has cancer," "she's in a lot of pain" |
| 3 | Airway, CPR | 30 | Female | No | "her face is getting all pale," "breathing hard" |
| 4 | Airway, CPR | 86 | Female | Yes | "excruciating pain" |
| 5 | Airway, CPR | 83 | Female | Yes | "been in bed for over one month" |
| 6 | Airway, CPR | 80 | Male | Yes | "my husband is very sick" "all of the sudden he has terrible pain" |
| 7 | Airway, CPR, Defibrillation | 77 | Female | Yes | "clammy and weak" |

*CPR,* cardiopulmonary resuscitation.

dispatches. This underscores the importance of a robust, dispatch quality improvement program. Close monitoring, feedback, and education are necessary to ensure that the system is being properly used to protect the public and allow for effective and efficient dispatch protocols.

Hypotension was the most common outcome of interest that was documented. However, it is difficult to infer the clinical significance of these numbers and whether a closer (BLS) first responder or an ALS response with IV fluids would have been of benefit. ECGs that met STEMI criteria were also very uncommon events in this cohort. None of the patients with ECGs that met STEMI criteria were hypotensive upon EMS arrival nor did they require CPR, airway management, or defibrillation prior to ED arrival. Furthermore, 50% of them were deemed to be false positives by the software algorithm.

Finally, there is an association between age and time-sensitive outcomes. Patients who had time-sensitive events tended to be older (mean of 75.3 years old vs 49.9 years old) and female (85.7% vs 56.3%). Additionally, patients with ECGs that met STEMI criteria also tended to be older (61.7 vs 49.9). While patients over the age of 65 accounted for 21.9% of all included calls, they made up 85.7% of time-sensitive events.

## LIMITATIONS

This was a retrospective study of existing electronic health records and possesses the limitations inherent to retrospective reviews, including issues of omitted and incorrectly entered data. However, given the large dataset, we believe this effect to be small. A second limitation is that hospital outcome data was not available for these cases. However, our definition of a time-sensitive event clearly met the threshold of a life-threatening problem. Further studies are needed to analyze characteristics of patients with time-sensitive events, prehospital interventions, and ultimate patient outcomes.

## CONCLUSION

Among adult 911 patients with a chief complaint of non-traumatic abdominal pain, time-sensitive events were exceedingly rare and occurred more often in the female and elderly. In a system with low response times, dispatching a BLS ambulance alone without a closer first responder or ALS resource appears to be safe.

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# Impact of an Extraglottic Device on Pediatric Airway Management in an Urban Prehospital System

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**Introduction:** Prehospital pediatric endotracheal intubation has lower first-pass success rates compared to adult intubations and in general may not offer a survival benefit. Increasingly, emergency medical services (EMS) systems are deploying prehospital extraglottic airways (EGA) for primary pediatric airway management, yet little is known about their efficacy. We evaluated the impact of a pediatric prehospital airway management protocol change, inclusive of EGAs, on airway management and patient outcomes in children in cardiac arrest or respiratory failure.

**Methods:** Using data from a large, metropolitan, fire-based EMS service, we performed an observational study of pediatric patients with respiratory failure or cardiac arrest who were transported by EMS before and after implementation of an evidence-based airway management protocol inclusive of the addition of the EGA. The primary outcome was change in frequency of intubation attempts when paired with an initial EGA. Secondary outcomes included EGA and intubation success rates and patient survival to hospitalization and discharge.

**Results:** We included 265 patients age <16 years old, with 142 pre- and 123 post-protocol change. Patient demographics and event characteristics were similar between groups. Intubation attempts declined from 79.6% pre- to 44.7% ($p<0.01$) post-protocol change. In patients with an intubation attempt, overall intubation success declined from 81.4% to 63.6% ($p<0.01$). Post-protocol change, an EGA was attempted in 52.8% of patients with 95.4% success.

**Conclusion:** Implementation of an evidenced-based airway management algorithm for pediatric patients, inclusive of an EGA device for all age groups, was associated with fewer prehospital intubations. Intubation success may be negatively impacted due to decreases in procedural frequency. [West J Emerg Med. 2019;20(6)962-969.]

## INTRODUCTION

### Background

Prior research suggests the addition of paramedic endotracheal intubation (ETI) in pediatric patients does not improve survival or neurologic outcomes in children.[1] Median success rates for prehospital ETI in the United States are lower than those for extraglottic airway (EGA) placement.[2] Currently, the national emergency medical services (EMS)

educational standards for paramedics do not define intubation training requirements for paramedics.[3] Also, paramedics have few requirements during training to adequately practice the skill of intubation,[4] and few ongoing opportunities to maintain proficiency.[4-5,6] Neonatal resuscitations that use EGAs have demonstrated safety, high placement success, and improved resuscitation rates when compared to bag-valve mask ventilation (BVM).[7] Limited data exists across the entire pediatric age spectrum on the use of EGAs, especially in EMS.

A National Association of EMS Physicians position statement recommends that EMS have at least one blindly inserted nonsurgical airway available.[8] Likewise, the American Academy of Pediatrics Committee on Pediatric Emergency Medicine and the American College of Emergency Physicians Pediatrics Committee have recommended the inclusion of EGAs with supplies for difficult airway conditions in the emergency department.[9] In 2014 the National Association of State EMS Officials (NASEMSO) published its Model Clinical EMS Guidelines, which included recommendations from an evidence-based guideline for pediatric airway management that was implemented as part of a separate project in several New England states and the City of Houston Fire Department (HFD). The guideline emphasized step-wise escalation in airway management from BVM to EGA to ETI, only if the less-invasive method was not effective (Figure 1).[10]

*Population Health Research Capsule*

What do we already know about this issue?
*Extraglottic airways have high procedural success and increasing deployment in EMS systems for pediatric airway management.*

What was the research question?
*Does widespread deployment of an extraglottic airway affect frequency of intubation in pediatric patients with respiratory failure or cardiac arrest?*

What was the major finding of the study?
*Increased use of an extraglottic airway by EMS for pediatric airway management resulted in fewer intubations, potentially affecting procedural success with intubation.*

How does this improve population health?
*EMS systems using extraglottic airways and intubation should continue intensive airway management education with all available devices to maintain procedural competency.*

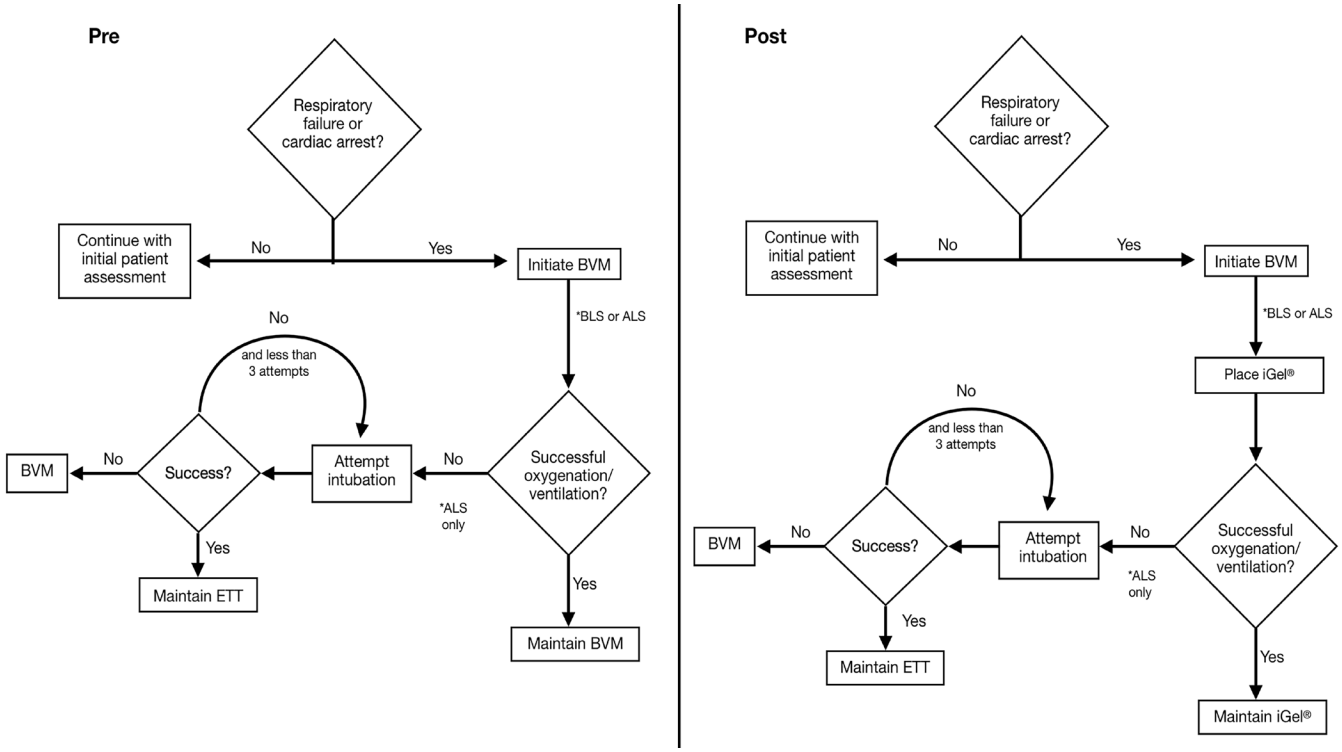


**Figure 1.** Post-intervention airway management algorithm.
*ETT*, endotracheal tube; *BLS*, basic life support; *ALS*, advanced life support; *BVM*, bag valve mask; *iGel*, supraglottic airway device from Intersurgical.

Our study evaluated the impact of a pediatric prehospital airway management-protocol change consistent with the NASEMSO guidelines and inclusive of a pediatric EGA, on airway management and patient outcomes in children with prehospital respiratory failure.

## METHODS

We performed a retrospective cohort study of pediatric patients <16 years old cared for by the HFD EMS from January 1, 2013 – March 31, 2017. We compared the intubation rates, operational metrics, and clinical outcomes of pediatric patients with respiratory failure (respiratory rate < 5 breaths per minute or oxygen saturation <85%) or in cardiac arrest two years before and after an airway management algorithm (Table 1) change that included addition and prioritization of the EGA device, i-gel, (Intersurgical Ltd., Berkshire, UK). We used recorded end-tidal waveform capnography as a marker of both EGA and endotracheal tube success, or paramedic-reported passage through the vocal cords for ETI success. Prehospital return of spontaneous circulation (ROSC), as recorded from the patient care and records, was defined as presence of a pulse with cessation of cardiopulmonary resuscitation (CPR) prior to hospital arrival. We recorded survival outcomes from both hospital records and the EMS agency cardiac arrest database.

### Study Setting

HFD is a two-tiered 9-1-1 EMS system with Basic Life Support (BLS) and Advanced Life Support (ALS) units. HFD serves a geographic area totaling 2.3 million persons and 667 square miles in the greater Houston region. The agency receives 300,000 EMS calls annually. No other EMS agencies provide emergency 9-1-1 response within Houston city limits. HFD has 3500 prehospital providers, all of whom are trained as firefighters and have at least BLS emergency medical technician (EMT) training. HFD also has 700 paramedics providing ALS care. Dispatch of the initial unit is determined based on the 9-1-1 call type and severity.[11] The local EMS protocol for management of respiratory failure in pediatric patients changed to include the use of an EGA for pediatric patients – the i-gel – in addition to algorithmic progression from one device to a more advanced device. Prior to the protocol change no EGA device was available for pediatric airway management due to the size restrictions of the then-used King LT-D airway (Ambu, Copenhagen, Denmark).

Prior to the protocol change pediatric patients with respiratory failure or cardiac arrest were managed first with BVM followed by intubation. Both ALS and BLS providers were equipped with the i-gel EGA post-protocol change for both adults and pediatric patients. The King LT-D was not available post-protocol change. The airway management protocol directed members to use BVM first and then advance to an EGA for all patients requiring transport and continued assisted ventilation. If the EGA provided inadequate oxygenation or ventilation it could be removed, with intubation attempted by a paramedic. The new protocol inclusive of EGAs was implemented in conjunction with an in-person lecture and skills training described in a prior publication.[12] No other aspects of pediatric cardiac arrest management changed during the study period. All study patients received ALS care.

### Data Collection

We retrospectively reviewed electronic patient data to establish the baseline characteristics, incidence of airway procedures, and outcomes for patients meeting this study's inclusion criteria (Figure 2). Prospective patients were electronically identified on a weekly basis via the patient care record (Imagetrend, Lakeville, MN) and cardiac arrest quality-assurance databases. Records were reviewed by trained abstractors (CB, JM) who were aware of the study design and outcomes in question. Hospital and outcome data were abstracted from the EMS agency's cardiac arrest database and hospital inpatient medical records.

### Statistical Analysis

Our primary outcome was a difference in the frequency of prehospital attempted intubations between the pre- and post-intervention groups. We estimated a 20% reduction in intubation rate from implementation of the new protocol with a sample size of 266 (alpha 0.05, power 0.8). For skewed continuous data (Shapiro-Wilks<0.001) we used non-parametric testing (Mann-Whitney test). Incomplete data or negative timed operational metrics (ie, time on scene) were coded as missing. We analyzed categorical variables using the Pearson chi-square test or Fisher's exact test. A p-value less than 0.05 was considered statistically significant. Categorical variables were reported using frequencies and percentages, continuous variables were reported using median and interquartile ranges. We conducted all analyses using the Statistical Package for the Social Sciences (SPSS), version 24 (IBM Corp., Armonk, NY).

### Institutional Review Board Approvals

The University of Texas Health Science Center at Houston and Baylor College of Medicine institutional review boards approved this study. The study was approved with waiver of consent for patients observed and data accessed.

## RESULTS

Demographically and clinically, there were no significant differences between patients during the pre- and post-protocol change timeframes (Table 1). We found a significant difference in the frequency of intubation and the success of intubation in the two groups. Specifically, the number of children with an ETI attempted decreased from 79.6% pre to 44.7% post (p<.001). In those that had ETI attempted, the overall success rate was 81.4 % pre and 63.6% post (p<.001). Post protocol, 52.8% had an attempted EGA airway with a success rate of 95.4%. Table 2 summarizes the number of advanced airway attempts.

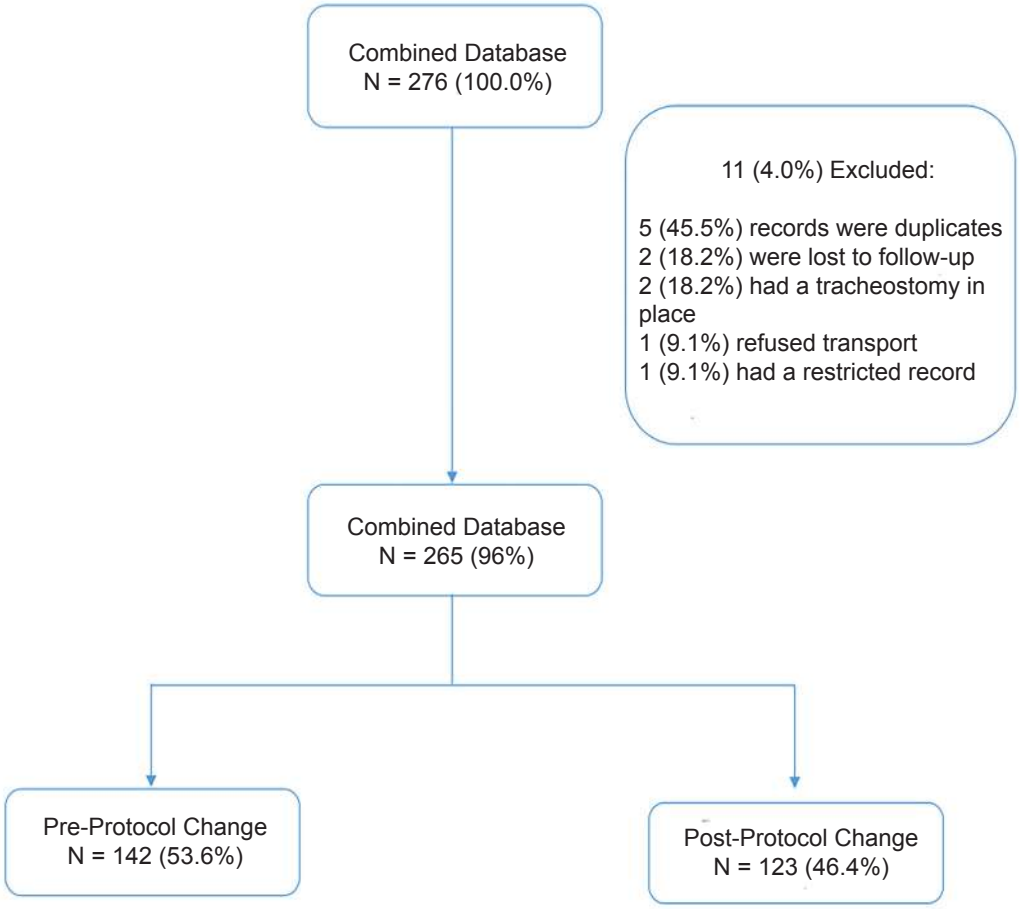


**Figure 2.** Patient flow diagram for before and after analysis of implementation of new prehospital pediatric airway management process incorporating supraglottic ariway.

The majority of patients pre and post, 74.6% and 66.7% respectively, were in cardiac arrest (Table 3).

Of the intubations attempted after the protocol change, 96.4% were not performed in adherence to the protocol change since 36.4% had no EGA attempted and 60% had intubation performed after successful EGA placement (Figure 3). The vast majority of patients during this period were in cardiac arrest (Table 3) with no difference between pre and post with regard to initial arrest rhythm. Our study was not powered to detect a prehospital ROSC or survival benefit in cardiac arrest patients,[13] and we did not find a significant change in prehospital ROSC (Table 3) or survival to hospital admission or discharge (Tables 2 and 3).

## DISCUSSION

In this observational study, we found that the establishment of an airway management algorithm paired with an EGA suitable for all ages of pediatric patients decreased the rate of ETI in an urban EMS system. No differences in survival to hospital admission or discharge were observed in all patients with cardiac arrest or respiratory failure. For cardiac arrest patients specifically, we observed no difference in rates of ROSC. These observations suggest that deployment of a pediatric EGA can successfully decrease the need for prehospital intubation.

Although prior research suggests no improvement in neurologic outcome with ETI,[1] the skill is taught as part of the EMT-Paramedic National Standard Curriculum and still widely practiced in EMS agencies across the U.S.[14] As many EMS agencies progress toward widespread EGA deployment given evidence against significant benefits from intubation during initial cardiac arrest care, intubation skill retention remains largely unknown.[15,16] For pediatric patients especially, the effects of implementing an EGA-first strategy decreases a paramedic's exposure to the already rare intubation. Prior research has demonstrated a low number of clinical opportunities for paramedics to maintain procedural competency with intubation,[5] let alone the exceedingly rare pediatric intubation.

In our cohort, we observed a decline in the success rate for pediatric intubations when attempted (81.4% vs 63.6%) after introducing an EGA. The effects of implementing the EGA in this system, while continuing to allow ETI, resulted in a further dilution of procedural experience. The potential difficulty with maintaining paramedic intubation skills for pediatric and adult patients, is well documented by prior

studies,[5,17-20] and may be augmented in systems such as this where ETI exists concurrently with EGA prioritization. The potential training solutions and their effectiveness have not been described. High-performance EMS agencies with intensive training, continuing education, and quality assurance report intubation success rates as great as 97% but with low first-pass success.[17] Systems with infrequent airway management training and skill maintenance when coupled with the addition and widespread use of EGAs may experience declines in success, as those observed in our system.

However, in the intubations that occurred post-protocol change, 96.4% occurred due to protocol non-adherence. Despite our reported 95% success rate with EGA placement, which is consistent with previous publications,[21,22] many patients during the study period still underwent ETI attempts. Of the 36.4% with ETI attempted prior to an

**Table 1.** Baseline characteristics of patients before and after a change in the airway management protocol.

| | Pre-protocol change N = 142 (53.6%) N (%) or Median (IQR) | Post-protocol change N = 123 (46.4%) N (%) or Median (IQR) | P-value |
|---|---|---|---|
| Age (years) | 1.0 (0,6) | 1.2 (0,6) | 0.79 |
| Sex | | | 0.76 |
| Female | 58 (40.8) | 48 (39.0) | |
| Male | 84 (59.2) | 75 (61.0) | |
| Race | | | 0.41 |
| Hispanic | 61 (43.0) | 47 (38.2) | |
| Caucasian | 15 (10.6) | 9 (7.3) | |
| African American | 59 (41.5) | 63 (51.2) | |
| Other | 7 (4.9) | 4 (3.3) | |
| Top paramedic working assessments | | | 0.05 |
| Cardiac | 114 (80.3) | 87 (70.7) | |
| Respiratory | 10 (7.0) | 11 (8.9) | |
| Seizure | 5 (3.5) | 10 (8.1) | |
| Trauma | 3 (2.1) | 10 (8.1) | |
| Other | 10 (7.0) | 5 (4.1) | |
| Traumatic arrest | 16 (11.3) | 14 (11.4) | 0.74 |
| ALS on scene time (minutes)* | 27.0 (18, 36) | 24.0 (18, 34) | 0.17 |

*N=10 missing scene time pre and 13 post.
*IQR,* interquartile range; *ALS,* Advanced Life Support.

**Table 2.** Airway interventions and outcomes for all patients pre- and post-airway management change.

| | Pre-protocol change N = 142 (53.6%) N (%) or Median (IQR) | Post-protocol change N = 123 (46.4%) N (%) or Median (IQR) | P-value |
|---|---|---|---|
| ETI attempted | 113 (79.6) | 55 (44.7) | <0.001 |
| Intubation success | 92 (81.4) | 35 (63.6) | <0.001 |
| ETI attempts if successful | 1.0 (1.0, 2.0) | 1.0 (1.0, 2.0) | 0.36 |
| ETI attempts if intubation unsuccessful | 2.0 (1.0, 3.0) | 1.50 (1.0, 2.0) | 0.22 |
| EGA attempted | N/A* | 65 (52.8) | N/A |
| EGA success | N/A* | 62 (95.4) | N/A |
| Survival to hospital admission | 50 (35.2) | 49 (39.8) | 0.44 |
| Survival to hospital discharge | 30 (21.1) | 31 (25.2) | 0.38 |

*Extraglottic airways were not part of the pediatric protocol during the pre-protocol change period.
*IQR,* interquartile range; *ETI,* endotracheal intubation; *EGA,* extraglottic airway.

**Table 3.** Cardiac arrest subgroup.

| | Pre-protocol change* N = 106 (56.3%) N (%) or Median (IQR) | Post-protocol change* N = 82 (43.7%) N (%) or Median (IQR) | P-value |
|---|---|---|---|
| Bystander CPR | 39 (36.8) | 42 (51.2) | 0.048 |
| Witnessed arrest | 31 (29.2) | 22 (26.8) | 0.72 |
| VF/VT | 4 (3.8) | 2 (2.4) | 0.70 |
| PEA | 19 (17.9) | 15 (18.3) | 0.95 |
| Asystole | 78 (73.6) | 63 (76.8) | 0.61 |
| Undocumented rhythm | 5 (4.7) | 2 (2.4) | 0.47 |
| ROSC | 25 (23.6) | 17 (20.7) | 0.64 |
| Survival to hospital admission | 28 (26.4) | 17 (20.7) | 0.37 |
| Survival to hospital discharge | 11 (10.4) | 7 (8.5) | 0.67 |

*P-value was calculated using Fisher's exact test when any cell value was less than five.
*IQR,* interquartile range; *CPR,* cardiopulmonary resuscitation; *VF,* ventricular fibrillation; *VT,* ventricular tachycardia; *PEA,* pulseless electrical activity; *ROSC,* return of spontaneous circulation.

EGA attempt only, 85% experienced a success. Similarly, only 54.4% were successful when attempted after an already successful EGA. Although prior commentary has suggested that EGAs, specifically the i-gel, perform well in the prehospital environment, success rates may be lower than previously demonstrated in hospital-based studies.[21,23]

In non-paralyzed adults, for example, ventilation with the adult size 4 i-gel may exceed the 24 millimeters of mercury laryngeal seal, causing significant air leak.[24] For children, the degree of leak if the device is sized incorrectly is unknown. For our cohort, the rationales behind the protocol deviations (Figure 3) were not consistently documented. It is possible that many of the ETIs after EGA placement were in fact warranted but appeared as protocol violation due to inadequate documentation of EGA failure. Providers' perception of inadequate ventilation or incorrect device sizing may have contributed to the intubation attempts occurring after initial EGA placement.

Our study was not powered to detect a prehospital ROSC or survival benefit in cardiac arrest patients.[13] In this small cohort we did not observe any measurable effects on cardiac arrest care, although metrics such as compression fraction, CPR rate, and exact timing of EGA or ETI were not available. Also, given our small sample size and low frequency of shockable rhythms in the pediatric population,[25] further research is required to address the initial airway management device by rhythm and likelihood of a primary respiratory arrest.[17,26]

## LIMITATIONS

This study is not without limitations. First, it was partially limited by the nature of the retrospective review that determined the EMS system's baseline in addition to the inability to associate clinical outcomes with the applied airway device. The small cardiac-arrest subset also limits generalizability to pediatric cardiac care. There was also unclear documentation with regard to paramedic reasoning to proceed through the airway algorithm to a more advanced device. Further, some patients' airways were managed with multiple devices or the same device multiple times in different sizes. We could not analyze this dataset for correlation with weight and device sizing. In addition, success was based on provider documentation rather than direct review of capnography waveforms. Due to limitations with record review, isolating the effect of a singular airway management device or timing of placement was not possible.

## CONCLUSION

Implementation of an evidenced-based airway management algorithm for pediatric patients paired with EGA devices for all ages was associated with decreased frequency of prehospital pediatric intubation. Intubation success when attempted may be negatively impacted by the decrease in skill frequency.

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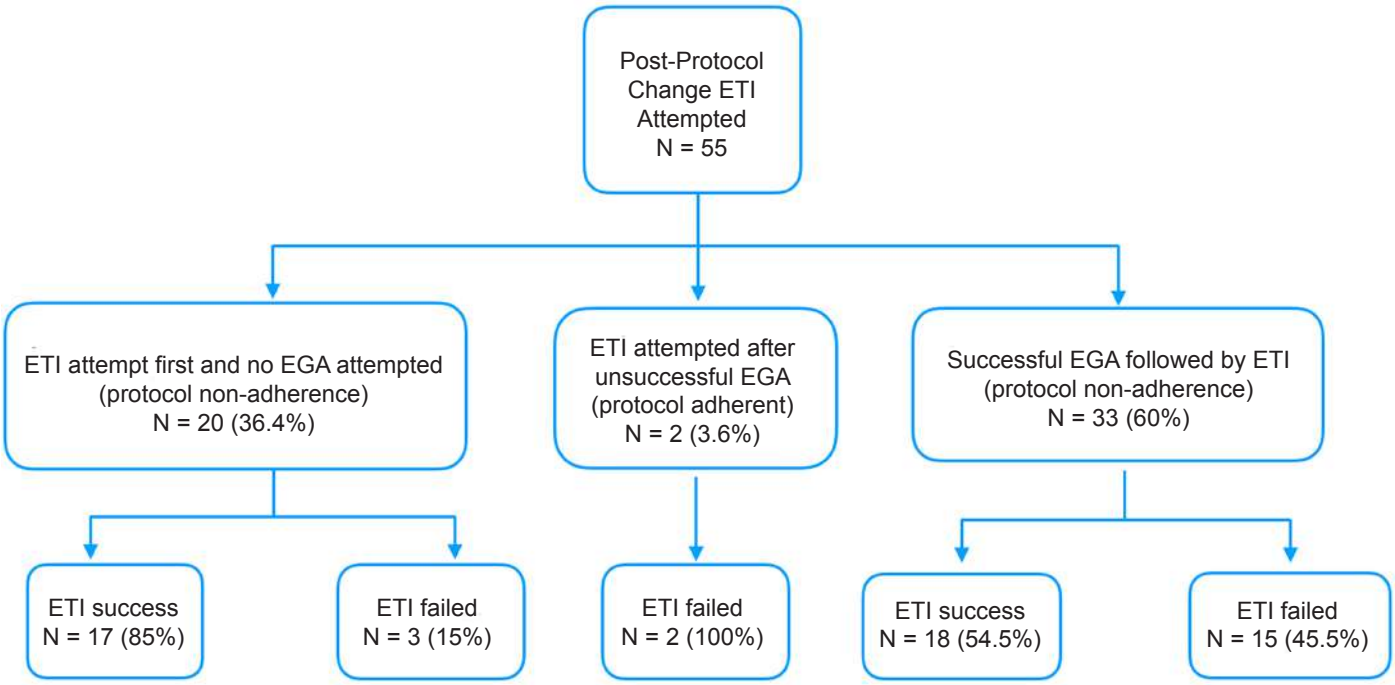


**Figure 3.** Endotracheal intubations post-protocol change.

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# Ketamine as Monotherapy in Difficult Airways Is Not Ready for Prime Time

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*To the Editor:*

We appreciate the discussion outlined by Merelman et al. regarding the important role ketamine has in emergency airway management,[1] and agree with the sentiment that ketamine may be preferable to other agents in many different clinical scenarios. Based on our experience teaching and discussing emergency airway management with national experts, however, we believe a few points are more nuanced and warrant further discussion.

For patients with predicted intubation difficulty, the authors advocate sedation with ketamine and the use of a standard laryngoscope. While this technique may be appropriate in certain clinical scenarios, there is a dearth of evidence demonstrating its success or safety and we recommend further study before it is widely implemented. Intubation with ketamine alone, in the references cited, was successful in 21/31 (68%) cases.[2,3] Fiberoptic intubation success with ketamine monotherapy has also had low success rates.[4] Ketamine may dissociate the cortex from brainstem functions, but because brainstem reflexes remain intact, vomiting can still occur when the upper airway structures are stimulated. Emesis occurs in approximately 5-15% of ketamine administrations in adults,[5] which often leads to aspiration–the largest contributor to morbidity in airway management globally. Ideally, patients thought to be too difficult for neuromuscular blockade are managed with meticulous topical anesthesia and as little parenteral sedation or anxiolysis as feasible; sedation without dissociation or obtundation allows the patient to follow commands, which is advantageous during endoscopic intubation.

Although standard laryngoscopy is the most common emergency intubation technique, we strongly believe that flexible endoscopic intubation is an important skill within the procedural capability of emergency physicians. This has long been the gold standard method for patients deemed too risky for neuromuscular blockade. While video laryngoscopes have largely replaced direct laryngoscopy, the utilization of flexible endoscopy has remained fairly constant.[6] Historically, the expense of flexible fiberoptic scopes and endoscopes hindered widespread access to these important devices; for this reason, many physicians have not received adequate training or ongoing practice, especially in departments that infrequently perform intubation. The advent of disposable endoscopes, now produced by multiple companies, should improve accessibility and affordability. Like any procedure, continual practice with a flexible endoscope is essential. This can be accomplished in many ways that should be feasible by all physicians. In our department we have practiced nasal intubation on each other, which has honed our topical anesthesia skills. Endoscopic evaluation of ED patients with severe sore throats, foreign body sensation, new hoarseness, and other conditions provides practice with endoscope controls; manikin-based practice is another option.

Ketamine, while uncommonly causing overt respiratory depression or apnea, frequently causes subclinical respiratory depression.[7,8] This is inconsequential in patients with normal respiratory effort (eg, procedural sedation of healthy patients), but it is important to consider when caring for critically ill patients. In our experience, when ketamine is administered to patients with high minute ventilation (eg, severe agitation and excited delirium, diabetic ketoacidosis, acute respiratory distress syndrome), they continue to breathe but with a significantly lower minute ventilation that sometimes does not meet their metabolic needs. We believe that patients with high respiratory effort who are deemed too risky for neuromuscular blockade should be managed either with a completely awake approach (ie, no slowing of respiration), or with rapid sequence intubation, which maximizes the chance of first-pass success and allows placement of a first-line backup device (eg, intubating laryngeal mask airway) should the first attempt fail. It may be preferable to cause apnea with neuromuscular blockade rather than risk a longer ketamine-

facilitated intubation attempt with relative hypoventilation. The worst possible circumstance when managing these patients is to have a patient who is not breathing adequately and also not relaxed enough to facilitate tube passage or allow placement of a modern extraglottic device.

Ketamine is an old drug that remains valuable in all phases of airway management. Before widespread use as a monotherapy for patients with difficult airways, however, it seems prudent to gather additional data to determine its success and safety profile relative to other approaches.

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# Author Response to: "Ketamine as Monotherapy in Difficult Airways Is Not Ready for Prime Time"

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*In reply:*

We appreciate the response to our manuscript "Alternatives to Rapid Sequence Intubation: Contemporary Airway Management with Ketamine*"* and value the authors' perspectives, both competing and complementary.

We agree that flexible endoscopy is a powerful, safety-preserving airway management modality that should be a foundational component of the emergency physician's arsenal and that, ideally, all emergency physicians would be competent in this skill and use it regularly for fully *awake* intubation technique, facilitated by "meticulous topical anesthesia," as well as dissociated ketamine-only breathing intubation (KOBI). At the moment, however, the majority of practicing emergency physicians **are not** able to efficiently apply topical anesthesia dense enough to facilitate a fully awake technique in most patients, and **are not** able to able to efficiently intubate using a flexible endoscope, either because they lack the equipment or the skill set, or both.

Furthermore, even providers capable of performing these techniques may not be able to successfully execute a fully awake technique on critically ill patients, who often require intubation quickly and cannot cooperate with a procedure that involves instrumenting their glottis. The relevant comparison is therefore not between fully awake endoscopic intubation technique and KOBI, because most emergency providers *cannot do* the former, whereas nearly all can do the latter. What the literature cannot at present tell us is how KOBI performs against RSI, in patients thought to be especially vulnerable to the harms of RSI. We took special care to indicate in our manuscript that fully dissociated, non-paralyzed intubation technique using conventional or video laryngoscopy has little evidentiary base. Our goal was to provide guidance to facilitate procedural safety and efficacy, and to encourage future research.

We also make special mention in our manuscript of the concern around vomiting present in any awake technique and recommend strategies for mitigating this risk. However, the comment "Emesis occurs in approximately 5-15% of ketamine administrations in adults, which often leads to aspiration…" is misleading. Ketamine-related vomiting typically occurs "late during the recovery phase," which is why we do not see unacceptable rates of aspiration around ketamine PSA.[1] The risks of an a*wake* or *breathing* technique must be weighed against the risks of paralysis and providers must be prepared to manage the most important risks associated with any procedure undertaken, which in this case includes vomiting, muscle rigidity, and intubation failure.

We agree with the authors' concerns for severely acidemic patients and agree that such a patient who is dissociated with ketamine will likely develop relative hypoventilation that, depending on its duration, could be dangerous. Again, however, the current literature is silent on whether these patients, or which subset of these patients, are more likely to be harmed by KOBI compared to RSI (or any other technique). Ultimately, as always, providers must account for a host of factors, including the degree and danger of the underlying physiologic derangement, anticipated anatomic airway difficulty, patient cooperation, and perhaps most importantly the provider's capabilities. "The best technique for your patient is usually the technique you're best at doing." We look forward to more science and discussion as ketamine-based airway techniques are refined to meet emergency providers' evolving needs and skills.

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# Randomized Controlled Trial of Simulation vs Standard Training for Teaching Medical Students High-quality Cardiopulmonary Resuscitation: The Methodological Issue

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*To the Editor:*

We read with great interest the paper by McCoy et al.[1] published in the January 2019 issue of your valuable journal. The authors sought to evaluate the comparative effectiveness of high-fidelity simulation training vs standard manikin training for teaching medical students, using the American Heart Association guidelines for high-quality cardiopulmonary resuscitation (CPR). They concluded that high-fidelity simulation training was better than low-fidelity CPR manikin training.

Although this study was done in detail with an interesting result, there are some important methodological issues which should be considered to improve its application in practice and for future research:

1. The participants wereall fourth-year medical students, but there was no information about baseline data regarding their characteristics. Wouldn't this issue be important as to whether or not the characteristics between the two groups were comparable?

2. There were two comparative groups in the study, but the authors used Kruskal-Wallis rank sum test without any adjustment. Mann-Whitney U test is commonly used to compare two sample means when the distribution is non-normal.[2]

3. It would have been better to refer to a related reference for calculating sample size in the study. Based on what justification was an effect size of five millimeters considered for comparing two groups?

4. We believe that some confounding variables such as previous experience, education, or interest in their own field may have had an effect on the results.[3]

5. The method of data collection appears to be missing or was not made clear to the reader.

6. Real-time feedback can increase the average of physical and mental workloads, and the quality of CPR then improves[4] with higher reported physical workloads. In this study, it would have been better to do the training in the two groups by the mentioned method, and the two groups could then have been evaluated after a time interval.

7. We thank the authors for reporting the limitations of their study honestly. In one limitation, the authors declare that increasing the number of outcome measures increases the potential for a type I error. In this analysis a two-group comparison was done, not multiple comparisons.[5]

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# Author Response to: "Randomized Controlled Trial of Simulation vs Standard Training for Teaching Medical Students High-quality Cardiopulmonary Resuscitation: The Methodological Issue"

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*In reply:*

Thank you for your interest in our study entitled "Randomized Controlled Trial of Simulation vs Standard Training for Teaching Medical Students High-quality Cardiopulmonary Resuscitation." Your comments and questions were insightful and appreciated.

The participants in this study were all fourth-year medical students enrolled in a required emergency medicine (EM) clerkship. We excluded foreign medical students doing an observation rotation in the emergency department to evaluate a representative group of U.S. medical students. All students were in their final year in medical school, on a required EM rotation, and had previous simulation experience with simulation as part of their medical school curriculum. The participants were balanced with regard to these independent variables.

We chose a prospective, randomized controlled trial study design as this is the optimal methodological approach to evaluate the effectiveness of an intervention compared to a control. Randomization affords the generation of two prognostically balanced groups such that any difference observed at the end of the trial can be attributed to the intervention. Furthermore, randomization is the optimal methodological approach to control for both known and unknown confounders.

The Kruskal-Wallis test is an analytical approach that allows for the assessment of significant differences on a continuous dependent variable by a categorical independent variable (with two or more groups). Since it is a non-parametric method, this test does not assume a normal distribution of the data. The Kruskal-Wallis test can be used for both continuous and ordinal-level dependent variables and is used for comparing two or more independent samples of equal or different sample sizes. It extends the Mann-Whitney U test, which is used for comparing only two groups.

Our decision to evaluate the effect size of a 5-millimeter difference in compression depth between the two groups was a balance between identifying a clinically relevant difference within the practical context of a study protocol with the power to detect that difference with statistical significance. To our knowledge, there are no studies to date evaluating a difference in compression depth smaller than that reported in our trial.

A confounder is an underlying variable that is both linked to the exposure of interest and independently associated with the outcome under study. One of the major benefits of randomization is that this is the optimal methodological approach to control for both known and unknown confounding variables. We chose to conduct a prospective randomized controlled trial for this reason, as this is the gold standard when evaluating for and establishing a causal relationship between independent and dependent variables.

Our methods for data collection can be found in the methods and measurements section. In short, the performance metrics measured for high-quality CPR in our study were specifically defined in the AHA guidelines. The high-fidelity simulation software we used allows for the real-tine collection of chest compression rate, depth and recoil. Video capture of each scenario was performed with B-Line Medical SimBridge software (Washington, DC). Data input was done via standardized abstractions sheets.

Thank you again for your insightful questions, comments, and interest in our study.

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# Incidence of *Clostridium difficile* Infection After Sepsis Protocol Antibiotics

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**Introduction:** The management of sepsis includes the prompt administration of intravenous antibiotics. There is concern that sepsis treatment protocols may be inaccurate in identifying true sepsis and exposing patients to potentially harmful antibiotics, sometimes unnecessarily. This study was designed to investigate those concerns by focusing on in-hospital *Clostridium difficile* infection (CDI), which is a known complication of exposure to antibiotics.

**Methods:** Our emergency department (ED) recently implemented a protocol to help combat sepsis and increase compliance with the 2017 Sepsis CMS Core Measures (SEP-1) guidelines. In this single-center, retrospective cohort analysis we queried the electronic health record to gather data on nosocomial CDI and antibiotics prescribed over a five-year period to analyze the effect of the introduction of a sepsis protocol order set. The primary goal of this study was to measure the hospital-wide CDI rate for three years prior to implementation of the sepsis bundle, and then compare this to the hospital-wide CDI rate two years post-implementation. As a secondary outcome, we compared the number of antibiotics prescribed in the ED 12 months prior to administration of the sepsis protocol vs 12 months post-initiation.

**Results:** Over the course of five years, the hospital averaged 9.4 nosocomial CDIs per 10,000 patient hours. Prior to implementation of the sepsis bundle, the average CDI rate was 11.6 (±1.11, 95%) and after implementation the average rate dropped to 6.2 (±1.27, 95%, $p<0.01$). The mean number of antibiotics ordered per patient visit was 0.33 (±0.015, 95%) prior to bundle activation, and, following sepsis bundle activation, the rate was 0.38 (±0.019, 95%, $p<0.01$). This accounted for 38% of all ED patient visits receiving antibiotics, a 5% increase after the sepsis bundle was introduced.

**Conclusion:** In this study, we found that CDI infections declined after implementation of a sepsis bundle. There was, however an increase in the number of patients being exposed to antibiotics after this hospital policy change. There are more risks than just CDI with antibiotic exposure, and these were not measured in this study. Subsequent studies should focus on the ongoing effects of timed, protocolized care and the associated risks. [West J Emerg Med. 2019;20(6)977-981.]

## INTRODUCTION

The management of sepsis according to the 2017 Surviving Sepsis Campaign guidelines is multifaceted and includes the prompt administration of intravenous antibiotics.[1] The Centers for Medicare and Medicaid Services (CMS) core measures require administration of antibiotics within three hours of sepsis being identified. It is recommended that broad spectrum antibiotics be used in the initial treatment of sepsis or suspected sepsis based on systemic inflammatory response syndrome (SIRS) criteria.[2] Although antibiotic treatment may be life-saving, antibiotic

exposure has known potential complications, including the risk for developing *Clostridium difficile* infection (CDI).[2-4]

CDI has important implications affecting patient mortality, cost, and even potential hospital reimbursement. Studies show mortality of CDI in hospitalized patients ranges from 8-37.2%.[5] CDI is a major contributor to healthcare expenditure in the United States and was responsible for as much as $4.8 billion U.S. dollars of cost to the health system.[6] In addition to costs, sepsis performance data are currently being collected by The Joint Commission regarding antibiotic administration in the presentation of SIRS patients, and hospitals may soon find that it will be tied directly to reimbursement.[7]

Compliance with the CMS Sepsis Core Measures (SEP-1), or sepsis bundle, mandates early antibiotic administration. Providers at this facility were encouraged to use an order set that included the SEP-1 required components of sepsis management. Use of antibiotics is known to be associated with the risk of CDI.[2,4] The Infectious Diseases Society of America (IDSA) chose not to endorse the 2016 sepsis guidelines due to concern over excessive antibiotic use and its associated risks, including CDI.[8] We hypothesized that the incidence of CDI in this hospital would not change after implementation of the sepsis bundle-required antibiotics administration. The primary goal of this study was to measure the hospital-wide CDI rate for three years prior to implementation of the sepsis bundle vs the CDI rate two years post-implementation. As a secondary outcome, we compared the overall number of antibiotics prescribed in the emergency department (ED) 12 months prior to administration of the sepsis protocol vs 12 months post-initiation.

*Population Health Research Capsule*

What do we already know about this issue?
*There is concern that sepsis treatment protocols may be exposing patients to more antibiotics, and research has shown that antibiotic exposure can be harmful.*

What was the research question?
*Does implementation of a sepsis treatment protocol increase hospital-wide incidence of C. difficile infections?*

What was the major finding of the study?
*C. difficile infections decreased after implementing a sepsis treatment protocol despite an increase in antibiotic use.*

How does this improve population health?
*Emergency department antibiotic stewardship has long reaching effects in the community. Hospital administrators should consider carefully the effects of the policies they implement.*

## METHODS

This study was a single-center, retrospective cohort analysis designed to test the hypothesis that the introduction of sepsis bundle antibiotics had no effect on hospital-wide CDI rates. The study was performed in an academic, suburban hospital ED with an annual census of approximately 90,000 visits per year that implemented a protocol on January 15, 2016, to help combat sepsis and increase compliance with SEP-1 guidelines. The facility's institutional review board approved the study as exempt.

Over the five-year period, the protocol in place to diagnose CDI in the hospital was updated once. Initially, a nosocomial CDI was defined as a positive *C. diff* polymerase chain reaction test. However, in October 2016 the infection control department changed the protocol to a laboratory panel, which includes an enzyme immunoassay test paired with a glutamate dehydrogenase test. If both return positive, the patient was considered to have CDI. If one result was positive and the other negative, the test was considered indeterminate. In that case, a follow-up polymerase chain reaction (PCR) test was sent reflexively to an outside laboratory to evaluate for the presence of two *C. diff*, toxin-related genes (tcdB and tcbC). This follow-up PCR test was considered the final deciding factor for all indeterminate tests.

We extracted data from the EPIC electronic health record (EHR) with the help of the infection control department, which keeps record of nosocomial hospital infections. The overall number of hospital nosocomial CDI per 10,000 inpatient hours was reviewed and recorded monthly from January 2013–December 2017. For the secondary outcome, we queried the EHR for the daily number of antibiotics ordered on patients ≥18 years of age during their ED stay for the two-year period January 2015–January 2017 . The study focused only on antibiotics available to be ordered directly from the sepsis order set (Table 1), and included only those antibiotics ordered by ED providers. Orders placed by inpatient providers were not counted, as the secondary outcome was limited to this protocol's effect on ED

**Table 1.** Antibiotics available in the facility sepsis order set.

| |
|---|
| Amikacin |
| Ampicillin-Sulbactam |
| Azithromycin |
| Aztreonam |
| Ceftriaxone |
| Clindamycin |
| Gentamicin |
| Levofloxacin |
| Meropenem |
| Metronidazole |
| Piperacillin-Tazobactam |
| Vancomycin |

provider antibiotic usage. The sepsis order set went live on January 15 of 2016.

CDI rates three years before January 2016 and two years after were grouped and analyzed for an overall difference in means. For the secondary outcome, we queried, recorded and analyzed the number of antibiotics for one year before and after this date. This period was chosen, as the database for this specific information was limited to one year prior to the time period. Abstractors were blinded to the study's hypothesis. For analysis, we performed a two-sample t-test assuming equal variances.

## RESULTS

Over the course of five years, the hospital averaged 9.4 nosocomial CDIs per 10,000 patient hospital hours. Prior to implementation of the sepsis bundle, the average CDI rate was 11.6 (± 1.11, 95%) vs 6.2 (±1.27, 95%) per 10,000 patient hours (Figure 1, Table 2). There was a decrease in the number of hospital-acquired CDIs after the sepsis order set was activated, with a mean monthly decrease of 5.5 nosocomial CDIs per 10,000 patient hours ($p<0.01$) (Table 2). For the secondary outcome, we measured ED antibiotics ordered the year before and after the sepsis bundle. The mean proportion of patients receiving antibiotics during their ED visit was 0.33 (± 0.015, 95%) prior to bundle activation, with approximately 33% of all patient visits receiving antibiotics. After sepsis bundle implementation, this rose to 0.38 (± 0.019, 95%), or 38% of patient visits receiving antibiotics, for an increase of 5% ($p<0.01$) (Figure 2, Table 2). Variances were found to be similar across the datasets.

## DISCUSSION

Prior research has shown that antibiotic exposure leads to an increased risk of CDI development.[4] When earlier CMS recommendations in the management of community-acquired pneumonia outlined strict time periods for antibiotic administration, research on the topic indicated concern that these recommendations could lead to misdiagnosis and inappropriate antibiotic exposure.[9] CMS has now put a time constraint on management of SIRS-positive patients with presumed or suspected infectious etiology, a protocol that can lead to increased antibiotic administration prior to formal diagnosis and, given the greater antibiotic exposure, a potential increased risk of CDI. As previously noted, the IDSA did not support the 2016 guidelines due to this concern.[8]

This study demonstrated a 5% increase in antibiotic prescriptions for ED patients after sepsis bundle order set initiation. While this supports provider concerns over an increase in antibiotic utilization, hospital CDI rates actually decreased by a mean of 5.5 nosocomial infections per 10,000 patient hours during the study period. Although some practitioners may feel some relief knowing that this study failed to find a CDI epidemic as the result of an overall protocol change, these results may be only one small piece in an overall concerning trend. Instead, it is important to recognize that there are more risks than just CDI with antibiotic exposure, risks that were not measured in this study. Subsequent studies should focus on rate of antibiotic use and the other risks that are involved with these mandated prescribing practices.

There are multiple risk factors for development of CDI other than antibiotic exposure. Some of these include proton-pump inhibitor exposure and poor compliance with the use of personal protective equipment.[10,11] Healthcare facilities frequently implement new practices and staff educational procedures, which may have had an impact on the results and CDI rates.[12] Although this study showed that rates of antibiotic administration increased

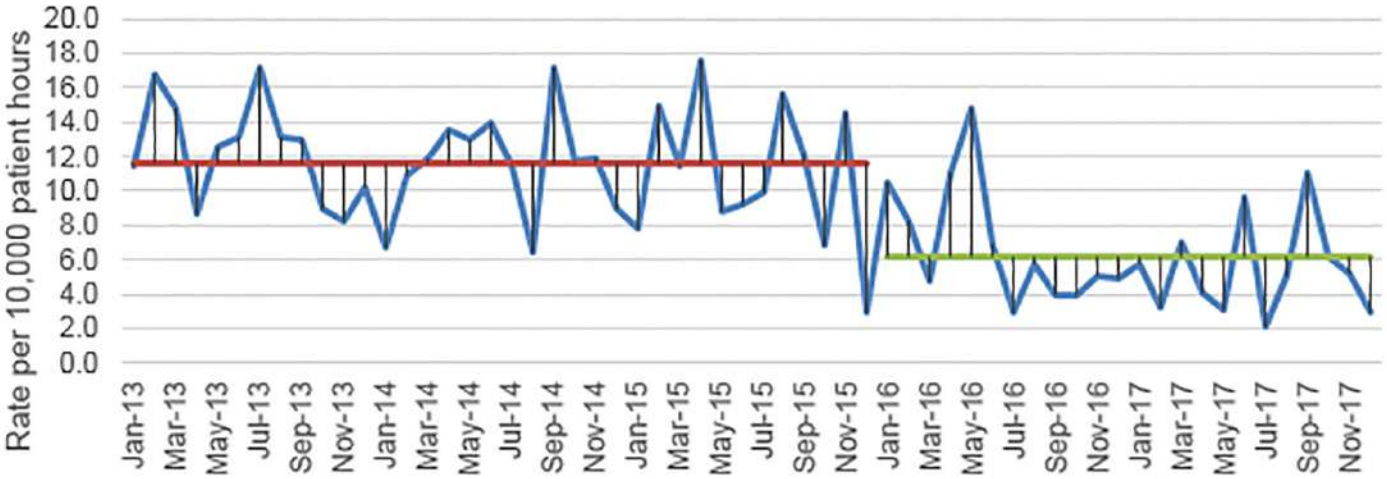


**Figure 1.** Hospital *Clostridium difficile* rates 2013-2017 before (red) and after (green) sepsis protocol implementation.

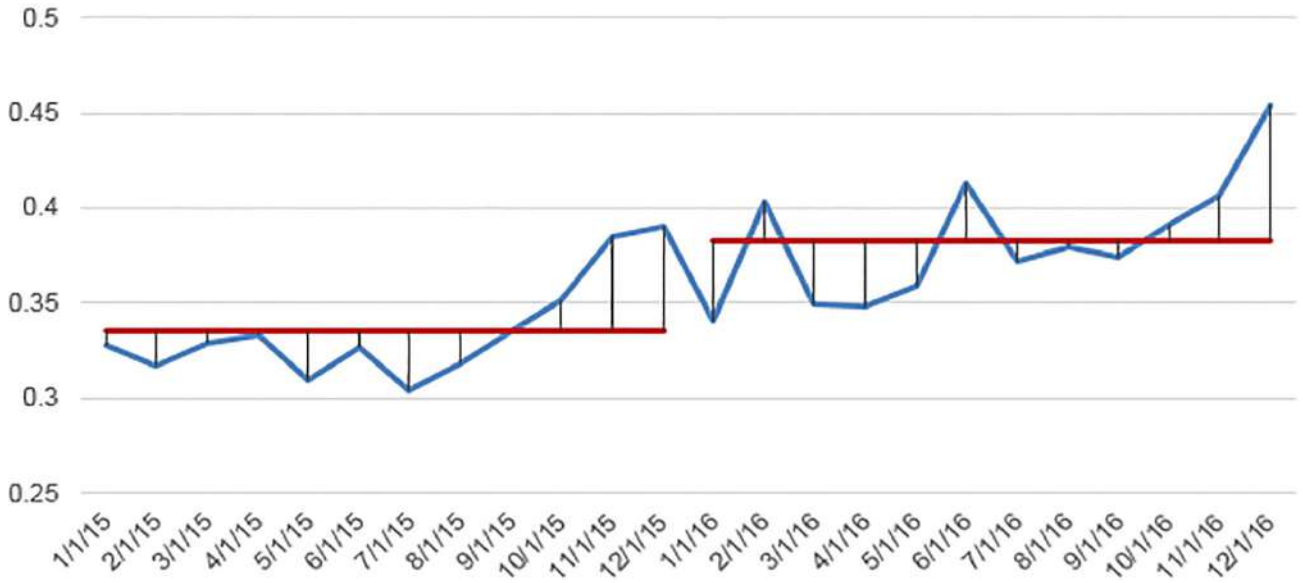


**Figure 2.** Emergency department antibiotics ordered per patient visit before (1/2015 -12/2015) and after (1/2016 -12/2016) sepsis protocol implementation.

explained by practice improvements and staff education. While the study was not designed to look at these effects, it provides hope that ongoing facility practices may be mitigating CDI risk despite increased antibiotic exposure.

## LIMITATIONS

Because this was a retrospective analysis limited to a single hospital it comes with the limitations inherit to this type of study. While patients may have been lost to follow-up due to death, utilization of other nearby health systems, or decision to not complete their hospital course, we expect the pre- and post-implementation population to be similarly affected by these confounding factors.

Of note, the protocol for diagnosing nosocomial CDI at this hospital changed during the observation period. A subset analysis of CDI rate before and after implementation of these new diagnostic criteria showed no compelling difference in means in these time periods. As such, this change should have had little impact on our results.

## CONCLUSION

CDI infections decreased after implementation of a sepsis protocol, despite an increased proportion of ED patients receiving antibiotics. There is strong evidence in the literature to support that increased antibiotic exposure leads to an increased rate of CDI. This single-center study did not support that concern. More research is needed to further determine the effects these CMS sepsis bundle implementation guidelines on patient outcomes.

## ACKNOWLEDGEMENT:

This abstract for this article was presented at the Fall 2018 The American College of Osteopathic Emergency Medicine (ACOEP) FOEM Competition.

**Table 2.** Rate of *Clostridium difficile infection (CDI)* and proportion of patients receiving emergency department antibiotics before and after sepsis bundle implementation.

| | Before protocol | After protocol | Change |
|---|---|---|---|
| Mean number hospital-wide CDI per 10,000 patient hours (±SD) | 11.6 (±1.11, 95%) | 6.2 (±1.27, 95%) | -5.5 (p<0.01) |
| Mean proportion of patient visits receiving antibiotics (±SD) | 0.33 (±0.015, 95%) | 0.38 (±0.019, 95%) | +0.05 (p<0.01) |

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*Conflicts of Interest*: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. No author has professional or financial relationships with any companies that are relevant to this study. There are no conflicts of interest or sources of funding to declare.

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# Fall 2018 The American College of Osteopathic Emergency Medicine (ACOEP) FOEM Competition Abstracts (October 22, 2018)

The Foundation for Osteopathic Emergency Medicine (FOEM) promotes research and graduate medical education to advance the science of patient centric holistic emergency care consistent with the osteopathic philosophy. Each year the FOEM hosts a number of research competitions that are presented at the American College of Osteopathic Emergency Physicians (ACOEP) fall scientific assembly and spring seminar. The *Western Journal of Emergency Medicine* (*West*JEM) annually sponsors the research paper competition at the fall scientific assembly and is considered the premier research award at the competition. This *West*JEM issue highlights FOEM research presented at the 2018 ACOEP Fall Scientific Assembly.

John Ashurst, DO, MSc
Kingman Regional Medical Center

## 1 Reducing Substance Use by an Emergency Department Intervention

RE Fieman[1], MD Marschall[1], SR Bhimani[1], DJ Fikse[1], RA Anderson[1], P Roth[1], JS Stephens[2], MF Colon[1], KR Weaver[1], DM Richardson[1], DB Burmeister[1], MR Greenberg[1], RD Cannon[1] / [1]Lehigh Valley Health Network, USF MCOM, Department of Emergency Medicine, Allentown, Pennsylvania; [2]Lehigh Valley Health Network, USF MCOM, Department of Internal Medicine, Allentown, Pennsylvania

**Introduction:** Substance use and misuse is prevalent in emergency department (ED) patients. We set out to determine substance use reduction rates after a brief ED intervention for patients with tobacco, alcohol, or drug use.

**Methods:** In this pilot prospective study, we approached a convenience sample of subjects in 2 EDs in PA during scheduled provider nonclinical times. One site was a trauma center while the other was a smaller community hospital. Subjects had to be ≥18 yo, have capacity to answer survey questions and participate in the program interventions, could not be critically ill, and had to be willing to participate. Participating subjects admitted to definitions of unhealthy use of one or more of: tobacco products, alcohol, street drugs, or addictive prescription drugs. Subjects received a structured survey and intervention tool that was previously validated (Project ASSERT), a brief intervention based on motivational interviewing, and referral to treatment, which took on average 5-10 minutes1. The intervention was carried out by a medical student, Emergency Medicine (EM) Resident, or an Addiction Recovery Specialist (a licensed social worker and certified recovery specialist with lived substance use disorder experience). These providers had training in Project ASSERT prior to the study start. Phone follow-up was used to determine current substance use by the patient. Subjects received no financial incentives.

**Results:** One-hundred ninety-one patients were recruited (105 for tobacco usage, 54 for alcohol, and 32 for drugs). At follow-up, 16/105 tobacco users (15.0%) reported stopping smoking, 51 (48.6%) a decrease in the number of cigarettes per day, and 32 (30.5%) attempting to quit. Of 54 patients in the high-risk alcohol utilization group, 40 (74.1%) reported either a decrease in the number of days per week of drinking, or a decrease in the number of drinks per day. Of the 32 patients who used drugs, 25 (78.1%) reported a decrease in usage.

**Conclusion:** In this pilot study involving medical students, EM residents and drug counselors at 2 EDs, we found that a brief intervention to patients with unhealthy tobacco, alcohol, and drug use resulted in overall decreased use. A more robust study, with a larger patient sample size is indicated.

## 2 Teamwork Between Engineering and Medicine: Collaborative Training in the Emergency Department

PT Bowers[1], X Peng[2], ER Stevens[2], A Alexandrescu-Anselm[2], RS Mackenzie[1], TE Theman[2], AC Miller[1], AL Gallagher[1], MR Greenberg[1] / [1]Lehigh Valley Health Network, Department of Emergency and Hospital Medicine/USF MCOM, Allentown, Pennsylvania; [2]Lehigh University, Bethlehem, Pennsylvania

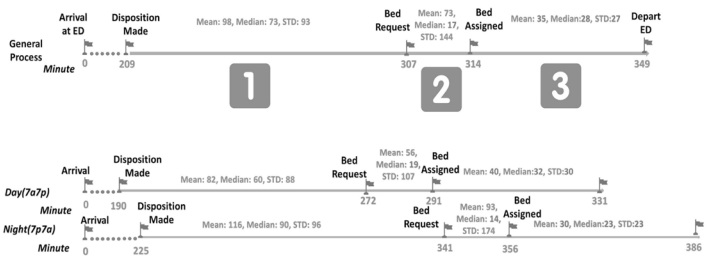
**Introduction:** Entrustable Professional Activities (EPAs) 9 and 13 are to "collaborate as a member of an interprofessional team" and to "identify system failures thereby contributing to a culture of safety and improvement." Addressing EPA 9, an interprofessional initiative was begun using a project team between two university programs: medical education and health systems engineering. Addressing EPA 13, this team set out to provide diagnostic analytics for Length of Stay (LOS) delays in the Emergency Department (ED).

**Methods:** This project was performed in 2018 at an ED with 42 beds, an annual census of 70,000, and a 38% admission rate. Two healthcare systems engineering students and a medical student performed on-site observations to identify specific bottlenecks that could contribute to ED LOS. This data and data generated from the electronic medical record were analyzed and correlated with observations. Factors (44) that affect ED processes were analyzed, including time interval metrics such as arrival to triage, arrival to admit, disposition to departure, and bed request to admit.

**Results:** Patients had an average LOS of 5.9 hours. A total of 4,940 adult, non-psychiatric cases presented; 1,599 (32.4%) of these were admitted. Process evaluation (Figure, mean and median minutes) showed differences between day (7a-7p) and night (7p-7a) flow patterns. These quantitative results (EPA 13) were determined by the interprofessional collaborative work efforts of the students (qualitatively, the outcome of EPA 9).

This project demonstrated a synergistic educational experience that allowed the blending of medical education with process engineering, ultimately improving knowledge gaps of both. This unique process allowed for diagnostics to be performed that were necessary for the ED and simultaneously provided a stronger foundation for QI undertakings for both engineering and medical students.

**Conclusion:** Medical students can benefit from working alongside systems engineers, allowing them to see the value of using tools (simulation modeling, statistical analysis, process flow mapping, etc.) to uncover evidence-based improvements to a variety of medical processes. Healthcare systems engineering students can gain valuable experience in a complex medical environment. Looking for solutions to the disparity between flow during the day and night is an opportunity for future study.




## 3 Scenario-based Pilot Testing of EMS Provider Interpretation of a Novel Pediatric Triage Protocol

KA Fratta[1], JN Fishe[2], JF Anders[1] / [1]Johns Hopkins University School fo Medicine, Department of Pediatrics, Division of Pediatric Emergency Medicine, Baltimore, Maryland; [2]University of Florida College of Medicine - Jacksonville, Department of Emergency Medicine, Jacksonville, Florida

**Introduction:** Pediatric care is increasingly concentrated in a small number of hospitals. No widely operative triage protocols guide emergency medical services' (EMS) pediatric destination decision for nontrauma patients. The PDTree tool is an evidence-based protocol validated by expert consensus, which was developed to assist EMS providers' in choosing a pediatric destination facility capable of definitive care. The PDTree defines four tiers of pediatric care (specialty/trauma center, comprehensive pediatric facility, regional pediatric facility and closest ED), and matches patients by condition and EMS assessment.

**Objective:** To pilot test the PDTree tool with practicing EMS providers for accuracy of interpretation and performance across the range of practice levels and prior experience.

**Methods:** Maryland EMS providers voluntarily participated in online testing. Demographic data included certification level, location of primary EMS jurisdiction, and years of experience. Providers were provided with a copy of the PDTree tool and presented 14 patient scenarios; each scenario was written to match one condition description in the PDTree tool with a clear recommendation for destination facility capability level. For each scenario, providers were asked to name their most likely destination, and to select the level of care suggested by their interpretation of the PDTree tool.

**Results:** 100 providers (52 ALS, 48 BLS) completed the electronic pilot test. Providers named a destination hospital with appropriate capabilities in 60% of scenarios. Providers' interpretation of the PDTree's advised destination level agreed with the intended response for 71% of scenarios. Greater than 90% agreement was seen for burns, witnessed child abuse, and cervical spine injury. Less than 50% agreement was seen for shock and a nondistressed child with a tracheostomy. Rates of agreement differed for diabetic ketoacidosis and nondistressed medically complex child based on provider level, and for elbow injury with deformity with years of experience (Chi Square p value = 0.01 and p value = 0.04, respectively).

**Conclusion:** EMS providers accurately interpreted the PDTree tool to determine the advised destination for a majority of pediatric scenarios. Future evaluation will focus on conditions with lower rates of agreement to determine if educational interventions or tool alterations are required. Virtual pilot testing using clinical vignettes is a reasonable first step in assessing the usability of a novel clinical decision-making tool.

**Acknowledgement:** Funding was provided by a grant from the United States Health Resources and Service Administration (HRSA-16-053: PDTree: A Tool for Prehospital Pediatric Destination Choice).

## 4 The Incidence of Infected Patients Identified Through a Sepsis Order Bundle

N Nazzise, R Gekle, R Bramante, D Levy / Good Samaritan Hospital Medical Center, West Islip, New York

**Introduction:** Sepsis order sets improve compliance with the established guidelines, but clinicians must be careful to initiate these protocols on appropriate patients. Many conditions can mimic sepsis as defined by SEP-1 (two or more SIRS* criteria and a suspected infection) such as trauma, COPD, etc. SEP-1 criteria alone can lead to initiating a sepsis protocol without true infection based solely on vital signs.

**Objective:** To assess the incidence of patients who had a sepsis order set, but an infection was not discovered during their hospital course.

**Methods:** This study is a single-center retrospective chart review of all "SIRS positive" patients >21 years old who presented to a busy community ED who had the sepsis order set initiated from the emergency department in 2017. A total of 1577 encounters met inclusion criteria. The discharge diagnoses were reviewed to identify unique diagnoses. Similar diagnoses (e.g. RLQ abdominal pain and abdominal pain) were grouped together into the more generalized diagnosis. Several of the unique discharge diagnoses (161) were vague and required individual chart review by two people.

**Results:** Two hundred fifty-one unique discharge diagnoses were identified and then categorized as infectious or not. Conditions which may be inflammatory versus infectious (e.g. diverticulitis), but are classically treated with antibiotics were counted as infectious. One hundred sixty-one charts were reviewed by two physicians, of which, 130 (81%) were identified as having an infectious condition (K = 0.87). The most common sepsis mimic was abdominal pain, followed by COPD, and cough. A third (33.6%) did not have an infection identified.

**Conclusion:** SEP-1 criteria for diagnosis and treating sepsis are not specific, with one-third false positives. Identification criteria with higher specificity is needed, and may reduce healthcare expense.

*SIRS (Systemic Inflammatory Response Syndrome) is defined as temperature > 38C° or < 36C°, heart rate > 90 beats per minute, respiratory rate > 20 or $PaCO_2$ < 32 mmHg, and WBC > 12k or < 4k/$mm^3$.

## 5 Attitudes, Behavior, and Knowledge of Emergency Medicine Healthcare Providers Regarding LGBT+ Patient Care

L Driver, W Adams, JM Dziedzic / Loyola University Chicago, Stritch School of Medicine, Chicago, Illinois

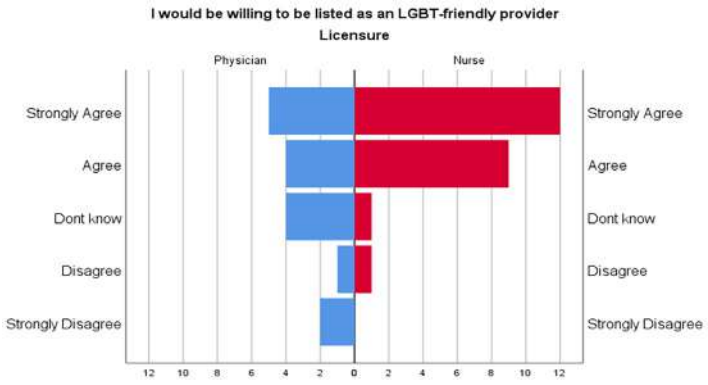
**Introduction:** There is evidence that healthcare providers are lacking in knowledge and confidence when it comes to treating LGBT+ patients.

**Objective:** To assess providers' LGBT+ health-care knowledge, willingness to treat LGBT+ patients, communication behaviors, and whether there is a need for additional training. This involved an assessment that measured respondents' knowledge of LGBT+ patients' reluctance to communicate with providers, risk for certain cancers, and risk for suicide. Secondary outcomes assessed providers' attitudes and practices toward LGBT+ patients.

**Methods:** 16 physicians and 24 nurses in the emergency department of an urban Level 1 trauma center were asked to participate in a survey regarding LGBT+ health. The survey was modified from published work and included questions about transgender patients. The effects of age, gender, and type of provider were contrasted with their willingness to treat and knowledge of LGBT+ healthcare. Descriptive statistics, Fisher's exact test, and the Wilcoxon rank-sum and Kruskal-Wallis tests were used. This study was approved by the IRB and all data was de-identified.

**Results:** Compared to nurses, physicians were 9.0 (95% CI: 2.09–38.79) times more likely to agree with the statement "LGBT+ patients avoid accessing healthcare due to difficulty communicating with providers" (p=.003). Further, providers under the age 45 had a higher level of agreement with the statement "There should be more education in health professional schools on LGBT+ health needs" (p=.03) and with "being listed as an LGBT-friendly provider" (p=.001), as did nurses (p = .04) and those who identify as LGBT+ or know someone who identifies as LGBT+ (p=.005). Finally, respondents reported higher agreement to the statement "There should be educational events at my hospital about LGBT+ health needs" (Mdn=4, IQR=3–5) than to "I am well informed on the health needs of the LGBT patients" (Mdn=2, IQR=2–3).

**Conclusions:** There is a need and desire for educational events at the professional school and provider level, in addition it is recommended to conduct an educational intervention.




| | | There should be educational events at my hospital about LGBT health needs. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Strongly Disagree | | Disagree | | Don't know | | Agree | | Strongly Agree | |
| | | n | Row% | n | Row% | n | Row% | n | Row% | n | Row% |
| I am well informed on the health needs of the LGBT patients. | Strongly Disagree | 0 | 0.0% | 1 | 25.0% | 0 | 0.0% | 1 | 25.0% | 2 | 50.0% |
| | Disagree | 0 | 0.0% | 1 | 5.0% | 4 | 20.0% | 11 | 55.0% | 4 | 20.0% |
| | Don't know | 0 | 0.0% | 0 | 0.0% | 3 | 42.9% | 2 | 28.6% | 2 | 28.6% |
| | Agree | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 2 | 28.6% | 5 | 71.4% |
| | Strongly Agree | 2 | 100.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% | 0 | 0.0% |
| | Total | 2 | 5.0% | 2 | 5.0% | 7 | 17.5% | 16 | 40.0% | 13 | 32.5% |

*Note*: Wilcoxon signed rank $z = 4.03$, $p < .001$

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