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Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

Indexed in MEDLINE

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Western Journal of *Emergency Medicine*:

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JOURNAL FOCUS

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

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VITAL STATISTICS

Western Journal of Emergency Medicine (WestJEM): Integrating Emergency Care with Population Health (WestJEM) is the premier open-access Medline-indexed EM journal in the world. As the official journal of California ACEP, American College of Osteopathic Emergency Physicians (ACOEP) and the California chapter of American Academy of Emergency Medicine (AAEM), the journal focuses on how emergency care affects health and health disparities in communities and populations. Additionally, WestJEM focuses on how social conditions impact the composition of patients seeking care in emergency departments worldwide. WestJEM is distributed electronically to 23,278 emergency medicine scholars and 4,323 in print. This includes 78 academic department of emergency medicine subscribers and 6 AAEM State Chapters.

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Why the EMTALA Mandate for Emergency Care Does not Equal Healthcare "Coverage"

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House GOP members Rep. Mark Meadows (R-NC) and Rep. Raúl Labrador (R-ID) recently made alarming and misleading statements about American emergency departments' role in U.S. healthcare. In March of this year, while speaking with CNN's New Day host Alisyn Camerota, Mr. Meadows stated:

"The goal is to allow access to all. There's a federal law right now that if you show up at a hospital, you get coverage, Alisyn. And so, it's a false narrative to suggest we have people who can't go in and get coverage. It's a federal law."[1]

After passing the House GOP American Health Care Act (AHCA) last Thursday, which would allow individual states to seek waivers to eliminate essential health benefits, including emergency department visits, this narrative was reiterated by Mr. Labrador at a town hall meeting in Southern Idaho. The statement was met with loud boos by constituents, and a video of the event has been widely shared on social media. In response, Labrador stated on Saturday:

"In the five-second clip that the media is focusing on, I was trying to explain that all hospitals are required by law to treat patients in need to [sic] emergency care regardless of their ability to pay and that the Republican plan does not change that."[2]

It is vital that all Americans, including Mr. Meadows and Mr. Labrador understand the details of the law they are referencing, including why the law certainly does not provide healthcare access or "coverage." The law, called the Emergency Medical Treatment and Labor Act (EMTALA) was passed in 1986 in response to "patient dumping," the practice of hospitals refusing to treat people with medical emergencies because of their inability to pay or insufficient insurance. "Patient dumping" also applies to early and inappropriate hospital discharge due to high anticipated treatment costs.

Firstly, EMTALA only applies to "participating hospitals," those that accept Medicare and Medicaid payments. Combined payments for Medicare and Medicaid in 2015 totaled $1.19 trillion, making up 45% of national health expenditures, which total $3.2 trillion. This makes not participating in EMTALA impractical for nearly all hospitals.[3] However, the law does not apply to doctors' offices or clinics, so it has no effect on preventive or primary care.

Next, contrary to the misconception assumed by many, including Mr. Meadows and Labrador, EMTALA does not mandate treatment of non-emergent conditions. EMTALA only mandates that providers provide a "medical screening exam" including blood tests, imaging, and consultation with specialists as necessary to decide whether an emergency medical condition (EMC) does or does not exist. The U.S. government defines an EMC as "a condition manifesting itself by acute symptoms of sufficient severity (including severe pain) such that the absence of immediate medical attention could reasonably be expected to result in placing the individual's health [or the health of an unborn child] in serious jeopardy, serious impairment to bodily functions, or serious dysfunction of bodily organs."[4] For example, a patient presenting with a heart attack must be treated by emergency physicians and interventional cardiologists until their blocked coronary artery is reopened. But it says nothing about the ongoing care of the heart patient, unless and until there's another emergency. Nor does it "cover" any prevention to slow or mitigate the development of heart disease. How foolish is it to require treatment for the emergency only, and yet not "cover" any post-emergency care, or try to prevent the crisis in the first place?

While Mr. Meadows and Mr. Labrador are correct in saying that under EMTALA, Americans presenting to their local emergency departments are eligible to receive care, the law does not mandate care be provided under three caveats:

1. patients will only receive care if they have an EMC;
2. EMTALA contains no requirement for physicians and hospitals to provide uncompensated care or stabilizing treatment for patients with non-emergency conditions; and
3. uninsured or underinsured patients are still responsible for the costs of care and will be personally billed for all services. There is no "coverage" at all, only mandated emergency care for which the patient still must pay (or go bankrupt).

EMTALA was passed in 1986 without any funding whatsoever, so there is no "insurance" component to the law that our congressmen refer to as "coverage." EMTALA is considered by many to be an "unfunded mandate."[4]

Further, stating that access to care in emergency departments implies access to care in general ignores the fact that board-certified emergency physicians, like myself, are trained as experts in emergencies, not routine primary care. We spent years becoming experts in the diagnosis and treatment of life-threatening conditions such as cardiac arrest, respiratory failure, acute kidney failure, shock states (very low blood pressure), emergent child delivery, poisonings, acute heart failure, stroke, neonatal emergencies, blunt and penetrating injury, and much more.

We do not specialize in routine health maintenance including disease prevention or surveillance, and management of chronic diseases like high blood pressure, diabetes, asthma, heart disease, cancer, obesity, arthritis, chronic pain, psychiatric disorders, and a variety of other "pre-existing conditions" affecting millions. If the AHCA is signed into law in its current form, millions of Americans will once again be uninsured, preventing them from accessing primary care.[5]Although the Congressional Budget Office estimated on March 13, 2017, that the AHCA would save $337 billion over the 2017-2026 period, it would also cause the number of uninsured Americans to increase by 14 million in 2018, 21 million in 2020, and 24 million in 2026.[5] For reference, the number of uninsured non-elderly adults aged 19-65, prior to the implementation of the Patient Protection and Affordable Care Act (also known as PPACA, ACA or Obamacare), hit an all-time high in 2010 at 45 million or 18.3% of the U.S. population, in comparison to an all-time low of 28 million or 10.3% in 2016 under Obamacare.[6]

So, yes, Reps. Mark Meadows and Raúl Labrador are correct when they say that federal law requires everyone to be seen in America's emergency departments. But what they neglect to mention is that treatment of non-emergent conditions is not and will not be required, and uninsured patients will receive bills for all services rendered. This will return us to the pre-Obamacare era when Americans were sicker and routinely delayed seeking care early for minor problems. With no access to primary care, more Americans will once again need to file for bankruptcy due to lack of health insurance and mounting medical bills. And, in the long run, care for these people will be more expensive to society, when we treat only the emergency when the disease is far advanced.

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The Economics of an Admissions Holding Unit

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Introduction: With increasing attention to the actual cost of delivering care, return-on-investment calculations take on new significance. Boarded patients in the emergency department (ED) are harmful to clinical care and have significant financial opportunity costs. We hypothesize that investment in an admissions holding unit for admitted ED patients not only captures opportunity cost but also significantly lowers direct cost of care.

Methods: This was a three-phase study at a busy urban teaching center with significant walkout rate. We first determined the true cost of maintaining a staffed ED bed for one patient-hour and compared it to alternative settings. The opportunity cost for patients leaving without being seen was then conservatively estimated. Lastly, a convenience sample of admitted patients boarding in the ED was observed continuously from one hour after decision-to-admit until physical departure from the ED to capture a record of every interaction with a nurse or physician.

Results: Personnel costs per patient bed-hour were $58.20 for the ED, $24.80 for an inpatient floor, $19.20 for the inpatient observation unit, and $10.40 for an admissions holding area. An eight-bed holding unit operating at practical capacity would free 57.4 hours of bed space in the ED and allow treatment of 20 additional patients. This could yield increased revenues of $27,796 per day and capture opportunity cost of $6.09 million over 219 days, in return for extra staffing costs of $218,650. Analysis of resources used for boarded patients was determined by continuous observation of a convenience sample of ED-boarded patients, which found near-zero interactions with both nursing and physicians during the boarding interval.

Conclusion: Resource expense per ED bed-hour is more than twice that in non-critical care inpatient units. Despite the high cost of available resources, boarded non-critical patients receive virtually no nursing or physician attention. An admissions holding unit is remarkably effective in avoiding the mismatch of the low-needs patients in high-cost care venues. Return on investment is enormous, but this assumes existing clinical space for this unit. [West J Emerg Med. 2017;18(4)553-558.]

INTRODUCTION

Boarding is recognized nationwide to be a severe problem in emergency departments (ED). Boarding prevents incoming patients from being treated, leads to increased left without being seen rates, and increases the rate of patients leaving against medical advice, a route taken by some patients frustrated with long wait times.[4,5,6] ED visits have exponentially increased, already reaching 130.4 million in 2013.[20] Concurrently, available hospitals, EDs associated with hospitals, and inpatient hospital beds have all decreased.[1,2,3,4,5] By 2009, more than 90% of ED providers reported that they are operating at full ED occupancy on a consistent basis.[6] Consequently, the United States has experienced a worsening crisis of ED crowding.[1,2,3,4] Crowding, defined in a 2006 ACEP policy, occurs "when the identified need for emergency services exceeds available resources for patient care in the

ED, hospital or both."[3] On average, patients wait almost three hours more for an inpatient bed in crowded EDs as compared to those that are not constricted by crowding, according to the Joint Commission (JCAHO).[9] Crowding correlates with undesirable consequences, including delays in definitive treatment, increased mortality in the critically ill, and increased rates of complications leading to poorer patient outcomes.[2,3,4,7] Crowding and the consequent ED boarding not only impact patient mortality and morbidity through treatment delays, but may as well have financial implications for the both the ED and the hospital by increasing hospital length of stay (LOS).[4,5,6,10,11] Multiple surveys show ED providers consistently ranking ED crowding as their most important patient safety concern.[9] JCAHO identifies over one half of all "sentinel events" in cases leading to morbidity and mortality to be the result of delays in treatment in hospitals. One third of such events could have been attributed to crowding.[8] A study by Bernstein et al. demonstrated that crowding compromises at least two of the six domains of the Institute of Medicine: safety and timeliness.[5] Moreover, crowding has also been shown to increase provider frustration, patient and family dissatisfaction, and prolonged pain and suffering of patients.[3,6,8]

For hospitals operating at nearly full capacity, a bottleneck in output from the ED develops. Without available inpatient beds, the ED has nowhere to offload admitted patients. The lack of available inpatient beds is compounded in some hospitals by lack of flexibility between services that do not accept patients on their service in certain areas of the hospital and delays in room turnover or patient transport.[4] Unlike inpatient units, which accept patients until beds are filled and then stop, the ED cannot close the door. EDs, some already operating at or above capacity, are forced to board patients in less-than-ideal treatment areas, such as hallway beds.[1,11] This has a negative effect on patient satisfaction, as it has been shown that patients would prefer boarding in an area with more privacy than an ED hallway.[12]

Crowding can be conceptualized as the relationship between the "need for service" and "available resources."[3] Several solutions have been proposed to alleviate the problem of boarding, including adding additional personnel or additional ED bed space, using observation units, ambulance diversion, and eliminating non-urgent ED referrals.[6,17] However, these proposed solutions are problematic. As personnel constitute the bulk of the operating budget, adding additional personnel is not always an option. It has been shown that simply increasing the number of available ED bed space, without a concomitant increase in the number of providers, does not have a substantial effect on boarding or overall LOS.[6,17]

In a hospital with limited inpatient bed availability, one solution to the problem of crowding and boarding is an admissions holding unit adjacent to the ED, where patients could receive good clinical care, but at less cost. To further investigate the practicality of this concept, we conducted a three-part study focusing on true cost, opportunity cost, and post-load resource utilization.

Population Health Research Capsule

What do we already know about this issue?
The concept of an admissions holding unit is not new, but the actual financial impact has not previously been studied.

What was the research question?
From the hospital financial officer point of view, what is the cost-benefit of a holding unit?

What was the major finding of the study?
ED boarding keeps patients in a high-cost treatment zone while using a bare minimum of clinical services.

How does this improve population health?
A holding unit allows increased access to emergency care while yielding augmented reimbursements far in excess of operating expense.

METHODS

Study Design

This study was conducted at an urban academic center, with an annual volume of 76,000 patients and a 26% admission rate during the study period. The study center is a trauma center, with 55 treatment spaces in the main ED, divided into three zones of high, mid and low acuity. The admissions holding unit occupies a small space (1,015ft^2) adjacent to the ED proper, but it is not directly staffed by emergency physicians. Pre-existing space was re-purposed to create the unit. No renovations were required. The admissions holding unit in the study hospital is different than a traditional observation unit, in which patients are admitted and cared for over a 24-hour period, by ED or inpatient physicians. Patients admitted to the hospital are under the care of the inpatient teams, who provide care regardless of whether the patient is in an ED bed, an admissions holding bed, or an inpatient bed. When inpatient beds become available, patients are moved from the admissions holding unit to their assigned bed, and the admissions holding bed is then occupied by another ED patient awaiting admission. Although additional nursing staff are needed to maintain the observation unit, no additional physician staffing is necessary.

This study was performed in three phases. The first phase focused on calculating the true cost of boarded patients in the

ED. The second phase focused on calculating opportunity costs for those patients who left without being seen while other patients were boarding in the ED. The final phase focused on the care provided to boarded patients, to determine their true resource utilization.

We did not include in this analysis critically ill patients admitted to an intensive care unit, as they would not be appropriate patients for the admissions holding unit. Similarly, pediatric patients were not included, as they are seen in separate section of the ED, and if admission is merited they are transferred to a nearby pediatric hospital for admission. Moreover, the admissions holding unit is not staffed by pediatric nurses. Neither did we include patients with mental health diagnoses, as all mental health admissions are transferred to a crisis center at an affiliate hospital and do not spend significant time boarding in the main ED.

Phase I

The first phase determined the cost of maintaining a staffed bed in the ED for a unit of time versus alternative options. Since patients do not instantaneously leave the department at the time of disposition, we arbitrarily determined that boarding time began one hour after the admission order was placed to account for the routine logistics of admission including bed assignment, nursing report, and patient transport. Boarding time ended when the patient physically departed the ED. This allowed for calculation of the true cost of boarded patients. We obtained boarding data from ED chart time stamps. Charts were abstracted from June 2010 to May 2011.

Overhead and operating cost data were obtained from the hospital finance office. The data obtained represented the direct cost to treat, and not charges. We referenced an article in the *Harvard Business Review*, "How to Solve the Cost Crisis in Health Care," in which authors applied the concept of time-driven activity-based costing (TDABC), which has been validated in business, to medicine (Supplement).[13,14] TDABC builds on the two-stage cost attribution model of activity-based costing, in which a pool of resources is created and then subsequently assigned to costly activities, by using a time equation to directly allocate costs from resource pools to products. Resources are allocated based on capacity cost rates and process time.[14,15] The authors identified cost centers along the chain of medical care including the administration process (for registration) and the clinical process (for care). Costs were allocated based on the consumption of resources over time, which led to the conclusion that the longer a resource is used, the greater its cost. The more time patients spend boarding, the greater the cost to treat.[1]

To apply this concept to the study hospital, we determined capacity costs per patient bed-hour in the ED, the inpatient floors, the observation units and the holding unit, using the following formula:

$$\text{Capacity Cost Rate}^{\text{time-1}} = \frac{\text{Cost of Resource}}{\text{Available Capacity of Resource}}$$

The cost of the resource included all costs attributable to that resource including salary, supervision, space and equipment, for each resource identified along the chain of care. The available capacity of the resource was the available work time for both staff and equipment. Boarding costs were determined using the following formula:

$$\text{Cost of Boarding} = \frac{\text{Avg cost} - \text{Avg cost}}{(\text{Pt Hour}_{ED} \quad \text{Pt Hour}_{Floor})} \times \text{Boarding Time (hours)} + \frac{\text{Avg cost} - \text{Avg cost}}{(\text{Pt Hour}_{ED} \quad \text{Pt Hour}_{Obs})} \times \text{Boarding Time (hours)}$$

By using the delta costs for a patient in the ED versus an inpatient or observation bed and multiplying that by the actual time spent boarding, we determined total costs of boarded patients for a time period of one year.

Phase II

The second phase of the study looked at opportunity costs, defined as the loss of any potential gains from alternative options when a particular option is chosen.[16] In this scenario, we calculated opportunity costs based on the implementation of an admissions holding unit in our department. It was assumed that our admissions holding unit was an eight-bed unit operating at 12 hours/day at only 60% capacity (219 days/year). The hours of free bed space that became available by using the admissions holding unit were calculated and applied to the current hours patients spent in the ED prior to disposition, as determined by times derived from chart time stamps. We then estimated the number of new patients able to be seen. We then used the actual reimbursement per patient to calculate potential increased revenue generated from additional patient encounters.

Phase III

The final phase of the study focused on how much care patients actually received during the post-load time, defined as an hour after the time from disposition (physician decision-to-admit) to actual physical departure from the ED. A work-study medical student observed patients minute by minute during the post-load time and recorded all interactions that patient had with any nurse or physician. Literature search did not find previous report of such granular observations, with regard to possible mismatch between resources available and resources consumed.

RESULTS

Phase I

Over a typical week, patients spent anywhere from 60 minutes to 122 minutes boarding in the ED, with total time averaging 94 minutes. We calculated total boarding time over

one academic year to be 32,094 hours. Costs per patient bed-hour were determined to be $58.20 in the ED, $24.80 on the inpatient floor, $19.20 in the observation unit, and $10.40 in the admissions holding unit (Figure 1). The total cost to the institution of boarded patients for one year was determined to be $877,290.

Phase II

In the study hospital during the study time period, an average of 21.5 patients left without being seen each day. By using an admissions holding unit, it was calculated that 57.4 additional patient bed-hours per day in the department would become available, based on average turn-around times (TAT) of 3.26 hours for discharges and 6.27 hours for admissions. We performed calculations using the following formula, which assumed a one-hour adjustment for routine logistics.

Avg Admission TAT – Adjustment for Logistics = Hours available for new admissions

Avg Discharge TAT – Adjustment for Logistics = Hours available for new discharges

This would allow for four extra patients to be admitted per day and for 16 more patients to be seen, treated, and discharged. The additional patient visits would lead to increased revenue of $27,796 per day, totaling $6.09 million in the course of a year, assuming the admissions holding unit was operating at 60% capacity. We calculated revenue impact by averaging true collections of $151 for discharged patients ($100 hospital reimbursement plus $51 physician reimbursement) and $6,345 for a hospitalization. Third-party payers demonstrate varying methods of reimbursing ED charges for hospitalized patients, so these numbers represent averages, overall. Cost basis would come from increased staffing costs of $218,650 (two nurses per hour) for the number of days in operation per year, with no further overhead in locating a unit already physically equipped for patient care.

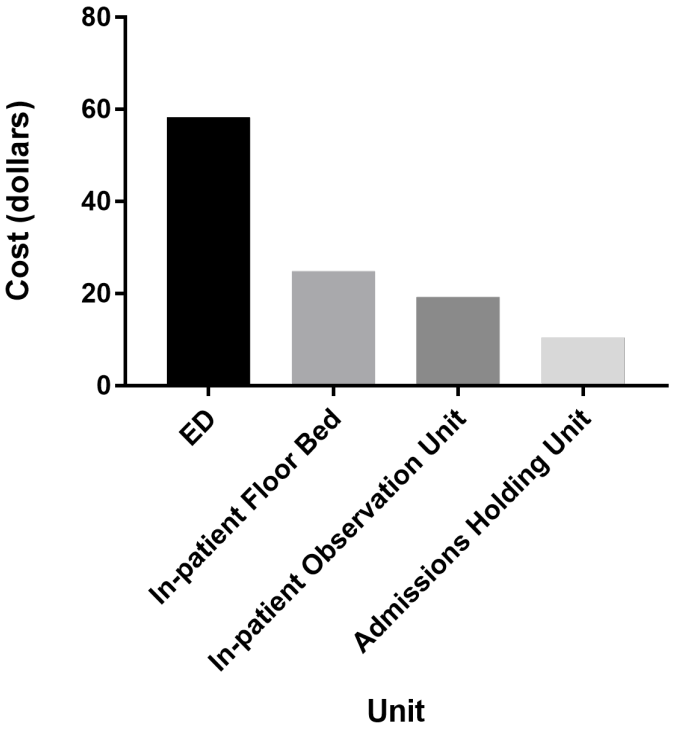

Figure 1. Costs per patient bed-hour by unit.

Phase III

On average, admitted patients spent 2.3 hours in our ED from the time of admission to actual disposition. In that time, patients interacted with nurses an average of 2.5 times in the first 30 minutes, 1.2 times in the second 30 minutes and had near-zero interactions with nursing more than one hour after time of disposition (Figure 2). Similar data were found for interactions with physicians. In the first 30 minutes, patients interacted with physicians an average of 2.8 times. In the second 30 minutes, they interacted an average of 2.5 times. And again, there were near-zero interactions more than one hour after time of disposition. During the actual boarding time period, which does not include the first hour after time of disposition, patients had near-zero interactions with both nurses and physicians.

DISCUSSION

We found that our patients boarded in the ED for a substantial, but variable, amount of time each day, re-demonstrating the cyclical nature of boarding noted by Handel et al. They are cared for by ED nurses, at higher staffing costs, and prevent other patients from being seen by occupying potentially available bed space. It costs twice as much to maintain the same patient in an ED bed as compared to the inpatient bed, and five times as much to keep that patient in the ED instead of a bed in the holding unit. Boarding patients have direct cost to our hospital of almost $900,000 annually.

While occupying the ED bed at a higher cost, these patients demand minimal resources. The care they receive significantly declines over time and is care that could be provided in a less costly inpatient floor bed. When no inpatient beds are available, an admissions holding unit provides a remarkably cost-effective way to provide the same amount of care, with no extra physician costs required.

Significant potential value of the admissions holding unit is the opportunity costs recouped. We showed that 20 more patients can be seen per day in an ED when the admissions holding unit is operating at 60% capacity for only half of each day. This assumption was made to reflect

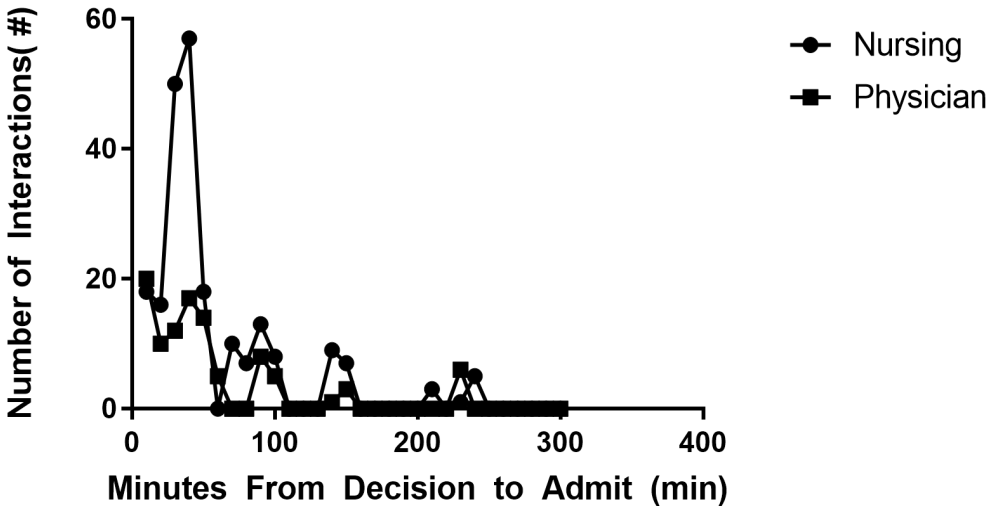

Figure 2. Nursing and physician care of boarded patients.

the practical capacity of the unit.[14] Operating at practical capacity, the hospital is able to generate almost $28,000 more per day, and $6.09 million over only two thirds of a year.

Similar studies in a variety of hospital settings have similarly shown that by reducing boarding time by as little as 30 minutes a day, sufficient time to see an additional 8.7 to 36 patients per day is created, and there is potential for an increase in revenue by $2.7 to $3.9 million per year.[11,18,19] Khare et al. in a computer-simulation model showed improvement in the rate at which admitted patients departed the ED and an overall improvement in LOS. They also found that simply increasing the number of available ED beds had no such impact.[17] Huang et al. also analyzed the impact of delays of moving admitted ED patients to inpatient beds and showed that those delays impact the entirety of the hospital stay, by increasing the inpatient LOS and cost.

LIMITATIONS

This study was conducted at a single center, and therefore, the operational factors used to calculate the economics may not be generalizable to other institutions. The economics were also calculated assuming the admissions holding unit could be placed in pre-existing space within an ED. It did not account for any cost associated with renovations that may be needed to incorporate such a unit at other institutions.

The majority of costs in this study, as obtained from the hospital finance office, were representative of staffing. It was assumed that the cost of equipment such as IVs, monitors, imaging, and medications, remained the same across the entire hospital system and would not be different in the ED versus the inpatient floors. Assumptions were also made to reflect the practical capacity of the admission holding unit, but may not be precise in determining the actual availability of staff or hours the unit was operational.

Figures for hospital and physician reimbursement used in this study, obtained from the hospital finance office, predate the time frame during which the study was conducted by one fiscal year. In the time between that which the figures reflect and the study period, an electronic medical record was implemented, and therefore, the actual reimbursement during the study period may have been higher.

CONCLUSION

It costs more than twice as much to maintain the same patient in an ED bed compared to an inpatient bed and more than five times as much to keep that same patient in the ED compared to an admissions holding unit. While patients are boarding in the ED, they need and receive minimal resources. The hospital, therefore, takes a triple hit by boarding patients in the ED. Money is lost maintaining an empty inpatient bed; more money is spent keeping a patient in the resource-intensive ED setting while receiving very few resources; and, quite substantial revenue is lost by preventing patients in the waiting room from accessing care. An admissions holding unit, while not a definitive overall solution to the boarding problem, nevertheless offers a win-win strategy. Such a unit comes with cost to outfit and staff, but by providing care at less overall cost, can be seen as having great return on investment.

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Ultrasound vs. Computed Tomography for Severity of Hydronephrosis and Its Importance in Renal Colic

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Introduction: Supporting an "ultrasound-first" approach to evaluating renal colic in the emergency department (ED) remains important for improving patient care and decreasing healthcare costs. Our primary objective was to compare emergency physician (EP) ultrasound to computed tomography (CT) detection of hydronephrosis severity in patients with suspected renal colic. We calculated test characteristics of hydronephrosis on EP-performed ultrasound for detecting ureteral stones or ureteral stone size >5mm. We then analyzed the association of hydronephrosis on EP-performed ultrasound, stone size >5mm, and proximal stone location with 30-day events.

Methods: This was a prospective observational study of ED patients with suspected renal colic undergoing CT. Subjects had an EP-performed ultrasound evaluating for the severity of hydronephrosis. A chart review and follow-up phone call was performed.

Results: We enrolled 302 subjects who had an EP-performed ultrasound. CT and EP ultrasound results were comparable in detecting severity of hydronephrosis (x^2=51.7, p<0.001). Hydronephrosis on EP- performed ultrasound was predictive of a ureteral stone on CT (PPV 88%; LR+ 2.91), but lack of hydronephrosis did not rule it out (NPV 65%). Lack of hydronephrosis on EP-performed ultrasound makes larger stone size >5mm less likely (NPV 89%; LR-0.39). Larger stone size > 5mm was associated with 30-day events (OR 2.30, p=0.03).

Conclusion: Using an ultrasound-first approach to detect hydronephrosis may help physicians identify patients with renal colic. The lack of hydronephrosis on ultrasound makes the presence of a larger ureteral stone less likely. Stone size >5mm may be a useful predictor of 30-day events. [West J Emerg Med. 2017;18(4)559-568.]

INTRODUCTION

Renal colic is a common emergency department (ED) presentation and places a significant burden on the healthcare system, with an estimated prevalence affecting 1 in 11 people.[1] Computed tomography (CT) is considered the imaging gold standard for the diagnosis of renal colic.[2-4] CT has sensitivities of 91-97% and specificities of 91-100% for detecting ureteral stones and also provides information on stone size and

location, which can be helpful for predicting successful medical expulsion therapy versus the need for urologic intervention.[3,5-9] There are multiple reasons to choose CT imaging selectively in this patient population, most notably to rule out other serious disease such as aortic dissection and other surgical emergencies. However, as many as 50% of patients diagnosed with renal colic will have recurrent episodes and may receive multiple CTs throughout their lifetime, adding to costs, increased length of stay, and radiation exposure.[10-13] There are currently no validated practice guidelines for the diagnosis and ED management of renal colic; thus, the need for a multidisciplinary approach to managing this disease is clear.[12,14-17].The role of emergency physician-(EP) performed ultrasound (US) in the management of patients with renal colic has recently gained more attention, but its incorporation into an accepted algorithm remains debatable.[18-21]

US has the advantage of using no radiation, and research continues to support its role in the diagnosis and management of renal colic in the ED.[22] The low sensitivity of US for identifying stone size and stone location may limit its usefulness in predicting the clinical course or follow-up planning for patients with renal colic.[23] However, hydronephrosis is easily detected by US and its presence or absence may provide physicians with useful information to assist in renal colic management. US has been shown to have sensitivities ranging from 72-87% and specificities between 73-83% in the detection of hydronephrosis when compared to CT.[24-26] Hydronephrosis is a secondary sign of ureteral calculi and is a dilation of the renal pelvis and calyces (Figures 1a, 1b, 1c).

Hydronephrosis can be identified by EPs with various levels of US experience, with a moderate degree of hydronephrosis yielding a higher specificity.[27] The clinical significance of hydronephrosis is still unclear, although some have suggested that hydronephrosis may be a predictor of stone size and the need for urologic intervention or hospitalization.[17,28-32] If EPs are to implement an "ultrasound-first" approach, it is important to know the test characteristics of hydronephrosis detected by EP-performed US for the diagnosis of renal colic and whether there is any predictive value for 30-day events.

The primary goal of this study was to determine if EP-performed US can detect severity (none, mild, moderate, severe) of hydronephrosis in ED patients with suspected renal colic when compared to CT. We also sought to determine the diagnostic test characteristics of hydronephrosis detected by EP-performed US for the presence of a ureteral stone and ureteral stone size > 5mm. A secondary goal of this study was to generate hypotheses regarding predictors of 30-day events in renal colic patients.

Population Health Research Capsule

What do we already know about this issue?
Renal colic will affect 1 in 11 people and 50% have a recurrence. CT scan is the imaging choice for urologic management of renal colic but multiple CT scans can be costly and have health risks.

What was the research question?
Can EP ultrasound detect the degree of hydronephrosis as compared to CT scan? Does hydronephrosis diagnose a ureteral stone or predict renal colic outcomes?

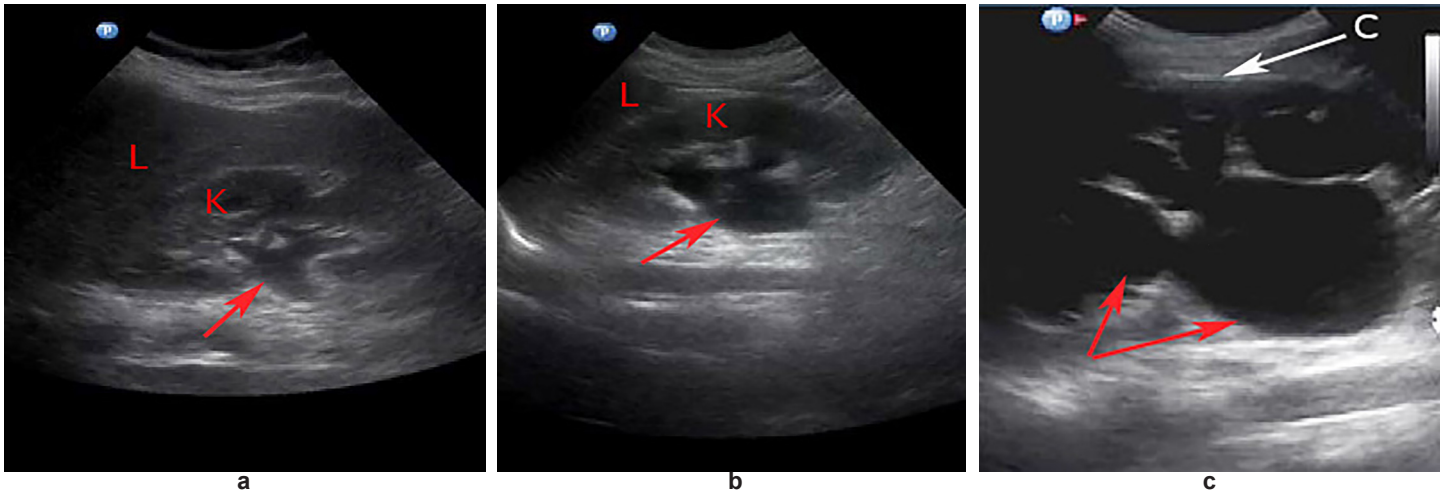
What was the major finding of the study?
EP Ultrasound can diagnose the degree of hydronephrosis as compared to CT. Larger ureteral stones are less likely present when there is no hydronephrosis. Larger ureteral stone may predict important renal colic outcomes.

How does this improve population health?
Using an EP ultrasound first approach is reasonable and may help avoid the need for a CT scan in renal colic patients on the day of their ED visit.

MATERIAL AND METHODS

This was a prospective, observational cohort study of a convenience sample of ED patients with suspected renal colic from November 2010 to March 2014. The study was performed at an urban academic medical center with over 130,000 annual visits. The Boston Medical Center and Boston University Medical Campus Institutional Review Board approved this study. Eligible patients were identified for inclusion by either a trained research assistant (RA) or a physician investigator. RAs were available to screen the department electronic medical record system for potential eligible patients Monday-Friday from 8:00 am-11:00 pm. Enrollment occurred during periods when an EP investigator was able to perform the US. Patients were approached if they met inclusion criteria: age ≥21; CT of the abdomen and pelvis without contrast ordered; and ability to provide a telephone number for 30-day follow-up. We excluded prisoners, non-English speaking patients and those unable to provide informed consent (defined as medically unstable, those who had dementia, altered mental status, or deemed mentally incompetent by the treating physician). Written informed consent was obtained from all study participants. Participants were excluded if an US could not be completed prior to discharge from the ED.

After consent was obtained, one of the investigators, blinded to CT results, performed an US and completed a standardized data collection sheet. All video images were obtained with a Philips (Amsterdam, Netherlands) HD11 XE



Figures 1a, 1b, 1c. Hydronephrosis visualized as an anechoic black area on ultrasound. Figure 1a: mild hydronephrosis (red arrow) showing dilation of the proximal renal pelvis of the kidney (K), liver (L); Figure 1b: moderate hydronephrosis (red arrow) showing dilation of the renal pelvis and calyces of the kidney (K), liver (L); Figure 1c: severe hydronephrosis showing large dilation of the renal pelvis and calyces (red arrows) extending outward and resulting in a thinning of the renal cortex (C).

machine, a Philips Sparq machine, or a Zonare (Mountain View, CA, USA) z.one *ultra sp* machine using a curvilinear probe (6-2 MHz). Fourteen EP investigators participated in this study and performed all of the ultrasounds. The principal investigator (PI) of the study was the emergency ultrasound director, who had formal fellowship training. Three of the investigators were attendings and 11 were residents throughout the study enrollment period. The physician investigators were required to complete minimum training requirements before participating in this study, which included satisfying the 2008 American College of Emergency Physician (ACEP) Ultrasound Guidelines.[33]. In addition, the PI of the study trained all investigators how to obtain proper renal US views and how to classify the severity of hydronephrosis to ensure uniformity. All US images were recorded and later reviewed by the PI, who was blinded to clinical information and outcome data. The review ensured adequate image acquisition and interpretation and was used to assess inter-rater reliability.

Study Protocol

The study protocol required both long- and short-axis views of each kidney. The US findings recorded on the data sheet were hydronephrosis (none, mild, moderate, severe). Color Doppler was used to differentiate mild hydronephrosis from the confluence of vessels in the renal pelvis. The CT parameters recorded were hydronephrosis and/or hydroureter (none, mild, moderate, severe); renal stone location and size; and any additional pathological findings. The PI reviewed the final reading on all CT imaging to ensure accuracy. The reading was considered final when a dictated report by an attending radiologist appeared in the medical record.

In our study, we defined renal colic as one of the following: 1) CT-confirmed ureteral stone; 2) the presence of CT findings confirming the recent passage of a stone as dictated on the radiology report, which included hydronephrosis, hydroureter, perinephric or periureteric stranding or stone in the bladder; 3) attending clinical impression or discharge diagnosis of renal colic obtained from review of the medical chart. The medical records were reviewed for disposition, hospital discharge diagnosis and return events. In cases where the medical record showed no return outcome within 30 days, an investigator or RA conducted a structured follow-up phone call to gather information directly from the participant. Two EP investigators, who were attending physicians, reviewed all medical records to ensure accurate data extraction and to confirm the diagnosis of renal colic and 30-day events. The simple kappa of agreement was reported. If there were any discrepancies between the two reviewers, these were resolved by the review of a third EP attending physician investigator.

Primary Data Analysis

We needed 273 participants in order to evaluate the primary goal of comparing EP-performed US with CT in identifying the severity of hydronephrosis (none, mild, moderate, severe) with a chi-square test. This sample size calculation was made using a chi-square test of independence with three degrees of freedom, looking for a minimum effect size of 0.2 with 80% power to detect whether the EP US findings yielded the correct classifications as determined by the corresponding gold standard CT. CT interpreted by an attending radiologist blinded to EP US findings was the criterion standard for diagnosing

presence or absence of hydronephrosis and its severity. We also performed a Wilcoxon signed-rank test to further assess whether differences existed between the EP-performed US and CT classifications of hydronephrosis. An ROC (receiver operator curve) was drawn and the area under the curve calculated to assess the ability of US to correctly classify those patients with and without hydronephrosis, using CT as the criterion standard. We calculated the diagnostic test characteristics (sensitivity, specificity, positive predictive value [LR+), and negative predictive value, [LR-]) of any degree of hydronephrosis on EP-performed US for the presence of any ureteral stone or ureteral stone size > 5mm on CT.

For the secondary objective of assessing predictors of 30-day events in participants with confirmed renal colic, a binary outcome measure was used and defined as the following: admitted to the hospital on the day of enrollment due to renal colic; or return visit for pain, infection, the need for a urologic procedure, or hospital admission related to renal colic. We analyzed four different models to generate hypotheses on the association of 30-day events among renal colic patients with EP-performed US or CT findings. Four simple logistic regression models were fit using the following as independent variables: Model 1) any hydronephrosis on EP US; Model 2) severity of hydronephrosis on EP US categorized as none, mild, moderate or severe; Model 3) ureteral stone, size ≥ 5mm on CT; and Model 4) proximal ureteral stone location on CT. The 30-day event outcomes used for each of the four models were defined as admission at initial ED visit or return visit within 30 days for pain, infection, GU procedure, or hospital admission (related to pain, infection, or planned urologic procedure). We calculated odds ratios (OR) and 95% confidence intervals (CI) for each model. We used 95% CIs and *P* values to determine significance at the 0.05 level. All analyses were done in SAS (version 9.3; SAS Institute, Inc., Cary, NC).

RESULTS

Between November 2010 and March 2014, 564 eligible participants with suspected renal colic were evaluated in the ED and 316 were enrolled (Figure 2). We excluded an additional 14 participants due to the US not being performed prior to the patient leaving the ED, leaving 302 participants for analysis (Table 1).

Our results show that EP-performed US can detect the severity of hydronephrosis when compared to CT as the gold standard, (chi-square p<0.001) (Table 2). Of the 302 participants, five were missing CT results for the classification of hydronephrosis severity, which left 297 included in the analysis. In comparing EP-performed US to the criterion standard CT in the detection of the severity of hydronephrosis, the area under the curve using ROC analysis was 88.3%. A Wilcoxon signed-rank test determined that there was a statistically significant median difference between the CTs and EP-performed US classifications of hydronephrosis, $W = -312.5$, $p = 0.03$, with ultrasound under-classifying the severity in 9% of participants, over-classifying in 13%, and correctly classifying in 78%. The majority of misclassified degrees of hydronephrosis by US were off by one degree of severity (Table 2).

The PI reviewed all recorded ultrasounds, and the inter-rater agreement between the PI interpretation of hydronephrosis and all other investigators was 91% with a weighted kappa of 0.86. The test characteristics for detection of hydronephrosis are displayed in Table 3a,b. The detection of any hydronephrosis on EP-performed US had a sensitivity of 85%, a specificity of 71%, a LR+ = 2.91, and a LR- = 0.22 for the presence of any ureteral stone visualized on CT. For the presence of a ureteral stone >5mm on CT, the detection of any hydronephrosis by EP- performed US had a sensitivity of 86%, a specificity of 37%, a LR+ = 1.36, and a LR- = 0.39.

Of the 302 participants who had an EP-performed US, 166 (55%) had a diagnosis of renal colic based on our study definition and 136 had an alternate diagnosis by CT (Figure 2). There was 96% agreement between the two physician reviews of the 302 charts, with 13 discordant charts that required a tiebreaker review by a third physician investigator (simple kappa=0.91[0.87, 0.96]). Of the 166 participants with a diagnosis of renal colic, 128 had a stone visualized on CT, 15 had no stone visualized but had signs of a recently passed stone on CT, and 23 had an ED attending clinical impression or discharge diagnosis of renal colic on chart review. There were 39 (13%) participants who had some other diagnostic findings on CT, including 21 (7%) who required additional management. Significant pathology included diverticulitis (5), malignancy-related findings (7), non-specific mesenteric inflammatory findings (5), chronic pancreatitis (1), small bowel obstruction (1), pneumonia (1), and common bile duct and pancreatic duct dilation (1). The remaining 97 patients who did not have renal colic had no other pathology identified on CT.

Table 1. Descriptive summary of participants, n=302, in a study comparing ultrasound and computed tomography for detection of degree of hydronephrosis.

Demographic characteristics	n (%)
Age, years (mean ± SD (median))	43.1 ± 13.6 (43)
Gender	
Male	170 (56.3)
Female	132 (43.7)
Race	
White/non-Hispanic	90 (29.8)
Black/African American	111 (36.8)
Hispanic	76 (25.2)
Asian	6 (2.0)
Other	19 (6.3)

Table 2. Comparison of emergency-physician-performed ultrasound and computed tomography in the detection of degree of hydronephrosis, n=302.

	CT scan classification (frequency missing=5)							
ED ultrasound classification	None	Mild	Moderate	Severe	Total	Correct	Incorrect	Total
None	160	14	0	0	174	160	14	174
Mild	18	46	11	0	75	46	29	75
Moderate	6	16	24	1	47	24	23	47
Severe	0	0	0	1	1	1	0	1
Total	184	76	35	2	297	231	66	297

ED, emergency department; *CT*, computed tomography.
Chi-squared = 51.7; df = 3; p-value = <0.001.

Table 3a,b. Test characteristics of emergency physician performed ultrasound-diagnosed hydronephrosis in detecting ureteral stones among renal colic patients, n=166.

a.

	CT positive for any ureteral stone	CT negative for ureteral stone
Hydronephrosis detected by EP ultrasound (mild/moderate/severe)	100	14
No hydronephrosis detected by EP ultrasound	18	34

CT, computed tomography; *CI*, confidence interval; *LR*, likelihood ratio.
Sensitivity=84.8% (95% CI [78.3, 91.2]); Specificity=70.8% (95% CI 58, 83.7);
Positive Predictive Value=87.8% (95% CI [81.7, 93.7]); Negative Predictive Value=65.4% (95% CI [52.5, 78.3]); LR+=2.91 (95% CI [1.6, 4.21]); LR-=0.22 (95% CI [0.12, 0.32]).

b.

	CT positive for any ureteral stone >5mm	CT negative for ureteral stone >5mm
Hydronephrosis detected by EP ultrasound (mild/moderate/severe)	100	14
No hydronephrosis detected by EP ultrasound	18	34

CT, computed tomography; *CI*, confidence interval; *LR*, likelihood ratio.
Sensitivity=85.7% (95% CI [71.5, 94.6]); Specificity=37.1% (95% CI [28.6, 46.2]);
Positive Predictive Value=31.6% (95% CI [23.2, 40.95]); Negative Predictive Value=88.5% (95% CI [76.6, 95.65]); LR+=1.36 (95% CI [1.13, 1.64]); LR-=0.39 (95% CI [0.18, 0.84]).

Of the 166 participants who had renal colic, 12 were admitted to the hospital. One admitted participant went to the intensive care unit for urosepsis and had severe hydronephrosis on CT that was correctly identified on EP US. The remaining 154 participants with renal colic were discharged home from the ED and had a 30-day medical record review and/or phone call performed. Information abstracted during chart review included the presence or absence of one of the following return events within 30 days: a return visit for continued pain; infection; the need for urologic intervention; or hospital admission related to renal colic. Seventeen participants were lost to 30-day follow-up due to lack of information in the chart review and inability to contact by phone call. Of the remaining 137 participants included in the follow-up cohort, 77 had no further events, 19 had a routine visit and 41 had a 30-day return event (Figure 2).

The cohort used in the hypothesis-generating secondary analysis of predictors of 30-day events related to renal colic were the 12 patients admitted to the hospital on the day of the ED visit and the 137 participates who were discharged home with a diagnosis of renal colic and had a completed 30-day follow up (n=149). We performed four logistic regression models to analyze factors that may be predictive of 30-day events. These factors included the presence of hydronephrosis on EP-performed US, the degree of hydronephrosis on EP-performed US, the presence of a ureteral stone > 5mm, and proximal ureteral stone location on CT (Table 4). Of these four exploratory models, we found a significant association only for the presence of a ureteral stone > 5mm. Renal stones > 5mm had an OR of 2.30 for a 30-day event compared to smaller stones, 20 out of 40 vs. 33 out of 109 (95% CI [1.10, 4.84]; p=0.03).

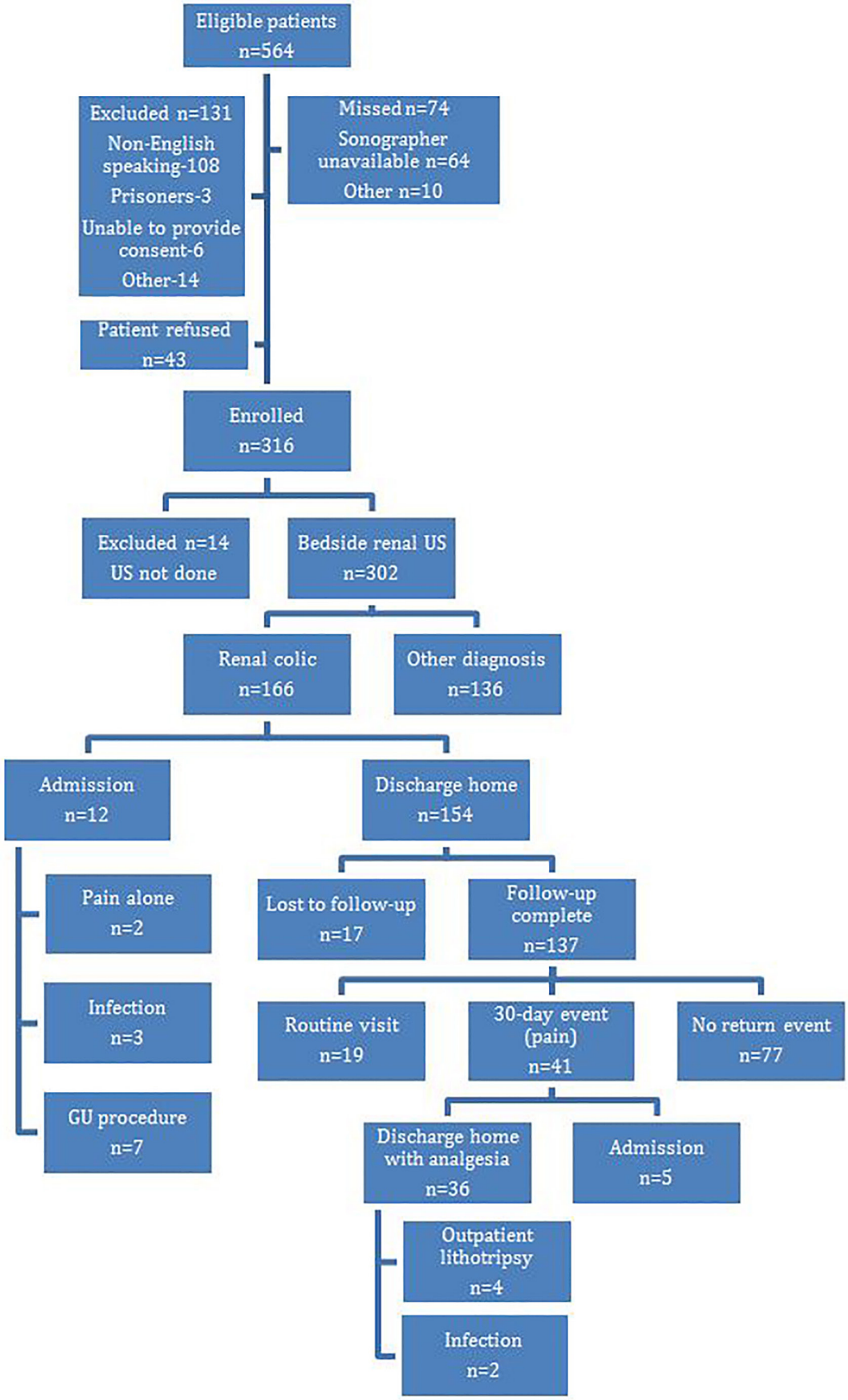


Figure 2. Flowchart of enrollment figures in study comparing ultrasound and computed tomography for detection of severity of hydronephrosis.

GU, genitourinary.

Table 4. Exploratory analysis of predictors of 30-day events, n=149†‡.

	OR (95% CI)	p-value
Model 1		
Any hydronephrosis on ED ultrasound (no hydronephrosis is ref.)	1.39 (0.66, 2.93)	0.38
Model 2		
Severity of hydronephrosis on ED ultrasound (no hydronephrosis is ref.)		
Mild	1.28 (0.57, 2.88)	0.55
Moderate or severe	1.59 (0.65, 3.89)	0.31
Model 3		
Obstructing stone, size ≥ 5mm§ (no is ref.)	2.30 (1.10, 4.84)	0.03
Model 4		
Proximal stone location (no is ref.)	2.08 (0.88, 4.89)	0.09

ED, emergency department.
†Outcome defined as admission at initial emergency department (ED) visit or return to ED or clinic within 30 days for pain, infection, genitourinary (GU) procedure, or hospital admission (related to pain, infection, or planned GU procedure); probability modeled is outcome = 'yes'.
‡Those who did not have renal colic or were lost to follow-up were excluded from this analysis.
§§Obstructing stone, determined by CT scan, defined.

DISCUSSION

This study supports the findings of prior research that EP-performed US can reliably identify the severity of hydronephrosis when compared to CT as the criterion standard[24-30]. We found that any degree of hydronephrosis on EP US makes the presence of a ureteral stone on CT more likely (PPV 88%, LR+ 2.91), but a lack of hydronephrosis did not rule out the diagnosis (negative predictive value [NPV] 65%, LR- 0.22). Prior studies show that 4-8% of patients with renal colic will not have any secondary signs of ureteral obstruction, such as hydronephrosis, on imaging.[34,35] The diagnosis should still be considered in cases with high enough clinical suspicion, and CT can be performed to confirm the diagnosis if deemed necessary by the treating physician. Many EPs caring for patients with renal colic will order a CT to rule out other significant diagnoses and report feeling more confident when a CT is performed.[36] This study found an incidence of other findings on CT to be 7%, which is consistent with other research that has reported CT-diagnosed incidental findings in 3-12% of patients imaged for renal colic.[37-39] When physicians are deciding on imaging in the ED, acceptable risk tolerance for missing an important alternate diagnosis still needs to be considered.

Prior studies have suggested that hydronephrosis is more sensitive and specific for identifying larger stones.[28-30] We did find that hydronephrosis on EP-performed US had a high sensitivity (85.7%) for a stone > 5mm on CT, but it did not have a high specificity (37.1%) or LR+ (1.36) to rule in larger stones. However, we found that the absence of hydronephrosis on EP US is good for ruling out the presence of stones > 5mm (NPV 88.5%, LR- 0.39) and may reassure the provider that a large stone is not present.

What remains unclear is whether or not the severity of hydronephrosis provides additional predictive information in patients with renal colic. Most patients who present to the ED with renal colic have few adverse events within a follow-up period of 180 days.[16-40] We chose to perform follow up at 30 days based on the recommended trial of medical expulsion therapy of 4-6 weeks.[8,10,41,42] Two prior studies found moderate and severe hydronephrosis to be more predictive of the need for urologic intervention.[17,32] A smaller prospective study analyzed the test characteristics of severity of hydronephrosis and stone size >5mm on risk of 30-day hospitalization in renal colic patients and found any hydronephrosis to be 100% sensitive and 44% specific.[31] For our renal colic outcomes measure, we defined 30-day events as admission to the hospital on the day of enrollment or 30-day return for admission related to renal colic, urologic intervention, pain control, or infection based on prior definitions of adverse outcomes in the literature and clinical factors we felt most important to EPs evaluating these patients in the ED[16,17,31,32]. In addition to examining the predictive value of hydronephrosis on EP US for return events, we looked at the predictive value of proximal ureteral stone location and ureteral stones ≥5mm identified on CT due to research suggesting these factors lead to an increased likelihood of requiring urologic intervention.[7,9,43] In this study, the presence of any degree of hydronephrosis on EP US was not predictive of a 30-day event. In addition, the presence of moderate or severe hydronephrosis was also not predictive of 30-day events. There may be other factors contributing to the severity of hydronephrosis, such as the length of time the stone has been present or a patient's hydration status. If a larger stone size is not associated with greater degrees of hydronephrosis, then the severity of

hydronephrosis may not be predictive of 30-day events, as prior studies have suggested. This also implies that misclassifying the degree of hydronephrosis on US compared to CT may not be clinically relevant. Therefore, it may be reasonable to ask an EP to identify the presence or absence of hydronephrosis alone without attempting to differentiate the degree.

This study did find that larger stone size > 5mm on CT was a statistically significant (P= 0.03) predictor of a 30-day event. This is consistent with prior studies that show that larger stones are less likely to pass without intervention.[7,41,43] A more proximal stone location had 2.08 times the odds of a 30-day event, but it was not statistically significance. The secondary analysis in this study is underpowered and limited by small sample size; therefore, larger multi-center studies are needed for further investigation.

From an observational perspective, this study found that all subjects (41) with a 30-day event had one due to continued pain. Of these subjects, only five were admitted and later discharged without further complications. If most return events are due to continued pain, which is the natural course of this disease, we need to question the utility of obtaining a CT on every patient who presents to the ED with the suspected diagnosis. US is a reasonable first-line screening modality in suspected renal colic patients, especially if further research confirms the predictive value of hydronephrosis in detecting any or larger ureteral stones. Using an "ultrasound-first" approach can help decrease potential radiation exposure, costs and prolonged lengths of stay in the ED.

LIMITATIONS

This was a single-site study performed at an academic ED with an emergency medicine residency and an active US section. These results may not be generalizable to other clinical settings and may not be easily reproducible at institutions where EPs lack equivalent training in the use of US. This study was a convenience sample based on availability of the EP investigators and RAs. Inclusion criteria required participants to receive a CT, which may have introduced a selection bias in the population studied by missing potential subjects with suspected renal colic who had no imaging. Also, although the literature supports CT as the gold standard for evaluation of renal colic it is possible that CT may be an imperfect gold standard for identifying the severity of hydronephrosis. This may introduce an imperfect gold standard bias when evaluating the test characteristics of EP-performed US in classifying severity of hydronephrosis.

The physician investigators were residents and attendings who may have had varying degrees of training in performing renal US; however, all investigators had met ACEP minimum standards and had uniform training in the renal US protocol.

We included attending clinical impression or discharge diagnosis of renal colic on chart review in the definition of renal colic because this disease is often a clinical diagnosis and negative imaging may have been a result of a recently passed stone. The intention was to not miss the group of patients who would be managed by physicians as renal colic despite negative imaging. This may have introduced information bias in our study. Efforts were made to ensure accuracy of data extraction from the chart review by having two separate physician investigators blindly review all medical information pertaining to the ED visits. The reviewers, however, were not blinded to the hypothesis of the study. The follow-up period of 30 days may also be a limitation to our results, with longer periods of follow-up revealing more events. The interpretation of our analysis of a return event is limited by sample size and not powered for this study. This analysis was intended to be hypothesis generating. Further research with a larger sample size is required to determine significant predictors of 30-day events in patients with renal colic.

CONCLUSION

EP-performed ultrasound can identify the severity of hydronephrosis in patients with suspected renal colic compared to CT. The diagnostic test characteristics of hydronephrosis detected by EP-performed US indicates that any degree of hydronephrosis is a good predictor for the presence of a ureteral stone on CT, but may be less reliable in identifying larger stones than previously reported in the literature. The lack of hydronephrosis on EP-performed US should not be used to rule out the presence of a ureteral stone but it does makes the presence of a larger stone less likely. This may be helpful in risk stratifying patients for a return event and prioritize appropriate follow-up. Our follow-up revealed that most patients who have a 30-day return event for renal colic come back for continued pain rather than more serious morbidity, and therefore CT may not be needed on all patients presenting to the ED with suspected renal colic. Although EP-performed ultrasound is a reasonable first-line screening tool in suspected renal colic, CT may still be warranted in high-risk patients or in those with suspicion for an alternate diagnosis. Larger multi-centered studies are needed to further explore these predictors in renal colic patients.

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Patient Perspectives on Accessing Acute Illness Care

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Introduction: Older adults use the emergency department (ED) at high rates, including for illnesses that could be managed by their primary care providers (PCP). Policymakers have implemented barriers and incentives, often financial, to try to modify use patterns but with limited success. This study aims to understand the factors that influence older adults' decision to obtain acute illness care from the ED rather than from their PCPs.

Methods: We performed a qualitative study using a directed content analysis approach from February to October 2013. Fifteen community-dwelling older adults age≥65 years who presented to the ED of an academic medical center hospital for care and who were discharged home were enrolled. Semi-structured interviews were conducted initially in the ED and subsequently in patients' homes over the following six weeks. All interviews were audio-recorded, transcribed, verified, and coded. The study team jointly analyzed the data and identified themes that emerged from the interviews.

Results: The average age of study participants was 74 years (standard deviation ±7.2 years); 53% were female; 80% were white. We found five themes that influenced participants' decisions to obtain acute illness care from the ED: limited availability of PCP-based care, variable interactions with healthcare providers and systems, limited availability of transportation for illness care, desire to avoid burdening friends and family, and previous experiences with illnesses.

Conclusion: Community-dwelling older adults integrate multiple factors when deciding to obtain care from an ED rather than their PCPs. These factors relate to personal and social considerations, practical issues, and individual perceptions based on previous experiences. If these findings are validated in confirmatory studies, policymakers wishing to modify where older adults receive care should consider person-centered interventions at the system and individual level, such as decision support, telemedicine, improved transport services, enhancing PCPs' capabilities, and enhancing EDs' resources to care for older patients. [West J Emerg Med. 2017;18(4)569-576.]

INTRODUCTION

The 46.2 million older adults (age≥65 years) residing in the United States require medical care frequently for acute illnesses, making over 20 million visits to emergency departments (EDs) annually.[1] Policymakers have implemented incentives and barriers, often financial, to encourage older patients to obtain acute illness care from their primary care providers (PCP). This work has been driven by a desire to reduce healthcare

expenditures, but interventions have had limited success.[2,3,4,5] More recently, researchers and clinicians have recognized that acute illness care in a PCP's office may offer advantages over ED-based care. Among the proposed benefits are enhancing continuity of care for complex older patients, avoiding the challenging ED environment with its prevalent infectious illnesses, excessive noise, inadequate lighting, frequent interruptions, and insufficient nourishment, and potentially avoiding the impaired cognition, mood, and functional status often experienced by older adults following ED care for minor problems.[6,7,8,9,10] In contrast, the ED, unlike the PCP's office, can provide the extensive diagnostic testing and therapeutic interventions needed by older adult patients.[11,12]

Patients generally have a limited role in this discussion of the optimal location for acute illness care. Studies have shown that they usually have robust relationships with their PCPs and thus would likely access their PCPs for care.[13] The Emergency Medicine Patients' Access to Healthcare (EMPATH) study found that medical necessity, ED preference, convenience, affordability, and insurance limitations were the primary reasons for seeking ED care.[14] Rust and colleagues also found that practical barriers to accessing the PCP for acute care exist, such as a lack of transportation and of appointments.[15] Other studies have focused on demographic and clinical factors associated with patients who use the ED. Older adults with certain diagnoses, a hospital admission within the previous six months, a history of alcohol abuse, and poor overall health, among other characteristics, use the ED more frequently than others.[16,17] However, little research has explored in depth how or where older adults obtain care for acute illnesses, and few researchers have specifically examined system-level factors.[18,19] Furthermore, to our knowledge no studies have directly queried older adults to fully understand the factors that influence where they obtain care for their acute illnesses. This hypothesis-generating qualitative study aimed to identify the factors that influence older adults decision to seek care from the ED, rather than their PCPs, for acute illnesses.

Population Health Research Capsule

What do we already know about this issue?
Older adults use the ED at high rates, including for illnesses that could be managed by their primary care providers (PCP), despite attempts to decrease ED use.

What was the research question?
What factors influence older adults' decision to obtain acute illness care from the ED rather than their PCPs?

What was the major finding of the study?
Older adults integrate many non-medical factors when deciding to seek care from an ED instead of their PCPs.

How does this improve population health?
For more efficient acute illness care for older adults, planners must develop and integrate person-centered care concepts into a complex healthcare system.

METHODS

This research is one aim of a larger study whose purpose is to broadly examine how community-dwelling older adults manage their care and navigate their healthcare and health concerns within the context of their lives surrounding an ED visit. The larger study aims to uncover, from the patient and caregiver perspectives, the supports and constraints that shape the ED-to-community transitioning process. One specific goal within this work is to build a better understanding of the factors that influence whether they obtain medical care from the ED, rather than their PCPs, for acute illness symptoms. The study was approved with informed consent by the University of Rochester Research Subjects Review Board and the University of Wisconsin-Madison Institutional Review Board. All COREQ criteria were met apart from our inability to retain records of individuals approached who declined inclusion in the study.

Study Setting

This study took place in Rochester, New York. All subjects were identified and consented in the University of Rochester Medical Center ED, which is an academic medical center and Level I trauma center ED that cares for approximately 100,000 patients per year.

Study Subjects

A convenience sample of community-dwelling older adult ED patients (age≥65 years) was recruited from February 2013 to October 2013 between 9 am and 9 pm when a study investigator was available. Potential subjects were excluded if they lived in skilled nursing facilities or assisted living facilities, lacked decisional capacity, could not communicate in English, presented for alcohol intoxication, or had received care in an ED within the previous 30 days. In addition, patients needed to be discharged from the ED to their homes to be eligible for participation in the study. All participants provided informed consent, along with any caregivers who were present and were willing to be included in the interviews.

Study Methods

The study team developed a semi-structured interview guide based on the aims of the larger study and the existing literature. The guides were iteratively revised based on study team review and pilot testing. Additionally, we completed chart reviews for basic demographic and clinical information. In the ED, the initial interview explored circumstances that contributed to the ED visit, perceptions of health, social relationships, anticipated challenges upon discharge, and relationships with the participant's PCP.

After discharge, participants were interviewed in their homes up to two times, approximately two weeks apart, over a six-week period. Interviews were framed as conversations and built upon the data gathered in previous conversations. Participants and caregivers discussed the acute illnesses that led to the ED visit, their reasons for choosing the ED over a visit to the PCP, their perceptions of health and challenges associated with staying healthy, their personal, social and health priorities, and their relationships with medical systems, PCPs, and social support structures. The interview in the ED lasted approximately 30 minutes, and each of the in-home interviews lasted approximately one hour. We collected a total of 728 pages of transcripts.

All interviews (n=36) were audio recorded, transcribed verbatim, and verified. The study team ceased enrollment when data saturation was achieved and no new information was being obtained through the qualitative interviews for any of the aims of the parent study. To evaluate saturation, the team reviewed the transcripts of the interviews after every 2-3 subjects had completed study procedures. When the team agreed no new information was being collected, we decided to cease new enrollment.

Data Coding and Analysis

This study, which aimed to identify the factors influencing whether older adults elected to seek care from the ED rather than their PCP, was a pre-planned analysis of data gathered for the larger qualitative study. We conducted data analysis using methods consistent with directed content analysis approaches to research and analysis.[20] Codes were derived based on a synthesis of the literature and previous pilot work.[4,8,13,15] The study team also identified in-vivo codes within the data. To ensure consistency in coding, six transcripts were coded independently by the team, and then codes were compared and discussed as a group. Two study team members then coded all transcripts (AB, MKF) using NVivo software; 20% of these final coded transcripts were systematically verified for consistency and accuracy by two other team members (MNS, NEW). The percent agreement function in NVivo was used to crosscheck coding between researchers, and any individual codes or transcripts that did not exhibit an agreement of at least 80% were recoded. All transcripts had an agreement of greater than 80%. Study team members then jointly identified themes that emerged from the data.

RESULTS

For the cohort, the average age was 74 years (standard deviation 7.2 years); seven males and eight females participated; three participants were Black and the remaining participants were White (Table 1). We identified five themes that reflect the factors contributing to whether participants chose to obtain acute illness care from the ED, rather than their PCP, which are detailed below. Of note, biomedical concerns did not emerge as a factor in choosing one site over another; in other words, participants did not describe choosing one site of care over another due to the severity of their illness.

Theme 1: Limited availability of PCP-based illness care

Some participants commented upon their ability to see their PCPs whenever needed (Table 2, Quote 1-2), while others commented on their inability to obtain care from their PCPs and the convenience of ED-based care (Table 2, Quote 3-5). No comments clearly explained the difference between these two responses. The lack of PCP availability after hours and on weekends was noted by participants; no participant indicated that their PCP was available after hours and on weekends (Table 2, Quote 3-4).

Theme 2: Variable interactions with healthcare providers and systems

Participants remarked upon their positive and productive working relationships with their PCPs (Table 2, Quote 6-8). Participants provided comments describing

Table 1. Demographic characteristics of participants.

Pseudonym	Gender	Race	Chief complaint
Mandy	Female	White	Knee pain
Joe	Male	White	Unable to urinate
April	Female	White	Fall
May	Female	Black	Motor vehicle crash
June	Female	White	Syncope
Carol	Female	White	Constipation
Mark	Male	White	Bee sting
Peter	Male	Black	Bee sting
David	Male	White	Knee pain
Audrey	Female	White	Hand injury
Ray	Male	White	Arm injury
Mildred	Female	Black	Hand injury
Jenny	Female	White	Abdominal pain/ difficulty sleeping
Arthur	Male	White	Syncope
Quinton	Male	White	Abdominal pain

Table 2. Representative participant quotations.

	Line	Quote
Limited availability of PCP-based illness care	1	April: "If I need him, I call him, but there's not too often that he'll say he wouldn't take me; he usually always takes me."
	2	Mark: "I called him and he said…he'll make time for me and he said I could come right in… they're very accommodating."
	3	Peter: "Well, 5:00 in the afternoon the doctors' offices are closed…I went out here to Urgent Care and they wouldn't deal with me. They said they would call the ambulance…"
	4	Carol: "…when we had an emergency situation like this, they [the PCP's office] didn't respond, which is no good."
	5	David: "I was amazed that from the time I went through the door to the time I actually had some care, probably 8 minutes, 7 or 8 minutes…(regarding ED care)."
Variable interactions with healthcare providers and systems	6	Joe: "He [PCP] doesn't spend a lot of time with me, but he seems to listen to what I have to say…I trust him."
	7	April: "Yeah, he's a good doctor, I think the world of him…I have a lot of faith in him, I trust him and I think you need that more than anything."
	8	Carol: "We moved from the Adirondacks and I had to find a doctor and I went through four different doctors before I found a doctor that I could talk to…what decided me [was] not only his efficiency but his caring…"
	9	Mark: "I think for the most part our visits to [the emergency department] have always gone very well for us…"
	10	Mandy: "I have to say I was pleasantly surprised when I came to the ER because I'd heard horror stories about coming here to the ER and when I got here they couldn't have been more helpful…"
	11	Mandy: "…I tried to talk the doctor into sending me [to his office] that day…He said, 'I want you in the hospital now."
	12	Audrey: "We've done it in the past through going to the emergency room…[my PCP] wouldn't want me to come to the office, I knew that."
	13	June: "[The PCP] sent me straight to the emergency room."
	14	David: "Well, I can honestly tell you that if I had health-related problems, well like this for instance, this [the ED] is the place I would rather be...I was amazed that from the time I went through the door to the time I actually had some care, probably 8 minutes, 7 or 8 minutes, I was amazed."
Availability of transportation for illness	15	June's caregiver: "She does not drive anymore, so obviously all the driving has to come from somebody else…"
	16	May: "Sometimes [the medical cab] don't come…I've missed about four or five appointments messing with them."
	17	June: "Medicaid has to provide transportation and I have had one of the biggest struggles of anything with [that] transportation system."
	18	June: "I said 'well, I'll have to find somebody to give me a ride and it will take a couple of hours' and she said 'if you can't find someone, then call the ambulance and get in [to the ED]."
	19	Mandy: "[T]hat was the hardest lesson…I had to ask friends. Even though I had helped them a thousand times, it was different when you have to ask, do the asking. You really take, it's a blow to your self-esteem, you know, who've you been all these years, so it is hard."
Desire to avoid burdening friends and family	20	June: "I have a real need for independence…I have to learn how to let some of that go and accept that I need help from other people and that is a real challenge for me…"
	21	April: "It's so hard to even ask my own kids."
	22	Peter: "I don't burden my people down with my problems, because everybody's got problems."

PCP, primary care physician.

Table 2. Continued.

	Line	Quote
Previous experiences with illnesses	23	Carol: "I got up and thought 'Oh God, it's the same situation'…I suspected it had something to do with my bowel…we've got to find out what the problem is."
	24	Mandy: "I guess that's my personality, to be more proactive…I don't like to be confused. I'm very unconfident if I don't understand what is going on around me and I didn't understand a lot of times."
	25	June: "If I hadn't come in [to the ED] I would have always wondered if I should have."
	26	Audrey: "I am worried about the future, right now we've taken care of things the way we know we had to, and if they go and change it on us then I'm going to probably have some problems, I don't know."
	27	April: "I was scared. I'm not chicken or anything but I woke up and couldn't breathe… I did think 'I can't die here alone' and then the more I thought about it the more anxiety and then it was worse…"
	28	Audrey: "We've done it in the past through going to the emergency room…[my PCP] wouldn't want me to come to the office, I knew that."
	29	Jenny: "My daughter said that if I had any complaints I should come."
	30	Mark: "She goes 'you want to go to the emergency [room]...that's where you're going and I'll be there in a few minutes.' She drove over here and picked me up...and we went."
	31	April: "And the minute she walked in, I knew what she was going to do...she was right on that phone for 911."

PCP, primary care physician.

positive interactions as they obtained the care they desired (Table 2, Quote 9-10). Participants also noted that PCPs often referred them to the ED because the PCPs could not provide the services needed in the office (Table 2, Quote 11-13). A few participants claimed the ED was preferred (Table 2, Quote 14). No participants identified a conflict in their positive relationships with their PCPs despite using the ED for care.

Theme 3: Limited availability of transportation for illness care

Participants spoke extensively about the problems they encountered procuring transportation to perform healthcare-related tasks (e.g., physician appointments) because they did not drive (Table 2, Quote 15). Public transport problems included 1) poor availability of transportation; 2) lack of available transportation for emergent appointments; and 3) poor reliability of public transportation providers. When public transport was used, participants described multi-hour trips that were exhausting (Table 2, Quote 16-18). The alternative was to ask friends and family to assist with their needs, which the participants did not want to do (Table 2, Quote 19).

Theme 4: Desire to avoid burdening friends and family

Participants expressed their fears of burdening friends and family for maintaining health-related appointments. They specifically highlighted their discomfort and dislike with having to trouble family or friends for help with taking them to appointments or with their complex healthcare needs (Table 2, Quote 20-22). This discomfort even extended to non-health related support, such as grocery shopping.

Theme 5: Previous experiences with illnesses

Participants commented on their experiences with previous acute illnesses, their reactions to those episodes, and how these experiences and reactions influenced their decision-making regarding the site of their care. Some participants discussed their inability to tolerate uncertainty related to their symptoms, with many choosing to present at the ED because, as one patient put it, "if I hadn't come in, I would have always wondered if I should have." Others discussed the convenience of obtaining care whenever they needed it (Table 2, Quote 23-27). Some patients discussed their previous experiences, and how those experiences led to accessing ED care (Table 2, Quote 28). Finally, participants remarked that the opinions of their friends and family members weighed heavily on their decision as to where to seek care (Table 2, Quote 29-31).

DISCUSSION

In this qualitative study, we found that a wide variety of factors influence whether older adults obtain acute illness care from the ED rather than their PCPs. Most of these factors were unrelated to their medical symptoms or to the severity of their illness. Instead, they stemmed from personal and social

considerations, practical considerations, and perceptions based on previous experiences. Policymakers who desire to modify the location at which older adults obtain acute illness care must consider interventions, primarily at the systems level, to address these issues.

Care availability proved to be a significant factor that influenced the site for acute illness care. Consistent with the literature, the participants in this study spoke highly of their PCPs and their relationship with them.[21,22] However, they struggled with the system of care in which their PCPs operate: participants highlighted the problems they experienced in obtaining care when they needed it, particularly after hours and during weekends, without going to the ED. They also discussed being referred to an ED to obtain the necessary care, despite their requests to be cared for in the PCPs' offices. These barriers are not surprising as PCP offices have limited hours and limited ability to perform diagnostic testing and deliver treatments, which are frequently needed by ill older adults.[8,11,15,23]

Participating older adults also described their struggles with acquiring transportation to appointments because those who did not drive wished not to burden friends and family members. For some, an insurance-based transportation system was available, but they lamented its poor reliability and lack of on-demand availability (Table 2, Quote 15-21).

Older adults' experiences with illness, and their reaction to their illnesses, played a substantial role in where they sought care. Participants noted that their previous experience of being referred to the ED for acute illness care had led to their decision to access ED care. It was also clear that worries about their health and the uncertainty of their conditions, particularly in the setting of multiple comorbidities, drove participants to obtain immediate care in the ED. This finding is consistent with other research studies, which have found that high anxiety related to the implications of illnesses can act as a strong driving force in choosing the ED for its immediacy of care.[18,24]

Interventions exist that could address the factors described by community-dwelling older adults as influencing their preferred site for acute illness care. While no single intervention will likely apply to all community-dwelling older adults, an approach that places the individual at the center of the system may have benefit. Westphal describes this need for individualization when he advocates for *person*-centered care.[25] Considering the notion of person-centered care with the themes from our participants regarding the difficulties they encounter in navigating a complex healthcare system, it is clear that any acute illness care delivery system needs to be flexible for the diversity of patients and their situations, and needs to consider the intensity of healthcare required by these patients.

A number of potential interventions could operate at the system level. A major consideration is where acute illness care is available. PCPs' offices do not have the same diagnostic and therapeutic capabilities as EDs. These deficiencies could be addressed through structural changes (e.g., expand capabilities at PCP offices), but the value of this change must be measured against the cost. Alternatively, a better source of illness care may be the ED, as long as the ED structure and processes are optimized to the needs of older patients, such as through geriatric EDs.[9]

Another consideration is developing a more flexible system that can support the wide range of older adults' needs. Telemedicine is increasingly being used to deliver acute illness care to patients in their homes, making care available when patients want it and without creating other needs, such as transportation to a PCP's office or an ED. Studies have shown the feasibility, acceptability, and effectiveness of telemedicine to provide acute illness care.[26,27]

In the era of on-demand transportation such as Uber, the transportation barrier described by participants is likely surmountable. Developing a more robust and affordable transport system should be possible to support older adults who require in-person treatment.[28]

Finally, a potential individual-level intervention is decision support for patients. Decision support, such as a nurse help line, could assist older adults in choosing the proper site for illness care, and even address the uncertainty and anxiety issues raised by participants. Bolstering this patient support may allow for a more streamlined and efficient system of acute care, but the accuracy of such a help line will need to be evaluated. Help lines have been successfully used for children, but may be inaccurate among complex geriatric patients.[29]

LIMITATIONS

This study has a few limitations that must be considered. As the study was conducted in a single ED in one mid-sized city, the findings may not be generalizable to different patient populations; the hypotheses generated from this study must be confirmed through larger survey studies. Another limitation is not enrolling patients who obtained acute illness care from their PCPs. However, our goal was to broadly understand the decision-making process of patients who chose to go to the ED for care over their PCPs. Our findings can now build to a future study that compares patients who receive acute illness care in EDs to those who receive care in PCP offices. A final limitation relates to internal validity. Because this is a hypothesis-generating qualitative study with a small number of participants, patients with every presenting condition were not included. Because we did not survey indidivuals who refused to consent to participate in this study, differences may have existed between those who participated and those who refused to participate. Because the interviews occurred after the participant decided to present to the ED for care, we cannot know if the patients' opinions changed as a result of the experiences in the ED. Thus, these findings must be considered with the caveat that a confirmatory study must be performed.

CONCLUSION

Older adults integrate a number of factors when deciding whether to obtain acute illness care from an ED rather than their PCPs. These factors relate to personal and social considerations, practical considerations, and perceptions based on previous experiences. Person-centered interventions at the system and individual level should be considered to optimize the care that community-dwelling older adults receive for their acute illnesses.

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Effectiveness of Resident Physicians as Triage Liaison Providers in an Academic Emergency Department

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Introduction: Emergency department (ED) crowding is associated with detrimental effects on ED quality of care. Triage liaison providers (TLP) have been used to mitigate the effects of crowding. Prior studies have evaluated attending physicians and advanced practice providers as TLPs, with limited data evaluating resident physicians as TLPs. This study compares operational performance outcomes between resident and attending physicians as TLPs.

Methods: This retrospective cohort study compared aggregate operational performance at an urban, academic ED during pre- and post-TLP periods. The primary outcome was defined as cost-effectiveness based upon return on investment (ROI). Secondary outcomes were defined as differences in median ED length of stay (LOS), median door-to-provider (DTP) time, proportion of left without being seen (LWBS), and proportion of "very good" overall patient satisfaction scores.

Results: Annual profit generated for physician-based collections through LWBS capture (after deducting respective salary costs) equated to a gain (ROI: 54%) for resident TLPs and a loss (ROI: -31%) for attending TLPs. Accounting for hospital-based collections made both profitable, with gains for resident TLPs (ROI: 317%) and for attending TLPs (ROI: 86%). Median DTP time for resident TLPs was significantly lower ($p<0.0001$) than attending or historical control. Proportion of "very good" patient satisfaction scores and LWBS was improved for both resident and attending TLPs over historical control. Overall median LOS was not significantly different.

Conclusion: Resident and attending TLPs improved DTP time, patient satisfaction, and LWBS rates. Both resident and attending TLPs are cost effective, with residents having a more favorable financial profile. [West J Emerg Med. 2017;18(4)577-584.]

INTRODUCTION

Emergency department (ED) volumes continue to grow, with a 23% increase over 10 years to 116.8 million visits in 2007.[1] ED crowding remains a complex and challenging problem for healthcare systems worldwide, with negative impacts upon staff and patient satisfaction, ED wait times, and potentially harmful delays in providing quality patient care.[2-4]

Crowding can result from input (patient volume), throughput, and output stressors (ED boarding, inpatient capacity constraints).[5,6] Operationally, throughput is the

factor under greatest direct control of the ED, as it represents patient care from ED arrival to disposition. As a result, the majority of interventions directed towards addressing ED crowding have focused on throughput optimization.

Several metrics are commonly used as surrogate measurements for the quality of ED care, including assessments of the timeliness of ED care and patient satisfaction. Timeliness metrics have been defined to include door-to-provider times (DTP) and length of stay (LOS).[7] As waiting times increase, patients may leave the ED prior to physician evaluation. These patients, categorized as left without being seen (LWBS), can suffer deleterious consequences including death and disability. From an operational standpoint, LWBS also constitutes lost ED revenue and potentially lost hospital revenue if the patient's condition would warrant further inpatient admission.

Many interventions in EDs across the country have aimed to mitigate the effects of crowding and optimize these metrics. Such efforts have ranged from nurse-initiated triage order sets to ED compartmentalization based on acuity to the installment of advanced practice providers or ED attending physicians in triage to initiate patient workups.[8] These triage liaison providers (TLPs) work to expedite and initiate the workup of patients, especially those of higher acuity, as well as identify and rapidly assist those of lower acuity who can be cared for without an official ED treatment space. They have the potential to effectively mitigate the consequences of crowding by decreasing DTP, LOS, and LWBS and improving patient satisfaction.

Prior studies have evaluated both attending physicians and advanced practice providers (i.e. nurse practitioners, physician assistants) serving as TLPs with varied results.[10-12,19] Many studies have illustrated decreased LOS with TLPs, including a systematic review by Rowe in 2011 including 28 studies that showed a 37-minute decrease in average LOS.[13-25] Others have also shown improved LWBS[12,14-16,18] and DTP.[13,18] Alternatively, some studies have suggested that having an attending TLP is not feasible due to the increased labor costs, increased staffing needs, and variations in practice between the TLP and end provider.[8] The few studies on cost effectiveness of TLPs demonstrate a net increase in the cost when using an attending provider.[19, 24]

TLPs have been shown to be successful in improving ED metrics including DTP, LWBS, LOS, and patient satisfaction. The majority of these studies have evaluated attending physician or advanced practice providers. To our knowledge, the literature on the impact of resident physician TLPs is limited to a single abstract and a single study indicating decreased LOS without significant change in LWBS.[20, 28] The goal of this study is to compare operational performance metrics, patient satisfaction, and cost-effectiveness outcomes between resident and attending physicians as TLPs.

Population Health Research Capsule

What do we already know about this issue?
Prior studies have evaluated attending physicians and advanced practice providers as triage liaison providers (TLP) with mixed results. However, few studies have assessed residents as TLPs.

What was the research question?
What is the difference in operational performance metrics between resident TLPs, attending TLPs, and historical controls?

What was the major finding of the study?
Both attending and resident TLPs improved performance metrics, with residents having a more favorable return on investment.

How does this improve population health?
This article provides information on an alternative staffing model to manage crowding in EDs with emergency medicine residents.

METHODS

Study Design

This was a retrospective cohort study that compared predefined aggregate operational performance metrics between resident TLPs, attending TLPs, and a historical control group. This study was approved for exempt status per our institutional review board.

Setting

This study was conducted at a single urban academic ED associated with a residency program. This ED has approximately 88,000 annual visits and is staffed by 50 residents and 28 attending physicians. The mean admission rate is 20% inpatient admissions and 15% observation admissions. The ED uses electronic medical records (EMR) for all of its encounters and has computerized physician-order entry.

Selection of Participants

All patients presenting during the hours when a TLP was present were eligible for inclusion. We excluded pediatric patients (defined as age less than 18 years) because they were frequently seen in the nearby dedicated pediatric ED. Senior residents (defined as post-graduate year [PGY] 3 and 4

emergency medicine residents) and attending physicians were eligible for participation as the TLP. Senior resident physicians were staffed as TLPs through voluntary moonlighting. Attending physicians were staffed as TLPs based upon scheduled faculty shifts.

Interventions

A TLP was present between 11:30 and 19:30 on Monday through Friday from October 2013 through January 2014. Patients were initially evaluated by triage registered nurses (RN) as on non-TLP days. Typical triage flow for RNs included patient evaluation at intake by an initial triage nurse (T1), who would direct immediate placement of critically ill Emergency Severity Index (ESI) 1 or ESI 2 patients as well as immediate placement of ESI 4 and ESI 5 patients into our fast track area, which was open during the day and included the hours a TLP was present. All other patients were then taken to a second intake area and seen by a second triage nurse (T2). On TLP and on non-TLP days, T2 nurses initiated labs off of care-initiation guidelines or in discussion with the TLP physician when present, but did not order any advanced testing. On TLP and non-TLP days, all patients with a chief complaint of chest pain had electrocardiograms (EKGs) performed in triage. These EKGs were then taken to the TLP or an attending physician or senior resident physician on a main ED team for review.

TLP staffing was in a split-flow design. TLPs worked in our second triage intake area with T2 nurses. When staffing permitted, a dedicated RN was assigned to assist the TLP. Due to the high ED volume, TLPs did not see every patient. Typical TLP responsibilities included screening of EKGs, prioritizing placement of ESI 2 patients, care initiation of as many ESI 3 patients as possible, and primary management of select ESI 3 patients. TLPs were not directed to focus on ESI 4 and ESI 5 patients as our ED had a fast-track area open during the same hours. TLPs were able to order all labs, medications, EKGs, and imaging tests as would be ordered during a regular ED evaluation. TLPs wrote brief, 2-3 sentence notes on evaluated patients who were placed in regular ED beds, which were visible by the primary ED team in the EMR. TLPs wrote full ED notes for patients whom they managed primarily. Patients managed primarily by the TLP were evaluated in a private room in triage and then placed back in the waiting room to await test results and imaging. These patients were admitted or discharged from the waiting room.

Study Protocol

Outcomes for all ED patients on the TLP days (from 10/2013-1/2014) were compared for senior residents and attending physicians. We also compared outcomes to a historical control (defined as pre-TLP data from 10/2011-1/2012). No other major co-interventions were performed during this time period. Outcome data was generated using data from the entire TLP day or non-TLP day, and was not limited to the specific hours that a TLP was present.

Outcomes

The primary outcome was overall cost effectiveness, defined as the return on investment (ROI). We calculated ROI using the annual revenue based upon the LWBS capture offset by the TLP cost. TLP cost was calculated by multiplying the provider hourly cost by the annual number of hours worked as a TLP. We evaluated revenue capture based on projected physician-based collections and hospital-based collections. Secondary outcomes included differences in median ED LOS (for both admitted and discharged patients), median DTP, percentage of LWBS, and proportion of "very good" overall patient satisfaction scores. For ED LOS, start time for the ED visit was determined by initial arrival and registration into the system. Time of admission and time of discharge were based on the times when the patient physically left the ED, based on the patient's clinical status change in the EMR to admitted status with an assigned inpatient location, or to discharged status. We tracked median DTP on TLP and non-TLP days by assignment of a physician to the patient in the EMR. On TLP days, TLPs used an icon in the EMR to assign themselves to patients they had seen and provided care for in triage.

Analysis

Data were extracted and stored through an offsite, secured electronic data warehouse. We described proportions as means with 95% confidence intervals (CI), while the remainder of the data was described with medians with interquartile ranges. We analyzed data with t-tests for data with normal distribution and the Mann-Whitney U test for non-normally distributed data using Stata statistical software (StataCorp Version 13.0; College Station, Texas).

RESULTS

Over the four-month study period, residents worked 29 days as a TLP and attending physicians worked 48 days as a TLP, for a total of 77 TLP days, compared to 92 historical control days. We analyzed 6,683 visits in the resident group, 10,814 in the attending group, and 19,298 in the historical control group.

Annual profit generated for physician-based collections through LWBS capture (after deducting respective salary costs) equated to a gain of $77,997 (ROI: 54%) for resident TLPs and a loss of $104,752 (ROI: -31%) for attending TLPs (Table, Figure 1). Accounting for hospital-based collections made both profitable, generating $684,504 in profit (ROI: 317%) for resident TLPs and $519,467 in profit (ROI: 86%) for attending TLPs (Table, Figure 2).

Overall median LOS was not significantly different with a TLP compared to historical control (Table, Figure 3).

Table. Comparison of resident TLP, attending TLP, and historical control.

Outcome	Resident TLP	Attending TLP	Historical control
Profit	$77,997	-$104,752	N/A
Return on investment	$684,504	$519,467	N/A
Median length of stay (admitted)	6.97 hours	6.63 hours	7.03 hours
Median length of stay (discharged)	4.18 hours	4.28 hours	4.17 hours
Door-to-physician time	35 minutes	39 minutes	51 minutes
Left without being seen	3.12%	3.08%	4.71%
Patient satisfaction	55%	56%	53%

TLP, triage liaison provider.

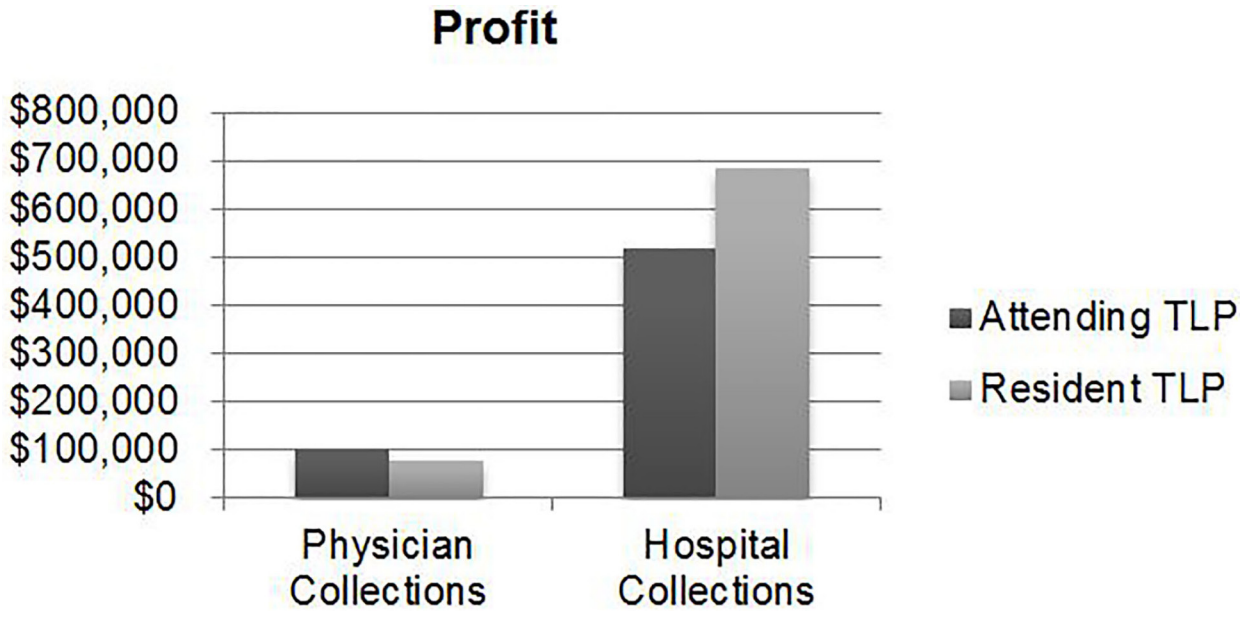

Figure 1. Difference in annual profit generated by attending triage liaison provider (TLP) and resident TLP, through physician collections and hospital collections.

Attending TLPs were associated with a *lower* median LOS for admitted patients compared to resident (6.63 hours vs. 6.97 hours, p=0.004) or historical control (6.63 hours vs. 7.03 hours, p<0.0001). Conversely, attending TLPs were associated with a *higher* median LOS for discharged patients compared to resident TLPs (4.28 hours vs. 4.18 hours, p=0.01) or historical control (4.28 hours vs. 4.17 hours, p=0.0002).

Median DTP was significantly lower with a TLP compared to historical control (Table, Figure 4). Median DTP was 35 minutes (interquartile range [IQR] 17-81 minutes) for resident TLPs, significantly lower (p<0.0001) than attending TLPs (39 minutes, IQR 19-87 minutes) or historical control (51 minutes, IQR 21-117 minutes).

Proportion of LWBS was significantly improved with a TLP compared to historical control (Table, Figure 5). LWBS was 3.12% (95% CI [2.73%-3.55%]) for resident TLPs and 3.08% (95% CI [2.77%-3.41%]) for attending TLPs, both significantly better than historical control (4.71%, 95% CI [4.43%-5.01%]).

Proportion of "very good" patient satisfaction scores was 55% (95% CI [53%-56%]) for resident TLPs and 56% (95% CI [55%-57%]) for attending TLPs, compared to historical control (53%, 95% CI [52%-54%]). This was not significantly improved with a TLP (Table, Figure 6).

LIMITATIONS

This was a single center study at an urban academic emergency medicine residency program and thus may not

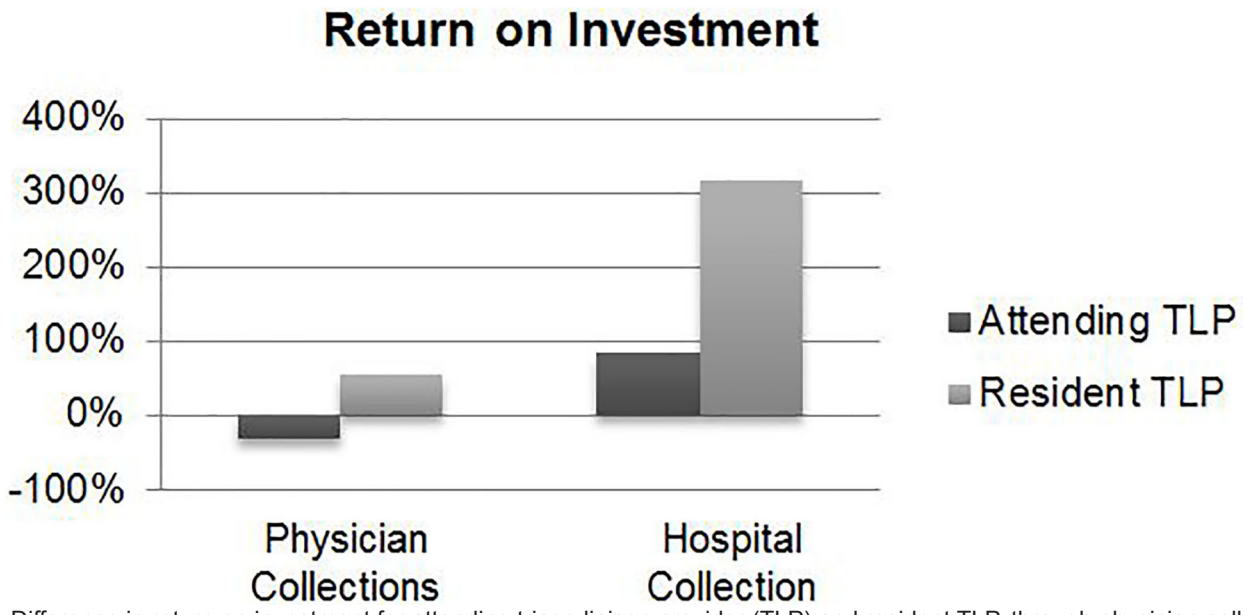

Figure 2. Difference in return on investment for attending triage liaison provider (TLP) and resident TLP, through physician collections and hospital collections.

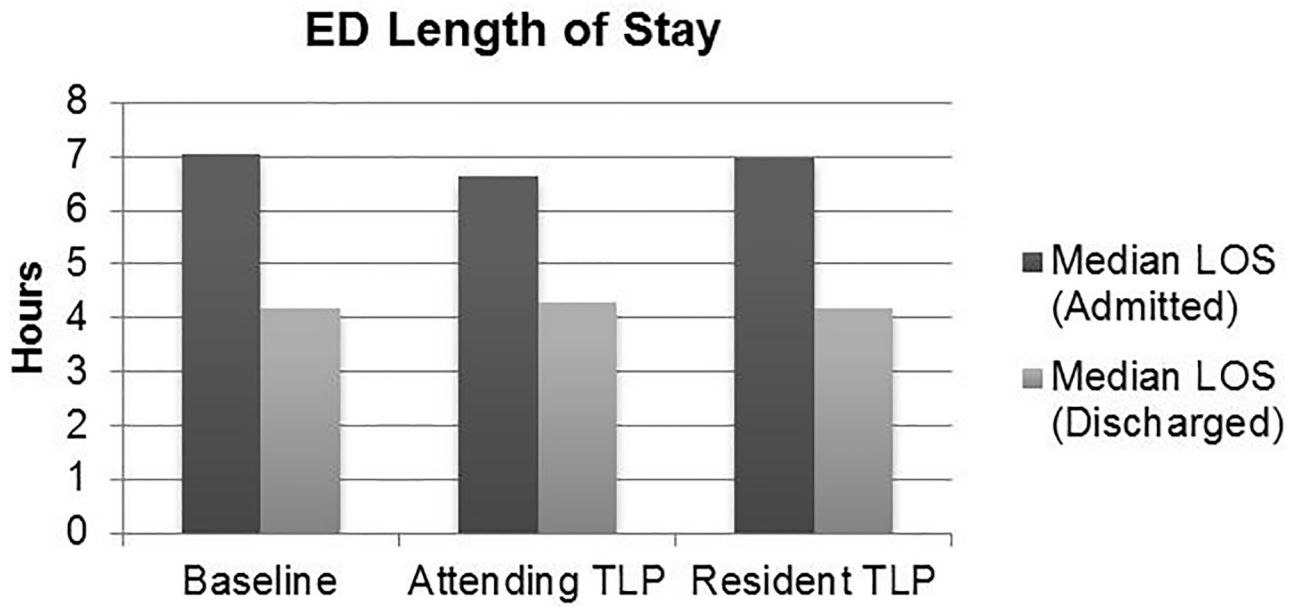

Figure 3. Difference in ED length of stay between attending TLP, resident TLP, and historical control.

readily generalize to other practice settings. This was also a retrospective design and is subject to all of the potential biases and limitations inherent in this study design. This study was performed over a single four-month period, but there is no reason to suggest that using a different study period would have significantly altered the study results. This study was performed only during high-volume ED times. and it is unclear if similar results would be obtained if a TLP were used during times with lower patient volumes. Our hospital has a separate pediatric ED, so further study would be needed to assess the applicability in pediatric patients. Finally, only senior (PGY 3 and 4) residents were studied as TLPs. Further study is needed before applying this process to more junior residents.

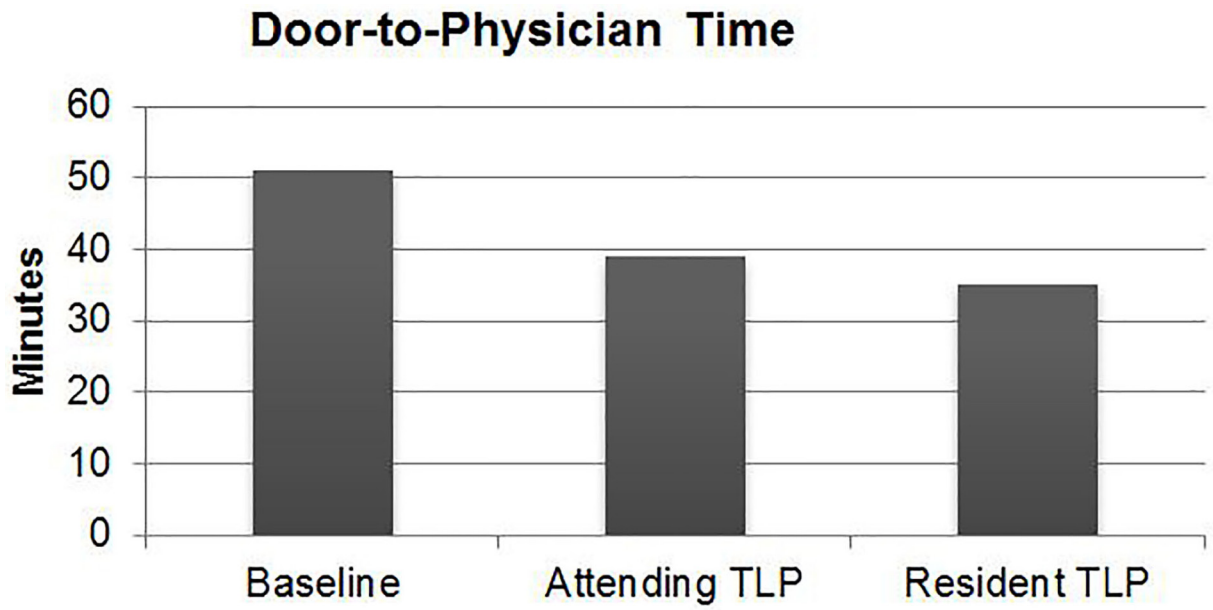

Figure 4. Difference in door-to-physician time between attending triage liaison provider (TLP), resident TLP, and historical control.

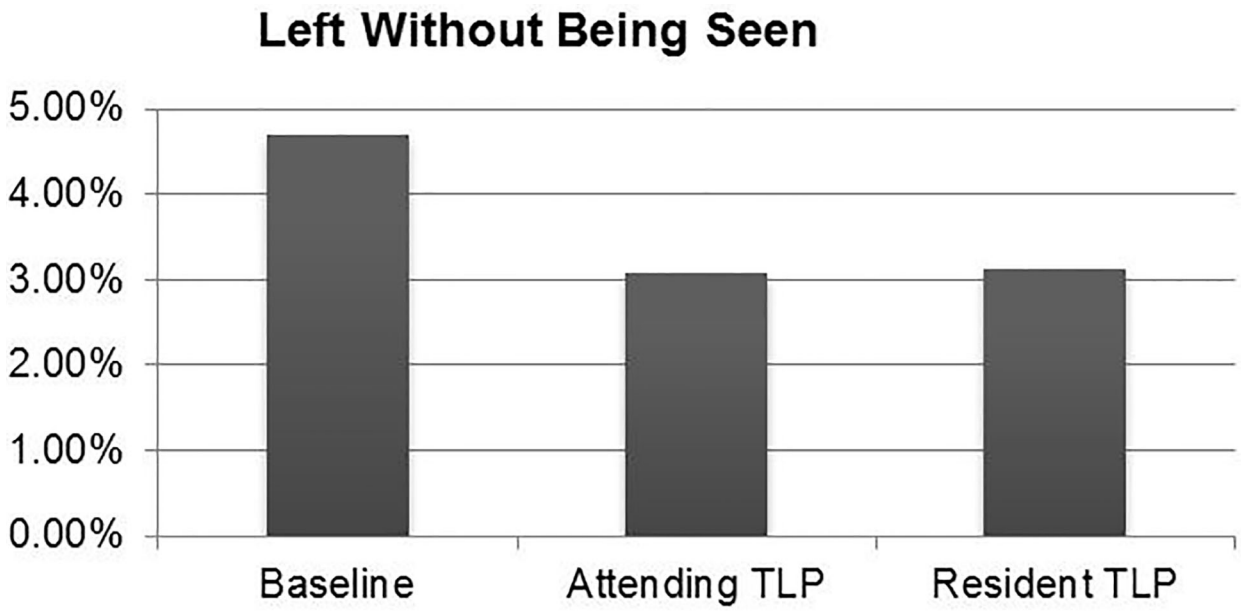

Figure 5. Difference in "left without being seen" percentage between attending TLP, resident TLP, and historical control.

DISCUSSION

Crowding is a widespread problem that has been increasingly common in many EDs. Studies on crowding have demonstrated negative impacts on patient and provider care, as well as on patient outcomes.[2-4] As a result, EDs have used a variety of techniques to improve throughput and efficiency. One of the more common approaches is to use a TLP, but the majority of studies have assessed only attending physicians and advanced practice providers in this role.[13-25] Our primary outcome was overall cost effectiveness of using a TLP, defined as the ROI.

We are aware of only a few studies assessing the cost effectiveness of using a TLP in triage, none of which assessed resident TLPs. One study was performed in a pediatric ED using an attending pediatric provider as the TLP and suggested an increased cost of $42,883 with this approach.[19] Another study using attending physicians in an urban county teaching program

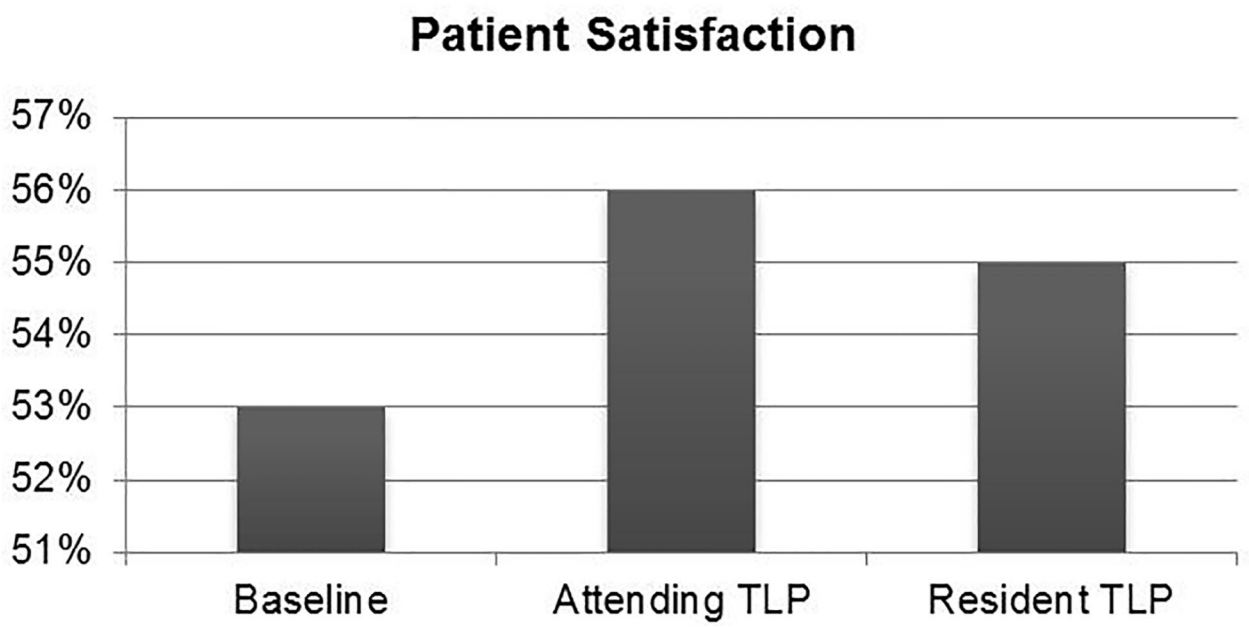

Figure 6. Difference in proportion of "very good" patient satisfaction scores between attending triage liaison provider (TLP), resident TLP, and historical control.

demonstrated an increased cost of $11.98 per patient.[23] Alternatively, our study demonstrated that both resident and attending TLPs were cost effective, with resident TLPs being significantly more cost effective than attending physicians and generating a significantly higher ROI. Our study also showed that both resident and attending physician TLPs resulted in improved patient DTP, LWBS, and ROI when compared with historical controls. Additionally, there was no clinically significant difference between attending and resident providers with regard to LOS, DTP, and percentage LWBS.

The effect of TLPs on LOS has been mixed in the literature, though the majority of studies (including a recent systematic review) demonstrate favorable effects on LOS and LWBS.[13-25] To the best of our knowledge, only two prior publications have assessed using residents as a TLP and had conflicting results. An abstract by Porter et al. demonstrated no significant difference in LOS between resident TLPs and standard nursing triage,[28] while a study of 1,346 patients by Svirsky et al. demonstrated decreased LOS without a significant change in LWBS.[20] Of note, these were both much smaller studies and did not include attending physician TLPs as a comparator. Our study demonstrated only a minimal difference in LOS but a significant difference in LWBS when compared to historical control with minimal difference between attending and resident TLPs. The difference in LOS between our study and priors may be due to a variety of external factors, including number of available ED beds, acutely ill patients preventing the primary provider from seeing or dispositioning the patients, or delays in laboratory or imaging results.

Our study was performed at a large, urban residency-affiliated ED and the results may not apply to other practice settings. Additionally, creating a TLP requires infrastructure, including additional staffing and provider space. However, our study suggests that if a TLP program is already established, allowing resident physicians to serve as TLP may be more cost effective than staffing with attending providers. Given the increasing prevalence of providers serving as TLPs, it may be beneficial for residents to gain experience in this role. Another benefit of using a TLP is the ability to identify abnormal laboratory or imaging findings earlier in the patient presentation, which may theoretically decrease the probability that patients will decompensate during their ED stay. Finally, the increased percentage of "very good" patient satisfaction scores suggests that patients may be more likely to return and refer people to the hospital, which may lead to further unmeasured ROI.

Future studies should include a prospective randomized controlled trial to confirm our findings. Additionally, studies should determine which days and hours are most cost-effective and whether similar outcomes would occur in different practice settings.

CONCLUSION

In conclusion, both resident and attending physician TLPs improved DTP time, patient satisfaction, and LWBS percentages. Additionally, both resident and attending TLPs are cost effective with residents having a more favorable cost-benefit profile.

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Emergency Department Pain Management Following Implementation of a Geriatric Hip Fracture Program

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Introduction: Over 300,000 patients in the United States sustain low-trauma fragility hip fractures annually. Multidisciplinary geriatric fracture programs (GFP) including early, multimodal pain management reduce morbidity and mortality. Our overall goal was to determine the effects of a GFP on the emergency department (ED) pain management of geriatric fragility hip fractures.

Methods: We performed a retrospective study including patients age ≥65 years with fragility hip fractures two years before and two years after the implementation of the GFP. Outcomes were time to (any) first analgesic, use of acetaminophen and fascia iliaca compartment block (FICB) in the ED, and amount of opioid medication administered in the first 24 hours. We used permutation tests to evaluate differences in ED pain management following GFP implementation.

Results: We studied 131 patients in the pre-GFP period and 177 patients in the post-GFP period. In the post-GFP period, more patients received FICB (6% vs. 60%; difference 54%, 95% confidence interval [CI] 45-63%; p<0.001) and acetaminophen (10% vs. 51%; difference 41%, 95% CI 32-51%; p<0.001) in the ED. Patients in the post-GFP period also had a shorter time to first analgesic (103 vs. 93 minutes; p=0.04) and received fewer morphine equivalents in the first 24 hours (15mg vs. 10mg, p<0.001) than patients in the pre-GFP period.

Conclusion: Implementation of a GFP was associated with improved ED pain management for geriatric patients with fragility hip fractures. Future studies should evaluate the effects of these changes in pain management on longer-term outcomes. [West J Emerg Med. 2017;18(4)585-591.]

INTRODUCTION

Every year over 300,000 Americans sustain low-trauma fragility hip fractures[1-5] at an estimated cost of over $12 billion.[6] Following a hip fracture, inpatient mortality is around 4%[7] and 12-month mortality is 20-25%.[4,8] Only half of patients sustaining a hip fracture recover their pre-fracture mobility.[7]

Multidisciplinary geriatric fracture programs (GFP) reduce mortality,[9] morbidity,[9-11] and hospital costs.[12] GFP interventions include early multimodal pain management,[13] delirium prevention,[14] management of medical co-morbidities,[13,14] early operative fixation,[15,16] early mobilization,[17] and early discharge planning.[10,11,17] Many GFPs also include preoperative regional

anesthesia that has been shown to reduce overall opioid requirements,[18] reduce rates of delirium[19] and relieve pain more effectively than standard care.[20] Other elements of multimodal pain management include acetaminophen,[13] urinary catheter use,[17] and patient positioning.

Our overall goal was to determine the effects of a multidisciplinary GFP on the emergency department (ED) pain management of fragility hip fractures. We hypothesized that the implementation of a GFP in the ED would be associated with increases in the use of regional anesthesia and acetaminophen and decreases in the time to first analgesic and amount of opioid medication.

Population Health Research Capsule

What do we already know about this issue?
Geriatric fracture programs (GFP) reduce mortality, morbidity, and hospital costs for geriatric patients with hip fractures.

What was the research question?
Does a GFP improve ED pain management for geriatric patients with hip fractures?

What was the major finding of the study?
A GFP was associated with enhanced ED pain management for geriatric patients with hip fractures.

How does this improve population health?
A GFP was associated with decreased variability in analgesia timing and use and with more patients receiving evidence-based pain management.

METHODS

Study Design

This was a retrospective, before-and-after cohort study using data from the University of California, Davis Health System's electronic health record (EHR). This study was approved by our institutional review board.

Study Setting and Population

We performed this study at a single urban, academic ED with an annual volume of approximately 60,000 adult patients. Our hospital is a tertiary care facility with 619 licensed acute care beds and serves a 65,000 square-mile area that includes 33 counties and six million residents. Our hospital implemented the GFP on January 1, 2014. The GFP was developed by the departments of orthopaedics, internal medicine, anesthesiology, pharmacy and emergency medicine and was started as a quality improvement program on January 1, 2014. The program includes osteoporosis screening, medical co-management, operative fixation within 48 hours, early physical/occupational therapy including mobilization and early discharge planning, as well as strategies to recognize, prevent and manage delirium. The GFP team meets weekly to discuss patient and system issues. In the ED, the GFP includes a multimodal pain-control order set consisting of early acetaminophen, opioid medication, and fascia iliaca compartment block (FICB) regional anesthesia.[21] ED providers received both didactic and practical training on the administration of FICB in the fall of 2013 and approximately annually thereafter. They were also educated on opioid and non-opioid strategies for pain relief. Information was also distributed via email and posters in the ED. Emergency medicine residents perform most FICBs. Indications for FICB include moderate to severe pain or receipt of two or more doses of opioids. Contraindications include, but are not limited to, use of anticoagulants or oral antiplatelet agents (not including aspirin) and inability to obtain informed consent. During both periods, the study site ED's procedure was to complete a pain assessment (a) immediately upon presentation at hospital and (b) within 30 minutes of administering initial analgesia, and (c) regularly as part of routine nursing observations throughout ED stay. The pre-GFP period extended from December 27, 2011, to December 31, 2013, and the post-GFP period extended from January 1, 2014, to January 9, 2016.

We included all patients age 65 years and older who presented via the ED with a unilateral, native, non-pathologic, low-energy, proximal femur fracture (including subcapital, intertrochanteric and subtrochanteric hip fractures) who were admitted to the hospital. We excluded patients under 65 years of age, fractures resulting from high-energy mechanisms (ex. motor vehicle collision, falls from greater than five feet), periprosthetic fractures, isolated trochanteric fractures, femoral shaft fractures and patients with multiple injuries.

Study Protocol

Eligible patients were initially identified based on an International Classification of Diseases (ICD)-9-CM code of 820.xx, 821.xx, or 733.14 prior to October 1, 2015, or an equivalent ICD-10 code (Appendix A) after October 1, 2015. These charts were manually reviewed for the inclusion and exclusion criteria. The following elements were directly extracted from the EHR: sex, age, admitting service, and American Society of Anesthesiologists class. The following elements were manually abstracted from the EHR using a standardized form designed a priori: race, ethnicity, acetaminophen administration in the ED, FICB use, contraindications for FICB, and complications of FICB. Time to imaging, time to surgery, ED length of stay, time

to first analgesic, time to first opioid analgesic, time to acetaminophen administration and total intravenous (IV) morphine equivalents outside of the operating room in the first 24 hours were calculated from data directly and manually abstracted from the EHR. One reviewer abstracted patient data for all outcomes. The reviewer was blinded to the study's hypotheses and patient group (pre- vs. post-GFP period). An independent reviewer randomly selected 30 charts and abstracted data on two outcomes (IV morphine equivalents and ED acetaminophen administration). We collected and managed study data using REDCap electronic data capture tools hosted at the University of California, Davis.[22]

Key Outcome Measures

Our primary outcomes were FICB use in the ED, acetaminophen use in the ED, time to first analgesia, and IV morphine equivalents administered in the first 24 hours. We also evaluated race and sex differences in these outcomes.

We defined ED length of stay as the time from ED triage to the time that the patient physically left the ED. ED acetaminophen was defined as any administration of acetaminophen (oral, rectal, or IV) while the patient was in the ED. Time to first analgesic was defined as the time from ED triage to first administration of any analgesic. IV morphine equivalents in the first 24 hours included all opioid medications administered outside the operating room within 24 hours of ED arrival. We used a calculator approved and used by the UC Davis Medical Center Pharmacy and Therapeutics Committee to convert all other opioid medications to IV morphine equivalents (Appendix B).

Data Analysis

We calculated summary statistics. To evaluate inter-rater reliability, we used kappa coefficient for the binary outcome and Pearson's correlation coefficient for the continuous outcome. Chi-square and Fisher's exact tests were used to compare patients in the pre-GFP and post-GFP periods. We compared binary outcomes between the pre-GFP and post-GFP period using two-sample binomial Z-tests. Both time to first analgesic and IV morphine equivalents had skewed distributions. Hence, we used regression models and permutation tests to assess the statistical significance for independent variables. To compare mean differences in these outcomes between periods, we fit regression models to these outcomes and applied permutation tests to the resulting regression coefficients to obtain valid p-values.[23] To compare differences between the pre- and post-GFP periods we fit simple regression models. To assess sex and race differences, we fit a multiple regression model that adjusted for period, race, and sex. Equality of variance was analyzed using median-based Levene testing. For all analyses, a $p<0.05$ was considered statistically significant. We performed analyses using Stata Version 14.1 (StataCorp LP, College Station, TX).

RESULTS

Of 325 patients with eligible diagnosis codes, 17 patients were excluded from the study due to non-isolated injuries (6), high-energy mechanism (5), peri-prosthetic fracture (2), femur fracture with no hip involvement (2), lack of an acute fracture (1), and pathologic fracture (1). We studied 131 patients in the pre-GFP period and 177 patients in the post-GFP period. The majority of patients in the study were female (213, 69%) and White (194, 63%). Median age was 82 years. Demographic and clinical characteristics of the two groups are shown in Table 1.

The two reviewers had perfect agreement for ED acetaminophen use (30/30, 18 "yes;" kappa=1.00) and excellent agreement on outcomes for morphine equivalents (correlation coefficient 0.94). In the post-GFP period, more patients received FICB (6% vs. 60%; difference 54%, 95% CI 45-63%; $p<0.001$) and acetaminophen (10% vs. 51%; difference 41%, 95% CI 32-51%; $p<0.001$) in the ED. Patients had shorter time to first analgesic (103 vs. 93 minutes; $p=0.04$) and received fewer morphine equivalents in the first 24 hours (15mg vs. 10mg, $p<0.001$). Differences in time to imaging, ED length of stay, and time to surgery were not statistically significant between the pre-GFP and post-GFP periods. (Table 2)

No cases of local anesthetic systemic toxicity or other complications were reported for patients who received FICB (0/107; 0%, 95% CI 0-3.3%). Seventy patients (70/177; 40%) in the post-GFP period did not receive FICB. Of these 70 patients, the procedure was contraindicated in 40 patients (57%) due to anticoagulation therapy, nine patients (13%) due to refusal, and one patient (1%) due to anesthetic allergy. In 20 of the 70 patients (29%) there was no documented contraindication to FICB in the EHR.

We observed less variance in amount of opioid medication used ($p=0.006$) and time to first analgesic ($p=0.03$) in the post-GFP period (Figures 1 and 2).

Notably, seven patients in the pre-GFP period but no patients in the post-GFP period received over 60mg IV morphine equivalents for pain control in the first 24-hour period. Twelve patients in the pre-GFP period but only three patients in the post-GFP period received their first analgesic over 600 minutes after ED arrival.

In univariable analysis, non-White patients received less opioid medication than White patients ($p=0.03$). This association persisted ($p=0.03$) in a multivariable analysis adjusting for pre- vs. post-GFP period and sex. There was no interaction between race and pre- vs. post-GFP period ($p=0.07$) with regard to opioid timing. No differences were found in time to first analgesic, acetaminophen use or FICB use between White and non-White patients (data not shown). No sex differences were found in any of the four outcomes (data not shown).

DISCUSSION

We provide one of the first reports of a GFP's effect on ED pain management of fragility hip fractures in the United States.

Table 1. Patient characteristics before and after implementation of a geriatric fracture program in the emergency department.

	Pre-GFP period (n=131 patients)		Post-GFP period (n=177 patients)		p-value
Age (years)	*83 (77-88)		*82 (74-88)		0.9
Female sex	93	71%	120	68%	0.5
Race					0.5
White	89	68%	125	71%	
Black	10	8%	10	6%	
Asian	13	10%	12	7%	
Other	9	7%	20	11%	
Missing	10	8%	10	6%	
Ethnicity					0.2
Hispanic	5	4%	10	6%	
Missing	11	8%	7	4%	
Admitting service					0.02
Orthopedics	88	67%	114	64%	
Internal medicine	10	8%	33	19%	
Trauma surgery	23	18%	24	14%	
Intensive care	1	1%	1	1%	
Missing	9	7%	5	3%	
ASA class					0.3
Class 1	0	0%	0	0%	
Class 2	18	14%	18	10%	
Class 3	76	58%	118	67%	
Class 4	31	24%	32	18%	
Class 5	0	0%	1	1%	
Missing	6	5%	8	5%	

GFP, geriatric fracture program; *ASA*, American Society of Anesthesiologists.
*Data presented as median (Q2-Q3).

Table 2. ED pain management and time intervals before and after implementation of a geriatric fracture program.

Clinical outcome	Pre-GFP period (n=131 patients)	Post-GFP period (n=177 patients)	p-value
Time to first pain medication (minutes)*	103 (52-203)	93 (50-192)	p=0.04
Time to first opioid medication (minutes)*	103 (52-203)	104 (51-220)	p=0.15
Morphine equivalents in first 24 hours (mg)*	15 (8-24)	10 (5-17)	p<0.001
Acetaminophen use in ED	13 (10%)	91 (51%)	p<0.001
FICB use in ED	8 (6%)	107 (60%)	p<0.001
Time to imaging (minutes)*	70 (47-137)	111 (70-167)	p=0.20
ED length of stay (hours)*	8.7 (6.4-11.7)	8.7 (7-12.5)	p=0.65
Time to surgery (hours)*	25 (19-39)	26 (20-41)	p=0.39

GFP, geriatric fracture program; *ED*, emergency department; *FICB*, fascia iliaca compartment block.
*Data presented as median (Q2-Q3).

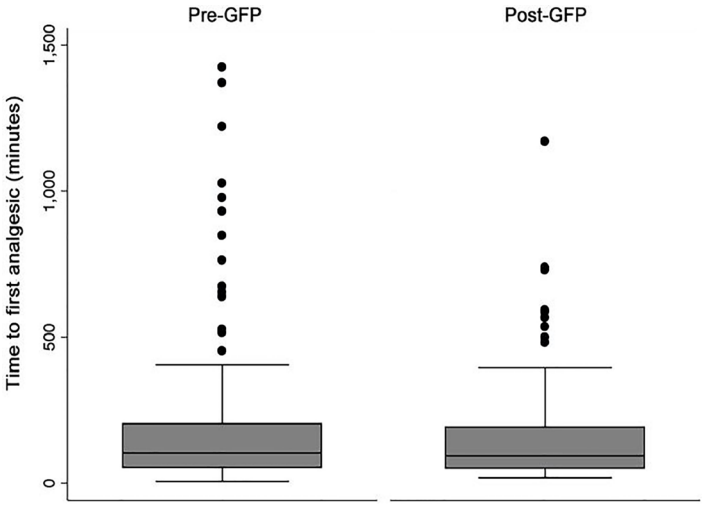

Figure 1. Time to first analgesic in minutes before and after implementation of a geriatric fracture program (GFP).

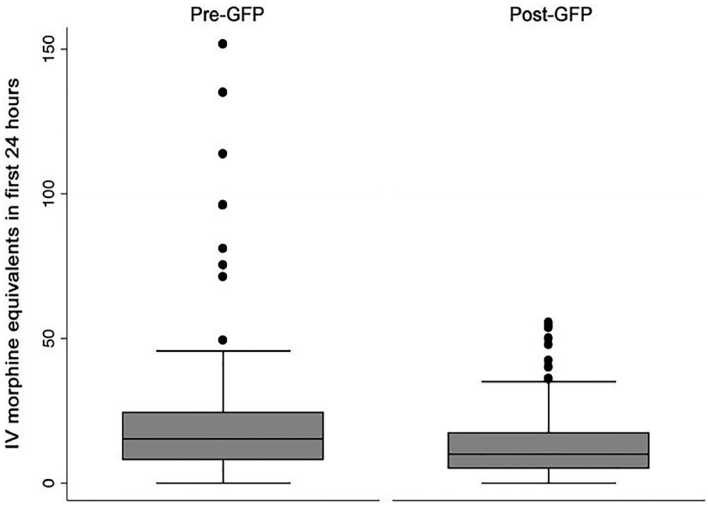

Figure 2. Intravenous (IV) morphine equivalents (mg) before and after implementation of a geriatric fracture program (GFP).

Overall, our results suggest that patients received earlier and more comprehensive ED pain management following the implementation of a GFP as evidenced by increased usage of regional anesthesia and acetaminophen along with decreased patient opioid requirements and time to first analgesia. The decrease in opioid use was likely due to pain relief provided by the FICB and acetaminophen. Pain management in this population is important because good pain control is associated with increased mobility, fewer complications resulting from immobility, and decreased rates of delirium. Rapid pain management in this population is also important because time to administration of oral, parenteral or intranasal pain medication is a Medicare quality measure for patients presenting with a long bone fracture.[24]

Our data demonstrate the feasibility and safety of FICB performed in the ED by emergency physicians (EP). We adopted conservative guidelines from the American Society of Regional Anesthesia and Pain Medicine[25] in the design of the FICB clinical pathway and received support from the departments of anesthesia and pharmacy. FICB was chosen over femoral nerve block to avoid injury to the vascular bundle and to decrease the risk of local anesthetic systemic toxicity. To our knowledge, no patients suffered local anesthetic systemic toxicity or other complications from the FICB. The safety profile we observed is comparable to that reported in other studies.[19,26-28] Our data suggest that most patients are both eligible for and agreeable to FICB as pain management. Importantly, our FICB clinical pathway had no effect on ED length of stay, time to imaging or time to surgery. This result suggests that FICB can be incorporated into a patient's ED pain management without delaying other aspects of hip fracture care. At our institution, written informed consent is required prior to FICB performance. In the post-GFP period, patients with dementia but no documented contraindications may have lacked a healthcare proxy to consent to the procedure.

The GFP's multimodal pain management education for resident and attending physicians regarding FICB was critical to the program's success. We held annual FICB training sessions with didactic and practical components for EPs. We discovered a need for continued re-education, particularly in July with the arrival of new EPs who were unfamiliar with the FICB clinical pathway.

We found less variability in the post-GFP period in both opioid requirements and time to first analgesia. These differences are likely multifactorial. First, the GFP included an EHR order set that included acetaminophen and set doses of opioid medication. Second, ED provider education emphasized early pain relief. Third, the use of oral or rectal acetaminophen was stressed with occasional use of IV acetaminophen. In our ED, acetaminophen can be ordered by a physician in triage and administered prior to IV access. This decreased variability suggests that more patients are receiving the evidence-based, high-level standard of care included in our GFP clinical pathway.[17]

Non-White patients received less total opioid medication than White patients; however, no racial differences existed in other ED pain management measures. The existence of racial disparities in ED opioid prescribing for long bone fracture is controversial.[29-32] The reasons for this difference in our data are unclear. ED providers may have unconscious racial bias and administer less opioid medication to non-White patients.[33,34] Alternatively, non-White patients may request less opioid medication due to cultural differences in pain management strategies. Further research is necessary to confirm this difference and elucidate the reasons for it. Notably, no sex differences were found in the ED pain management of this population.

LIMITATIONS

Our study has several limitations. While we used strategies to minimize bias, our study is subject to limitations inherent in retrospective studies.[35] We were able to show association between the GFP and outcomes, not causation. Contraindications for FICB were dependent on accurate clinical documentation. Similarly, we were unable to compare pain scores and rates of delirium between the two periods because they were not reliably documented in the pre-GFP period. We evaluated analgesia use in the first 24 hours following ED presentation; possible differences in opioid use after this period remain unknown. The GFP's effect on several other important outcomes such as in-hospital mortality, length of hospital stay and time to ambulation following surgery remain unknown and warrant investigation.

CONCLUSION

Implementation of a GFP was associated with improved ED pain management for geriatric patients with fragility hip fractures via ED use of FICB and acetaminophen. Future studies should evaluate the effects of these interventions on longer-term patient outcomes.

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Physician Variability in Management of Emergency Department Patients with Chest Pain

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Introduction: Chest pain is a common emergency department (ED) presentation accounting for 8-10 million visits per year in the United States. Physician-level factors such as risk tolerance are predictive of admission rates. The recent advent of accelerated diagnostic pathways and ED observation units may have an impact in reducing variation in admission rates on the individual physician level.

Methods: We conducted a single-institution retrospective observational study of ED patients with a diagnosis of chest pain as determined by diagnostic code from our hospital administrative database. We included ED visits from 2012 and 2013. Patients with an elevated troponin or an electrocardiogram (ECG) demonstrating an ST elevation myocardial infarction were excluded. Patients were divided into two groups: "admission" (this included observation and inpatients) and "discharged." We stratified physicians by age, gender, residency location, and years since medical school. We controlled for patient- and hospital-related factors including age, gender, race, insurance status, daily ED volume, and lab values.

Results: Of 4,577 patients with documented dispositions, 3,252 (70.9%) were either admitted to the hospital or into observation (in an ED observation unit or in the hospital), while 1,333 (29.1%) were discharged. Median number of patients per physician was 132 (interquartile range 89-172). Average admission rate was 73.7±9.5% ranging from 54% to 96%. Of the 3,252 admissions, 2,638 (81.1%) were to observation. There was significant variation in the admission rate at the individual physician level with adjusted odds ratio ranging from 0.42 to 5.8 as compared to the average admission. Among physicians' characteristics, years elapsed since finishing medical school demonstrated a trend towards association with a higher admission probability.

Conclusion: There is substantial variation among physicians in the management of patients presenting with chest pain, with physician experience playing a role. [West J Emerg Med. 2017;18(4)592-600.]

INTRODUCTION

Within the emergency department (ED) variation exists in the rate of testing and admission for a variety of clinical conditions.[1-5] This is likely multifactorial and linked to patient, ED, hospital, geographic, and physician-related factors.[6-15] While the emergency physician (EP) typically decides patient disposition, he or she may be influenced by a variety of issues beyond the patient's clinical presentation. Fear of malpractice and risk aversion have both been demonstrated to be predictive of ED admission

rates and testing for clinical conditions including chest pain and abdominal pain.[12,14] In general, variation in care is a well-established marker of low-value care. For example, data from the Dartmouth Atlas in the United States (U.S.) and the National Health Service in the United Kingdom demonstrate that much of the variation is supply sensitive (related to the capacity or supply of the local healthcare system), and that "much of the variation in use of healthcare is accounted for by the willingness and ability of doctors to offer treatment rather than differences in illness or patient preference."[16]

Chest pain accounts for 8-10 million visits per year across the U.S., and about half of these patients are admitted to either an observation unit or inpatient service at a cost of $10-13 billion every year.[17] Evidence continues to accumulate that many of these are "low risk" chest pain patients who are unlikely to benefit from prolonged observation or additional cardiac risk stratification (e.g., stress testing or coronary computerized tomography [CT]).[18-22] Recently developed accelerated diagnostic pathways (ADPs) for chest pain, including the HEART score, have been demonstrated to reduce overall admissions for chest pain without exposing patients to major adverse cardiac events (MACE). [23-25] Growing data suggests that when low-risk criteria are met, additional testing offers no benefit and may increase the mortality rate for this particular subset of chest pain patients.[18-22,26] In addition, modern-generation troponins (generally with 99th percentile of the upper reference limit in a healthy population of < 0.01 µg/L, even without considering high-sensitivity troponins not yet in use in the U.S.) can reliably exclude acute coronary syndrome (ACS)when done in serial testing without additional risk stratification.[27-29] On the other hand, one recent study of Medicare patients found an association between more conservative practice (higher admission rates) and lower incidence of acute myocardial infarction (MI) and death for this patient population.[30]

We live in an era in which available pathways exist to risk stratify patients with chest pain and rapidly rule out ACS with increasing accuracy but where clinical guidelines suggest 72-hour provocative testing[31] and substantial medico-legal risk still pervades practice. Our major objective was to determine if chest-pain admission variation exists between physicians and what physician-related factors might predict this variation after controlling for appropriate patient and hospital factors. In essence, this paper purports to evaluate the extent to which variation exists in a common condition, and to elucidate some of the reasons why it might exist.

Population Health Research Capsule

What do we already know about this issue?
There is substantial variation in rates of admission from the ED for patients with chest pain.

What was the research question?
Are there factors related to the individual physician that predict this variation?

What was the major finding of the study?
After controlling for patient level variables, physician-level factors are associated with variation in admission rates.

How does this improve population health?
Interventions directed at physician decision-making may reduce admission rates and potentially unnecessary cardiac testing, procedures, and costs.

METHODS

This was a single-institution retrospective observational study at a tertiary-care academic facility with an annual ED volume of approximately 55,000 patients. We included all ED visits from 2012 and 2013 with chest pain as the coded discharge ED or hospital diagnosis (*International Classification of Disease-9* codes 786.50, 786.51, 786.52, 786.59, and 413.9). Diagnoses for chest pain were obtained from the hospital administrative database, in which the ED diagnosis for discharged or ED observation patients and the inpatient diagnosis for admitted patients are recorded. We did not evaluate other surrogate markers of potential ACS like dyspnea, dizziness, and epigastric pain. We excluded patients with an elevated troponin (Troponin T ≥0.01 ng/ml) or an ECG demonstrating an ST elevation myocardial infarction since there is unlikely to be any variation around admission rates for patients with obvious ACS. ED visit and admission-level information were obtained from administrative hospital databases. We included physicians with a minimum of 30 patient encounters for chest pain and stratified physicians by age, gender, years since finishing medical school, and residency location (our institution versus other institutions). Since most of this study predates more recent literature on accelerated diagnostic pathways like the HEART score and the 2015 data on the short-term safety of patients with normal ECGs and two normal troponins, decisions in this study were made by individual discretion and not based on a particular accelerated diagnostic pathway.[23,24,29]

We divided the study population into "discharge" and "admission" groups. For the purposes of this study we considered patients placed in observation status (either in the ED or medical floor) to be part of the admission arm. Consistent with current literature and Medicare billing rules, we included any patient with an observation order and two sets of cardiac markers, but a length of stay (LOS) under eight hours, in the "discharge" group. All patients with an observation order and LOS over eight hours were included in our admission group.[30] In our administrative databases we were unable to distinguish between patients placed in observation status in the ED versus those placed in observation status on the inpatient floor. Patients kept in our ED observation unit typically have a LOS over eight hours and under 24 hours, and typically have stress testing performed prior to discharge. Those discharged in under eight hours are still likely to have at least one (more often two) cardiac biomarkers drawn, but then are discharged without additional testing based on a classification as "low risk" chest pain. Thus, the key clinical distinction is whether a patient was felt to be low enough risk to be discharged without prolonged observation or additional provocative testing. This distinction is our anticipated root cause of variance in practice patterns among physicians, which was our primary outcome of interest.

The study was approved by the institutional review board at our institution.

Primary Data Analysis

We used patient-visit as the unit for the univariate analysis and multivariate models, adjusted for the repeated visits. Patient-visit characteristics are presented as mean ± standard deviation (SD) for continuous variables and as percentage for categorical variables. Categorical variables were compared using the chi-square test. We examined continuous variables using unpaired T-testing. Non-parametric variables were compared with Mann-Whitney test.

We assessed individual physicians' rates of admissions by a multivariable logistic regression model using generalized estimation equation (GEE) method, which accounted for clusters of multiple visits by the same patient. Covariance matrix was conservatively defined as unstructured. Variable selection in multivariable modeling was based on clinical and statistical significance. We included the following patient-level variables into the models: patient age, previous ischemic heart disease, hypertension, dyslipidemia, diabetes mellitus, glucose (in increments of 10 mg/dL) and creatinine levels. Physician characteristics were also included in the model and included gender, residency location, and years since medical school graduation. We reported final parsimonious models.

A two-sided P value <0.05 was considered statistically significant. We performed all statistical analyses using SPSS 22.0 (SPSS Inc. Chicago, Illinois, USA).

RESULTS

Study Size

Of 4,585 total patient visits (3,917 distinct patients) presenting with chest pain in the two-year period, 4,577 had documented dispositions. Of these, 3,252 (70.9%) were either admitted to the hospital or into observation status, while 1,333 (29.1%) were discharged after evaluation in the ED. Median number of ED visits per physician was 132 (IQ range 89-172). Average admission rate per physician was 73.7±9.5% ranging from 54% to 96% (Figure 1 presented as rate of discharges). A sizeable majority of the admissions (2,638/3,252; 81.1%) were to observation.

Characteristics of Study Subjects

Mean age in the discharged group was 44 years (±17.3) and 59 years (±14.3) in the admission group (p<0.001). There was statistically significant variation between the prevalence of clinical risk factors and comorbidities including coronary artery disease (CAD), hypertension, diabetes, dyslipidemia (p < 0.001) and atrial fibrillation/flutter (p = 0.032) between the groups. Patient demographic and clinical characteristics for discharge versus admission groups are noted in Table 1. Physician level characteristics are demonstrated in Table 2.

Admission Risk

Results of the unadjusted analysis are displayed in Table 3. In terms of unadjusted factors at the patient level, female patients were less likely to be hospitalized compared to male patients (odds ratio [OR]=0.773; p<0.001 95% confidence interval [CI] [0.680-0.879]). Black patients were less likely to be hospitalized compared to white patients (OR 0.736, p<0.001, 95% CI [0.40-0.846]). Older patients had a higher likelihood of admission (OR=1.066, p<0.001; 95% CI [1.061-1.072]). Comorbidities associated with a higher likelihood of admission included diabetes mellitus (OR=2.199; p<0.001; 95% CI [1.724-2.806]), hypertension (OR=2.203; p<0.001; 95% CI [1.724-2.806]), CAD (OR=3.034; p<0.001 95% CI [2.164-4.252]), dyslipidemia (OR=1.889; p<0.001; 95% CI [1.483-2.407]), and prior cardiac dysrhythmias (OR=1.778; p=0.034; 95% CI [1.045-3.025]). Higher initial glucose and creatinine levels were also significantly associated with higher admission rates (OR=1.007; p<0.001; 95% CI [1.005-1.009] and OR=1.558; p<0.001; 95% CI [1.216-1.998], respectively).

With respect to physician-related factors, female physicians were 1.4 times more likely to admit compared to male physicians (OR=1.415; p<0.001; 95% CI [1.214-1.648]). Physicians with greater patient volume were less likely to admit. (OR=0.995; p<0.001; 95% CI [0.995-0.997]). In the univariate analysis, neither residency location nor duration of experience (p = 0.24) were predictive of admission risk.

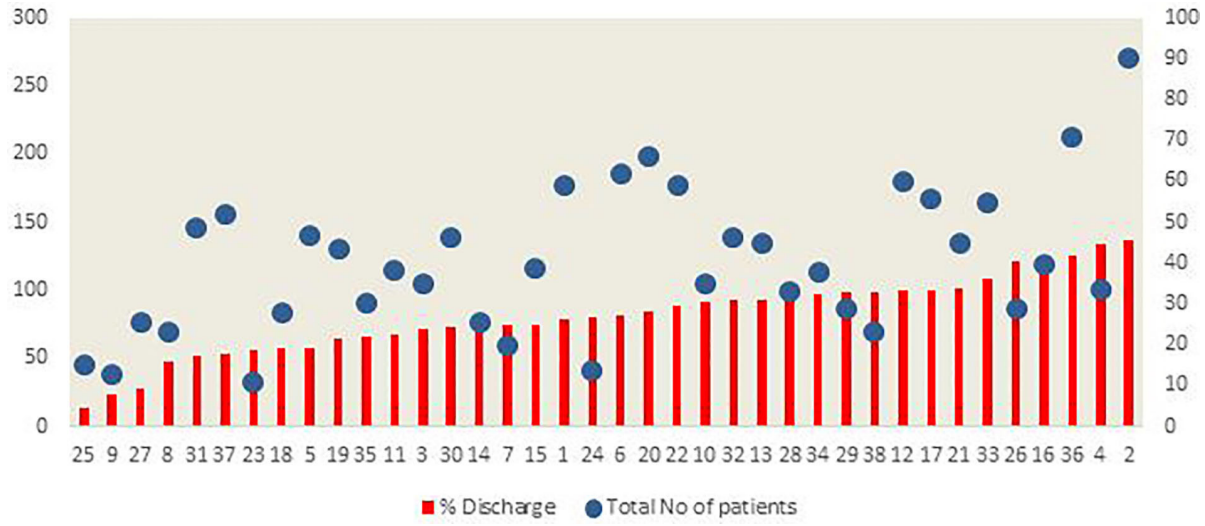

Figure 1. Summary of total patients with chest pain (left vertical axis) who were seen and percent discharged (right vertical axis) by physician. Each red bar and blue dot pair represents an individual physician (n=38).

After controlling for the potential confounders, significant variation remained in admission rate at the individual physician level with adjusted OR ranging from 0.42 to 5.8 as compared to the average admission rate. Factors found to be significant in a multivariate analysis of patient- and physician-level factors include male patient gender, patient age, hypertension, and history of coronary artery disease, with greater physician experience demonstrating a trend towards significance (OR 1.85, p 0.095, 95% CI [0.09 – 3.81]) (Table 4). We assessed the model performance by analyzing c-statistics. C-statistics for the model was 0.78 (95% CI [0.74-0.86]). After controlling for the potential confounders, significant variation remained in admission rate at the individual physician level with adjusted OR ranging from 0.42 to 5.8 as compared to the average admission rate (Figure 2).

Table 1. Patient demographic and clinical characteristics in study of variation in rates of admission from the ED for patients with chest pain.

Variable	Discharge, n = 1333	Admission, n = 3252	p value
Age, mean (SD)	44 (17.3)	59 (14.3)	< 0.001
Gender, n male (%)	570 (42.8)	1598 (49.1)	< 0.001
Race, n (%)			
White	847 (63.8)	2265 (70)	< 0.001
Black	436 (32.8)	858 (26.5)	< 0.001
Asian	40 (3.0)	86 (2.7)	< 0.001
Co-morbidities, n (%)			
Coronary artery disease	40 (3.0)	279 (8.6)	< 0.001
Diabetes mellitus	84 (6.3)	419 (12.9)	< 0.001
Congestive heart failure	2 (0.2)	12 (0.4)	0.376
Hypertension	243 (18.2)	1071 (32.9)	< 0.001
Dyslipidemia	87 (6.5)	379 (11.7)	< 0.001
Smoking	34 (2.6)	84 (2.6)	0.950
Atrial fibrillation/flutter	17 (1.3)	73 (2.2)	0.032
CVA/TIA	4 (0.3)	9 (0.3)	1

CVA, cerebrovascular accident; *TIA,* transient ischemic attack.

Table 2. Individual physician characteristics.

Variable	Physicians (n, %), total = 38
Gender	
Male	28 (73.7)
Medical school in the USA	35 (92.1)
Residency location	
Study hospital	12 (31.6)
Other hospital	26 (68.4)
Years since medical school, n (%)	
<5	4 (10.5)
6-10	10 (26.3)
11-20	17 (44.7)
>20	7 (18.4)

DISCUSSION

Our data supports the initial hypothesis that variation exists in admission and rates for patients presenting to our hospital with chest pain, and suggests that this variation is at least to some degree attributable to physician-related factors. This variation persists despite major improvements in the sensitivity of troponins to adequately rule out potential ACS acute coronary syndromes.[26,27]

Of note, while there are multiple factors within the univariate analysis that suggest factors with significant correlation to admission, only a few of these factors remain relevant when controlling for potential confounders. Additionally, it is not surprising that a few of the patient-level factors (namely age, comorbidities, and abnormal lab results) are associated with admission. What is interesting – and the main finding of this paper – is that after controlling for potential confounders, considerable variation in rates of admission exists that is at least to some degree attributable to physician-level factors.

Within the domain of chest pain, while it is possible that some of this variation will be eliminated by the adoption of new ADPs, this study simply affirms the presence of a substantial amount of variation at the physician level in one of the most common clinical conditions presenting to EDs worldwide. One of the most surprising features was the actual breadth of variation between physicians practicing at the same facility. This underscores the importance of variation as a

Table 3. Univariate analysis of patient- and physician-level characteristics' impact on variation in admission rates of patients with chest pain.

Variable	Odds ratio	95% CI, lower limit	95% CI, upper limit	p value
Patient age	1.066	1.061	1.072	<0.001
Patient gender	0.773	0.680	0.879	<0.001
Race (Reference white)				
Black	0.736	0.640	0.846	<0.001
Asian	0.804	0.548	1.180	0.804
Patient comorbidity				
Smoking	1.013	0.677	1.517	0.950
Dyslipidemia	1.889	1.483	2.407	<0.001
Diabetes mellitus	2.199	1.724	2.806	<0.001
Hypertension	2.203	1.724	2.806	<0.001
Coronary artery disease	3.034	2.164	4.252	<0.001
Congestive heart failure	1.465	0.551	11.128	0.238
Cardiac arrhythmia	1.778	1.045	3.025	0.034
Stroke/transient ischemic attack	0.922	0.283	2.999	0.893
Creatinine	1.558	1.216	1.998	<0.001
Glucose	1.007	1.005	1.009	<0.001
Troponin	4.066	0.304	54.420	0.289
Number patients per physician	0.996	0.995	0.997	<0.001
Years since medical school	0.995	0.986	1.004	0.244
Residency within study institution	0.983	0.862	1.122	0.804
Attending gender	1.415	1.214	1.648	<0.001

Table 4. Multivariate analysis of patient- and physician-level characteristics' impact on variation in admission rates of patients with chest pain.

	Odds ratio	95% CI, lower limit	95% CI, upper limit	p value
Male patient gender	1.34	1.17	1.54	<0.001
Age above 60 years	3.35	2.85	3.95	<0.001
Hypertension	1.42	1.21	1.68	<0.001
Diabetes mellitus	1.74	1.33	2.27	<0.001
History of CAD	2.28	1.58	3.30	<0.001
5 or more years from medical school graduation	1.85	0.90	3.81	0.095
Individual physician*				<0.001

CAD, coronary artery disease.
Adjusted odds ratio shown in Figure 2.

general phenomenon in healthcare, both likely in terms of intensity of testing and selection of patient disposition, as well as the central role of the physician as the main driver of variation. In general, variation is understood to be a marker of low-value care. Variation is prevalent across many conditions both within emergency care and other areas of healthcare, and it has been previously demonstrated to be related to several domains including patient, ED, hospital, geographic, and physician-related factors.[6-15,32-35] Thus, while our paper focuses on chest pain, we suspect these findings will be generalizable to other conditions within emergency care.

One of the interesting features of our findings was the trend towards an association of greater physician experience with greater rates of admission. There are many potential explanations for this. Older physicians may lag in terms of education with respect to the increased sensitivity of newer generation cardiac biomarkers, may be simply less likely to modify practice patterns to novel techniques, or may be overall less tolerant of risk. It is possible that with greater experience comes a greater appreciation for unanticipated

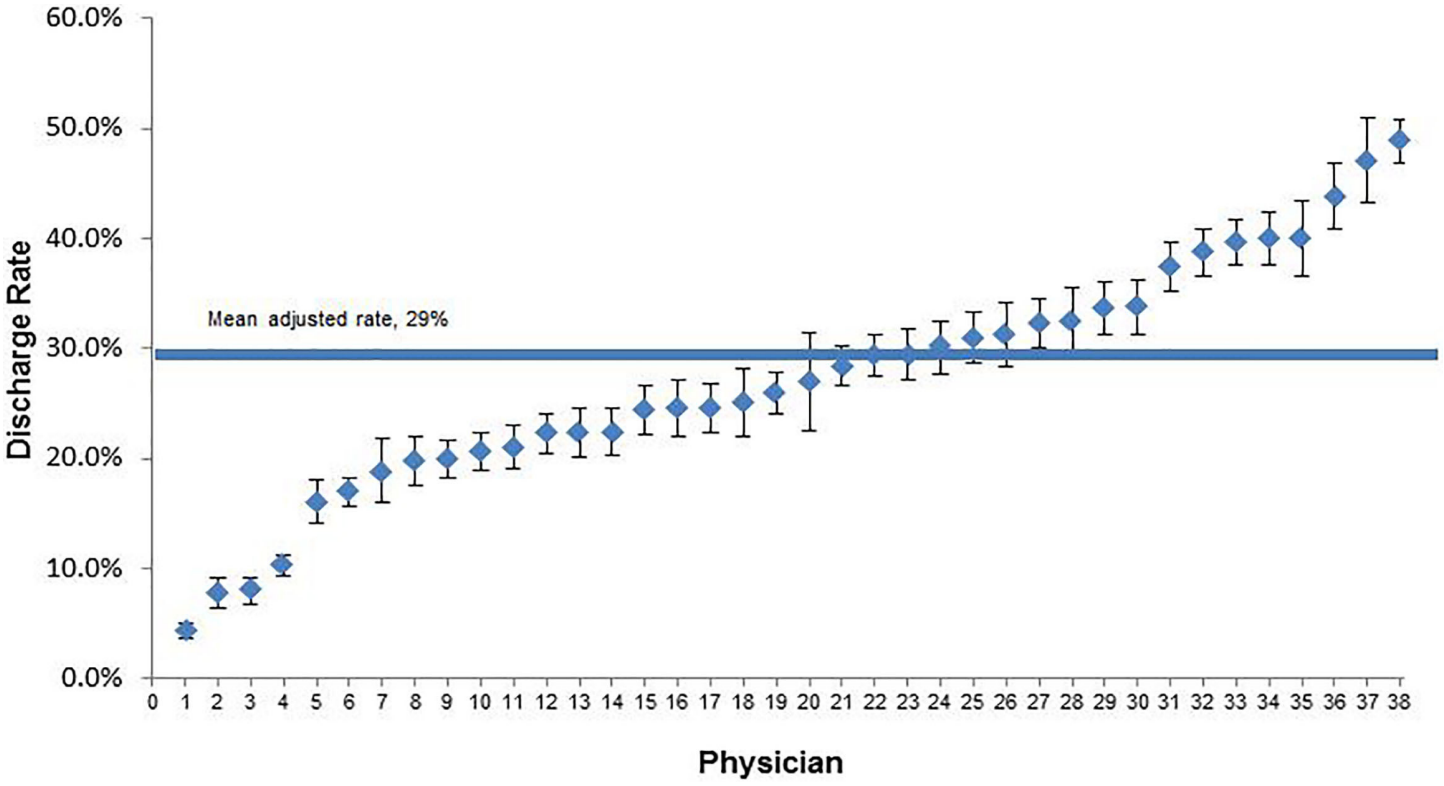

Figure 2. Adjusted physician-level variation in discharge rates represented by likelihood of discharge compared to average discharge rate.

outcomes, or that physicians are simply more likely to experience a lawsuit the longer they practice. Previous studies have been mixed in terms of the impact of physician experience on levels of testing and admission.[10,36,37] Further work will be necessary to clarify the exact impact and role of experience, how it differs for different clinical conditions, and how it interacts with risk tolerance.

Whatever the cause of physician-related variation in chest pain admission, this phenomenon suggests that interventions at the level of the physician – including evidence-based pathways and modern ADPs – may have the potential to provide support for decision-making and reduce variation in practice patterns and in turn reduce healthcare costs. Our results suggest that establishment of an ADP in our institution may help reduce variation and over-reliance upon observation or hospital admissions by establishing an evidence-based approach to risk stratification. However, even the HEART score relies on clinician gestalt as one of its major decision points, which may limit its effectiveness in reducing existing variation and admission rates.[24]

LIMITATIONS

Our most notable limitation is that this is a single-institution study. While this may limit the generalizability of the results, we believe the findings are consistent with existing literature with respect to variation in practice patterns. Another potential limitation is that we did not discern between ED observation status and inpatient observation status. While our cutoff of eight hours was intended to include in the "admission" group only those that were intended to receive prolonged evaluation, this still may not accurately reflect the thought process of the ordering physician. It is clear that this designation of "observation" patients as "admissions" may overestimate our overall percent of patients classified as admitted. While our true rate of admissions is undoubtedly lower than the roughly 70% found in our study, this does not reduce the impact of the observed variation in admission rates. Our true admission rate is likely higher than average, perhaps driven in part by a relatively conservative practice style in the Northeast U.S.. Furthermore, while in many hospitals in the U.S. patients kept in ED observation units might be counted as discharges, we consider these more appropriate to be counted as admissions since the majority of these patients at our institution will have serial cardiac biomarkers and provocative cardiac testing and therefore accomplish the same evaluation as commonly occurs during an inpatient admission, while those in observation status for less than eight hours typically only undergo two troponin tests without more advanced testing.

Once adjusted for observation stays, our rates would not be unusual for the U.S. The study by Cotterill et al. of Medicare patients found a wide swing in admission rates, with an average rate of 63% and the lowest and highest quintiles ranging from 38 to 81%.[30] We anticipate these numbers will drop with the implementation of modern ADPs.

A further limitation is our lack of data on basic measures of major adverse cardiac events (acute MI, positive cardiac catheterization, cardiac bypass surgery) and the lack of follow-up on outcomes. This was largely intentional since we were aiming to evaluate variation as an outcome and not the safety of decision-making.

We also did not include potential surrogate symptoms of ACS like dyspnea, dizziness, and epigastric pain. The goal of this study was to evaluate whether variation existed for the work-up of chest pain, not all potential presentations of ACS. We anticipate even greater variability in how physicians risk-stratify these other types of commonly presenting symptoms.

Additionally, this was a retrospective study using a hospital dataset that is subject to the limitations inherent in retrospective investigations.

CONCLUSION

In our single-institution study there is substantial existing variation at the physician level in the management of patients presenting with chest pain with a trend towards higher admission rates correlated with greater physician experience. It would be important to know the interaction between physician experience level and risk aversion. Additionally, novel ADPs may moderate the variation in and absolute rate of testing and admission for patients presenting with low-risk chest pain.

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Pitfalls in Electrocardiographic Diagnosis of Acute Coronary Syndrome in Low-Risk Chest Pain

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Less than half of patients with a chest pain history indicative of acute coronary syndrome have a diagnostic electrocardiogram (ECG) on initial presentation to the emergency department. The physician must dissect the ECG for elusive, but perilous, characteristics that are often missed by machine analysis. ST depression is interpreted and often suggestive of ischemia; however, when exclusive to leads V1–V3 with concomitant tall R waves and upright T waves, a posterior infarction should first and foremost be suspected. Likewise, diffuse ST depression with elevation in aVR should raise concern for left main- or triple-vessel disease and, as with the aforementioned, these ECG findings are grounds for acute reperfusion therapy. Even in isolation, certain electrocardiographic findings can suggest danger. Such is true of the lone T-wave inversion in aVL, known to precede an inferior myocardial infarction. Similarly, something as ordinary as an upright and tall T wave or a biphasic T wave can be the only marker of ischemia. ECG abnormalities, however subtle, should give pause and merit careful inspection since misinterpretation occurs in 20-40% of misdiagnosed myocardial infarctions. [West J Emerg Med. 2017;18(4)601-606.]

INTRODUCTION

The chief complaint of "chest pain" causes consternation for countless healthcare providers. Although it accounts for more than eight million emergency department (ED) visits annually, only a fraction will actually have an acute coronary syndrome (ACS).[1,2] Nevertheless, the possibility of impending cardiac death is worrisome for both the patient and provider alike. In the ED we are challenged with identifying those who are at the lowest risk for major adverse cardiac events and safely discharging this subset home. Disposition is aimed at preventing unnecessary hospital admissions and subsequent downstream testing that can be both harmful and costly. Patients who are suitable for a low-risk evaluation should have no hemodynamic or electrical derangements (i.e., dysrhythmias), a normal or near-normal electrocardiogram (ECG), and negative cardiac biomarkers.[2] They should also be screened for other life-threatening non-cardiac causes of chest pain.[2] Thereafter, their symptomatology, risk factors (e.g., diabetes, hyperlipidemia, hypertension) and personal plus family history (e.g., myocardial ischemia, infarction, revascularization) are measured, frequently using a clinical risk-stratification tool (e.g., HEART Score).[2-7] These scoring systems, however, are outside the scope of this article and will be discussed in another article as part of this three-part series. Ultimately those who are low score are considered at minimal risk for ACS based on current data.[2,3,6,7]

Studies seeking to identify which aspect is most significant in the chest pain evaluation have concluded that both ECG and history of present illness (HPI) are pivotal, but imperfect.[4-7] A HPI highlighting exertional chest pain, diaphoresis, vomiting, or a clutching/pressure quality with radiation is "classic" and places the patient at high risk for acute myocardial infarction (AMI), but is not diagnostic.[6,7] In fact studies have shown that even low-risk descriptors, believed to be "atypical" (e.g., sharp, pleuritic, reproducible), are seen in patients with AMI; hence, such

narratives should not be negated.[6,7] Moreover, regarding certain populations (i.e., the elderly, women, diabetics), "classic" symptoms are infrequent and a poor determinant in distinguishing between cardiac and noncardiac causes of chest pain,[6,7] leaving the ECG as the other reliable piece of evidence in the evaluation and stratification of patients. Healthcare providers must take care not to dismiss non-diagnostic and subtle ECG findings as normal or irrelevant. Such misclassification can have fatal consequences.

Nondiagnostic ECG

On ED presentation, fewer than half of patients with a clinical history reminiscent of ACS will have a truly diagnostic ECG.[7-10] The other half will have (1) signs of ischemia, (2) nonspecific ST segment and T-wave (NSSTTW) changes, or (3) a completely normal ECG.[7-10] Disposition of those with either ischemia (i.e., admission) or a truly normal ECG (i.e., risk stratification + cardiac biomarker) is becoming fairly standardized and well defined; but those with NSSTTW changes, defined as ≤1 mm ST elevation or depression with or without reciprocal changes, are more challenging.[8] Although current evidence demonstrates an unchanged overall miss rate in AMI (~2%), what remains clear is that "some proportion of those missed are primarily the result of failure by the emergency physician to detect subtle ST-segment elevation."[11] Therefore, however minuscule (≤1mm ST elevation) NSSTW findings should give pause since they may herald an event. Ischemia can be exhibited in several ways, most commonly T-wave inversion (TWI) or ST depression (STD). These two findings are not equivalent. Patients with STD are known to have a poorer prognosis.[8-10] Likewise, patients with NSSTTW changes are more likely than those with a normal ECG to be transferred from observation to an inpatient unit and have a higher likelihood of developing an infarction.[8-10] If an initial ECG is nondiagnostic, NSSTW serial tracings should be obtained to assess for further evolution.[8-10] The ECG is a cornerstone in identification of AMI, and scrutiny for elusive characteristics decreases its likelihood.

The Forgotten Lead (Figure 1)

Typically, when STD is identified, ischemia becomes the first, second, and third diagnoses considered. Serial cardiac biomarkers are obtained and anticoagulation is initiated. In the following scenario, infarction, not ischemia, should be considered first. Elevation in lead aVR with concomitant diffuse STD has been found in association with diffuse subendocardial ischemia and infarction of the basal septum.[12] Considered the "forgotten lead," aVR is frequently ignored and was thought to have no relevance, but its importance has recently become appreciated. In 2013 the Guidelines for Management of ST-elevation Myocardial Infarction (STEMI) issued by the American College of Cardiology Foundation/ American Heart Association added multi-lead STD with coexistent ST-elevation in aVR as an indication for acute reperfusion therapy.[13] This electrocardiographic finding has been observed in patients with left main, proximal left anterior descending, and triple vessel disease.[14] Controversy in the literature does exist as to whether elevation in aVR is indicative of complete or rather sub-occlusive coronary artery disease.[19-20] Thus far, studies have been small, retrospective, and heterogeneous in defining the type of occlusion, collateral circulation, ischemic conditioning, and various other factors. Irrespective elevation in aVR with reciprocal diffuse depressions warrants early aggressive therapy and should not be mistaken as non-specific. Tachycardia, cardioversion, and cardiopulmonary resuscitation all also can cause diffuse STD that resolves over time with normalization of the heart rate, as witnessed with serial ECGs. These unique circumstances

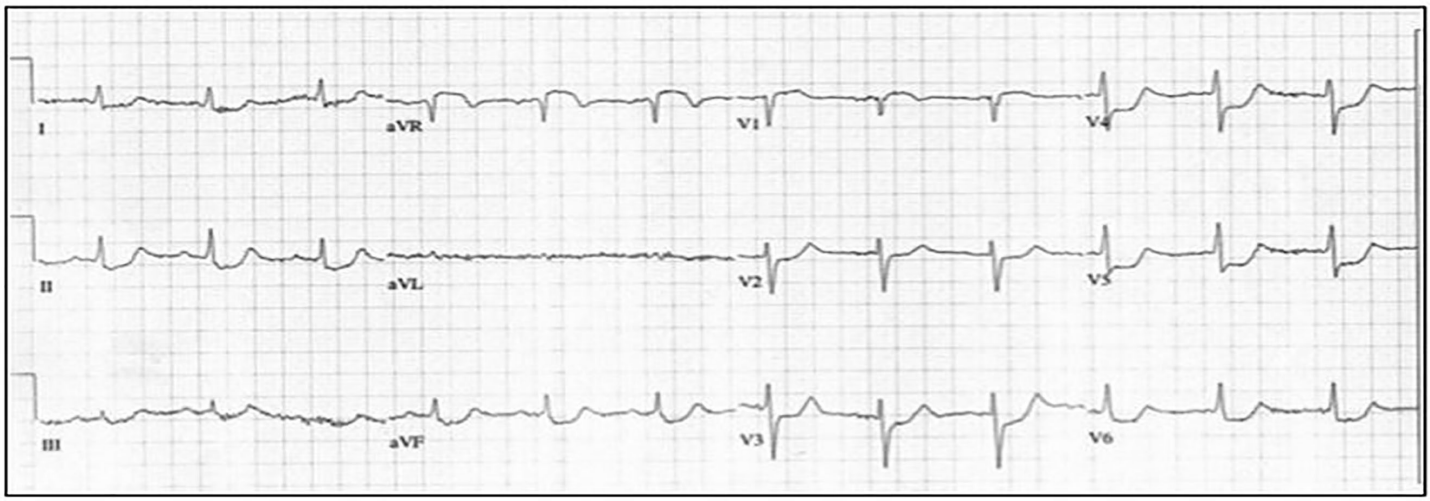

Figure 1. The Forgotten Lead. Diffuse ST depression with ST elevation in aVR>1mm and subtle ST elevation in V1; ST elevation in aVR>V1.

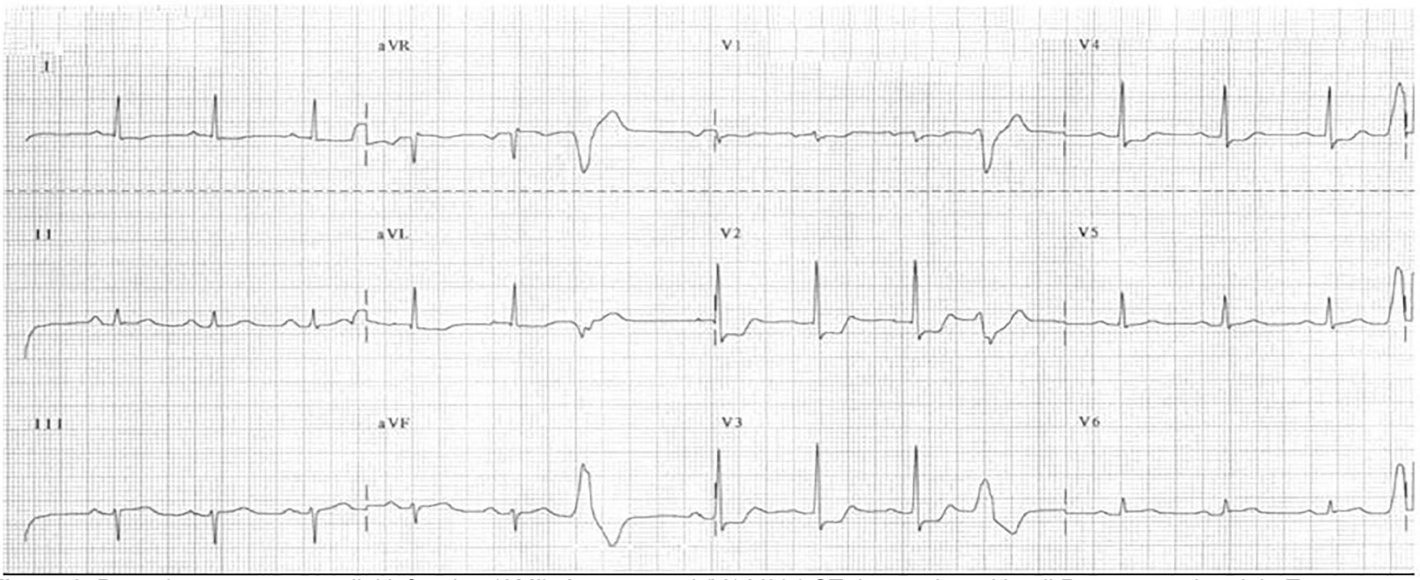

Figure 2. Posterior acute myocardial infarction (AMI). Anteroseptal (V1-V3/4) ST depression with tall R waves and upright T waves.

should be remembered so as not to be confused with AMI.

Posterior AMI (Figure 2)

Another ECG finding that is often mistaken for ischemia when infarction should be considered involves the posterior myocardium. A small percentage of posterior infarcts (~5%) occur in isolation and produce only STD, specifically in leads V1–V3, but the majority of them occur in conjunction with an inferior or lateral infarct, so ST elevations are evident. [21-23] Tall R waves and upright T waves are also characteristically seen in those leads.[21-23] The STD cues many clinicians to diagnose ischemia without considering infarct. Isolated posterior AMI is the most common infarct pattern that is mistaken for ischemia, even though it has been recognized for many years to be secondary to transmural posterior injury. [21] When doubtful regarding infarct versus ischemia, a posterior ECG should be obtained by placing leads V4–6 in the left scapular region. ST elevation of only 0.5 mm in any one lead is diagnostic.[22, 24] Despite the relatively small myocardial involvement with posterior AMI, its clinical sequela is far from inconsequential. It results in moderate to severe mitral regurgitation, an independent predictor of long-term heart failure and infarct-related mortality, in up to one third of patients.[25]

Inferior AMI (Figure 3)

When electrocardiographic findings are isolated in a single lead, they are frequently placed into the normal or NSSTW category. But even in isolation, certain findings should be considered a forewarning. To many physicians, a lone TWI in aVL would be considered insignificant; however, a number of studies have demonstrated the importance of aVL T-wave changes in recognition of right ventricular involvement, specifically its association with an imminent inferior AMI.[26-28] T-wave changes, especially in lead aVL, have not been emphasized and are not well recognized across all specialties. The accumulating evidence with regard to TWI in aVL indicates that it should not be considered normal or nonspecific despite its isolation.[29]

Ischemia

In most people, lead V1 looks akin to aVR because the main vector of ventricular depolarization is going away from both leads. During normal depolarization the QRS vector rotates from rightward to left corresponding to deep S waves in the right precordial leads (V1-2) and larger R waves in the left precordial leads (V5-6). The midprecordial leads (V3-4) typically show equal R and S waves; hence, it's called the transitional zone. The direction of the T wave in V1 depends on how much the vector is oriented anteriorly; it may be upright or inverted, but it's expected to be upright throughout the rest of the precordium. Although an upright T wave in V1 is considered a "normal variant," caution should be taken when the T wave is both upright and large. Specifically when it's taller than the T wave in lead V6 it is referred to as loss of precordial T-wave balance (Figure 4).[30] This scenario portends a high likelihood of coronary artery disease and, when new, should raise concern about ischemia.[31-34]

Another troublesome finding is a biphasic T wave. An initial positive deflection followed by terminal negativity in leads V2 and V3 is highly specific for subacute stenosis of the left anterior descending artery.[35, 36] This pattern is indicative of

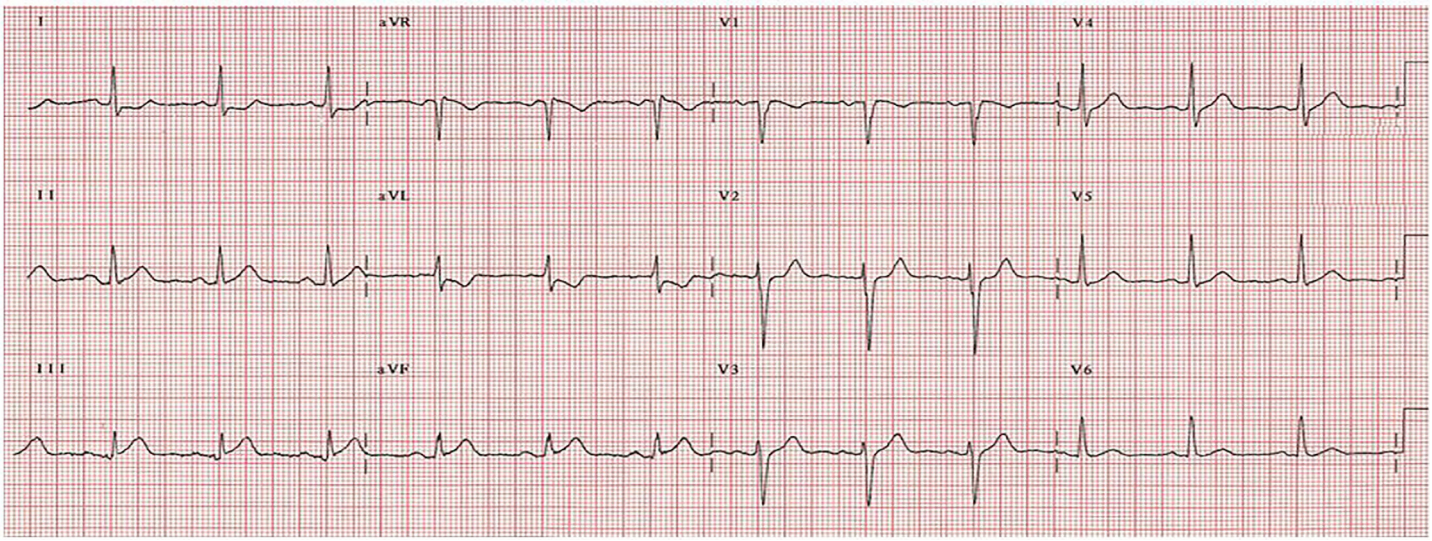

Figure 3. Inferior AMI. High lateral (I, aVL) ST depression with inferior (II, III, aVF) ST elevation.

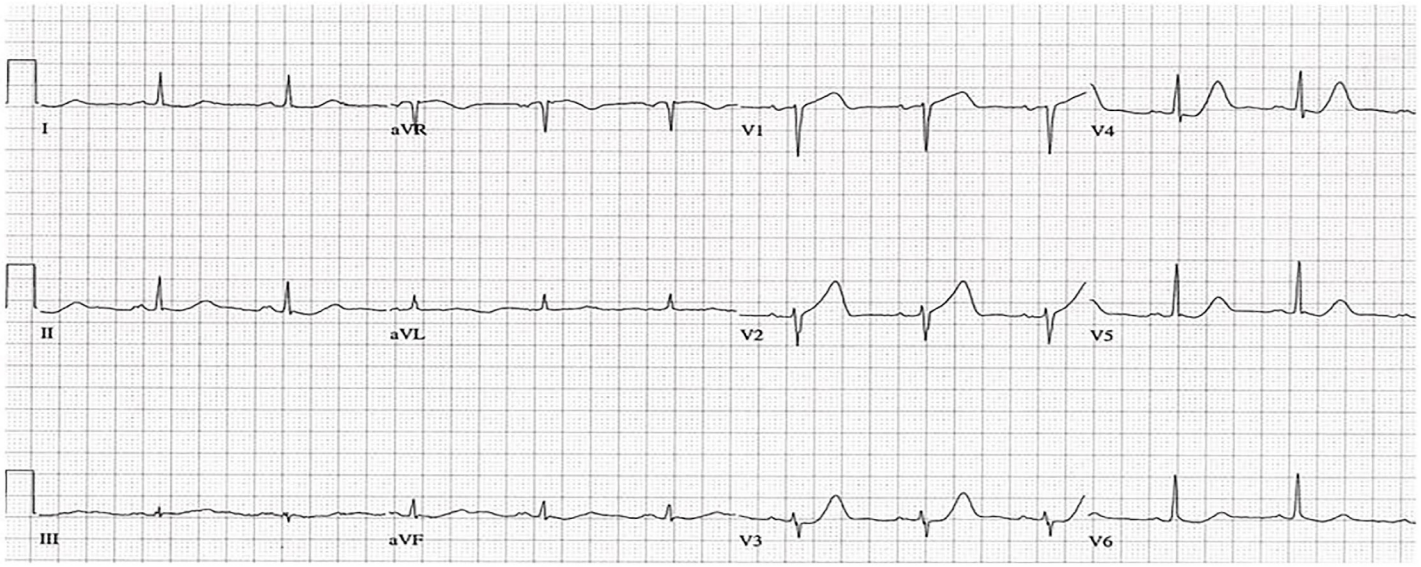

Figure 4. Tall T wave V1. Broad upright T wave V1>V6 with subtle septal (V1-V2) ST elevation and anterolateral (V4-V6, I) ST depression.

Wellens' syndrome (Figure 5). It was first described by Gerson and colleagues in 1980 as an inverted U-wave pattern[37-38] and then further delineated by De Zwaan and associates in 1982. It consists of characteristic electrocardiographic findings suggesting severe stenosis of the proximal left anterior descending artery, which, in most untreated patients, develops into an anterior AMI within days to weeks. The syndrome has two forms. Type A, the more common form (occurring in ~75% of cases), is characterized by deeply inverted T waves in V2 and V3.[35-36] Type B, characterized by biphasic T waves in V2 and V3, occurs in ~25% of cases.[35-36] When Wellens' syndrome is suspected, urgent activation of cardiac catheterization resources is recommended.[39-41] Provocative testing is not endorsed, since increasing cardiac demand in a patient with a highly stenosed left anterior descending artery could lead to complete occlusion, resulting in dysrhythmia and even cardiac arrest.[39-41]

CONCLUSION

Despite growing sophistication in computer-based analysis of ECGs, subtleties are often missed by these devices. STD read as ischemia or isolated TWI and biphasic T waves called normal or nonspecific respectively. Practitioners should not be falsely

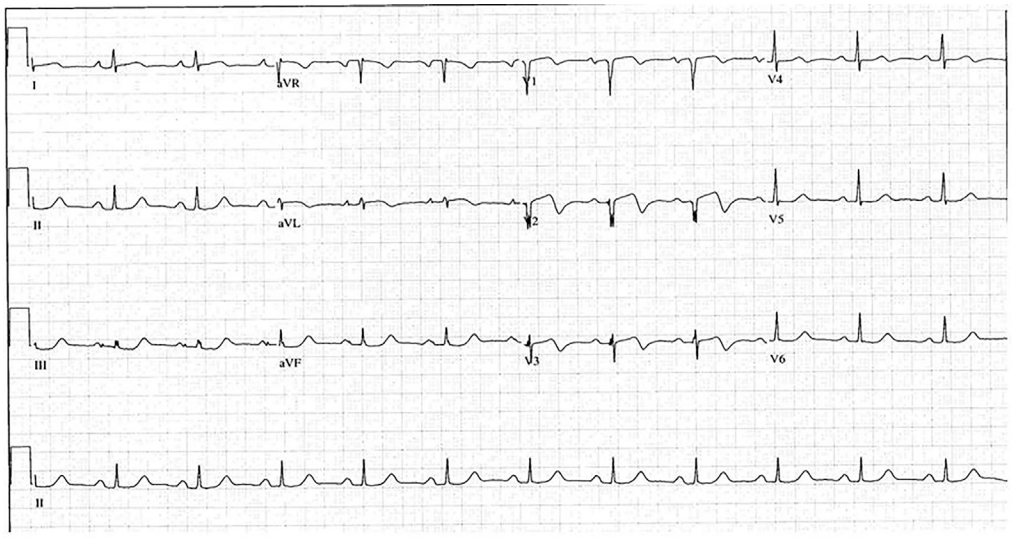

Figure 5. Wellens' syndrome. Biphasic T waves V2-V3 with minimal ST elevation.

reassured since we know many patients will present this way yet go on to have acute coronary syndrome. The astute physician will recognize that a nonspecific or nondiagnostic ECG warrants heightened awareness and close inspection to ensure accurate analysis.

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Optimizing the Use of a Precious Resource: The Role of Emergency Physicians in a Humanitarian Crisis

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Emergency physicians (EP) are uniquely suited to provide care in crises as a result of their broad training, ability to work quickly and effectively in high-pressure, austere settings, and their inherent flexibility. While emergency medicine training is helpful to support the needs of crisis-affected and displaced populations, it is not in itself sufficient. In this article we review what an EP should carefully consider prior to deployment. [West J Emerg Med. 2017;18(4)607-615.]

INTRODUCTION

You wake up at dawn to get ready for a day shift. As you're making coffee and preparing a quick breakfast, you turn on the news. An earthquake measuring 7.0 on the Richter scale has hit Haiti, resulting in chaos, tens of thousands of deaths and injuries. The local healthcare system is overwhelmed, and the pictures are devastating.

While heading to work, you feel deeply moved as you contemplate the suffering in Haiti. As an emergency physician, you are compelled to help. You reason that with only a few shifts to work in the coming two weeks, you could easily move these to deploy and provide assistance. But you have never helped in a crisis response before. You know you want to help in the most impactful way possible but aren't sure what to do.

Emergency physicians (EP) are uniquely suited to provide care in crises as a result of their broad training, ability to work quickly and effectively in high-pressure, austere settings, and their inherent flexibility. A board-certified EP is comfortable treating a trauma victim in one room, complications of pregnancy in another, and geriatric or pediatric emergencies in another. Additionally, EPs are well versed in managing acute complications of non-communicable diseases such as diabetes and hypertension, an increasingly common problem in recent crises as a result of the global burden of disease shifts with improving development.

While emergency medicine (EM) training is helpful to support the needs of crisis-affected and displaced populations, it is not in itself sufficient. In this article we review what an EP should carefully consider prior to deployment. This article will not consider the increasing role EPs play in the development of EM abroad as educators and clinicians. However, many of the principles discussed below apply in that context as well.

ALL AID IS NOT HELPFUL

EPs often wish to assist in the days and weeks following an emergency, but they may have less than 2-3 weeks time available. Often, with the best of intentions, they deploy with whatever group will take them for the short term, or they simply take a flight and arrive, hoping to find a way to help upon arrival. This is a dangerous practice for many reasons.

The influx of a large number of relatively inexperienced individuals and organizations into a crisis area—academic medical centers with limited global health capacity, faith-

based groups, or private organizations have all been culprits—can ultimately cause more harm than good. The 2010 Haiti earthquake was a clear recent example of this. Given physical proximity to the United States, a large number of medical groups and organizations that had neither an understanding of a low-income health system nor the knowledge of working within the international humanitarian community's framework in complex emergencies intervened in Haiti with poor results.[1] The Inter-Agency Standing Committee, a forum for coordination, policy, and development comprised of United Nations operational groups, the International Committee and Federation members of the Red Cross and Red Crescent Movement and non-governmental organizations (NGOs), published a review of the humanitarian response that highlighted the negative impact of this impulsive intervention. Their findings suggest that less-experienced groups do not understand the existing U.N.-based coordination mechanisms in humanitarian response, namely the cluster approach for humanitarian coordination.[2] Less-experienced organizations often did not participate in this cluster system resulting in poor coordination and overlapping or competing efforts that led to waste of limited resources and general chaos.[3]

Public Radio International highlighted the problems specifically created by physicians who flocked to Haiti without adequate training or supplies, minimal previous humanitarian experience, and either poor or no backing by established humanitarian organizations.[4,5] Surgeons arrived without either bringing anesthesia or ensuring that it was available in country. As one seasoned, humanitarian EP described during the interview: "Surgeries were either delayed because surgeons didn't want to operate without the anesthesia, or people had to undergo amputations and other surgeries without anesthesia, which was horrifying." Other surgeons found anesthesia and other medications had expired or no longer worked as a result of improper storage. Smaller, inexperienced groups of providers had done minimal-to-no needs assessments (perhaps because they did not know how), did not coordinate with any formal U.N. mechanisms, had poor supply chains and storage, and ultimately were unable to provide a net positive impact in the region. Even worse, when these groups left, thousands of surgical patients remained without adequate post-operative follow-up, overwhelming local health systems.

As a result, some national and international humanitarian experts have suggested that future responses implement an airport-based screening process for NGOs, only allowing those NGOs with adequate experience, training, and credentials permission to pass through customs during times of crisis.[3] Similarly, EPs and others wishing to assist in a crisis should ensure that they have adequate organizational backing *and* humanitarian training to help, rather than hinder, the response.

HOW TO ENGAGE IN HUMANITARIAN AID RESPONSIBLY

An EP's broad medical knowledge base, coupled with the ability to co-manage different types of patients and priorities, work in chaotic and uncertain environments and generally having flexible schedules, make EM one of the specialties most sought after by humanitarian organizations.[6] However, several principles must be adhered to in order to ensure that EPs engage in humanitarian aid in a positive manner and minimize harm. Prior to deploying, ask yourself the following questions.

Are you appropriately trained to provide care in a humanitarian crisis?

Despite a broad medical training, EPs may not be well prepared to care for the types of illnesses seen in a crisis context or to manage common illnesses in a severely resource-limited context. Clinicians should be familiar with health delivery standards in emergency settings, the disease processes that are commonly seen in the affected country, and the critical public health interventions that are foundational to all humanitarian populations. The average U.S.-based EP has likely not seen malaria, acute malnutrition or cholera, or appreciated the devastating consequences of missing key vector, water and air-borne diseases in temporary settlements.

Measles, cholera, bacterial and parasitic diarrhea, acute respiratory tract illness, malaria, and other infectious diseases are often seen during the acute phase of a crisis. As a result, immediate priorities in an emergency include measles vaccination and adequate provision of water and sanitation, food and nutrition.[7] Post emergency-phase priorities later broaden to include reproductive health, HIV and tuberculosis programs, and psychosocial and mental health needs. Reproductive health needs may be complicated by high rates of sexual violence in certain settings.

A globally aging population and increased rates of obesity, smoking, and poor dietary habits have also led to a dramatic increase in the burden of non-communicable disease in low- and middle-income countries.[8] As such, new conflict-affected populations reflect this: Refugees from Syria, Iraq and Afghanistan suffer from high rates of diabetes, hypertension, obesity and smoking and often present to NGO health facilities with complications of untreated non-communicable diseases, presenting clinicians with the unique challenge of managing resource-intensive chronic illnesses in resource-limited settings.[9-13] These priorities are reinforced in the internationally recognized "Sphere standards," which provide expert, consensus-based best practices for delivery of services in humanitarian crises, including both natural disasters and conflict.[14]

Thus, EPs deploying to crisis settings need to be well versed not only in traditional infectious disease needs of displaced populations, trauma management, and reproductive

health, sexual violence and mental health needs, but in the management of non-communicable diseases as well – and understand how these health needs can be most appropriately and sustainably treated in a crisis setting.

Typically, the scope of medical practice in humanitarian populations requires dedicated training, which most well-established humanitarian organizations offer after one has been accepted by the organization and prior to field deployment.[15,16] Humanitarian studies courses, ranging from a few weeks to year or two-year masters' degrees with humanitarian tracks, are available at many institutions.[17] The table provides useful field texts on health issues in crises, several of which are online or field portable.

Do you understand how humanitarian aid works?

Many stakeholders participate in humanitarian response, each with defined perspectives, roles, missions and mandates (Figure 1). Over the past several decades, humanitarian practitioners have made extensive strides towards professionalization of the field. Practitioners should understand the well-developed systems that exist for the delivery of care in crisis settings prior to deployment. At the outset of a crisis, the U.N. Office for the Coordination of Humanitarian Affairs (UN-OCHA) determines the type of response needed and may decide to declare the highest level (Level 3) emergency, immediately mobilizing funds and requesting the assistance of international health NGOs (such as Médicins Sans Frontieres (MSF), International Rescue Committee, International Medical Corps, Médicins du Monde, Mercy Corps, Save the Children, CARE, and the International Committee of the Red Cross/Red Crescent, among others). The coordinating mechanism has established protocols to conduct rapid needs assessments in the immediate aftermath of a crisis to ensure aid is efficient and targets those with the greatest needs. All international and local health organizations are expected to coordinate with UN-OCHA and its modular "cluster system";[18] the health cluster, coordinated by the World Health Organization (WHO), meets regularly throughout a crisis to ensure all health agencies are coordinating, sharing assessment data and program information about areas of greatest need, and distributing aid in a way that avoids duplication or misses populations in need. Additional "clusters" coordinate agencies concerned with water and sanitation, shelter, nutrition, and protection, among others; many of these directly impact population health outcomes.

Several resources that discuss humanitarian coordination mechanisms and standards for delivery of care are available online and free of charge. These include the "Building a Better Response" course (http://www.buildingabetterresponse.org/), which outlines the U.N. cluster system and the importance of coordination, and disasterready.org, a free online resource developed by a coalition of prominent humanitarian organizations that offers a range of courses with topics entitled Humanitarianism, Program/Operations, Protection, Staff

Table. Field texts for health issues in crises.

Brent A, Davidson R, Seale A. *Oxford Handbook of Tropical Medicine*, Oxford, England, 2014, Oxford University Press.
Beeching NJ, Gill GV: *Lecture Notes on Tropical Medicine*, Oxford, England, 2014, Blackwell Publishing Ltd.
Médecins Sans Frontières Reference Books (various): refbooks.msf.org.
Lampard B, et al. Global Humanitarian Medicine and Disaster Relief. In: *Auerbach's Wilderness Medicine*.7th ed. Philadelphia, PA. Elsevier; 2012:1893-1928
Perrin P: H.E.L.P. *Public Health Course in the Management of Humanitarian Aid*, Geneva, Switzerland, 2001, International Committee of the Red Cross.
Connolly MA, editor: *Communicable Disease Control in Emergencies: A Field Manual*, Geneva, Switzerland, 2005, World Health Organization: who.int/iris/bitstream/10665/96340/1/92415 46166_eng.pdf.
WHO Technical Report Series 985: *The Selection and Use of Essential Medicines: Report of the WHO Expert Committee*, 2013, Geneva, Switzerland, 2014, World Health Organization: who.int/iris/bitstream/10665/112729/1/WHO_TRS_985_eng .pdfs/.
David Werner, Carol Thurman, and Jane Maxwell: *Where There Is No Doctor: A Village Health Care Handbook*, 2013, Hesperian Foundation: hesperian.org.
Murray Dickson: *Where There Is No Dentist*, 2012, Hesperian Foundation: hesperian.org.
Maurice King: *Primary Surgery, Volumes I, II, III*, Oxford Medical Publication: primary-surgery.org/start.html.
Surgical Care at the District Hospital: The WHO Manual: who.int/ surgery/publications/imeesc/en/index.html.
Giannou C, Baldan M, War Surgery, May 2010, ICRC: icrc.org/eng/ assets/ les/other/icrc-002-0973.pdf.
Michael B. Dobson: *Anesthesia at the District Hospital*, World Health Organization: who.int/iris/handle/10665/42193.pdf.

*From Lampard B, et al. Global Humanitarian Medicine and Disaster Relief. In: *Auerbach's Wilderness Medicine*.7th ed. Philadelphia, PA. Elsevier; 2012:1893-1928.

Figure 1. Components of the humanitarian aid network, including international organizations, non-governmental organizations (NGOs), private donors, military actors, and community members: An overview of the ways in which these components interact.[34]
WFP, World Food Programme; *UNHCR,* United Nations High Commissioner for Refugees; *UNICEF,* United Nations Children's Fund; *UNRWA,* United Nations Relief and Works Agency; *WHO,* World Health Organization; *FAO,* Food and Agriculture Organization; *OCHA,* Office for the Coordination of Humanitarian Affairs.

Welfare, Management and Leadership, and Staff Safety & Security. Finally, the Sphere standards referenced above[14] should be familiar to all clinicians deploying to a crisis setting.

The best way to ensure adequate preparation is to deploy with a well-established, reputable humanitarian organization with experience in preparing volunteers and employees prior to deployment. Below, we outline some key issues to consider in evaluating an organization.

Should I deploy with this organization?

Well-established humanitarian NGOs have a long history of working in crisis settings, require training of all deployed clinicians and field workers, and generally require a minimum deployment of a month or more. [19] These organizations will have well-developed security and evacuation protocols, medical insurance for field workers, human resources departments, logistics expertise, and a history of working effectively with U.N. coordination mechanisms, national ministries of health, as well as other local and international NGOs.

Staff with these organizations may have professional degrees in humanitarian aid, and are familiar with international resources and standards for the provision of aid such as the aforementioned Sphere standards and WHO emergency health kits.[20] They are intimately familiar with the ways in which health needs interact with food and nutrition, water and sanitation, and other sector systems that are disrupted after a disaster or conflict.

If you decide that deploying is the right decision for you,

Action Contre la Faim (Action Against Hunger)
ACF, a global humanitarian organization committed to ending world hunger, works to save the lives of malnourished children while providing communities with access to safe water and sustainable solutions to hunger: actionagainsthunger.org

Alliance for International Medical Action
ALIMA operates a new model for responding to humanitarian crises. It brings together the medical expertise of international humanitarian aid workers with that of national medical organizations and global research institutions to provide quality medical care to people in need: alima_ong.org/en/

International Committee of the Red Cross
The ICRC is an impartial, neutral, and independent organization with an exclusively humanitarian mission to protect the lives and dignity of victims of armed conflict and other situations of violence and to provide them with assistance: icrc.org/en

International Federation of the Red Cross and Red Crescent Societies
The world's largest humanitarian organization, the IFRC carries out relief operations to assist victims of disasters, and combines this with development work to strengthen the capacities of its member National Societies: ifrc.org/en

International Medical Corps
The IMC works to relieve the suffering of those affected by war, natural disaster, and disease by delivering vital healthcare services that focus on training and helping devastated populations return to self-reliance: internationalmedicalcorps.org

International Rescue Committee
The IRC helps people whose lives and livelihoods are shattered by conflict and disaster, through provision of healthcare, infrastructure, learning, and economic support: rescue.org

Médecins du Monde (Doctors of the World)
MDM provides emergency and long-term medical care to vulnerable populations while fighting for equal access to healthcare worldwide: doctorsoftheworld.org

Médecins Sans Frontières (Doctors Without Borders)
MSF is an international, independent, medical humanitarian organization that delivers emergency aid to people affected by armed conflict, epidemics, natural disasters, and exclusion from healthcare: msf.org

Partners in Health
PIH strives to achieve two overarching goals: to bring the benefits of modern medical science to those most in need of them and to serve as an antidote to despair: pih.org

Save the Children
Save the Children ensures that children affected by floods, famines, earthquakes, and armed conflict get life-saving medical aid, shelter, food, and water: savethechildren.org

World Vision International
WVI is a global Christian relief, development, and advocacy organization dedicated to working with children, families, and communities to overcome poverty and injustice, through transformational development, emergency relief, justice promotion, partnerships, and public awareness: wvi.org

Figure 2. Select list of reputable organizations involved in healthcare delivery.
*From Lampard B, et al. Global Humanitarian Medicine and Disaster Relief. In: *Auerbach's Wilderness Medicine*.7th ed. Philadelphia, PA. Elsevier; 2012:1893-1928.

it is critical to obtain relevant humanitarian training and deploy with a reputable organization that understands the principles involved in working in a complex emergency and that engages in local coordination mechanisms. A partial list of well-established humanitarian organizations is in Figure 2. These organizations will typically have rosters for clinicians to join and often require pre-deployment training. If you are interested in deploying, take the opportunity to speak with these organizations, get on their rosters, get trained, and deploy during a future crisis.

Ask questions of the organization prior to signing up; a list is provided below (Figure 3). Often the best way to determine the reputation of an organization is to ask experienced colleagues, in particular those who have worked with the organization with whom you wish to deploy. Many major academic centers have international EM faculty who have worked closely with U.N. operational agencies and humanitarian NGOs and can provide advice.

Do you speak the language?

These health needs and the settings for healthcare provision often occur in highly complex political and social settings where English is not the primary language spoken. Clinicians routinely overestimate their fluency.[21] Even with non-English language fluency, practitioners may struggle with dialects that vary significantly from country to country or may not be familiar with medical terminology. During crises, already overburdened health staff are typically overwhelmed; thus, you cannot assume local support staff will have the time (or skills) to provide adequate interpretation. Ensure either that you speak the language prior to deployment or that adequate, dedicated interpreter services exist for you when you arrive—and ensure interpreter services are skilled at providing medical interpretation. Failing to do so can create additional burdens on an already under-resourced system.

1) What is your organization's experience in providing humanitarian aid?
2) What training does the organization require of its staff and volunteers?
3) Does this organization provide medical and evacuation insurance?
4) How does the organization coordinate with the U.N. cluster system on site, and with other NGOs in the region? Does this organization collaborate with the national ministry of health?
5) Does the organization have a security protocol and evacuation plan?
6) How does the organization manage its facilities and logistics (hospital, supply chains, supplies, resources, etc.?)
7) How long has it been active in this country? Does it partner and work well with local organizations?

Figure 3. Questions to ask to determine whether or not an organization is well-prepared for a humanitarian response.

Do you have enough time?

Physicians should ensure they have enough time to familiarize themselves with local medications, health systems, local colleagues, and the medical context in order to be useful. Specifically, this requires knowledge of the population demographic; the state of the health system at the national, district and local levels and how it functions at each; endemic diseases with knowledge of local vectors; and the country's baseline burden of communicable and non-communicable diseases. Experienced clinicians with pre-existing humanitarian and local expertise can be helpful in the short term, but this is generally the exception and not the rule.

As noted above, a two-week deployment is typically insufficient even for experienced clinicians. Consider that resources spent on short-term responses of questionable value might have paid for several full-time clinicians to work on site for several months, or for appropriate medical supplies, food aid, etc. Money spent on travel may be of much more use as cash aid to reputable organizations providing aid.[22] For example, according to the MSF website, a donation of U.S. $35 provides two high-energy meals for 200 malnourished children for a day; U.S. $50 can provide vaccinations for meningitis, measles, and polio for 50 people; U.S. $100 can provide antibiotics for 40 children; and a donation of U.S. $1000 can provide emergency medical supplies to 5,000 disaster victims for a month.[23] Considering that the cost of a plane ticket, room and board is roughly $2,000-$5,000 depending on the location of the crisis, direct financial support to professional organizations in disaster response almost always has a higher impact than deploying for a few weeks.

That being said, several models for long-term, sustainable engagement in global health are available to EPs.

MODELS FOR SUSTAINABLE ENGAGEMENT IN HUMANITARIAN AID

Below are a few models the authors have encountered that allow U.S.-based EPs to engage sustainably in humanitarian aid.

A note about trainees

Deployment of trainees (medical students, residents) to a humanitarian crisis zone is rarely appropriate, as there are not enough resources or time to allow for adequate supervision of residents or medical students in a crisis. Trainees engaging in unsupervised clinical practice abroad is largely viewed as unethical,[24-26] and can put academic institutions at risk. International EM fellows are often deployed to crisis zones, but generally have had significant training in standards and best practices in humanitarian aid prior to travel. Residents and students with an interest in humanitarian aid are advised to seek mentorship from experienced humanitarians and members of academic international EM departments on how they might best prepare themselves for work in humanitarian crises once their training is complete. Several opportunities exist to support domestic refugees and asylum seekers,[27] and trainees can lead very successful fundraising and awareness campaigns in their local communities.

A full time humanitarian career

Some EPs choose to enter a career as a full-time humanitarian aid worker. While this is often done immediately after residency, it is an option for the mid- or late-career EPs as well. This will typically involve a 6-9 month initial deployment, with the option to stay on at that site or deploy to another crisis. One can apply online or speak to a recruiter for the organizations listed in Figure 2 to explore available options.

The process generally involves a written application and interview, and if selected, requires training and deployment shortly afterwards. Depending on the organization, one may or may not have the option of choosing one's initial field site. Deployments are generally to austere settings with varying access to phone, internet, and other Western comforts. Some sites may be in or near active conflict zones.

Exposure to trauma, caring for survivors of war, witnessing human rights violations and living in insecure, poor settings can be difficult. Aid workers themselves can be the target of violence and locally transmitted infectious diseases, and their mental health can suffer.[28] Not every clinician is suited to this work. However, full-time humanitarians have the greatest impact in the field, amassing a wealth of knowledge and experience and developing close relationships with those residing in country as well as their fellow humanitarians. Most would describe their work as

deeply rewarding despite the challenges.

Financial considerations often keep EPs from deploying full time. According to a recent study, the average EM resident has $212,000 of educational debt, roughly 25% more than the average mortgage in the U.S.[29] Humanitarians are not generally paid enough to make payments on these loans; however, loan deferment can be sought while deployed.

Regular deployments and community EM practice

Given the above-mentioned financial constraints, some EPs divide their time between working in humanitarian crises and working in community emergency departments. While financially more sustainable, this can be challenging. First, it may be difficult to find a clinical practice that allows for the many months required in the field. EPs sometimes opt for locum tenens positions during periods of non-deployment, which allows for flexibility and short-term clinical practice while in the U.S. Others find departments with low overall shift requirements and flexible scheduling policies that allow them to batch shifts while in country and travel for 1-2 months at a time—though this arrangement does not allow for 3-9 month field requirements. Keep in mind, however, that many organizations will agree to shorter deployments once you have worked with them for several longer deployments—allowing you to spend more time in your home country as you become more experienced.

Some departments might be willing to consider splitting a full-time position in half, allowing you and a colleague to work six months a year, and deploy to the field for six months. It is critical to engage the support of department leadership to ensure that their needs are met when seeking these alternative arrangements, and to be a good citizen of the department once the arrangement has been made (ensure charts are done before deploying, help colleagues with their shift trade needs, be flexible with deployment dates to help your department meet staffing requirements, etc.). Many ex-humanitarians now work in community emergency department leadership—these chairpersons are often very willing to explore innovative staffing models to allow for their staff to serve in humanitarian crises. It is also important to identify a humanitarian organization that will support this model, and engage them in discussions regarding your scheduling constraints early.

Humanitarian careers in academic EM

International emergency medicine is a recognized subspecialty of academic EM, with formal sections in the Society of Academic Emergency Medicine,[30] the American College of Emergency Physicians,[31] and multiple recognized, non-ACGME accredited fellowships.[32] Academic international EM allows EPs to engage in humanitarian aid and research related to humanitarian aid while maintaining an academic home in the U.S. Academic EPs have been at the forefront of the movement to ensure high-impact, evidence-based humanitarian aid and population-based public health research in humanitarian crises. Several academic institutions have well-established academic EM divisions engaged in multidisciplinary field research at their institutions.

EPs with experience in public health research and health systems development and analysis can often engage in multiple short-term deployments over several years, collaborating with organizations that operate in conflict-affected settings to strengthen their response, measure impact, investigate health and human rights violations, or develop an evidence base for improved health programming. EPs interested in this type of work and a career in academic EM can consider international EM fellowships mentioned above. These fellowships typically involve project fieldwork, clinical practice in an academic center, and the opportunity for a master's degree in public health. International EM fellowship graduates work in humanitarian and other global health organizations, the Centers for Disease Control, U.N.-based groups such as UNICEF and WHO, as well as in academic EM centers.

Supporting your colleagues/fundraising

EPs interested in assisting the humanitarian aid effort can lead highly successful fundraising efforts and awareness events within their communities, religious organizations, and hospital systems. Aid can then be donated to organizations with active aid efforts in the affected area. Consider working a shift and donating the proceeds to an agency delivering aid, and asking colleagues to do the same. As mentioned above, a relatively small amount of cash can go a long way. Do keep in mind that *cash* is always the most helpful resource in any setting—as donated medications, supplies and clothing are often expensive to transport and not appropriate for local use on arrival.[32] Many EPs with significant humanitarian aid experience will need their colleagues' help to deploy to a crisis; supporting an experienced colleague in their deployment by taking a shift is a tremendous help.

Finally, it is our responsibility to educate our colleagues on the provision of responsible humanitarian aid.

CONCLUSION

Still haunted by the images of the earthquake, you arrive for your 7am shift. Your post-overnight colleague had previously worked with MSF and just became aware of the earthquake. You speak to him about your desire to help and ask him how you can get involved.

You have a conversation about many of the issues discussed above, and ultimately decide that you will help lead an effort to clear your colleague's schedule so he may travel, and raise funds to support MSF in Haiti. You also ask him to let you know when the next MSF recruitment meeting is in your city.

EPs have the flexibility, multi-disciplinary clinical skills, and exposure to intensive and chaotic work environments that allow them to provide high-impact, meaningful aid to crisis-affected populations. However, it is crucial that EPs carefully consider the impact and potential harm of any humanitarian deployment and consider alternative mechanisms to providing on-the-ground aid. EPs interested in engaging in meaningful humanitarian response should take coursework to learn about existing coordination systems and health issues they are likely to encounter in crisis settings. Deployments should be prepared for well in advance and undertaken with reputable humanitarian organizations. Medical students and residents should not engage in crisis response, and on occasion, the donation of money that would otherwise be spent on an ill-advised deployment may be more responsibly and effectively given to experienced organizations.

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Screening for Victims of Sex Trafficking in the Emergency Department: A Pilot Program

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Introduction: Estimates suggest that hundreds of thousands of sex trafficking victims live in the United States. Several screening tools for healthcare professionals to identify sex trafficking victims have been proposed, but the effectiveness of these tools in the emergency department (ED) remains unclear. Our primary objective in this study was to evaluate the feasibility of a screening survey to identify adult victims of sex trafficking in the ED. We also compared the sensitivity of emergency physician concern and a screening survey for identifying sex trafficking victims in the ED and determined the most effective question(s) for identifying adult victims of sex trafficking.

Methods: We enrolled a convenience sample of medically stable female ED patients, age 18-40 years. Patients completed a 14-question survey. Physician concern for sex trafficking was documented prior to informing the physician of the survey results. A "yes" answer to any question or physician concern was considered a positive screen, and the patient was offered social work consultation. We defined a "true positive" as a patient admission for or social work documentation of sex trafficking. Demographic and clinical information were collected from the electronic medical record.

Results: We enrolled 143 patients, and of those 39 (27%, 95% confidence interval [CI] [20%-35%]) screened positive, including 10 (25%, 95% CI [13%-41%]) ultimately identified as victims of sex trafficking. Sensitivity of the screening survey (100%, 95% CI [74%-100%]) was better than physician concern (40%, 95% CI [12%-74%]) for identifying victims of sex trafficking, difference 60%, 95% CI [30%-90%]. Physician specificity (91%, 95% CI [85%-95%]), however, was slightly better than the screening survey (78%, 95% CI [70%-85%]), difference 13%, 95% CI [4%-21%]. All 10 (100%, 95%CI [74%-100%]) "true positive" cases answered "yes" to the screening question regarding abuse.

Conclusion: Identifying adult victims of sex trafficking in the ED is feasible. A screening survey appears to have greater sensitivity than physician concern, and a single screening question may be sufficient to identify all adult victims of sex trafficking in the ED. [West J Emerg Med. 2017;18(4)616-620.]

INTRODUCTION

Sex trafficking is defined as "recruitment, harboring, transportation, provision, obtaining, patronizing, or soliciting of a person for the purpose of a commercial sex act…" by "force, fraud, or coercion."[1,2] Hundreds of thousands of victims of sex trafficking and labor trafficking are estimated to exist in the United States,[3] although accurate identification of victims is difficult due to the clandestine nature of trafficking. In 2015, 979

cases of human trafficking in California were reported to the National Human Trafficking Resource Center.[4] While sex trafficking affects both women and men of all ages, the majority of victims are women[5] with an average age at entry of 12-14 years old.[6]

Victims of sex trafficking have limited access to healthcare; any healthcare they receive frequently comes from the emergency department (ED).[7-9] Several "red flags" and questions for providers to identify victims of sex trafficking in healthcare settings have been suggested[10-13] but are not well studied in the ED. The feasibility of using these screening questions in the ED and their ability to identify victims of sex trafficking in the ED are unknown.

Our objectives in this study were (1) to characterize the feasibility of using a screening survey to identify adult victims of sex trafficking in the ED, and (2) to compare a screening survey to physician concern for the identification of adult victims of sex trafficking in the ED.

METHODS

Study Design

We performed an observational cohort study in a single academic ED during a seven-month period from March to October 2015. We also surveyed treating emergency physicians regarding their concern for the patient being a victim of sex trafficking. Prior to the study, ED social workers were educated on sex trafficking and local resources available to victims. This study was approved by our institutional review board (IRB).

Study Setting and Population

We surveyed a convenience sample of 143 female patients age 18-40 years in a single academic ED with an annual volume of 70,000 visits. Overall, 58% of the ED population is non-white. The surrounding county has a population of 1.5 million people, 64% of whom are white and 23% of whom are Hispanic or Latino. We selected women 18-40 years because they represent a substantial portion of the trafficked population. Furthermore, we were not able to enroll those less than 18 years of age because of the IRB requirement for informed consent. Prisoners and those in the custody of law enforcement were also excluded. Eligible patients were medically stable, able to provide informed consent, and able to read and understand either English or Spanish. Pregnant women were included. We surveyed patients at all times of the day.

Screening Survey

As there are no validated screening tools for sex trafficking in the ED, we assembled a 14-question screening survey based on published recommendations,[10-13] which could be administered in 5-10 minutes during the ED visit. We pilot-tested this survey on 15 ED patients. No significant changes were required after the pilot testing, and these patients were included in the overall study. Trained study personnel verbally administered the screening survey in a private ED treatment room without visitors present. A positive survey screen was defined as answering "yes" to any screening question(s).

Emergency Physician Concern

During the ED visit, the treating ED resident or attending physician was asked whether they were "concerned that this patient may be a victim of sex trafficking." This question was asked after the physician had completed his/her history and physical exam and prior to informing the physician of the survey screening result. Positive physician concern was defined as answering "yes" to this question.

Social Work Consultation

All patients with positive screens or physician concern were offered social work consultation during their ED visit. ED social workers independently interviewed patients to understand their situations, assess their needs, and provide relevant resources.

Data Collection and Management

Demographic and clinical data were abstracted from the EHR by trained study personnel. We managed study data using Research Electronic Data Capture (REDCap).[14]

Outcomes

Our primary outcome was the feasibility of identifying victims of sex trafficking in the ED. Our secondary outcome was identifying a patient who was a victim of sex trafficking. We defined a "true positive" victim of sex trafficking as a patient acknowledgment of or social work documentation of sex trafficking.

Analysis

We analyzed data using descriptive statistics with 95% confidence intervals (CI), where appropriate. Analyses were performed using Stata Version 14.1 (StataCorp LP, College Station, TX).

RESULTS

We enrolled 143 women with median age 27 years (interquartile range 22-33 years) (Table 1). Overall, 46 patients screened positive for possible sex trafficking: 30 (21%, 95% CI [15%-29%]) on the screening survey only, seven (7%, 95% CI [2%-10%]) on physician concern only, and nine (6%, 95% CI [3%-12%]) on both. Ten (7%, 95% CI [3%-12%]) patients were confirmed victims of sex trafficking. None were identified by physician concern only.

All victims of sex trafficking listed the U.S. as their country of origin. The majority (80%, 95% CI [44%-97%]) had prior ED visit(s) within the prior two years, but only one (10%, 95% CI [2.5%-45%]) had visited a clinic within the study site's health system. Victims presented to the ED with a broad range of chief complaints (Table 1).

Table 1. Demographic and clinical characteristics of 143 emergency department patients in a study to determine the feasibility of identifying victims of sex trafficking.

	True Positives (n=10)	All other patients (n=133)
Demographic characteristics		
Age (years)	29±6	27±6
Race/ethnicity		
White	5 (50%)	41 (31%)
Black/African-American	3 (30%)	35 (26%)
Asian	0 (0%)	7 (5%)
Hawaiian/Pacific Islander	0 (0%)	3 (2%)
Native American/Alaskan	0 (0%)	2 (2%)
Hispanic/Latino	1 (10%)	26 (20%)
More than one race/ethnicity	1 (10%)	18 (14%)
Country of origin outside U.S.	0 (0%)	16 (12%)
Clinical characteristics		
Chief complaint		
Gynecological	3 (30%)	16 (12%)
GI/abdominal pain	2 (20%)	27 (20%)
Cardiac	0 (0%)	3 (2%)
Pulmonary	0 (0%)	8 (6%)
Neurologic	1 (10%)	15 (11%)
Trauma/injury	1 (10%)	37 (28%)
Substance use	1 (10%)	2 (2%)
Mental health	0 (0%)	2 (2%)
Other	2 (20%)	26 (20%)
ED visit(s) within 2 years	8 (80%)	71 (53%)
Clinic visit(s) in past 2 years	1 (10%)	42 (32%)

US, United States; *GI*, gastrointestinal; *ED*, emergency department.

Sensitivity of the screening survey (100%; 95% CI [70%-100%]) was better than physician concern (40%; 95% CI [12%-74%]) for identifying victims of sex trafficking, difference 60%; 95% CI [30%-90%]. Specificity of physician concern (91%; 95% CI [85%-95%]), however, was slightly better than the screening survey (78%; 95% CI [70%-85%]), difference 13%; 95%CI [4%-21%]. All (100%, 95%CI [74%-100%]) "true positive" cases answered "yes" to the following screening question: "Were you (or anyone you work with) ever beaten, hit, yelled at, raped, threatened or made to feel physical pain for working slowly or for trying to leave?" (Table 2).

DISCUSSION

Identification of adult victims of sex trafficking in the ED using a brief screening survey is feasible. Our rate of "true positive" screens was surprising, particularly given prior reports that victims are often reluctant to disclose their situations in healthcare settings.[15] Victims fear discrimination from healthcare providers, reporting to legal authorities, and punishment from their traffickers.[10,15] The number of victims identified during this brief pilot study suggests that our ED regularly cares for victims of sex trafficking.

Consistent with other reports,[7,8] victims in our study appeared to receive the majority of their healthcare in the ED. Our region has a high rate of sex trafficking,[5] and it is likely that other EDs in our region also care for unrecognized victims. EDs are uniquely positioned to screen for sex trafficking and to provide interventions for victims. Victims of sex trafficking were not regularly recognized in our ED prior to this study. Thus, our study planning included research on available resources, community outreach, and emergency physician and social worker education. This multidisciplinary approach to caring for victims of sex trafficking, including physicians, nurses, social workers and community groups, is important for providing the ongoing support that these victims require.[9,10]

One question was answered positively by all victims of sex

Table 2. Questions and participant responses in a study to determine feasibility of using a brief screening survey to identify sex trafficking victims.

Screening tool items	"Yes" answers among true positive screens (n=10)	"Yes" answers among false positive screens (n=29)
Do you have to ask permission to eat, sleep, use the bathroom, or go to the doctor?	4 (40%)	2 (7%)
Were you (or anyone you work with) ever beaten, hit, yelled at, raped, threatened or made to feel physical pain for working slowly or for trying to leave?	10 (100%)	18 (62%)
Has anyone threatened your family?	6 (60%)	13 (45%)
Is anyone forcing you to do anything that you do not want to do?	5 (50%)	1 (3%)
Do you owe your employer money?	2 (20%)	1 (3%)
Does anyone force you to have sexual intercourse for your work?	5 (50%)	1 (3%)
Is someone else in control of your money?	4 (40%)	3 (10%)
Are you forced to work in your current job?	1 (10%)	0 (0%)
Does someone else control whether you can leave your house or not?	6 (60%)	1 (3%)
Are you kept from contacting your friends and/or family whenever you would like?	7 (70%)	6 (21%)
Is someone else in control of your identification documents, passports, birth certificate, and other personal papers?	4 (40%)	3 (10%)
Was someone else in control of arrangements for your travel to this country and your identification documents?	1 (10%)	0 (0%)
Do you owe money to someone for travel to this country?	0 (0%)	1 (3%)
Has anyone threatened you with deportation?	0 (0%)	1 (3%)

trafficking ("Were you [or anyone you work with] ever beaten, hit, yelled at, raped, threatened or made to feel physical pain for working slowly or for trying to leave?"). This one question could be more easily incorporated into ED workflows than our 14-question screening survey. However, it remains unknown whether patients would answer this question positively if it were asked in isolation or whether the series of questions affects patients' responses. Future research should evaluate the use of this question as a stand-alone screening tool.

Our screening survey had greater sensitivity than physician concern for identifying victims of sex trafficking. Several possible reasons exist. First, physicians may lack awareness of the risk factors for and signs of sex trafficking.[9] Second, physicians may not ask questions about a patient's social situation in the busy ED environment.[16] In our study and others,[17] victims presented with a variety of chief complaints that may not have prompted physicians to ask about their social situations or suspect them to be trafficking victims. Third, victims may hide their situation due to shame, fear, or distrust of the medical community.[16] Victims' traffickers may also be present, preventing them from disclosing their situation.[10,16] The low sensitivity of physician concern makes it a less effective screening method than a screening survey. Future research should evaluate the effectiveness of physician- or nurse-administered screening question(s) integrated into patient care.

LIMITATIONS

Our pilot study has several limitations. First, the "gold standard" for identifying victims of sex trafficking was patient acknowledgment or social work documentation of sex trafficking. It is possible victims of sex trafficking were never identified because they had a false negative screen or denied being victims following a positive screen. Second, our screening questions were derived from tools designed for other settings and had not been validated in an ED setting. Third, our study population for this small pilot study is a convenience sample from a single ED. Our results may not be generalizable to other settings, and a larger sample is required to draw definitive conclusions. Fourth, we were unable to obtain longer term follow-up on the effectiveness of our intervention for assisting victims of sex trafficking to escape their situation.

CONCLUSION

Using a brief screening survey to identify of victims of sex trafficking in the ED is feasible. Our screening survey had greater sensitivity than physician concern, and a single screening question may be sufficient to identify all adult victims of sex trafficking in the ED.

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Difference in R01 Grant Funding Among Osteopathic and Allopathic Emergency Physicians over the Last Decade

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Introduction: Receiving an R01 grant from the National Institutes of Health (NIH) is regarded as a major accomplishment for the physician researcher and can be used as a means of scholarly activity for core faculty in emergency medicine (EM). However, the Accreditation Council for Graduate Medical Education requires that a grant must be obtained for it to count towards a core faculty member's scholarly activity, while the American Osteopathic Association states that an application for a grant would qualify for scholarly activity whether it is received or not. The aim of the study was to determine if a medical degree disparity exists between those who successfully receive an EM R01 grant and those who do not, and to determine the publication characteristics of those recipients.

Methods: We queried the NIH RePORTER search engine for those physicians who received an R01 grant in EM. Degree designation was then determined for each grant recipient based on a web-based search involving the recipient's name and the location where the grant was awarded. The grant recipient was then queried through PubMed central for the total number of publications published in the decade prior to receiving the grant.

Results: We noted a total of 264 R01 grant recipients during the study period; of those who received the award, 78.03% were allopathic physicians. No osteopathic physician had received an R01 grant in EM over the past 10 years. Of those allopathic physicians who received the grant, 44.17% held a dual degree. Allopathic physicians had an average of 48.05 publications over the 10 years prior to grant receipt and those with a dual degree had 51.62 publications.

Conclusion: Allopathic physicians comprise the majority of those who have received an R01 grant in EM over the last decade. These physicians typically have numerous prior publications and an advanced degree. [West J Emerg Med. 2017;18(4)621-623.]

INTRODUCTION

For many physician researchers, receiving the National Institutes of Health (NIH) R01 grant is a major accomplishment and serves as an early career milestone from which further granting opportunities arise. However, receiving one of these prestigious grants is a rarity in academic emergency medicine (EM). A 2011 study found that 18 investigators in 2010 had one of these grants despite the relatively large population of practicing emergency physicians.[1]

In that study, however, there was no distinction made with regard to what type of degree the physician researcher held. Recently, a disparity has been noted among osteopathic and allopathic physicians who serve on editorial boards and publish manuscripts in EM.[2,3] With the recent merger of the Accreditation Council for Graduate Medical Education (ACGME) and the American Osteopathic Association (AOA), a heightened awareness of these topics may become evident. The ACGME states that obtaining a grant can be applied to a core faculty

member's scholarly activity, while the AOA notes that applying for a grant can meet this requirement.[4,5] In the current study, we looked to assess if there was a difference in R01 grants being awarded among the different medical professions in EM.

METHODS

Study Design

After obtaining institution review board approval, we queried the NIH RePORTER search engine (http://projectreporter.nih.gov) for ''emergency medicine'' as a key word for 2006 through 2016 for R01 grants. Each recipient was then categorized as either having a degree in osteopathic or allopathic medicine. We did this by completing a web-based search for the author and the author's home institution. Secondarily, we recorded any advanced degrees for each grant recipient.

Once the grant recipient was determined to be accurate, we quantified the author's publication activity by determining the number of peer-reviewed manuscripts published by the recipient in the10 years prior to being awarded the grant. This was accomplished by completing a PubMed (http://www.pubmed.com) search using the author's name. The author was then classified as either the first, second or last author for each manuscript.

We analyzed comparison of the proportions of allopathic and osteopathic physician grant recipients across the years by using simple descriptive statistics. The percentage of those holding both a medical degree and an advanced degree was also analyzed using descriptive statistics.

RESULTS

We identified a total of 264 R01 grant recipients during the study period. Allopathic physicians accounted for 78.03% (206/264) of all grant recipients, and no osteopathic physicians were awarded an EM R01 grant during the study period. Those who were categorized in the "other degree" category comprised the remainder of the grant recipients. Of the allopathic physicians awarded an EM R01 grant, 44.17% (91/206) held a dual advanced degree.

In the 10 years preceding the receipt of their award, all recipients had prior research publications that were identified in PubMed. Allopathic physicians accounted for 79.32% (2,881/3,758) of the primary authors, 73.31% (1,173/1,600) of secondary authors and 73.80% (5,744/7,783) of all senior authors. On average, each allopathic physician who successfully obtained an R01 grant had 48.05 publications over the 10-year period prior to receiving the grant. Upon subgroup analysis of allopathic physicians, we found that those with a dual degree comprised 52.90% (1,577/2,981) of primary authors, 41.69% (488/1173) of secondary authors and 45.82% (2,632/5,744) of all senior authors. Allopathic physicians who held a dual degree had on average 51.62 publications in the 10 years prior to receiving their R01 grants.

DISCUSSION

This is the first article to describe a medical degree disparity between those physicians who receive EM R01 grants and those who do not. Over the last 10 years, the majority of recipients of an EM R01 grant have been allopathic physicians, and no osteopathic physician has received an EM R01 grant during that same period. It is unclear why this disparity exists, but it appears that prior research publications and advanced research training play a crucial role in determining who receives EM R01 grants.

Recent literature has shown that there is a disparity in medical degree designation among those who have published manuscripts in high-ranking EM journals over the last two decades. According to Lammers et al., very few osteopathic EM physicians are either the first or senior author on original research manuscripts in these journals.[3] Previous data collected on those who have received EM R01 grants has shown that recipients were publishing approximately five articles a year and had published 38 peer-reviewed manuscripts.[1] The current data also has shown that almost 75% of all allopathic recipients have served in the role of first, second and senior author on numerous manuscripts. Based upon the prior results, coupled with the data found by this study, it appears that prior publications are a key component in determining who will be awarded a NIH R01 grant in EM. Without a track record of prior publications, osteopathic emergency physicians are at a disadvantage with regard to being awarded an R01 grant.

The current study also shows that almost half of all allopathic physicians who have received an EM R01 grant hold an advanced degree. A dual-degree program offers the physician researcher the opportunity to hone his/her research skills and work directly with a mentor who may have already successfully navigated the granting process. A total of 26 osteopathic medical students were enrolled in a dual-degree program in 2004 as reported by the American Association of Colleges of Osteopathic Medicine.[6] It is unclear which specialty these students chose to practice medicine in; however, it would make up the minority of practicing osteopathic physicians regardless. Without this prior training in the rigors of academic medicine, it is difficult for a community-based physician to be awarded an R01 grant.

Previous reported data has also shown that the median age to receive an R01 grant in EM was 43 years.[1] Based upon the previous data, coupled with the lack of osteopathic physician researchers with a dual degree, it can be theorized that the osteopathic physician researchers who hold a dual degree have not yet reached a point in their careers where they would feel qualified to apply for an R01 grant.,

It has been previously noted that receiving an R01 grant from the NIH is a gateway to increased involvement in peer review at the national level and is regarded as a seminal event for the physician researcher.[1] Since the majority of those receiving this grant are allopathic physicians, the views of osteopathic emergency physicians may not be expressed at these national levels. This has been evidenced by the lack of osteopathic physicians who have served on the editorial boards of major

academic journals including *Annals of Emergency Medicine*.[3]

A core faculty member's scholarly activity is a key component in determining if a residency program receives a citation from either the AOA or ACGME upon its site review. The current results show that no osteopathic EP has obtained a NIH R01 grant over the last decade, and based upon the new single accreditation standards would not have received any credit for scholarly activity. Previously, however, applying for a grant would have awarded an osteopathic core faculty member scholarly activity. As progression occurs through the merger, osteopathic EM residencies must be aware of these changes and attempt to rectify the situation through increased faculty development in order to develop faculty members who are better candidates for national grants.

LIMITATIONS

There are several key limitations to this study. First, the authors only reviewed one specialty's receipt of R01 grants over the last decade. Other specialties may have had more of an osteopathic presence among those who received R01 grants, which may alter the conclusions we have drawn. Also, the authors used a web-based search to determine the grant recipients' degree designations. Although the author's home institution was examined, the data on the website may not have been accurate and would therefore alter the results. We also note that PubMed is unable to distinguish the difference between those physicians who have the same name. This may have led to an increased number of publications being reported. Similarly, PubMed does not include all journals that are currently being published and the authors may have published manuscripts in journals that are not in the PubMed repository. Because we were unable to comment on the years that were not reviewed, it is possible that inclusion of a greater time span might have shown osteopathic physician-researcher involvement.

CONCLUSION

Authors who have received an R01 grant from the NIH in emergency medicine are primarily allopathic physicians who hold a dual degree and have a track record of prior publications. The osteopathic community must continue to further educate physician researchers in order to close the medical degree disparity gap among those who receive grant funding from the NIH.

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Altitude-Related Change in Endotracheal Tube Cuff Pressures in Helicopter EMS

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Introduction: Over-inflation of endotracheal tube (ETT) cuffs has the potential to lead to scarring and stenosis of the trachea.[1, 2, 3, 4] The air inside an ETT cuff is subject to expansion as atmospheric pressure decreases, as happens with an increase in altitude. Emergency medical services helicopters are not pressurized, thereby providing a good environment for studying the effects of altitude changes ETT cuff pressures. This study aims to explore the relationship between altitude and ETT cuff pressures in a helicopter air-medical transport program.

Methods: ETT cuffs were initially inflated in a nonstandardized manner and then adjusted to a pressure of 25 cmH_2O. The pressure was again measured when the helicopter reached maximum altitude. A final pressure was recorded when the helicopter landed at the receiving facility.

Results: We enrolled 60 subjects in the study. The mean for initial tube cuff pressures was 70 cmH_2O. Maximum altitude for the program ranged from 1,000-3,000 feet above sea level, with a change in altitude from 800-2,480 feet. Mean cuff pressure at altitude was 36.52 ± 8.56 cmH_2O. Despite the significant change in cuff pressure at maximum altitude, there was no relationship found between the maximum altitude and the cuff pressures measured.

Conclusion: Our study failed to demonstrate the expected linear relationship between ETT cuff pressures and the maximum altitude achieved during typical air-medical transportation in our system. At altitudes less than 3,000 feet above sea level, the effect of altitude change on ETT pressure is minimal and does not require a change in practice to saline-filled cuffs. [West J Emerg Med. 2017;18(4)624-629.]

INTRODUCTION

Air-medical critical care providers are frequently called upon to provide advanced airway management to our critically ill patients. The majority of these cases involve the transport of patients who have been intubated with standard endotracheal tubes (ETT).

ETT cuffs are typically instilled with 10 ml of air. This allows a closed system of ventilation via respirator or bag valve mask (BVM). However, measuring the volume of air instilled frequently does not equate to proper pressure of the ETT cuff on the trachea. It has been previously demonstrated that some ETT cuffs have been over-inflated, defined as pressures in excess of 30 cmH_2O. This has the potential to lead to ischemia and subsequent scarring and stenosis of the trachea.[1, 2, 3, 4, 5] This occurs because the pressure of the cuff against the tracheal mucosa is greater than the pressure of the capillary beds supplying the blood flow to this structure.[4,6] Studies have shown that this may be more pronounced in hypotensive states, as in septic shock.[7] There have even been case reports of tracheal rupture related to over-inflation of ETT cuffs.[8] One study reported rates of tracheal stenosis as high as 22%, of which 1-2% were clinically significant.[9]

The air inside ETT cuffs is subject to the forces of atmospheric pressure, which allows it to expand and contract. This is best illustrated by the application of Boyle's law, which states that the volume of a given gas relates inversely to its pressure (P1V1 = P2V2). The pressure effects of altitude on cuff volume are predicted by Boyle's law, which states that a fixed mass of gas will expand as ambient pressure decreases.[10] If there is no method of venting this expansion, there will be an increase in pressure within any air-filled space, such as in the fixed diameter of the trachea.[11] Therefore, the air inside of an ETT cuff is subject to expansion as atmospheric pressure decreases, as happens with increase in altitude.

Because emergency medical service (EMS) helicopters are not pressurized, they provide an ideal environment for directly studying the effect of altitude changes on the pressure inside the ETT cuff. Fixed-wing aircraft are pressurized to maintain stable atmospheric pressures of 3,000-8,000 feet above sea level, depending on the aircraft type. Critical care crews operating in these aircraft commonly use saline rather than air to fill patients' ETT cuffs.[7] It might follow that this should be a consideration in non-pressurized EMS helicopters as well. This also applies to pediatric patients, as more cuffed ETTs are being used in younger patients.[12]

Our goal in this study was to explore the relationship between altitude and the pressure in ETT cuffs. We hypothesized there would be a significant increase in ETT cuff pressures when at altitudes at which EMS helicopters typically fly and that there would be a relationship between maximum altitude and ETT cuff pressures.

Population Health Research Capsule

What do we already know about this issue?
Many endotracheal tube (ETT) cuffs are over-inflated, potentially causing pressure-related tracheal injuries. In a closed system at altitude, the pressure caused by air in an ETT cuff will increase.

What was the research question?
Is there a significant increase in ETT cuff pressures when at altitudes that EMS helicopters typically fly?

What was the major finding of the study?
There is not a linear relationship between ETT cuff pressures and maximum altitude during transports near sea level.

How does this improve population health?
The data support routine monitoring of ETT cuff pressures, as many cuffs were initially over-inflated. However, at altitudes near sea level, there is no need to replace air with saline.

METHODS

The subjects enrolled in this study were critically ill and were determined to meet the criteria for critical care transport by an outside medical facility or ground EMS service. The patients were all intubated prior to air transport by the referring medical team or by the Life Flight air medical team. The referring medical team was either a hospital or an EMS/ambulance ground crew. We excluded patients intubated with an uncuffed ETT from the study due to the inability to measure pressures. Prisoners were also excluded from the study per institutional review board recommendations.

The ETT cuffs were inflated in a non-standardized manner by the intubating personnel. Using a commercially available device, the Posey Cufflator™ Endotracheal Tube Inflator and Manometer (Posey Company, 5635 Peck Road, Arcadia, CA, USA), an initial ETT cuff pressure was recorded by the Life Flight medical team team prior to air transport. If this reading was found to be greater than 25 cm H_2O, enough air was removed to bring the pressure below 25 cm H_2O. If the reading was less than 25 cm H_2O, the ETT was examined for the presence of an air leak. If an air leak was detected, enough pressure was added to the cuff to eliminate it. Air transportation of the patient was then initiated.

The pilot alerted the crew once the aircraft had reached the maximum planned altitude. At that point the ETT cuff pressure was rechecked. Both the altitude and the cuff pressure were recorded. This was repeated for a total of three measurements at cruising altitude. Upon landing at the destination, the crew again checked and recorded the cuff pressure. Where altitudes were reported as a range, the average was calculated and used for the remainder of the study.

We collected study data via a research form completed by the air medical crew upon transfer of patient care to the receiving facility. The form contained minimal demographic information (age, gender, and diagnosis). The data were entered into a spreadsheet for storage (Microsoft Excel, Microsoft Corporation, Redmond, WA). We analyzed the data using IBM SPSS Statistics (IBM Corp. IBM SPSS Statistics for Windows. Armonk, NY)

No chart review or patient follow up was performed, as such details were not pertinent to the variables being studied. The study was granted approval after University of Massachusetts Institutional Review Board review.

RESULTS

We enrolled a total of 60 subjects in the study. Subjects ranged in age from 18-90 years old. Thirty-nine (65%) were

male (*p* value for the difference was not significant at p=0.27). The majority of patients' conditions were medical in nature (47 of 60, 78%) with trauma accounting for only 13 of 60 or 22% (*p* value for the difference at p<0.001). The majority of patients were intubated prior to air medical transport arrival (56 of 60, 93%, p<0.001) (Table).

Initial cuff pressures were measured and recorded for all but one patient and the majorities were well above the recommended pressure. Therefore, air was removed from the balloon to obtain an initial cuff pressure of mean 25.12 cm ± 3.93 cmH_2O (Figure 1).

The mode for initial cuff pressure for patients intubated by the referral agency was 120 cm H_2O. Based on an analysis of this subset (56/60 patients) the mean initial cuff pressure measurement was 70 cmH_2O, 40 cmH_2O higher than the accepted maximum safe value of 30 cmH_2O (p<0.0001, 95% confidence interval [CI] for the difference 31-50). This portion of the data is explored in more detail in a separate paper.

In a minimum of cases, the lowering of the initial cuff pressure resulted in a leak of air around the ETT cuff during positive pressure ventilation. The study protocol addressed

Table. Demographics of subjects enrolled in a study of the effect of altitude on endotracheal tube cuff pressure.

Characteristics	Result	Significance
Age (years), mean (95% CI)	56 (51-61)	
Minimum age	18	
Maximum age	90	
Gender, n (%)		P=0.27
Male	39 (65)	
Female	21 (36)	
Nature of case, n (%)		P<0.001
Trauma	13 (22)	
Medical	47 (78)	
ETT size		
Mode	8.0	
Minimum ETT size	6.0	
Maximum ETT size	8.5	
Intubated by air medical crew, n (%)		P<0.001
Yes	4 (7)	
No	56 (93)	

ETT, endotracheal tube.

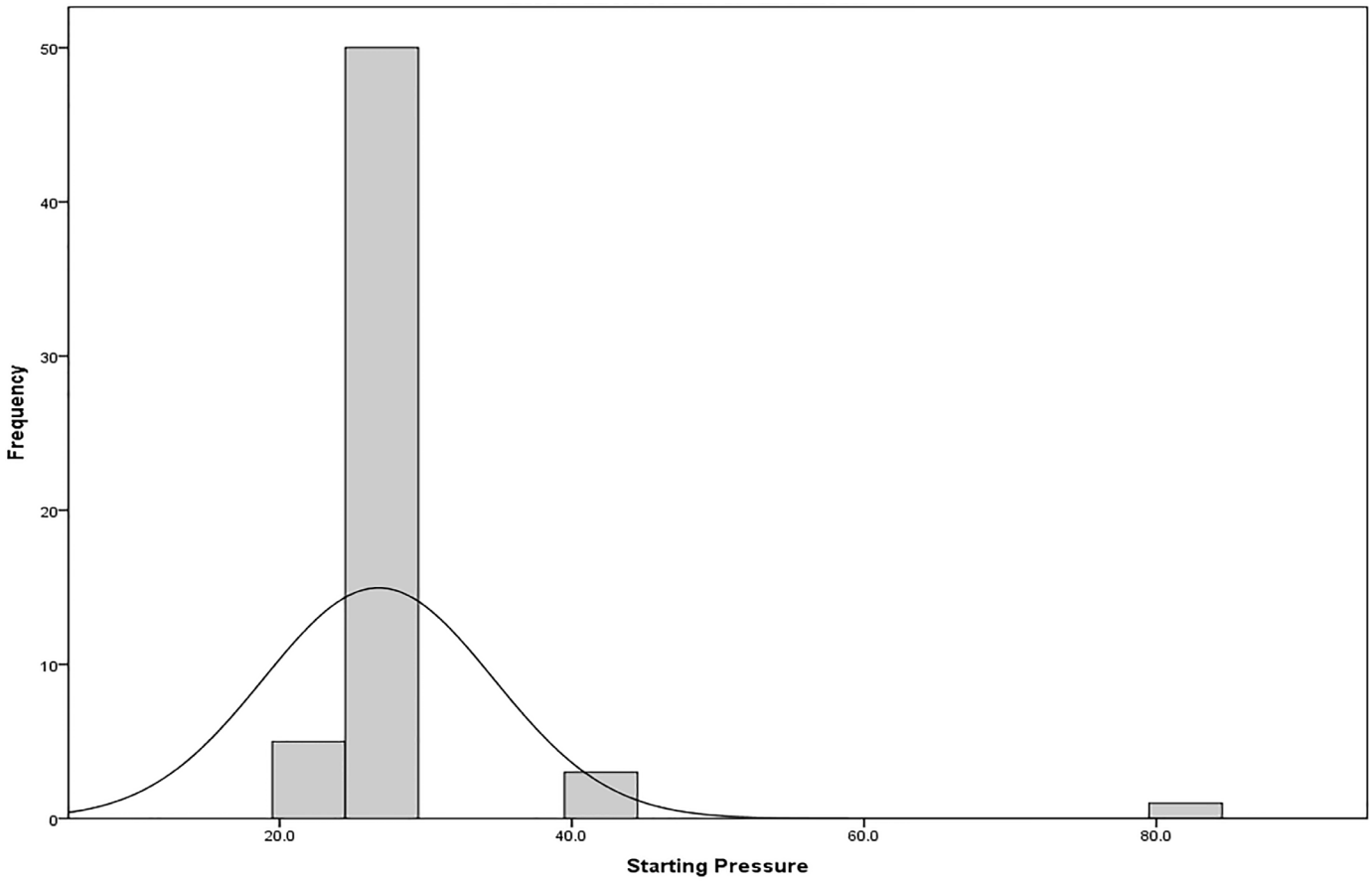

Figure 1. Distribution of endotracheal tube cuff pressures at takeoff.

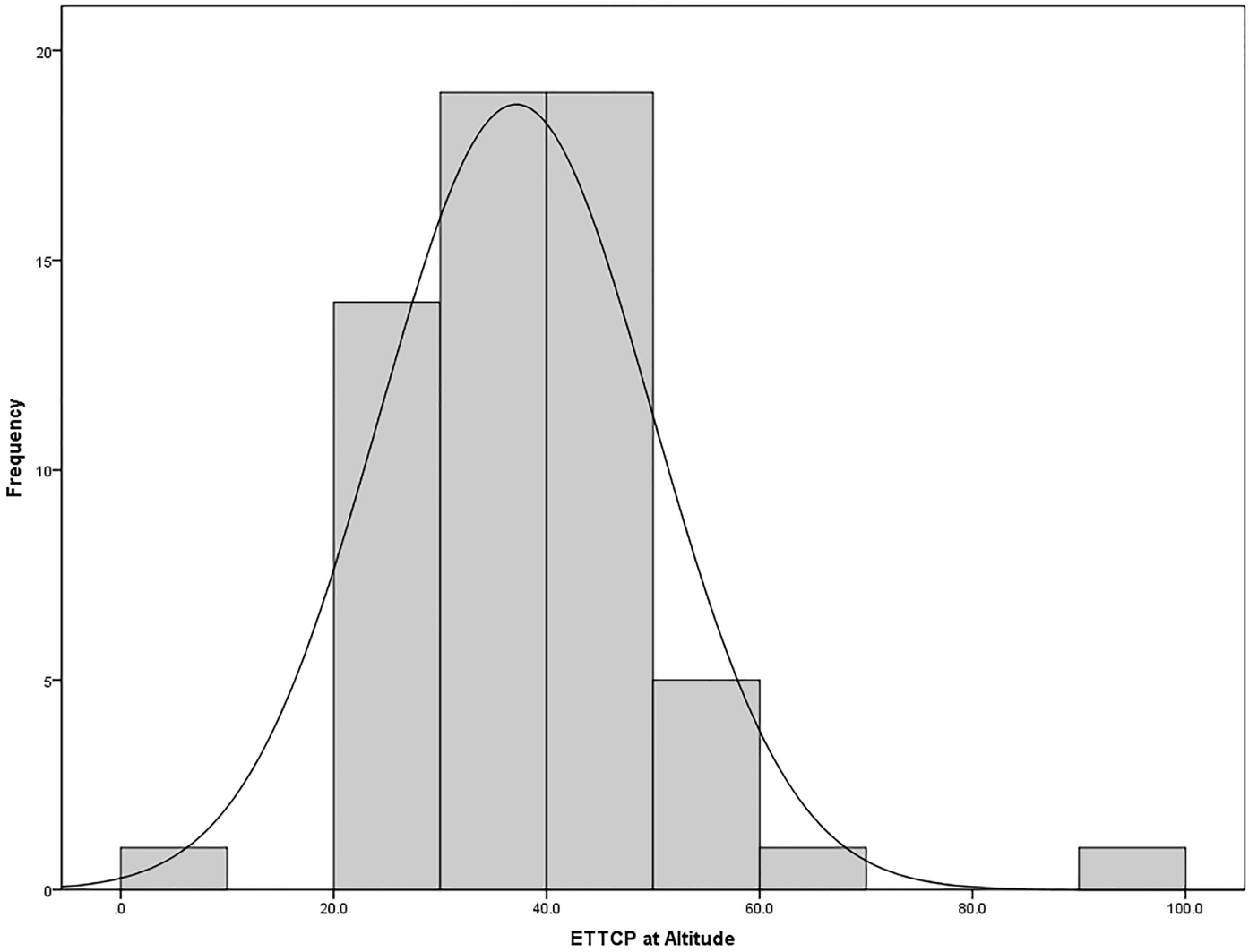

Figure 2. Distribution of endotracheal tube cuff pressures (ETTCP) at altitude.

this eventuality by including a protocol for inflating the cuff to the minimum pressure needed to stop a cuff leak in cases where a cuff leak was noted at normalization. This was an infrequent occurrence (6/60, 10%). The average pressure needed to seal the cuff was 42 $\pm$ 23 cm H_20.

Maximum altitude measurements were recorded for all subjects and ranged from 1,000-3,000 feet above sea level, mean 1,931 feet. Change in altitude from initial measurement to maximum flight altitude ranged from an increase in 800 to 2,480 feet. The mean increase in altitude was 1,420 ± 392 feet. Cuff pressures at maximum altitude ranged from 22-78 cm of water with a mean cuff pressure of 36.52 ± 8.56 cmH_2O (Figure 2).

The result of the *t* test for paired means comparing cuff pressure at departure and at maximum altitude is significant (t_{49} = -10.53, $p < 0.001$).

Despite the significant change in cuff pressure at maximum altitude, there was no relationship found between the maximum altitude and the cuff pressures measured (slope = -0.033, p= 0.803, R^2=0.001). Taking cabin temperature or provider into account as possibly affecting cuff pressure did not change the results (slope= +0.011, p= 0.947, R^2=0.009) (Figure 3).

The mean change in pressure from starting to cruising altitude was 10.8 ± 10.9 cmH_2O (95% CI [8-14]). The median change was 10 cmH_2O (IQR [3-18]). When at altitude, 41 (68%) had pressures >30 cmH_2O. Four patients (7%) had pressures > 50 cmH_2O. One patient (2%) had a pressure >80 cmH_2O.

DISCUSSION

Our study failed to demonstrate the expected linear relationship between ETT cuff pressures and the maximum altitude achieved during typical air-medical transportation in our system. Controlling for other variables, including cabin temperature and ventilator settings, did not change

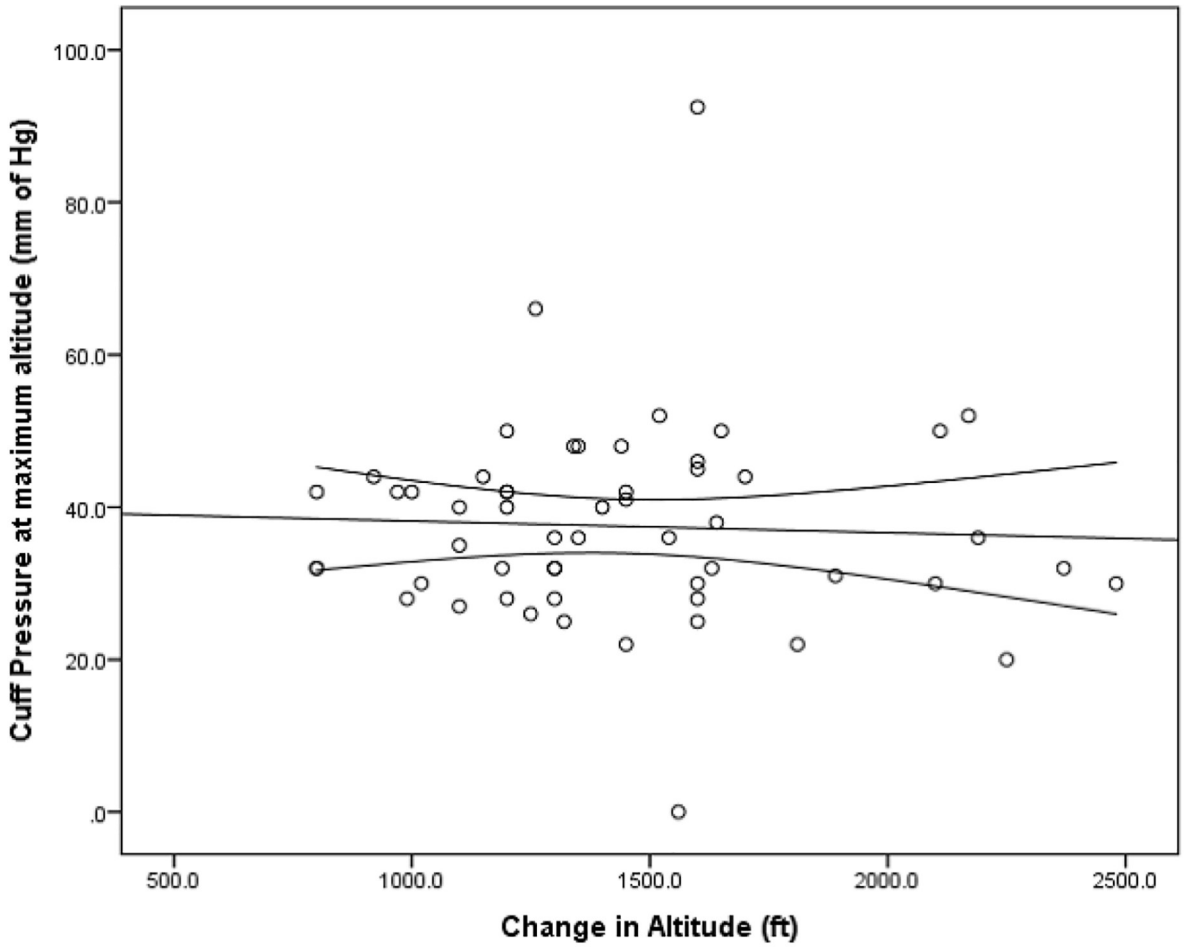

Figure 3. Comparison between cuff pressure at maximum altitude and change in altitude.

the lack of relationship. These findings contradict the findings in previous studies, which suggested that tube pressure increases at altitude, leading to recommendations to measure tube cuff pressures and inflate cuffs with saline instead of air.[1]

Despite the lack of a reproducible relationship at maximum altitude or increase in altitude, our results do demonstrate an increase in the pressures from those established prior to initiation of flight. Pressures increased on average almost 11 cmH_2O with 77% of cases exceeding the maximum recommended pressure of 30 cmH_2O while at altitude.

Both animal and human studies have demonstrated evidence of harm from increased ETT cuff pressure.[2, 3, 4] Seegobin performed tracheoscopy on patients whose ETT cuff pressure had exceeded 40 cmH_2O and found decreased blood flow evidenced by mucosal blanching.[4]

Complications reported in humans associated with increased ETT cuff pressure have ranged from the less severe realm of hoarseness, sore throat, and minor hemoptysis[13] to the more severe of post extubation stridor[14] and tracheal stenosis.[9, 15] There are even reports of tracheal rupture.[8,16] An association between elevated ETT cuff pressure and tracheal stenosis was demonstrated by Kastanos in his 1983 paper.[15]

One reason for the lack of relationship may be due to the altitudes of this flight program. The helicopter flew at a maximum altitude of 3,000 feet above sea level, with an average altitude of 1,931 feet and an average increase in altitude of 1,420 feet. The studies reporting clinically significant changes in tube cuff pressure reported these results at altitudes of at least 3,000 feet.[1, 17] In this study, the mean altitude was only 1,931 feet with only one air-medical mission reporting a maximum altitude of 3,000 feet above sea level.

While this study is only from one flight program, the findings should be generalizable to other programs flying at or near sea level. These data support the routine monitoring of ETT cuff pressure during flight, but do not suggest the need to replace air with saline at altitudes near sea level. We would encourage programs that typically fly above 3,000 feet to monitor their tube cuff pressures for potential increased pressure at altitude.

LIMITATIONS

This study does have several limitations. First, we obtained all data from a single air-medical transport program. While we may assume that the results are generalizable to other programs operating at similar altitudes, it is possible that there are confounders specific to this program or the transport crews.

This study only contained 60 subjects. While initial calculations suggested that this would be a sufficient number to detect a relationship between altitude and ETT cuff pressures, it is possible that the sample size was insufficient to detect this relationship.

Lastly, this air-medical program operates at altitudes relatively close to sea level. Most other studies examining this relationship studied programs that operated at higher altitudes. This limits the generalizability of our findings across the air medical industry.

CONCLUSION

We found no clear relationship between change in altitude and change in endotracheal tube cuff pressures in our cohort of missions flown at altitudes at or less than 3,000 feet above mean sea level. At these altitudes, the effect of altitude change is minimal and does not require a change in practice to saline-filled cuffs. The data do suggest the need for routine monitoring of the pressures during flight. Due to the frequently significantly elevated cuff pressures at the time of patient contact, services should adopt the practice of routinely measuring and normalizing the pressures.

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Emergency Medical Services Professionals' Attitudes About Community Paramedic Programs

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Introduction: The number of community paramedic (CP) programs has expanded to mitigate the impact of increased patient usage on emergency services. However, it has not been determined to what extent emergency medical services (EMS) professionals would be willing to participate in this model of care. With this project, we sought to evaluate the perceptions of EMS professionals toward the concept of a CP program.

Methods: We used a cross-sectional study method to evaluate the perceptions of participating EMS professionals with regard to their understanding of and willingness to participate in a CP program. Approximately 350 licensed EMS professionals currently working for an EMS service that provides coverage to four states (Missouri, Arkansas, Kansas, and Oklahoma) were invited to participate in an electronic survey regarding their perceptions toward a CP program. We analyzed interval data using the Mann-Whitney *U* test, Kruskal-Wallis one-way analysis of variance, and Pearson correlation as appropriate. Multivariate logistic regression was performed to examine the impact of participant characteristics on their willingness to perform CP duties. Statistical significance was established at $p \leq 0.05$.

Results: Of the 350 EMS professionals receiving an invitation, 283 (81%) participated. Of those participants, 165 (70%) indicated that they understood what a CP program entails. One hundred thirty-five (58%) stated they were likely to attend additional education in order to become a CP, 152 (66%) were willing to perform CP duties, and 175 (75%) felt that their respective communities would be in favor of a local CP program. Using logistic regression with regard to willingness to perform CP duties, we found that females were more willing than males (OR = 4.65; $p = 0.03$) and that those participants without any perceived time on shift to commit to CP duties were less willing than those who believed their work shifts could accommodate additional duties (OR = 0.20; $p < 0.001$).

Conclusion: The majority of EMS professionals in this study believe they understand CP programs and perceive that their communities want them to provide CP-level care. While fewer in number, most are willing to attend additional CP education and/or are willing to perform CP duties. [West J Emerg Med. 2017;18(4)630-639.]

INTRODUCTION

The number of patients presenting to emergency departments (ED) in the United States has been steadily increasing over the past three decades.[1] The Centers for Disease Control and Prevention estimated the total number of ED visits in 2009 to be 136.1 million,[1] a 16.5% increase from the estimated 116.8 million ED visits in 2007.[1] With the increase in annual ED visits, the time a patient has to wait to see a provider has also increased 25% from 46.5 minutes to 58.1 minutes between 2003 and 2009.[2] America's emergency medical services (EMS) systems and EDs alike have experienced the increased demands to treat patients seeking care.[3] One of several approaches to address this strain on emergency services is a new model of care provided by community paramedics (CP).[3]

The traditional model of care used by EMS systems in the U.S. has been to treat and transport patients to the ED for further assessment and care provided by physician and nursing staff. While each community's respective CP program can be tailored to its individual needs, the CP model, in general, uses specially educated paramedics to treat minor injuries and manage chronic illnesses in the patient's home and/or arrange care provided in the community, thereby limiting unnecessary transports to the ED.[3,4] By reducing the number of patients transported to the ED, this model of care has the potential to lessen the burden on both transport ambulances and EDs while providing an improved experience for patients by avoiding long ED wait times.[3]

Potential benefits of patients being assessed and treated in the prehospital environment include a reduction on the patient load in already strained EDs and a reduction in cost along the healthcare continuum. As the Affordable Care Act implementation continues to unfold, reducing the number of patients readmitted to the hospital within 30 days of discharge with diagnoses such as congestive heart failure, acute myocardial infarction, and pneumonia will also be financially advantageous for hospitals faced with potentially reduced levels of reimbursement for services.[5]

Although the problem of ED crowding from increased patient visits has been identified, and some local CP programs have demonstrated a reduction in the number of patients transported to these EDs,[6-9] the challenges of implementing and staffing CP programs need to be addressed. These challenges include cost, availability of appropriate education programs for potential providers, support from the local community, a reliable reimbursement stream, and acceptance from EMS professionals. Of these, attaining buy-in from EMS professionals is paramount, yet this precursor to successful implementation has not been evaluated. The goal of this study was to investigate EMS professionals' attitudes about and willingness to participate in CP programs.

Population Health Research Capsule

What do we already know about this issue?
Several studies have been published regarding community paramedic (CP) programs; we have not found any that address EMS professionals' willingness to participate.

What was the research question?
What are EMS professionals' attitudes about CP programs and are they willing to participate in them?

What was the major finding of the study?
Most EMS professionals stated they were willing to participate in a CP program.

How does this improve population health?
Meeting patients' healthcare needs in their respective communities may reduce unnecessary ED visits and lessen the strain on crowded EDs.

METHODS

Study Design

The authors used a cross-sectional survey (Supplement) method in this evaluation. Despite a thorough review of the literature, the authors were unable to identify a specific study instrument that addresses EMS professionals' perceptions of a CP program. Therefore, the survey instrument design was adapted from one used by Bercher in his evaluation of the attitudes of paramedics toward the performance of home hazard inspections in addition to their routine daily work tasks.[10]

Study Setting

EMS professionals (EMTs [emergency medical technicians] and paramedics) practicing in a hospital-based Advanced Life Support (ALS) EMS service headquartered in southwest Missouri were used as a sample of convenience. This EMS service delivers ALS ground coverage for 15 counties in four states (Missouri, Arkansas, Kansas, and Oklahoma) and consists of 9,871 square miles of service area. The coverage area is a mixture of rural, urban, and suburban areas with a total population of 686,462. The annual call volume is over 60,000 ambulance requests covered by 350 EMS professionals working out of 29 stations with 48 ambulances.

Study Sample and Demographic Variables

To acquire a representative sample from the entire coverage area of the service, a request for voluntary participation by EMS professionals and a link to the electronic survey were sent to their respective hospital-issued electronic mail address by each regional manager. We collected demographic information (age, gender, race, education level, current level of EMS licensure, years of EMS service, average number of calls per shift, typical length of shift, type of EMS service, current rank, and type of community served) via the survey instrument. The survey was delivered in an electronic format using Qualtrics online software.[11]

Survey Design and Validation

We asked participants to respond to a series of statements using a seven-point Likert-type scale. The survey was validated using an expert panel of four individuals with experience in emergency medical care. Three of the evaluators are EMS professionals with experience and licensure as paramedic-level instructors. Two have doctoral degrees, one of whom developed a CP education program at his university. The final evaluator is a practicing emergency physician with 19 years of experience and currently serves as the medical director for an ED, two EMS services, and an EMS education program. Following review and revision by the expert panel members, a pilot of the revised instrument was performed.

The pilot testing sample consisted of a group of 16 currently licensed and practicing EMS professionals. We obtained a written letter of agreement to recruit participants from the service's chief officer prior to initiation of the survey. These individuals were requested to provide additional feedback on ease of use, readability, and offer suggestions for further improvements. The pilot group was excluded from participating in the study.

Study Participant Protection

The Western Carolina University Institutional Review Board (IRB) approved this study. It also received approval from the IRB representing the hospital that oversees the EMS service which participated in this study. All study subjects granted their consent prior to participation in the study, and their responses were anonymous.

Data Analyses

All data were uploaded from Qualtrics into and analyzed with the Statistical Package for the Social Sciences (SPSS).[12] We used descriptive statistics to summarize participants' responses as means, medians, and percentages with regard to subjects' demographics. Percentages were calculated based on the total number of respondents to each respective question. Kolmogorov-Smirnov tests of normality indicated that the data were not normally distributed. Consequently, we used nonparametric testing. The alpha level for each of the statistical evaluations was set at $p \leq 0.05$.

We used a Mann-Whitney *U* test to analyze the effects of gender as well as the current usage of a CP model concerning participants' willingness to perform CP duties. A Kruskal-Wallis one-way analysis of variance was used to analyze the effects of participant characteristics (including EMS provider level, education level, type of EMS shift, community served, current rank, and perceived hours per shift that could be dedicated to CP duties) on their outcomes. We used the Pearson product-moment coefficient of correlation to determine if there was a relationship between factors (years of EMS experience, number of patient calls per shift, and age) and participant outcomes. Multivariate logistic regression was also performed to examine the impact of participant characteristics (such as gender, age, race, EMS provider level, level of education, type of shift, community served, current rank, and perceived hours per shift dedicated to CP duties) on the likelihood of participants' willingness to perform CP duties.

RESULTS

Survey Response

The survey was opened on January 19, 2015, and closed on February 23, 2015. Members of the EMS service used for this research were notified of survey availability via an email to their work email account sent from their manager. Of the 350 EMS professionals receiving an invitation, 283 (81%) participated. Consent was given by 277 (98%) of the respondents and comprised the final data set for analysis. There were no sequential questions that forced participants to respond to a question before answering additional questions. Consequently, not all questions were answered by all respondents. See Table 1 for sample demographic characteristics.

EMS Work Experience

While the survey was conducted using a hospital-based EMS service, many of its part-time coworkers have primary EMS employment with different types of services. As expected, hospital-based EMS was the type of service listed as the primary work experience for a majority of the participants (198, 83%). Survey responses were representative of differing types of response settings and hours worked per shift (Table 2).

Perceived CP Needs

When questioned about the perceived number of hours per shift worked in which the participant could commit to a CP program, 73 (31%) indicated that they could not commit any time. A majority of the respondents (162, 69%) stated that they could spend one hour or more, with 51 (22%) indicating that they could commit more than four hours per shift to CP duties. Providers perceived that 47% (SD 1.7) of the patients they currently encounter in the field could potentially benefit from a CP program.

Table 1. Participants' demographic characteristics in a study of emergency medical services professionals' attitudes toward community paramedic programs.

Demographics	
Age	
Mean	37 years
Standard deviation	±10.1 years
Gender	
Male	202 (75%)
Female	68 (25%)
Ethnicity	
White	253 (94%)
Hispanic	3 (1%)
American Indian/Alaska Native	6 (2%)
Multi-cultural	4 (1%)
Other	2 (1%)
Education	
Some college	118 (44%)
Associate	59 (22%)
Bachelor	59 (22%)
Master	9 (3%)
Doctorate	3 (1%)
Current level EMS certification/licensure	
EMT	84 (33%)
AEMT	10 (4%)
Paramedic	160 (62%)
Total years EMS experience	
Mean	13 years
Range	0-41 years
Standard deviation	± 0.6
Duration of current level EMS certification/licensure	
Mean	13 years
Range	0-41 years
Standard deviation	± 0.6

EMS, emergency medical services; *EMT*, emergency medical technician; *AEMT*, advanced emergency medical technician.

Table 2. Participants' work experiences.

EMS work experience	
Primary EMS work experience	
Hospital-based	198 (83%)
Fire-based	14 (6%)
Private service	13 (5%)
Third/government	8 (3%)
Public utility/nonprofit	6 (3%)
Other	1 (0%)
Typical hours worked per shift	
24 hours	122 (47%)
8-12 hour days	55 (21%)
8-12 hour evenings	7 (3%)
8-12 hour nights	33 (13%)
> 24 hours	33 (13%)
Other	9 (3%)
Type of community served (population size)	
<2,500	30 (13%)
2,500-74,999	119 (50%)
75,000-149,999	15 (6%)
150,000-499,999	64 (27%)
Other	12 (5%)
Typical number of calls/runs per shift worked	
Mean	6
Median	5
Mode	4
Standard deviation	± 0.2
Participants working for a service that currently utilizes community paramedic model	
Yes	13 (6%)
No	222 (94%)
Current rank/position	
Field provider of patient care	166 (69%)
Other (supervisor, manager, dispatcher)	73 (31%)

EMS, emergency medical services.

CP Attitudinal Responses

When questioned as to their confidence in their understanding of what a CP program entails, 165 (70%) revealed feeling knowledgeable as to the requirements of a CP program. Eighteen (8%) selected a neutral response. Fifty-three (22%) indicated that they did not have a good understanding about CP programs. Regarding EMT and paramedic respondents' perceived understanding of CP programs, positive responses were given by 49 (65%) and 111 (75%) respectively. A total of 135 (58%) survey participants indicated that they were likely, somewhat likely, or very likely to attend additional education to become a CP with 45 (19%) undecided. Fifty-six (23%) indicated that they were unlikely, somewhat unlikely, or very unlikely to participate in additional CP education.

In response to whether or not they would perform CP duties with as much or more enthusiasm as they currently have for traditional, prehospital patient care, 152 (66%) survey participants indicated that they would. The number of undecided was 38 (16%). Forty-three (18%) gave a negative

response. Regarding responses per licensure level, 44 (58%) EMTs and 102 (69%) paramedics indicated a willingness to participate in a CP program.

When questioned if a CP program should be a significant responsibility for EMS in their community, 174 (74%) respondents gave a positive indication. Thirty-eight (16%) were neutral in their responses. The 24 (10%) other respondents perceived that a CP program should not be a significant responsibility for their community's EMS agency.

Three-fourths of those participating (175, 75%) felt that their respective community would be in favor of their service performing CP duties. Forty-eight (21%) were unsure of their community's reaction to a local CP program. A minority of the respondents (11, 4%) felt that their community would not be in favor of CP duties being performed by their service. See Table 3 for further explanation of participant responses.

Data Analyses

Regarding the respondents' type of community served and their willingness to complete CP duties, we found no statistical significance ($p = 0.74$). Participants who reported working for an EMS service that currently uses a CP model of patient care delivery did not have a statistically significant difference ($p = 0.89$). Additionally, reported rank (field provider of care vs. non-field provider of care [supervisor]) and the participants' willingness to perform CP duties did not produce a statistical significance ($p = 0.34$). See Table 4 for further explanation of the data analyses.

Regarding participants' willingness to perform CP duties, the results of the regression model correctly classified 79.2% of all the cases. Females were four times more likely than males to indicate a willingness to perform CP duties (OR = 4.651, $p = 0.03$; 95% CI 1.186, 18.236). The respondents perceiving that they had no spare time while on duty to commit to CP duties

Table 3. Participant survey response summary regarding EMS professionals' attitudes toward community paramedic programs.

Survey question/statement	Somewhat agree, agree, or strongly agree	Neutral	Somewhat disagree, disagree, or strongly disagree
I currently have a good understanding of a CP program.	165 (70%)	18 (8%)	53 (22%)
I would volunteer to attend additional education to become a CP.	135 (58%)	45 (19%)	56 (23%)
A CP program will help those in most need (i.e. the very young, the very old, and the disabled).	197 (84%)	22 (9%)	14 (7%)
A CP program should be a significant responsibility for EMS in my community.	174 (74%)	38 (16%)	24 (10%)
I would perform the duties of a CP with as much or more enthusiasm as I currently have for traditional, prehospital patient care.	152 (66%)	38 (16%)	43 (18%)
My coworkers would be in favor of performing CP duties.	140 (60%)	55 (24%)	39 (16%)
The community I serve would be in favor of our service performing CP duties.	175 (75%)	48 (21%)	11 (4%)
The leaders in my EMS service, in general, would support our organization's involvement in a CP program.	172 (74%)	35 (15%)	27 (11%)
I became an EMS professional in order to save lives during emergencies - not to participate in a CP program.	64 (27%)	60 (26%)	110 (47%)
My EMS service is not busy enough to benefit from a CP program.	19 (8%)	38 (16%)	176 (76%)
My EMS service is too understaffed to develop a CP program.	98 (42%)	53 (24%)	80 (34%)
Performing CP duties would take up valuable down-time that I depend upon (i.e. for rest and other personal activities).	75 (32%)	64 (28%)	92 (40%)
I work hours that would not be compatible with CP duties for many people.	67 (28%)	67 (28%)	97 (44%)
My EMS service would be willing to develop a specific position or positions dedicated to performing CP duties.	131 (57%)	73 (32%)	27 (11%)

CP, community paramedic; *EMS*, emergency medical services.

Table 4. Project data analyses.

Dependent variable	Independent variable	p-value
Willingness to perform CP duties	Gender	0.03*
Willingness to perform CP duties	Perceived hours worked per shift dedicated to CP duties	< 0.001†
Current understanding of what a CP program entails	Perceived hours worked per shift dedicated to CP duties	0.01†
Willingness to volunteer to attend additional education to become a CP	Perceived hours worked per shift dedicated to CP duties	< 0.001†
An effective CP program will help those most in need	Perceived hours worked per shift dedicated to CP duties	< 0.001†
A CP program should be a significant responsibility for EMS in my community	Perceived hours worked per shift dedicated to CP duties	< 0.001†
My coworkers would be in favor of performing CP duties	Perceived hours worked per shift dedicated to CP duties	0.01†
The community I serve would be in favor of my service performing CP duties	Perceived hours worked per shift dedicated to CP duties	0.02†
I became an EMS professional in order to save lives during emergencies and not to participate in a CP program	Perceived hours worked per shift dedicated to CP duties	0.01†
My EMS service is too understaffed to develop a CP program	Perceived hours worked per shift dedicated to CP duties	0.02†
I work hours that would not be compatible with CP duties for many people	Perceived hours worked per shift dedicated to CP duties	0.00†
My EMS service would be willing to develop a specific position or positions dedicated to performing CP duties	Perceived hours worked per shift dedicated to CP duties	0.04†
The leaders in my EMS service would support our organization's involvement in a CP program	Rank	0.05†
I became an EMS professional in order to save lives during emergencies and not to participate in a CP program	Rank	0.02†
I work hours that would not be compatible with CP duties for many people	Typical shift worked	< 0.001†
My service is not busy enough to benefit from a CP program	Type of community served	< 0.001†
Willingness to volunteer for additional education to become a CP	Age	0.03‡
Willingness to volunteer to attend additional CP education	Years of EMS experience at current level of EMS certification/licensure	0.01‡

CP, community paramedic; *EMS*, emergency medical services.
*Mann-Whitney *U* test.
†Kruskal-Wallis one-way analysis of variance.
‡Pearson product-moment coefficient of correlation.

were less willing to accept the additional duties of a CP program than those who perceived they had any time on duty for these activities (OR = 0.198, p < 0.001; 95% CI .087, 0.449). See Table 5 for further logistic regression results.

DISCUSSION

While some reports on the effectiveness of CP programs regarding the reduction of ED bed hours, unnecessary ambulance transports, and emergency services' cost savings appear in the literature,[1,3,6] the authors were unable to identify any studies on the attitudes of EMS professionals toward their understanding of these programs or their willingness to participate in them. Our survey findings indicate that EMS professionals believe that they have an understanding of CP programs and most are willing to volunteer to attend additional education in order to participate in them. EMS professionals also feel that CP programs will help those in their community who have the greatest need and that CP programs should be a significant responsibility for EMS in their respective communities. Responses also indicate that most, but not all, EMS professionals are willing to perform CP duties with as much or more enthusiasm as they currently have for traditional, prehospital patient care. However, the time commitment for such duties was a concern, suggesting that successful

Table 5. Logistic regression model results for willingness to perform CP duties.

Parameter	OR	p-value	95% CI
Gender	4.651	0.03	1.186, 18.236
Race	0.191	0.02	0.049, 0.744
Perceived CP hours on duty	0.198	<0.001	0.087, 0.449
Constant	6.124	<0.001	

OR, odds ratio; *CI*, confidence interval; *CP*, community paramedic.

implementation may be more likely when staff members are committed directly to CP duties instead of dual responsibilities.

Female participants were more than four times as likely as their male cohorts to express a willingness to participate in a CP program. Female willingness may be impacted, in part, by participants' empathy levels. Compared to males, Williams et al. found that female paramedic students had higher empathy ratings toward all medical conditions queried.[13] Similar results were reported by other authors evaluating healthcare students' empathy levels.[14-17]

We found no statistically significant differences in willingness to participate in a CP program with regard to EMS provider level, age, level of education, type of shift, community served, or current rank. EMTs and paramedics both expressed an interest in providing CP-level care to their communities. While a study by Simpson et al. found that younger EMS providers with a tertiary education had a higher level of support for evidence-based practice,[18] young EMS professionals were as likely as their older counterparts to express a willingness to participate in a CP program. In addition, educational preparation, shift hours worked, and rural vs. urban practice settings were not found to impact EMS professionals' willingness to participate in a CP program.

Attitudinal Implementation Barriers: Parallels with other Public Safety Professions

Prior to implementing a CP program, EMS leaders should investigate potential barriers to successful implementation. While there is a paucity of research exploring the attitudes of EMS professionals regarding CP programs, the importance of employee acceptance to successful implementation of new programs has been reported among other public safety professions. For example, several reports examining the attitudes of law enforcement officers (LEOs) and firefighters toward the nontraditional role of providing care to patients in the prehospital environment exist in the literature.[19] Such reports may provide insights and parallels to gauging EMS professionals' attitudes toward implementing CP programs.

Over the past four decades, policing strategies have changed from an enforcement role to one of problem-solving.[20] These new roles have included the use of automated external defibrillators (AEDs) and cardiopulmonary resuscitation (CPR) for victims of out-of-hospital cardiac arrest, as well as officer-administered naloxone to treat overdose victims.[20] With CP programs changing the EMS profession from a primarily reactive role to one of prevention, EMS leadership might encounter similar implementation barriers faced by their law enforcement counterparts.

Green et al. found that LEOs expressed concerns with the added responsibilities inherent in preventing overdoses in a naloxone administration program.[20] With the new focus on assessing and managing patients with chronic medical conditions in their respective communities, EMS professionals may also have concerns about the added responsibilities of CP programs. One-fourth (27%) of those participating in our survey perceived that they became an EMS professional to respond to emergency calls and not to participate in a CP program. These respondents might see the new CP responsibilities as a barrier to participation.

When attempting to implement an AED program, Husain et al. found that law enforcement leaders were challenged by LEOs who did not believe providing medical care was a part of their role in the community.[21,22] The lack of officer comfort with providing medical care in the prehospital environment has been linked to a failure to implement this role change.[21-23] Leaders of EMS programs attempting to develop and/or staff CP programs might be challenged to recruit willing participants if EMS professionals do not believe that CP is part of their role. Forty percent of participants responding to our survey did not perceive that their coworkers would be in favor of performing CP duties. Lack of coworker willingness to participate in this role change is a potential implementation barrier.

Another obstacle faced when attempting to implement law enforcement and fire service AED and naloxone programs was hesitancy of the LEOs and firefighters to use the new equipment out of a concern for perceived new liability.[23,24] Prina et al. found that LEOs and firefighters felt that the public's perceptions about AED success were unrealistically high.[25] This also created a fear of liability if their resuscitation attempts were unsuccessful.[25] With the CP focus of providing and/or arranging care in the patient's community instead of transporting patients to the ED, liability concerns from EMS professionals may also create a barrier to successful CP program implementations. Nearly three-fourths (74%) of our respondents felt that a CP program should be a significant responsibility for EMS in their respective community. This may indicate that liability concerns are not dissuading our survey participants from expressing a willingness to participate in CP programs.

Many obstacles to successful implementation of novel programs in emergency professions that can correlate to EMS providers' implementation of CP programs have been identified. Fortunately, several items have been found to assist with the start of new programs. When LEOs and firefighters felt that their new roles could benefit the communities they served, they were more likely to have positive attitudes toward these new

roles.[21,23,25-27] A majority (84%) of our respondents believe that a CP program would help those in their community with the greatest needs. Like their LEO counterparts, the EMS professionals who understand the potential benefits a CP program could offer to the underserved and vulnerable members of their community might be more willing to participate.

All police chiefs and a majority of their respective officers surveyed by Papson et al. believed that the use of AEDs by police was not only appropriate, but also a valuable service to their communities.[23] A strong show of support from EMS leaders toward CP programs may also translate to increased positive attitudes among their service's frontline providers. Almost three-fourths (74%) of our respondents felt that their leaders would support a CP program. These positive feelings regarding CP-level care may bode well for successful CP implementation.

In addition to the benefits provided to the community via the new roles of LEOs and firefighters, a majority of public safety professionals surveyed agreed that providing EMS-related activities improved the public's perception of the participating departments and their members.[23-25,30] As EMS professionals transition into the expanded CP roles, this additional service provided to the community may also improve the public's perception of these providers and their agencies. Of those responding to our survey, three-fourths perceive that the community they serve would be in favor of having a CP program delivered by their EMS agency.

A positive attitude among LEOs and firefighters was found when they personally experienced the impact of EMS-related activities while performing their traditional public service duties.[19,20,25] An even higher trend of favorable attitudes was found among those officers and firefighters who restored a pulse for a victim of out-of-hospital cardiac arrest.[25] Ray et al. found a reluctance, even toward naloxone training, with LEOs who had less experience or lacked recent experiences with overdose cases.[28] EMS professionals may have a more positive attitude toward CP programs when they can see the tangible benefits to the community they serve. Respondents to our survey felt that nearly half (47%) of the patients they currently encounter in the field could potentially benefit from a CP program.

A significant barrier to implementing AED programs for public safety professionals has been negative attitudes related to a lack of education regarding the programs and their benefits.[29] To overcome this barrier, educating LEOs and firefighters about these public health programs has shown to increase their willingness to participate.[19,23-25,29] EMS professionals educated about CP programs and their subsequent benefits to the community may be more willing to participate in them. A majority of our survey respondents (70%) perceived that they currently have a good understanding of CP programs and stated they would volunteer (58%) to attend additional education to become a CP.

EMS leaders interested in pioneering a CP program in their area could use this information when making strategic plans for growth and expansion of their services in the community. This survey's results indicate that EMS professionals perceive they understand CP programs, support providing CP services to their community, and are willing to participate in this model of care delivery.

LIMITATIONS

A significant limitation to this study was a lack of diversity among the subjects regarding the type of their primary EMS service. The service used for this study was hospital-based. While the service does employ part-time EMS professionals who have full-time employment at different types of EMS services, a majority of the respondents were hospital-based. The sample size was also relatively small and geographically non-diverse. A majority of the participants also had no current CP experience.

The lack of racial and gender diversity among the participants are other limiting factors. Survey respondents identified themselves as White and as male, 94% and 75% respectively. While a 2013 study by Bentley et al. found that 85% of nationally certified EMS professionals identified themselves as nonminority and 74% as male,[30] generalization of the findings toward services with differing percentages of ethnicities and genders may be limited.

As with all cross-sectional studies, participants may be biased toward or against participation based on their feelings regarding the topic. In addition, several participants did not respond to all questions. The lack of complete responses combined with self-reporting could have led to biased results.

While our results indicated that EMS professionals are generally receptive to participating in a CP model of care delivery, future studies are needed to confirm the findings in different regions, different types of EMS agencies, and among a more diverse group of EMS professionals.

CONCLUSION

The authors sought to quantify the attitudes of EMS professionals toward a CP program and found that the majority of those surveyed believe they understand what a CP program entails, most are willing to attend additional education to offer CP services and are willing to serve in this new role. EMS administrators might reach buy-in from their employees if separate CP shifts or CP positions are offered instead of adding these new responsibilities to their employees' current job duties. Results of this survey are limited by the predominate type of EMS service represented, as well as the geographical location and limited racial and gender diversity among the participants. Further studies are needed to assess the opinions of EMS professionals in differing types of EMS agencies, different geographical locations, and differing proportions of ethnicities and genders. These results will be important for EMS administrators and medical directors planning to develop and implement CP programs.

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American Association for Emergency Psychiatry Task Force on Medical Clearance of Adult Psychiatric Patients. Part II: Controversies over Medical Assessment, and Consensus Recommendations

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Introduction: The emergency medical evaluation of psychiatric patients presenting to United States emergency departments (ED), usually termed "medical clearance," often varies between EDs. A task force of the American Association for Emergency Psychiatry (AAEP), consisting of physicians from emergency medicine, physicians from psychiatry and a psychologist, was convened to form consensus recommendations for the medical evaluation of psychiatric patients presenting to U.S.EDs.

Methods: The task force reviewed existing literature on the topic of medical evaluation of psychiatric patients in the ED and then combined this with expert consensus. Consensus was achieved by group discussion as well as iterative revisions of the written document. The document was reviewed and approved by the AAEP Board of Directors.

Results: Eight recommendations were formulated. These recommendations cover various topics in emergency medical examination of psychiatric patients, including goals of medical screening in the ED, the identification of patients at low risk for co-existing medical disease, key elements in the ED evaluation of psychiatric patients including those with cognitive disorders, specific language replacing the term "medical clearance," and the need for better science in this area.

Conclusion: The evidence indicates that a thorough history and physical examination, including vital signs and mental status examination, are the minimum necessary elements in the evaluation of psychiatric patients. With respect to laboratory testing, the picture is less clear and much more controversial. [West J Emerg Med. 2017;18(4)640-646.]

INTRODUCTION

Emergency physicians (EP) are commonly required to diagnose and treat psychiatric patients.[1] In 2011, for instance, EPs diagnosed "mental disorders" in approximately 3.9% of patient visits.[2] Many psychiatric patients presenting to an emergency department (ED) require some form of aftercare (i.e., psychiatric admission, transfer to a psychiatric crisis center, etc.). Thus, EPs are often asked to "medically clear" psychiatric patients.

As EDs often perform assessments of psychiatric patients, who commonly have coexisting medical and psychiatric disease, it is imperative that both emergency and psychiatric physicians find a common language and point of reference to care for these patients. A consequence of not sharing a common treatment algorithm or language is evident in the Tintinalli et al. study, in which 80% of patients listed as "medically clear" on the chart actually had medical disease that should have been identified during a standard history and physical.[3]

EDs are further limited by the capabilities of receiving institutions, as many free-standing psychiatric facilities lack medical equipment and trained staff to care for coexisting medical disease.[4] EDs have therefore been forced to perform increasingly comprehensive medical screening exams before transferring patients to these units. As funding for psychiatric facilities decreases, the number of psychiatric inpatient beds has declined, which has the deleterious effect of increasing the acuity of psychiatric units both medically and behaviorally. Limited bed availability prolongs lengths of stay (LOS) for psychiatric patients, although it is not known how medical complexity affects availability of psychiatric beds.[5] As numbers of psychiatric patients in the ED subsequently increase, waiting times and LOS for all ED patients are affected, making this an important issue for all EDs.[6]

This is part II of the American Association for Emergency Psychiatry (AAEP) task force on medical examinations of psychiatric patients presenting to EDs. The task force was composed of EPs, emergency psychiatrists, and an emergency psychologist. Task force members consisted of Michael P. Wilson, Kimberly Nordstrom, Eric L. Anderson, Anthony Ng, Leslie Zun, Jennifer M. Peltzer-Jones, and Michael H. Allen, chosen by the AAEP for their expertise on the topic, all with an extensive background in behavioral emergencies. Consensus was achieved by group discussion and iterative revisions of the written document. The purpose of this task force was to examine the existing evidence, synthesize it into cohesive guidelines, and examine areas for future research in the areas of emergency medicine (EM) and emergency psychiatry. This document was reviewed and approved by the AAEP Board of Directors.

CONTROVERSIES OVER "MEDICAL CLEARANCE"

There are a number of current areas of controversy in the emergency medical examinations of psychiatric patients:

- defining adequate medical examination for psychiatric patients;
- outlining the role of routine laboratory testing, including urine drug screens and medical algorithms;
- reviewing the standards of the capabilities of psychiatric receiving facilities.

Each of these questions is discussed in turn.

Defining an Adequate Medical Exam

Several studies have investigated the important elements of emergency medical triage or screening exams for psychiatric patients.[7-14] There is general consensus that psychiatric patients with abnormal vital signs, advanced age (>= 65 years of age), severe agitation, evidence of toxic ingestion, or decreased level of awareness are more likely to have a medical cause for their illness and therefore warrant further testing.[15] Many authors have also advised formal mental status screenings in the ED, especially for elderly patients, since patients with frank disorientation are more likely to have a medical cause of their symptoms than a psychiatric diagnosis.[16-17] Although there have been few studies investigating differences between screening tools in the ED, one study by Kaufman and Zun found that a six-item questionnaire had a sensitivity of 72% and a specificity of 95% in identifying individuals with severely impaired mental status, took only a few minutes to complete, and was rated as useful by most clinicians administering the test.[8]

Although a prospective randomized trial of the addition of mental status screenings alongside physical exams has never been performed, these studies highlight the importance of a mental status exam in the medical evaluation of psychiatric patients. Expert guidelines, such as those by the American College of Emergency Physicians (ACEP), recommend an assessment of mentation as part of medical screening in EDs.[18] Although no studies have investigated the use of allied health personnel in the screening of psychiatric patients, most have relied, either explicitly or implicitly, on the judgment of attending EPs or similarly qualified individuals.

The Role of Routine Laboratory Testing and Medical Algorithms

Whether or not there should be a reasonable suspicion of disease in asymptomatic patients with normal vitals and a psychiatric chief complaint has yielded conflicting results in the EM literature. Nonetheless, at least one study has indicated that many EPs are routinely required to obtain labs for psychiatric patients.[19] These routine labs generally do not reveal serious disease, especially if the patient is young.[20-23] Olshaker and colleagues, for instance, reported on a series of 65 patients with a coexisting medical condition presenting for a psychiatric complaint.[20] The authors concluded that history and physical examination alone were able to detect the vast majority of medical illness. Janiak and Atteberry reviewed 502

charts of psychiatric patients who received routine laboratory testing by the psychiatric service and found, with only one exception, no labs ordered routinely would have changed ED management.[21] Amin and Wang prospectively studied 375 psychiatric patients presenting for medical assessment. In this study, 14.9% of patients had non substance-induced laboratory abnormalities that either occurred in patients with abnormal history or physical exams or were not felt to alter final disposition or contribute to the patient's presentation.[22] Korn and colleagues reviewed 212 charts, finding that the initial complaints of these patients correlated directly with the need for additional testing.[23]

A study by Henneman and colleagues, however, reached opposite conclusions.[7] The authors investigated 100 consecutive patients aged 16-65 who presented to the ED with new-onset psychiatric complaints and no known past psychiatric history. In this cohort, 63 patients were found to have coexisting medical illness. History and physical examination alone suggested disease in only 27 of the 63 patients; the authors concluded that most adult patients with new-onset psychiatric symptoms have a medical etiology and recommended extensive assessment for all patients with new-onset psychiatric complaints.

Unfortunately, the controversy in the literature regarding the importance of physical exams and laboratory testing is difficult to resolve with existing studies such as these, since none of the studies above documented the elements of their physical or mental status examinations. Further, none of these studies investigated whether testing high-risk groups increases the yield of laboratory investigations. Although a definitive answer to the question of testing awaits further research, at least some evidence exists that routine testing adds little to disposition decisions beyond the clinical judgment of an attending EP. Based on evidence of this type, ACEP, in a recent clinical guideline on evaluation of adult psychiatric patients, stated that routine laboratory testing for asymptomatic, alert, cooperative patients was unnecessary.[24] It is unknown, however, how routine testing may contribute to the identification of chronic coexistent disease such as diabetes or renal failure, which may be more important for provision of care after the ED.

The utility of routine urine drug screens has also been questioned. In theory, provider knowledge of exposure to drugs of abuse could potentially alter diagnosis and disposition to addiction treatment versus a psychiatric setting. This is relevant partly because these settings are funded by different mechanisms in some states. In support of routine testing, studies such as Schuckman et al. have indicated self-reporting of illicit drug use is unreliable in the ED setting.[25] However, several ED studies have indicated that verification of a patient's substance use with urine drug screens does not often change ED disposition of psychiatric patients.[26-29] In a prospective study of 392 patients presenting to a psychiatric emergency service, for instance, Schiller and colleagues found 20.8% of patients who denied substance use actually had positive screens, but dispositions did not change between patients in whom a routine urine drug screen was ordered (the mandatory-screen group) and patients in whom it was not (usual-care group).[25] Similar results were found by Korn and colleagues in a retrospective review of 212 charts, Fortu and colleagues in a retrospective review of 652 charts, and Eisen and colleagues in a prospective study of 133 patients.[23,27-28]

At least one study has found that when a urine drug screen was checked, it was correct for all five drugs of abuse only in 75.2% of cases, raising questions about the accuracy of the test.[29] ACEP, in a guideline on evaluation of adult psychiatric patients, stated routine testing for urine drugs of abuse was unnecessary in the ED but offered this only as a Level C recommendation.[18] Based on these studies, it appears that ED management would not often be changed as a result of urine toxicologic testing. However, if comorbid substance use is detected, it should become a focus of any subsequent treatment. Receiving psychiatric facilities may request this study, as it is time critical and may affect the direction of further mental health treatment. Unfortunately, no studies have examined the cost of performing this test at psychiatric receiving facilities, whether the results of this test would change the subsequent care setting or treatment decisions, or the impact on payment.

Given the often conflicting demands between comprehensive medical testing that is useful to consultants and the desire of many EPs only to obtain testing that will affect their disposition and management in the ED, many authors have advocated the use of medical algorithms that are agreed upon in advance by all parties involved. Zun and colleagues in their work with the Illinois Mental Health Task Force set forth three basic criteria for hospitalization in a state-operated psychiatric facility: evidence of a psychiatric diagnosis severe enough to warrant inpatient hospitalization; clinically-indicated evaluation of any suspected medical illness; and the stability of any medical problems in order to allow both safe transport to the facility and hospitalization at that institution.[10] Additional guidelines were adopted to specify the term "clinically-indicated evaluation." In a later study, Zun and Downey performed a retrospective chart review of all ED patients with psychiatric complaints who were transferred to a psychiatric facility after the adoption of the medical clearance protocol, compared to all patients who were transferred before the protocol.[11-12] The total cost of diagnostic testing was $269 per patient after the adoption of the protocol and $352 before, which was a statistically significant difference. The return rate of patients to the ED after the protocol, however, was similar.

Another screening algorithm was recently proposed by Shah and colleagues.[13] In this study, the authors retrospectively reviewed 485 charts of psychiatric patients who had been evaluated by attending EPs with a five-item screening tool

created for psychiatric patients. Patients with a "yes" to all five questions (stable vital signs, prior psychiatric history, alert/oriented x 4, no evidence of acute medical problem, no visual hallucinations) were discharged to a psychiatric receiving facility without further testing. Only six patients (1.2%) with "yes" to all questions required further medical workup and were returned to the ED. No patients required medical or surgical admission.

Despite studies like these, however, a simple medical screening algorithm with broad applicability to psychiatric patients presenting to EDs has yet to be validated or widely adopted.

The Capabilities of Psychiatric Receiving Facilities

The Emergency Medical Treatment and Labor Act (EMTALA) requires that, for a transfer to be appropriate, the receiving facility must have the capability to treat the patient. For psychiatric facilities, this would imply the capability to treat both medical and psychiatric conditions. However, medical capability varies widely within the range of available psychiatric facilities. The level of capability often affects ED medical screening processes in ways that are not scientific. In 2002, the American Psychiatric Association (APA) task force on psychiatric emergency services set forth clear guidelines for basic capabilities of different types of psychiatric receiving facilities.[30-31] The lowest level of care in this report was termed a psychiatric urgent care facility, which was still required to be able to perform basic medical testing. However, these guidelines have not been widely adopted.

The idea that psychiatric receiving facilities, not attached to a hospital, should meet APA guidelines for operating at the level of a psychiatric urgent care facility or higher has been suggested in the literature,[30] but did not find consensus in the current work group.

AAEP CONSENSUS STATEMENT ON MEDICAL EVALUATION OF PSYCHIATRIC PATIENTS

After reviewing existing evidence, the AAEP Task Force makes the following recommendations for the evaluation of psychiatric patients presenting acutely to EDs. In general, there are no randomized clinical trials comparing different strategies for medically assessing psychiatric patients in the ED. Nor are there randomized trials investigating reliable markers of medical illness in the psychiatric patient. Thus, recommendations are based on expert consensus and should be treated as preliminary until further evidence is obtained.

Recommendation 1

The goal of medical assessment of psychiatric patients in an ED is to identify potential causative factors for a patient's presenting complaint (i.e., medical mimics) as well as medical problems that will need ongoing care but do not contribute directly to the presenting psychiatric complaint. Examples of the former include encephalopathy, substance intoxication/withdrawal, infections, or central nervous system disease. Examples of the latter include chronic obstructive pulmonary disease or diabetes. EDs should perform an appropriate medical screening exam and appropriate documentation for the presenting complaint. If there is a question whether the patient has delirium or a psychiatric disorder, this patient should be medically observed or hospitalized.

Recommendation 2

Further medical evaluation should be considered for patients who have (1) new-onset psychiatric symptoms after the age of 45 years,[32-33] (2) advanced age (65 years of age and older),[34-35] (3) cognitive deficits or delirium, (4) positive review of systems indicative of a physical etiology, such as cough and fever, (5) focal neurological findings or evidence of head injury, (6) substance intoxication, withdrawal, or exposure to toxins/drugs, (7) decreased level of awareness, or (8) other indications, such as abnormal vital signs that direct further assessment. An example includes a urinalysis in elderly patients with dysuria (or other sign/symptom of urinary tract infection) and new-onset altered mental status. As an aside, obtaining a urinalysis for all elderly patients with altered mental status but no symptoms specific to urinary tract infection may lead to premature treatment as asymptomatic pyuria is common in elderly patients.[37] The cause of the mental status change may lie elsewhere and require further workup.

Recommendation 3

The term "medical clearance" should not be used as it minimizes the presence of chronic medical problems and is not in line with current ED terminology. Instead, all patients seen in medical ED prior to transfer to psychiatric emergency services, psychiatric inpatient units, or other psychiatric settings must be evaluated medically. In place of a statement that the patient is "medically clear," a transfer note should accompany the patient indicating the patient is medically stable and appropriate for treatment in a psychiatric setting, i.e., that their behavioral disturbance is unlikely to be due to a medical condition or physical trauma, and that medical/surgical treatment for any concomitant conditions is within the capabilities of the receiving facility.

This last statement implies that the continuing medical care required has been defined by the sending facility and that the necessary care will be available in a timely fashion at the receiving facility. The transfer note should include the details of the assessment performed, the results, and the medical decision-making that occurred to deem the patient appropriate for transfer with recommendations for the further assessment and care of any active medical problems. It may be necessary to document that the patient is medically stable for transfer per EMTALA guidelines, though these guidelines ought to be considered the minimum rather than the standard level of evaluation.

Recommendation 4

Universal screening of the psychiatric patient must, at minimum, include vitals, history, a physical examination, and assessment of mentation. A brief cognitive exam is preferred over a simple assessment of mentation, as the latter typically includes only a statement regarding the patient's level of alertness and orientation. Ideally, this cognitive exam should include assessment of attention, executive function, orientation, and recent memory. This detailed evaluation of cognitive status may be performed by clinicians, such as mental health consultants or allied health staff, who have been trained in mental health testing. The decision for further evaluation, however, should be based on the EP's assessment.

Recommendation 5

Since many psychiatric settings have limited medical capability, e.g., phlebotomy available only at certain times on weekdays, accepting physicians may ask that "routine" tests be done before the accepted patient arrives at the facility. These requests should be honored where possible, but should not delay the transfer of patients who are otherwise deemed medically appropriate for transfer. Clinically directed ED laboratory testing should be reviewed prior to transfer. Routine laboratory testing may be reported after the patient is transferred as long as there is a communication process with the accepting facility.

Recommendation 6

EDs should work cooperatively with their psychiatric receiving facilities to develop protocols that identify low- and high-risk categories or conditions, and the procedures required for each category at each facility. Testing such as laboratory evaluations or neuroimaging may be deferred for some categories and required in others as in recommendation 2.

Recommendation 7

In resolving disputes over whether a patient's condition is appropriate for psychiatric transfer and treatment, clinicians at both the accepting and receiving facilities should carefully review the specific patient's vital signs, history, and physical exam. In this clinical encounter, it is important to be clinically reasonable about the odds of suspected non-psychiatric diagnoses. It is neither efficient nor effective for psychiatric staff to require that statistically unlikely diagnoses be "ruled out," e.g., systemic lupus erythematosus in a 20-year-old male with low energy and a rash. On the other hand, ED staff should consider non-psychiatric diagnoses that mimic psychiatric conditions, such as hypothyroidism causing depressive symptoms. The treatment is different than for a primary depression (such as major depressive disorder).

Recommendation 8

There is a great need for additional research in the area of medical screening. We recommend the following:

1. What are the essential elements of a history that might efficiently form the basis for universal screening of psychiatric patients? What are the vital elements of the physical exam?
2. What are the criteria that define groups at high risk for medical disease? Are there criteria that should be considered indications for more extensive evaluation in an ED? Are there critical values in vital signs or laboratory examinations that predict difficulty in managing the patient after leaving the ED?
3. What is role of urine toxicology and would point-of-care testing significantly alter the time required and the related cost benefit analysis?
4. Does the regionalization or specialization of emergency psychiatric receiving facilities, similar to regional trauma centers, provide better care for mental health patients? Could direct assessment by receiving facilities via telemedicine improve the processes and obviate the need for some procedures and transfers?
5. What is the most effective system for medical screening? In particular, qualitative studies are needed of receiving hospitals, as well as the match between the sending ED's assessment, the transfer plan, and the receiving service's assessment and capabilities of managing the patient.

CONCLUSION

The testing of psychiatric patients who present to the ED is an area of controversy, in part because there is little evidence to inform most elements of the evaluation process. After reviewing existing evidence, the task force believes there may be patients who can safely be considered low risk either for medical mimics of psychiatric disease or for co-existing medical disease. These patients generally have each of the following characteristics: young, present to the ED with an isolated psychiatric complaint, have a past history of psychiatric disease, are not using illicit substances, have normal vitals, and have a history and physical exam that does not suggest medical illness. Conversely, there likely exists a group of patients at higher risk both for medical mimics of psychiatric disease and for co-existing medical illness. These patients may have any of the following: older age, abnormal vitals and/or disorientation, no previous history of psychiatric disease, or a history and/or physical exam that suggests medical illness. In these patients, thorough medical assessment is likely indicated. The exact criteria defining these two groups are not well specified but should be subjected to further research. The essential elements of assessment of all psychiatric patients, regardless of risk of co-existing medical illness, are also not generally agreed upon. The task force believes further research in this area is necessary. In the interim, EDs should work cooperatively with their psychiatric facilities to develop protocols that allow both adequate medical screening of psychiatric patients and their efficient disposition from the ED.

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Managing Acute Behavioural Disturbances in the Emergency Department Using the Environment, Policies and Practices: A Systematic Review

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Introduction: Effective strategies for managing acute behavioural disturbances (ABDs) within emergency departments (EDs) are needed given their rising occurrence and negative impact on safety, psychological wellbeing, and staff turnover. Non-pharmacological interventions for ABD management generally fall into four categories: environmental modifications; policies; practice changes; and education. Our objective was to systematically review the efficacy of strategies for ABD management within EDs that involved changes to environment, architecture, policy and practice.

Methods: We performed systematic searches of CINAHL Plus with Full Text, PsycINFO, MEDLINE, and EMBASE, as well as reference lists of relevant review articles to identify relevant studies published between January 1985 - April 2016. We included studies written in English, which reported management of behavioural disturbances in adults associated with the ED through the use of environmental modifiers (including seclusion, restraint, specialised rooms, architectural changes), policy, and practice-based interventions excepting education-only interventions. Efficacy outcomes of interest included incidence, severity, and duration of ABD, incidence of injuries, staff absenteeism, restraint use, restraint duration, and staff and patient perceptions. Two reviewers independently screened titles and abstracts, and assessed the relevancy and eligibility of studies based on full-text articles. Two authors independently appraised included studies. A narrative synthesis of findings was undertaken.

Results: Studies reporting interventions for managing ABDs within the ED are limited in number and quality. The level of evidence for efficacy is low, requiring caution in conclusions. While there is preliminary evidence for environmental change in the form of specialised behavioural rooms, security upgrades and ED modifications, these are not supported by evidence from controlled studies. Many of these "common sense" environmental changes recommended in many guidelines have been widely implemented in EDs.

Conclusion: There is an unambiguous gap in the literature regarding the efficacy of interventions for ABD management in EDs involving environmental, policy or practice-based changes. With growing demand on EDs, and with increasing numbers of ABDs, identification of robust evidence-based interventions for safe and effective ABD management is vital. [West J Emerg Med. 2017;18(4)647-661.]

INTRODUCTION

Violence, aggression and abuse are highly prevalent in the healthcare sector, and have had a rising incidence over the past 15 years.[1-7] This is despite the widespread requirement that workers have the right to a safe and harassment-free workplace.[8] Together, violence and aggression can be conceptualised within the broader definition, "acute behavioural disturbance" (ABD). ABDs include verbal abuse, threats, physical assaults, assaults with bodily fluids and aggressive behaviours.[1,7] An ABD describes a person's conduct that does not respond to normal verbal intervention and interrupts the daily workings of the hospital department.[7,9] ABDs affect the morale, physical and psychological wellbeing of staff and staff performance, and, therefore, the healthcare provided to patients.[10]

A major focal point for ABDs within the healthcare sector is within emergency departments (EDs). EDs have the highest reports of violence globally.[2,11-13] EDs are generally open 24/7 and serve a large population of various backgrounds. In the United Kingdom, a staff survey identified that >30% of ED staff were assaulted.[13] Although unacceptably high, these figures may be significantly underestimated due to widespread underreporting.[2,14] Nonetheless, it is clear that minimising the frequency and impact that ABDs have within EDs is critical.

A significant body of research has identified factors leading to ABDs within the ED and other hospital units. ABDs can be conceptualised as arising due to patient factors, staff factors, environmental factors and their interaction.[15] It is logical, therefore, that efforts to reduce and effectively manage ABDs would be aimed at each of these areas. A Cochrane review[16] is currently underway examining the effectiveness of education and training interventions to prevent and minimise aggression toward healthcare workers. An examination of non-pharmacological methods other than educational interventions for staff is lacking. An integrative review by Anderson et al., focusing on interventions to reduce violence against emergency nurses reported in publications between 1986-2007, revealed a lack of substantial robust evidence for ABD management interventions.[17,18] Despite this, the use of environmental modifiers, such as specialised rooms[19-24] and changes in policy and practice, is becoming common. While the present paper reviews the efficacy of non-pharmacological management methods for ED ABDs, particularly focusing on policy, practice and environmental interventions, we take a broader focus to the study by Anderson et al. by expanding inclusion criteria to all ED staff, instead of predominately ED nurses. When used in conjunction with other topical literature, the findings may assist in guiding practice, interventions and management of ABDs within the ED.

Population Health Research Capsule

What do we already know about this issue?
Acute behavioural disturbances are common occurrences in emergency departments and represent a threat to safety and wellbeing. Non-pharmacological management strategies fall into four categories: educational interventions for staff; changes to policy or practice; or environmental modification. A systematic review of educational interventions is underway but a thorough examination of other non-pharmacological methods is lacking.

What was the research question?
Is the management of acute behavioural disturbances in emergency departments using non-pharmacological methods including changes to policy, practice or environment efficacious?

What was the major finding of the study?
The quality of all studies reviewed was weak. There is little evidence suggesting that the acute behavioural disturbance management strategies reviewed are efficacious. An unambiguous gap exists in the literature and there is a strong need to balance tailored interventions with unified approaches suitable for implementation on a widespread scale.

How does this improve population health?
This study underscores the need for rigorous testing of efficacy of interventions to manage acute behavioural disturbances. Continued practice of non-pharmacological strategies should be undertaken alongside rigorous evaluation.

Aims and Objectives

Our goal was to systematically search, summarise and critically appraise primary literature regarding efficacy of non-pharmacological strategies to manage ABDs within EDs, focused on environmental, architectural, policy or practice-based interventions. Efficacy studies were considered those that assessed changes in incidence, duration or severity of ABDs, incidence of injuries, staff absenteeism, restraint use, restraint duration, or subjective staff or client perceptions.

METHODS

Criteria for considering studies for this review

Studies were eligible if they did the following: (a) included adult participants (aged > 18 years) associated with the ED including service users/patients, staff, visitors and police; (b) were concerned with managing ABDs within the ED; (c)

involved environmental, physical or architectural management strategies, policy interventions, and new practices; (d) assessed any outcome measures of incidence, duration, or severity of ABDs, incidence of injuries, staff absenteeism, frequency or duration of restraint use, and staff or client perceptions; (e) were randomised control trials, non-randomised controlled trials, prospective or retrospective cohort studies, case-control studies, or pre-post observational studies; (f) were written in English; (g) were full-text articles; and (h) were published between January 1, 1985, and April 21, 2016. This date range was selected to overlap with previous systematic reviews including that by Nelstrop,[18] which was restricted to seclusion and restraint, but included studies set both in the ED and other acute inpatient settings; and Anderson,[10] who undertook an integrative review of methods for managing ED violence but restricted it to studies of nurses.

We excluded studies if they used qualitative methods only, were integrated literature reviews, systematic reviews or meta-analyses. In light of a systematic review currently underway on educational interventions for clinicians to better manage ABD,[16] we excluded studies reporting educational interventions only. Control groups (including pre-intervention), had to involve standard care.

Search of literature strategy

We conducted electronic database searches of OVID MEDLINE, CINAHL Plus with Full Text, PsycINFO (via OVID) and EMBASE (via OVID) on April 21, 2016, using Boolean/phrase, free-text search strategies, and medical subject heading (MeSH). Searches within titles and descriptors were used (Appendix A-D).

We also searched reference lists of meta-analyses, systematic reviews, and integrated reviews for relevant articles.

Study selection

Titles and abstracts were reviewed by two independent authors (TW, SI) to determine relevance. Full texts of potentially relevant articles were then evaluated against inclusion criteria. Disagreements between reviewers were resolved by consensus; if no agreement could be reached, the opinion of a third author (JH) was planned to be determinant.

Quality appraisal

Quality of included studies was appraised by two independent reviewers (TW, JH), unblinded to study purpose, using the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool For Quantitative Studies (Hamilton Tool).[25] Reviewers resolved disagreements by discussion and consensus.

Data extraction and synthesis

Data extraction was completed independently by one author (SI) and verified by another (TW) and included the following: primary author (year); setting, country; study design; participants; length of study; participant characteristics; interventions or exposures; outcome measures; main findings; study limitations.

Heterogeneity of interventions, data and methodologies meant statistical pooling was unsuitable; a narrative synthesis was undertaken.

Results

Search results

The systematic search resulted in 4,708 articles (Figure). We removed 1,940 duplicates, leaving 2,768 for review. Review of titles and abstracts of articles excluded 2,736. Full texts were sought for 35 articles written in the English language. Of these, three articles could not be sourced despite extensive searches by a librarian and multiple attempts to contact authors. Available full texts were further assessed against the inclusion criteria to provide a total of eight relevant articles[26-31] (Table 1).

Description of studies

Included studies were mostly interrupted time series (n=5). One study used an analytic cohort design, one was a prospective cohort study (single group pre-post), and there was one (non-randomised) control trial (Table 1).

Studies meeting inclusion criteria focused primarily on patients with ABD, with outcomes focused on rates of assault and ABDs, restraint use, staff perception and weapon detection. Several studies focused on more than one intervention. Three[3,7,26,27] implemented environmental strategies; three[3,7,27] reported on policy interventions, and seven[3,7,26,28-31] reported results of changes to practice. All studies were rated as being of weak quality (Table 2).

Narrative Synthesis

Casteel et al. described an analytic cohort to investigate how the California (CA) Hospital Safety and Security Act (CHSSA) of 1995 affected violent events against hospital employees in CA EDs three years pre-enactment and six years post-enactment.[27] The CHSSA required prevention and response interventions plans including environmental, security, policies and surveillance of violent events. New Jersey (NJ) EDs were used as temporal controls. Ninety-five CA and 46 NJ hospitals participated. Occupational Safety and Health Administration (OSHA) data were used to record violent injuries towards employees (physical contact and/or verbal assault) per 100,000 employee hours per year. Violent-event data were identified within OSHA logs, employers' reports and supporting documentation. Violent assaults abstracted were mostly physical (90%). The requirement to report only events producing employee injury necessitating absenteeism or more than first-aid is likely to have minimised event detection. Subsequently, very few events were recorded in each group.

Results indicated a decrease in assaults per 100,000 employee hours per year after policy enactment in CA

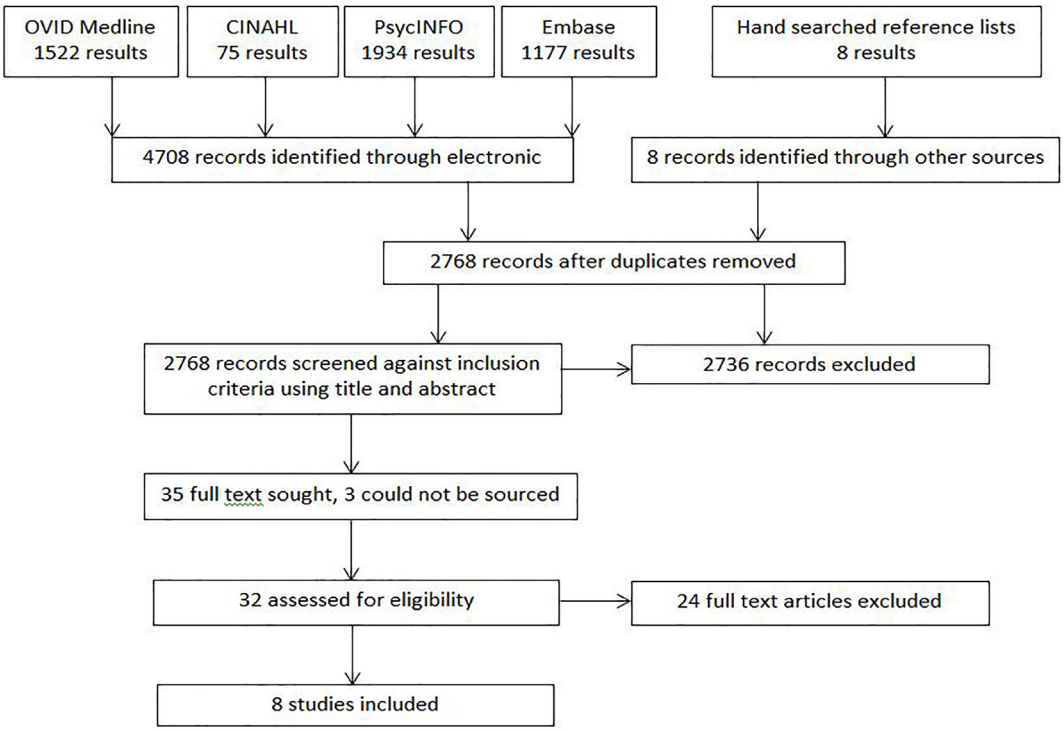

Figure. Systematic search results in a review of the efficacy of strategies for managing acute behavioural disturbances in the emergency department.

EDs (0.68 to 0.60), while there was an increase in NJ EDs over the same period (0.55 to 0.62). Several factors may have produced underestimation of results including unrecorded, underreported and missing violence data. Lack of differentiation between hospital staff and contractors may have confounded results since contractor hours were not recorded. Differences in the sociodemographics of the populations may have impacted violent-event frequencies. Additionally, lack of baseline data before CHSSA introduction precluded analysis of change in legislation compliance. It is of concern that there were highly unequal participation rates for CA (93%) and NJ hospitals (65%). In addition, control sites may have refused participation if they perceived their management of violence to be poor. The study was strengthened by the use of mandated documents, a large, diverse sample, and a sampling strategy that included rural and urban trauma facilities, and general acute care <300 beds and ≥300 beds. Additionally, there was consideration of confounders in the effect-modifiers between those with and without missing OSHA data. While the policy may have led to the observed difference in assault rates, the long-term effect of such policy change regarding maintained compliance and impact needs to be further assessed.

Cowling et al. presented a retrospective audit of behavioural assessment room (BAR) use within a single ED, together with an interrupted time series to evaluate the BAR as an ABD management strategy within the ED, assessed by staff survey.[7] The intervention involved the creation of a specialised room enabling ABD management away from the main ED area, and the introduction of associated policy. The audit was a 12-month retrospective evaluation of the BAR use by ED patients with ABD, five months post-intervention introduction. For the post-intervention questionnaire, responses were obtained from 80/110 possible ED clinical, non-clinical and security staff (72.7% response rate). A pre-intervention questionnaire was undertaken two years prior to this study. The post-intervention questionnaire was completed 10 months post-introduction of the BAR and associated policy. The study may have been limited by recall bias and the failure to use a reliable, validated tool to assess perceptions towards ABDs. Despite the high survey-response rate (73%) a test-retest approach could not be undertaken due to staff turnover. Selection bias and confounding may have impacted the study with no assessment of non-BAR ABD population characteristics, nor the comparative characteristics for questionnaire responders and non-responders. In addition, the audit's length of one year may have impacted on the ability of the study to investigate potential trends over time. The fact that all BAR ABD patients were audited would have minimised selection bias.

Emde et al. undertook a retrospective interrupted time series to evaluate whether increasing safety of seclusion rooms, together with staff education regarding restraint

Table 1. Summary of data extracted from studies included in a review of strategies to deal with acute behavioural disturbances by patients in the emergency department.

Primary Author (Year)	Setting, Country	Study Design & Duration	Participants (Type, N, selection, characteristics)	Interventions or Exposures	Data collection methods	Main Outcome Measures	Main Findings	Possible Confounders and biases
Gillespie (2014)[3]	The settings included 2 level I trauma centers, 2 urban tertiary care EDs, and 2 community-based suburban EDs	Controlled trial (quasi experimental). 18 month study period (9m pre, 9m post), Sites matched by type and then randomly assigned as intervention or comparison sites.	209/213 eligible participants. 71% female; 56% nurses.	environmental changes, policies and procedures, and education and training	3 researcher devised surveys: baseline demographic survey; monthly survey; and Violent Event Survey.	Mean rate of staff reported assaults and physical threats	Rate of assaults decreased significantly over time for both intervention groups and controls No significant differences in assault or physical threat rates based on gender, occupation, and ED type.	Unclear whether there was a direct comparison of change in assault rates between controls and intervention group. Inappropriate use of post-hoc testing. Individual participants not randomised. Lack of clarity regarding uniformity of intervention (sites were given key elements of policy only).
Casteel (2009)[27]	California (CA) and New Jersey (NJ) emergency departments (EDs) and Psychiatric Units. USA	Analytic cohort; Duration: 9 years (pre: 1993-1995; post: 1996-2001).	95 EDs in CA; 46 in NJ (control). No baseline data; Selection based on locality; uneven participation rates (93%, 65%); Whole of hospital data only	Enactment of the California Hospital Safety and Security Act	Assaults: Occupational Safety and Health Administration Logs, Employer Reports, hospital incident reports, supervisor reports security logs Employee hour data: Electronic Records	Assault rates per 100,000 employee hours per year.	Assault rates decreased 48% in CA post-enactment, compared with New Jersey (rate ratio = 0.52, 95% CI: 0.31, 0.90).	Uneven participation rates; Hospital staff and contract workers not differentiated in OSHA data. No blinding; Missing employee hour data mainly for CA hospitals; Higher ratio of severe events reported. Likely under-reporting of incidents.

Table 1. Continued.

Primary Author (Year)	Setting, Country	Study Design & Duration	Participants (Type, N, selection, characteristics)	Interventions or Exposures	Data collection methods	Main Outcome Measures	Main Findings	Possible Confounders and biases.
Cowling (2007)[7]	ED of Major metropolitan teaching hospital, Australia.	(1) interrupted times series; (2) 12m audit (2003)	(1) Audit: n=117 patients managed in behavioural assessment room (BAR): age range = 19.7-61.7 years; 76 male; 38 female; 3 no gender specified) (2) Cohort: 80/110 ED staff; staff self-referred, high attrition resulting in inclusion of staff at post-intervention that were not present at pre-intervention.	Use of a specialized behavioural assessment room (BAR); BAR policy, staff education; and team response.	Retrospective audit using pre-defined form; researcher devised survey	Duration in BAR; restraint method; patient clinical and demographics characteristics Staff type; incidence and frequency of verbal or physical abuse before and after intervention; perceived safety; policy awareness, perceived effectiveness of policy; violence-related absenteeism; effects of violence; perceived impact on care, response times; whether the intervention had supported	Median duration of BAR use: 20 min; 65.8% patients restrained; 23.3% chemical restraint alone, 28.5% Mechanically restrained alone; 29.8%, both Mechanical and chemical 58% intoxicated. Questionnaire Results: 44% Affected personally by violence; 14.9% required time off; 87.5%; verbally assaulted; 52.1% physically assaulted; 98.5% believed that the BAR created a safer environment; 86.5% of all respondents reported feeling safe; 74.5%; reported the BAR policy improved management of patients; 63.6% noted more timely response to patient management.	Recall bias; No reliable and validated tools, potential for selection bias. The percentage of missing data would affect results robustness and lower estimated results. The questionnaire post-intervention was modified from that performed 2 years ago (pre-intervention) complicating direct comparison. No blinding reported.

Table 1. Continued.

Primary Author (Year)	Setting, Country	Study Design & Duration	Participants (Type, N, selection, characteristics)	Interventions or Exposures	Data collection methods	Main Outcome Measures	Main Findings	Possible Confounders and biases.
Cailhol (2007)[28]	Emergency Psychiatric Department, of a single hospital, Geneva, Switzerland.	interrupted times series, 5 month pre, 5 months post)	478 patients attending during 10 month study period. Pre: 254 Post: 224)	Education focused on restraint and violent behavior Dialog between staff through meetings, including a journal club Medical presence during all security interventions for restraint Debriefing after restraint use	Ad hoc questionnaire of patient behaviour completed by clinicians	% Violent patients (as a function of total presentations)	A significant reduction in VB (was found before and after the intervention (17% to 7%). No significant differences for sex, age and diagnosis between the two periods between patients with VB and patients without VB.	Absence of a temporal control. No blinding: Clinicians making decisions about restraint were also those collecting data.
McMahon (2003)[29]	Urban level 1 trauma centre Boston Medical Centre (BMC)	interrupted times series ; (Pre: Jan-July 2000; Post: 2001, dates not specified) Interviews: Pre: Sept- Oct 2000; Post: 2001, dates not specified. Post-intervention Survey April 2001.	62 ED nurses from trauma, paediatric and cardiac areas. 84% Female, 50% >41 yrs; Self selected. Characteristics of patients participants not documented.	Modified restraint documentation tool + training	Audit data; interviews; surveys	Restraint episodes per months; qualitative feedback from staff	Restraint episodes reduced from 37/month to 21/month; Duration of retrain decreased from 2.3 hrs to 1.9 hrs; Staff reported heightened sense of safety.	No inferential analyses on final outcomes. Unclear what the post-intervention dates were. No blinding reported.

Table 1. Continued.

Primary Author (Year)	Setting, Country	Study Design & Duration	Participants (Type, N, selection, characteristics)	Interventions or Exposures	Data collection methods	Main Outcome Measures	Main Findings	Possible Confounders and biases.
Rankins (1999)[30]	A single urban ED, California, USA	Retrospective audit of interrupted times series 54 months, 1992-1996	264,970 patient attendances (155,976 pre-intervention; 108,994 post-intervention). No characteristics provided. Participant selected based on period of observation and security records of outcomes.	Implementation of a security system incorporating metal detectors	Security records	Rate of weapons confiscated per 10,000 ED pts; Number of assaults per 10,000 ED patients	No change in reported assaults per 10, 000 persons. A significant greater number of weapons (per 10,000 persons) were confiscated post-intervention compared to baseline (24 vs 40). The percentage of weapons confiscated in the patient are decreased significantly over time (92% to 42%).	Excluded verbal assaults; and patients that required restraint. Chart abstractors and data assessors not blinded. Retrospective data subject to bias due to non-documentation. Results may have been attributable to more people carrying weapons over the study period resulting in increased rates of detection. The number of violent events was rare due to the definition of assault used.

Table 1. Continued.

Primary Author (Year)	Setting, Country	Study Design & Duration	Participants (Type, N, selection, characteristics)	Interventions or Exposures	Data collection methods	Main Outcome Measures	Main Findings	Possible Confounders and biases.
Emde (2002)[26]	ED of a single level III community hospital (USA)	Retrospective audit of interrupted times series. Pre-intervention: Mar-May; Post intervention: Oct-Dec 2001	51 restrained patients, characteristics not provided; ED staff: number and details not specified. No baseline data for staff or patient characteristic provided; 100% of staff exposed to intervention	Safety modifications to seclusion room; Restraint and de-escalation education; Restraint form with monthly review of charts Psychiatric staff used as sitters for seclusion observation	Purpose designed forms; unclear how injuries documented; attendance records	Restraint forms; #injuries to staff; #restrained patients; # staff trained	Fewer restraint used (20 per month to 7) post-intervention with no increase in injury to staff. No tests of significance. Decrease in damage to seclusion room.	Limited methodological information provided Participant characteristics not provided. Staff training completed by 100% staff by Dec 2001, but post-intervention audit was Oct-Dec 2001 thus ongoing staff training may have affected results. Modification of outcome measures between the pre- and post-intervention limits comparisons Attrition bias likely as incomplete data presented. Data for injury to staff not provided. The "inability to use restraints on the new beds" and the requirement to use beds in other rooms may have impacted on the amount of restraint use confounding results. Inferential statistics not provided No blinding reported.

Table 1. Continued.

Primary Author (Year)	Setting, Country	Study Design & Duration	Participants (Type, N, selection, characteristics)	Interventions or Exposures	Data collection methods	Main Outcome Measures	Main Findings	Possible Confounders and biases.
Griffey (2009)[31]	Academic, urban, adult-only, Level I ED (USA)	Prospective Cohort July 2003 and December 2004. 3 successive 6-month blocks	All doctors that had restraint orders for patients during the study period (including physical restraints, seclusion, and sitter/observers). Patients: 139 patient visits across the 3 study intervals included restraint renewal orders, with a total of 261 renewal orders in all.	(1) baseline; (2) computerised forcing function, allowing acknowledgement or renewal of restraint orders without consequence; (3) computerized forcing function with a requirement of addressing before enabling access to the ED information system.	Data source: Charts where restraint orders were given within the study period. The use of a query search using the computerized order entry system database included: patient age and sex; indication for restraint, restraint type ordered, and patient disposition.	Time to order renewal, number of restraint orders, renewal orders per hour in restraints, and time in restraints	Median time to order renewal decreased in periods 1 and 2 versus baseline by 64 and 56 minutes. Mean number of restraint orders in periods 2 and 3 significantly increased vs those in baseline (1.46 to 1.89 to 2.34). Mean renewal orders per hour in restraint significantly increased in period 2 versus baseline and 2, from 0.08 to 0.23 to 0.89. Non significant decreases in median time spent in restraints observed in periods B and C versus baseline of 45 and 105 min.	Underestimation of the number of restraint orders for an individual as the orders captured were truncated to a maximum of 7. Assessment included physical restraint only Orders for discontinuation were not specifically addressed and No quantification of orders discontinued or allowed to expire. No blinding undertaken.

Table 2. Quality-of-evidence rating based on the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies.

First Author (year)	Selection bias	Study design	Confounders	Blinding	Data collection method	Withdrawals and dropouts	Global rating
Cailhol (2007)[28]	Weak	Moderate	Moderate	Moderate	Weak	Weak	Weak
Casteel (2009)[27]	Weak	Moderate	Moderate	Weak	Weak	Weak	Weak
Cowling (2007)[7]	Weak	Moderate	Weak	Weak	Weak	Weak	Weak
Gillespie (2014)[3]	Moderate	Strong	Strong	Weak	Weak	Weak	Weak
McMahon(2003)[29]	Weak	Weak	Weak	Weak	Weak	Weak	Weak
Rankins (1999)[30]	Moderate	Moderate	Moderate	Weak	Weak	Weak	Weak
Emde (2002)[26]	Weak	Moderate	Weak	Weak	Weak	Weak	Weak
Griffey (2009)[31]	Moderate	Moderate	Moderate	Weak	Moderate	Weak	Weak

use and improved restraint documentation, affected ED restraint use.[26] Thirty-six medical charts were audited prior to intervention (March-May 2000), which commenced June 2000, and 15 charts post-intervention (October-December 2001). Participants were ED staff, mental health aides/sitters, and patients who were restrained. Outcomes included percentages of accurate documentation recorded, as well as the number of staff injuries, restrained patients, and participants undertaking training. Emde et al. found that fewer restraints were used (20 per month to 7) post-intervention with no increase in injury to staff. Notable limitations include the following: limited detail presented in methods and results; no discussion of participant characteristics; possible attrition bias affecting injury data. The interventions may have acted as confounders as each may have individually both increased or decreased the number of violent events. Furthermore, it was unclear what percentage of staff completed training prior to the post-intervention audit that began prior to the stated 100% staff completion mentioned in December. The reduction in charts audited between the two periods could be due to reduced seclusion and/or restraint; however, this point was not made. Particular aspects of the intervention were cited as producing an "inability to use restraints on the new beds," and the requirement to use beds in other rooms may have contributed to the overall restraint rate and use of the seclusion room affecting the validity of the findings presented. Further concern regarding validity of results arises from the lack of statistical analysis description or confidence intervals for the outcome measures.

Rankins et al. undertook a retrospective interrupted time series to assess the effectiveness of a security system with metal detectors in a single urban ED.[30] Records were retrieved for 29 months pre-implementation and 25 months post-implementation covering 1992-1996. Outcome measures included rates of assaults per 10,000 ED patients treated and the percentage of weapons confiscated. Although reported assaults did not change significantly, the rate of weapon confiscation was significantly reduced at post-implementation compared to the period before the introduction of the security system, with the greatest difference observed for the patient treatment area (pre: 92%; post: 42%, $p<0.001$). That is, there was a higher rate of detection prior to attending the treatment area. The study was weakened by the use of one data extractor; the use of retrospective data, which limited the ability to estimate non-documentation; the inability to assess how many weapons were missed by the security system; and the inability to differentiate whether more people were bearing weapons or whether more weapons were being detected. Overall, this study demonstrated that a security system may assist in weapon detection and confiscation, but does not provide evidence for a reduction in assault rates.

Gillespie et al. reported a prospective, non-randomised controlled trial involving three intervention and three comparison sites matched by ED type (Level 1, urban tertiary care, community)[3]. Allocation to intervention was randomly assigned, and participants were eligible if they worked >20 hours a week and provided direct patient care. Intervention sites received a workplace violence intervention comprising unspecified environmental changes, policies, procedures and education over three months in 2010. Outcomes were assessed during the nine months before and nine months after the intervention using a baseline demographic survey, a monthly survey (number of assaults and physical threats in preceding month), and a violent-event survey recording details of the perpetrator. Results indicated a decrease in assault rates for intervention groups and control sites, but no differences between controls and intervention sites after accounting for pre-intervention differences. Although there was no mention of interaction effects (time X allocation), post-hoc analyses of individual intervention sites were reported. Between-group differences in change scores (from baseline) would have been a more appropriate method of analysing assault rates and

threats. The study may have been weakened by recall bias, reporting bias due to being increasingly aware of violence, survey fatigue, and the inability to randomise participants to treatment or control. Additionally, there was a preponderance of female and nurses among participants. The study was strengthened by stratification of the intervention and control groups according to ED type.

McMahon et al. performed a mixed-method study involving an interrupted time series, pre-intervention interviews, and post-intervention staff survey.[29] The intervention involved new restraint documentation, assessment of security personnel deployment, de-escalation/self-defence training and an adoption of a "zero-tolerance policy." Data were collected over three years and included average restraints per month, diagnosis and patient disposition. Staff were interviewed about level of satisfaction with restraint documentation and attitudes with restraint interventions, and were also surveyed on demographics, use of restraint, assaults on witnesses and themselves, the response and attitude to assaults. Average monthly restraint decreased (from 37 to 21), as did the restraint duration (2.3 hours to 1.9 hours) following intervention implementation. Although strengthened by the multiple methods for assessing reduction in restraint and attitudes, the study was limited by missing data that increased potential attrition bias, as well as the failure to record restraint as a percentage of ABD episodes. It is unclear whether seasonal differences accounted for changes in the need for restraint. Finally, insufficient description of methods makes reproducibility and interpretation of the study difficult, particularly for data extraction and analysis, and consideration of bias and confounding.

Griffey et al. performed a prospective cohort study examining the effect of a forcing function within a computerized ED order-entry system on the timeliness of renewal of restraint orders.[31] The study period was between July 2003 -December 2004 and consisted of six months baseline, six months of a computerised forcing function that allowed acknowledgment or renewal of the restraint without consequence (hereafter, "soft stop"), and a subsequent six months wherein the computerized forcing function that required addressing before enabling access to the ED information system (hereafter, "forced function"). The reminder and lockout system were tracked to the physician managing the restraint of a particular patient. The primary outcome was median time to restraint-order renewal before and after successive implementation of the forcing function. Secondary outcomes included mean number of restraint orders per patient, mean number of renewal orders per hour a patient was restrained, and median patients spent in restraints, all with comparisons of variability in these measurements. A non-significant reduction in time in restraint was reported, as was an improvement in restraint reordering (mean number of orders per hour: baseline 0.08; soft stop 0.23; forced function 0.89. Mean number of restraint orders per patient: baseline 1.46; soft stop 1.89; forced function 2.34. Mean renewal of orders: baseline, 228 minutes; soft stop, 149 minutes; forced function, 140 minutes) and variability in practice. There are several study limitations. The maximum number of restraint orders per person was truncated to seven leading to an underestimation due to a ceiling effect. Further, orders for restraints included those for physical restraint, seclusion, and sitter/observers but not "chemical restraint." Discontinuation orders were not specifically assessed, limiting the impact the intervention had on the practice of allowing orders to expire rather than behaviourally indicated discontinuation. Strengths of the study include the use of a computerised system allowing easy data acquisition; the selected targeting of doctors who ordered particular restraint allowing for accountability of staff; the six-month interval may have provided sufficient time for adjustment to intervention iterations; and the generalisability of the program given the only requirements are computer-based systems and a tracking system. Given that all doctors who issued restraint orders were involved the potential for selection bias was reduced.

Cailhol et al. undertook an interrupted time series with data collected five months pre- and post-multimodal intervention involving education, staff dialogue in meetings and journal club, medical presence during restraint interventions, and debriefing following restraint.[28] Data were collected by clinician survey, and results indicated a reduction in ABDs compared to pre-intervention. The study lacked a temporal control, and there was no blinding of clinicians receiving the intervention and making decisions about restraint use. Additionally, it was a single-centre study involving a psychiatric emergency hospital that may limit any generalisability of the study findings. Of note, the main outcome measure was percentage of violent patients (as a function of total presentations), rather than rate of violent behaviour. This is critical given that more than one assault may occur by the same individual.

DISCUSSION

Summary of main results

ABDs within EDs are of great concern given their potential negative impact on wellbeing, retention, safety and performance of staff, as well as the impact on patient care and safety. This systematic review assessed the efficacy of non-pharmacological interventions for managing ED ABDs. Using our comprehensive search criteria, the number of interventions we identified that were specific to the ED were limited. Eight studies met pre-set criteria for inclusion with several incorporating multiple intervention components involving changes to environment, policy and practice rather than assessment of single interventions. Heterogeneity of study designs and outcome measures limited analysis to narrative synthesis. Alarmingly, despite searching a publication period spanning three decades, no study provided a level of evidence sufficient to warrant recommendation for any specific intervention.

Quality of the Evidence

All studies included in this review were rated as having weak quality. It is therefore inappropriate to make recommendations to uptake strategies to limit ABDs. Included studies were hampered by multiple factors: Although study designs were primarily interrupted time series and thus rated as having moderate quality for this criterion, several were subject to selection bias, most had problems with blinding and weak data collection methods, and studies were uniformly weak in terms of being affected by participant withdrawal or dropout. The degree to which studies were affected by confounders was variable. Others have noted the lack of quality evidence in this field. Nelstrop et al. reviewed the literature from 1985-2002 and found no evidence from comparative studies for or against the use of physical restraint and/or seclusion in the management of short-term ABDs within the adult psychiatric in-patient setting.[18] Similarly, Anderson et al. identified studies reporting management approaches of violence directed against emergency nurses (1986-2007); studies were of poor quality and were largely focused on defining the phenomenon instead of developing effective management methods.[10]

Applicability of evidence

The definition and description of interventions can profoundly affect interpretation of evidence and the way in which components of interventions are understood to have an effect on outcomes. In some cases (e.g., Emde[26]) interventions were poorly described, and for others (e.g., Rankins[30]) there was poor compliance with expected conventions for reporting. While all studies included were relevant to the ED setting, the specific context of interventions may have been affected by the small-scale nature of the studies. Patient demographics vary from ED to ED and while certain demographic profiles may provide a strong impetus for change in practice, assessments of efficacy for such changes must consider generalisability to other EDs.

Interventions described by studies reviewed here frequently modified multiple variables, possibly reflecting a real-world approach to the problem. Complex interventions with multiple components make it difficult to isolate and neutralize the influence of confounders as well as the relative influence of each intervention. Despite problems inherent to multifaceted interventions, it is pertinent that Casteel et al.'s[27] multifaceted prevention and response intervention (environmental, security, policies and surveillance) significantly reduced assault rates. Although of "weak" quality, this study adopted an approach whereby the exact prevention and response interventions implemented were not uniform across hospitals. Instead, each hospital identified and implemented the interventions deemed most relevant and feasible for each site.

It is clear that further studies are required to robustly evaluate the efficacy of management strategies in multi-site and multi-disciplinary studies to provide better evidence for interventions aimed at reducing the occurrence of ABDs within EDs.

Efficacy studies have been hampered by a lack of unifying definition for the phenomena under investigation with some adopting a broad umbrella term such as ABD, and others focusing on specific forms of violence, such as physical assault. Conceivably, in the search for hard outcome measures with unambiguous definition, physical assault has become the default outcome measure. Given the difficulties associated with documenting verbal assault, reliance on physical assault as the endpoint will under-represent the true prevalence of what most clinicians experience as assault. Establishing and supporting routine surveillance across all settings that truly reflects the incidence of ABD is the first step in moving towards protection of healthcare workers.

Studies in this field have been hampered by a lack of standardisation for assessing efficacy of methods aimed at reducing ABD. Clearly, there is no accepted standard rate of measuring assault, for example, with some using the sample population denominator, others expressing assault as a rate (e.g., per 10,000 patients), and yet others focusing on proportion of perpetrators rather than events. The lack of validated measures for some psychosocial outcomes is also problematic. While validated tools with sound psychometric properties exist for the assessment of clinician and patient attitudes to the management of violence,[32] it was not uncommon for studies included to adopt purpose-designed tools, the characteristics of which have not been tested rigorously. Overall, this lack of standardisation and limited use of rigorous tools limits the quality and comparability of research in this field, and is an important consideration when designing future studies.

The Way Forward

The present review has revealed an unambiguous gap in research. While this should provide impetus for directing next steps, as others have noted,[33] a lack of unified research effort in this field remains despite previous calls for solutions.[10,34] The shift toward building a sound evidence base in the non-pharmacological management of ABDs in EDs that is unified requires a coordinated approach, with cooperation across multiple sites. Our review revealed that the existing evidence base typically comprises single-site studies, with multiple different techniques and modalities employed. Whilst it is important for EDs to respond to the local environment, resources, staff and population, and develop interventions accordingly, the field would benefit from a greater emphasis on collaborative, multi-centre, suitably funded studies that may afford superior study designs and execution.

Despite weak, preliminary evidence for efficacy of specialised rooms such as BARs, architectural changes to manage ABDs are becoming common in EDs. These spaces may be perceived by hospital managers as having a potential preventive benefit, and given the pressing need to maintain staff safety, managers may not have the luxury of awaiting a sound body of evidence. Nonetheless, this begs the question: Do specialised

rooms assist in ED ABD management, and if so what format is best? Given the variable nature of EDs, it is unlikely that a one-size-fits-all approach will be suitable. Going forward, there is a definite need to balance flexible, tailorable interventions with a unified approach that facilitates larger scale, multi-site studies, and respects all local legal requirements.

There is little evidence that the ABD management strategies reviewed here are effective. In the clinical practice of employing any restrictive interventions, respect for human rights should be the paramount guiding principle; clinicians should employ the least restrictive means to provide a safe environment for both staff and patient. Guidelines[35-38] support a graded response from verbal de-escalation, to pharmacological means, with manual/mechanical restraint and seclusion the last resort. Additionally, clinicians should refer to existing legal frameworks as a reference point within which to work.

STRENGTHS AND LIMITATIONS OF THIS REVIEW

The search was limited to the English language. This may have biased against articles written in languages other than English, which may have prevented identification of relevant interventions for managing ABD. The same is true for the restriction to published literature and not to include grey-literature databases.

Our inclusive search terms produced a broad array of study designs and outcome measures. Whilst this resultant heterogeneity prevented meta-analysis and rendered narrative synthesis necessary, the inclusive search is a study strength as more studies would likely be identified. Other strengths of this study were the application of a critical appraisal tool by two independent abstractors to consider quality of evidence. The lack of blinding of these data abstractors against study aims, however, is a study limitation. The study was also limited by the inability to source three full-text papers deemed potentially relevant. Since EDs are of significant heterogeneity, the studies included in this review may not be representative of all EDs' patients and staffs across regions.

CONCLUSION

In the absence of well-controlled studies, no recommendations can be made about the efficacy of non-pharmacological strategies to manage ABDs within EDs. While ABD management interventions show a level of innovation, and may still be practical and safe, some are highly resource intensive. Further, more rigorous testing of efficacy for interventions designed to manage ABDs in EDs is essential. Continued practice of these strategies should be undertaken only in the context of ongoing evaluations of both efficacy and safety. The impetus for effective, evidence-based ABD management within the ED is escalating. The time is now for further research that is robust, multi-site, widely applicable or flexible, large in sample size, over significant periods and involving qualitative and quantitative evidence.

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Derivation and Validation of The Prehospital Difficult Airway IdentificationTool (PreDAIT): A Predictive Model for Difficult Intubation

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Introduction: Endotracheal intubation (ETI) in the prehospital setting poses unique challenges where multiple ETI attempts are associated with adverse patient outcomes. Early identification of difficult ETI cases will allow providers to tailor airway-management efforts to minimize complications associated with ETI. We sought to derive and validate a prehospital difficult airway identification tool based on predictors of difficult ETI in other settings.

Methods: We prospectively collected patient and airway data on all airway attempts from 16 Advanced Life Support (ALS) ground emergency medical services (EMS) agencies from January 2011 to October 2014. Cases that required more than two ETI attempts and cases where an alternative airway strategy (e.g. supraglottic airway) was employed after one unsuccessful ETI attempt were categorized as "difficult." We used a random allocation sequence to split the data into derivation and validation subsets. Using backward elimination, factors with a $p<0.1$ were included in the multivariable regression for the derivation cohort and then tested in the validation cohort. We used this model to determine the area under the curve (AUC), and the sensitivity and specificity for each cut point in both the derivation and validation cohorts.

Results: We collected data on 1,102 cases with 568 in the derivation set (155 difficult cases; 27%) and 534 in the validation set (135 difficult cases; 25%). Of the collected variables, five factors were predictive of difficult ETI in the derivation model (adjusted odds ratio, 95% confidence interval [CI]): Glasgow coma score [GCS] >3 (2.15, 1.19-3.88), limited neck movement (2.24, 1.28-3.93), trismus/jaw clenched (2.24, 1.09-4.6), inability to palpate the landmarks of the neck (5.92, 2.77-12.66), and fluid in the airway such as blood or emesis (2.25, 1.51-3.36). This was the most parsimonious model and exhibited good fit (Hosmer-Lemeshow test $p = 0.167$) with an AUC of 0.68 (95% CI [0.64-0.73]). When applied to the validation set, the model had an AUC of 0.63 (0.58-0.68) with high specificity for identifying difficult ETI if ≥ 2 factors were present (87.7% (95% CI [84.1-90.8])).

Conclusion: We have developed a simple tool using five factors that may aid prehospital providers in the identification of difficult ETI. [West J Emerg Med. 2017;18(4)662-672.]

INTRODUCTION

Airway management is a critical intervention in the prehospital resuscitation of specific patient populations. Endotracheal intubation (ETI) is a standard method of airway management, although its practice in the prehospital setting can be challenging.[1] Multiple factors related to the austere environment and unscreened patient population make prehospital ETI more challenging than in other settings. As a result, a greater number of intubation attempts may be required, which have been associated with adverse events including hypoxia, bradycardia and even death.[2,3]

Supraglottic airways (SGA) and bag-valve-mask (BVM) ventilation can be valuable alternatives when ETI efforts are unsuccessful and may be used as first-line interventions in select populations if difficult ETI is anticipated.[4,5] Proper identification of cases of potentially difficult ETI could allow providers to focus on alternative airway management strategies, thereby minimizing the risks associated with multiple or prolonged ETI attempts.[6-8]

Previous works have identified multiple factors associated with difficult ETI in a variety of acute care settings including the prehospital setting, intensive care unit, and emergency department.[9-13] Although predictors and resultant treatment pathways have been identified, we are unaware of any externally validated, simplified identification tools for prehospital providers, identifying those factors most predictive of difficult ETI.[9,10,14] Given the adverse events associated with ETI efforts, rapid identification of difficult ETI through such a tool could help to improve the safety of prehospital airway management. We sought to derive and validate a simplified tool to allow EMS providers to rapidly identify cases of difficult ETI.

Population Health Research Capsule

What do we already know about this issue?
Previous factors have been associated with difficult intubation in the prehospital setting.

What was the research question?
We sought to prospectively derive and validate a tool to identify difficult intubation in the prehospital setting.

What was the major finding of the study?
A simple tool, using five factors (GCS>3, limited neck movement, trismus/jaw clenched, inability to palpate the landmarks of the neck, and fluid in the oropharynx), may aid prehospital providers in identifying difficult intubation.

How does this improve population health?
This tool may help to guide prehospital airway interventions.

METHODS

Study Design and Setting

We performed a prospective, observational study involving 16 ground emergency medical service (EMS) agencies to develop a predictive model for difficult ETI. These suburban and rural EMS agencies respond to approximately 100,000 EMS calls annually within a 10-county regional EMS system in Southwestern Pennsylvania. Advanced Life Support (ALS) ambulances for all participating EMS agencies are typically staffed with one paramedic who can perform advanced airway management including intubation and SGA placement and one emergency medical technician (EMT) who can perform basic airway management only. EMS providers function within statewide EMS protocols, which do not allow the performance of rapid sequence or sedation-assisted intubation. For patients in cardiac arrest, intubation may occur after an initial resuscitation period of 10 minutes during which basic airway management is emphasized, consistent with national guidelines. Providers receive an annual hands-on airway skills assessment, ongoing didactic education on airway management (approximately 1-2 hours/year), and typically perform 1-2 intubations/year.[15] All participating EMS agencies receive medical oversight through the same healthcare system, coordinated through a single academic institution.

Selection of Participants

All patient-care documentation at these agencies is performed using a single National EMS Information System (NEMSIS)-compliant electronic patient care record (emsCharts, Warrendale, PA). Data were collected on all patients undergoing advanced airway management (intubation or supraglottic airway) by EMS during the study period. We excluded cases with an unknown number of ETI attempts, those where nasotracheal intubation was performed and those where a SGA was placed as the first advanced airway. There were no age, medical category, or other exclusionary criteria. This study had institutional review board approval.

Methods and Measurements

All data were collected using a custom form in the electronic patient care report within emsCharts. The form was automatically activated for any case where an advanced airway procedure was documented. Medical providers were required to complete this form before the medical record could be finalized. Based on previous work evaluating difficult airways, the data elements in the form included patient demographics, patient characteristics, difficult airway characteristics, procedural characteristics, and techniques used to successfully intubate the patient (Table 1).[9,10,12,16] Upon completion of the custom form, the form was automatically

Table 1. Patient and airway demographics.

Characteristic	Total derivation n=568 (%)	Difficult ETI n=155	Not difficult ETI n=413	Total validation n=534	Difficult ETI n=135	Not difficult ETI n=399
Age (years)	n=560			n=529		
<10	12 (2)	5 (3)	7 (2)	5 (1)	0 (0)	5 (1)
10-19	8 (1)	1 (1)	7 (2)	13 (2)	4 (3)	9 (2)
20-29	9 (2)	0 (0)	9 (2)	16 (3)	2 (1)	14 (4)
30-39	31 (6)	10 (6)	21 (5)	21 (4)	8 (6)	13 (3)
40-49	41 (7)	17 (11)	24 (6)	46 (9)	15 (11)	31 (8)
50-59	93 (17)	29 (19)	64 (16)	94 (18)	37 (27)	57 (14)
60-69	120 (21)	37 (24)	83 (20)	112 (21)	30 (22)	82 (21)
70-79	111 (20)	26 (17)	85 (21)	108 (20)	21 (16)	87 (22)
>79	135 (24)	29 (19)	106 (26	114 (22)	18 (13)	96 (24)
Gender, male	331 (58)	93 (60)	238 (58)	318 (60)	95 (70)	223 (56)
Weight (kilograms)	n=561			n=530		
<100	265 (47)	60 (39)	205 (50)	265 (48)	50 (38)	206 (52)
100-150	235 (42)	68 (45)	167 (41)	224 (42)	66 (50)	158 (40)
>150	61 (11)	24 (16)	37 (9)	50 (9)	17 (13)	33 (8)
Patient status	n=551			n=521		
Cardiac arrest	440 (80)	121 (82)	319 (79)	416 (80)	110 (83)	306 (79)
Medical condition (not in cardiac arrest)	73 (13)	15 (10)	58 (14)	67 (13)	13 (10)	54 (14)
Traumatic arrest	22 (4)	6 (4)	16 (4)	20 (4)	5 (4)	15 (4)
Traumatic condition (not in arrest)	16 (3)	6 (4)	10 (2)	18 (3)	5 (4)	13 (3)
Location of ETI	n=516			n=498		
Ambulance	242 (47)	67 (50)	175 (46)	236 (47)	56 (46)	180 (48)
Scene, not on a stretcher	252 (49)	61 (46)	191 (50)	247 (50)	61 (50)	186 (49)
Scene, on a stretcher	22 (4)	6 (4)	16 (4)	15 (3)	5 (4)	10 (3)
DACs						
Median total DACs (IQR)	1 (0-2)	2 (1-3)	1 (0-2)	1 (0-2)	2 (1-3)	1 (0-2)
Provider perceived ETI as difficult	244 (43)	135 (87)	109 (26)	224 (42)	108 (80)	116 (29)
None	257 (45)	37 (24)	220 (53)	235 (44)	41 (31)	194 (49)
GCS>3	57 (10)	23 (15)	34 (8)	49 (9)	10 (7)	39 (10)
Limited neck movement						
Cervical collar in place	19 (3)	8 (5)	11 (3)	30 (6)	8 (6)	22 (6)
Other limited neck mobility (e.g. kyphosis)	52 (9)	25 (16)	27 (7)	57 (11)	28 (21)	29 (7)
Gag reflex present	46 (8)	12 (8)	34 (8)	18 (3)	1 (1)	17 (4)
Trismus, jaw clenched	37 (7)	16 (10)	21 (5)	41 (8)	17 (13)	24 (6)
Neck or facial trauma	9 (2)	3 (2)	6 (1)	4 (1)	2 (1)	2 (1)
Unable to palpate landmarks of the neck	34 (6)	22 (14)	12 (3)	27 (5)	10 (7)	17 (4)
Fluid in the airway						
Blood	63 (11)	27 (17)	36 (9)	67 (13)	22 (16)	45 (11)
Emesis	143 (25)	54 (35)	89 (22)	167 (31)	66 (49)	101 (25)

ETI, endotracheal intubation; *DAC*, difficult airway characteristics; *IQR*, interquartile range; *GCS*, glasgow coma scale; *PreDAIT*, Prehospital Difficult Airway Identification Tool.
Percent totals may not equal 100% due to rounding.

Table 1. Continued.

Characteristic	Total Derivation n=568 (%)	Difficult ETI n=155	Not Difficult ETI n=413	Total validation n=534	Difficult ETI n=135	Not difficult ETI n=399
Number of PreDAIT factors						
0	278 (49)	41 (27)	237 (57)	244 (46)	41 (30)	203 (51)
1	213 (38)	72 (46)	141 (34)	202 (38)	55 (41)	147 (37)
2	64 (11)	34 (22)	30 (7)	74 (14)	31 (23)	43 (11)
3	13 (2)	8 (5)	5 (1)	12 (2)	7 (5)	5 (1)
4	0	0	0	2 (<1)	1 (1)	1 (<1)
5	0	0	0	0	0	0

ETI, endotracheal intubation; *DAC*, difficult airway characteristics; *IQR*, interquartile range; *GCS*, glasgow coma scale; *PreDAIT*, Prehospital Difficult Airway Identification Tool.
Percent totals may not equal 100% due to rounding.

forwarded, without patient or agency identifiers, to the study investigators. We then entered data into a spreadsheet for data analysis (Microsoft Excel, Redmond, WA).

Measurement Definitions

We defined difficult intubation ("difficult ETI") as either more than two attempts at laryngoscopy or one unsuccessful attempt at laryngoscopy, followed by either SGA placement or BVM ventilation. Providers were not informed of this definition and were simply asked to report the number of attempts and device placed. As the exact age of patients may be unknown to providers in the prehospital setting, providers were asked to estimate the patient's age by decile. Weight has previously been identified as a predictor of difficult ETI and although the exact weight is often unknown in the prehospital setting, EMS providers are often able to reliably estimate weight within 20% of actual weight.[17] As a result, providers were asked to estimate the patient's weight by categories. We collected difficult airway characteristics based on previous work, which included Glasgow coma score (GCS) >3; limited movement of the neck (e.g. cervical collar in place or "other"); gag reflex present; trismus/jaw clenched; neck or facial trauma; inability to palpate the landmarks of the neck (e.g., cricoid cartilage or thyromental distance); or fluid in the airway (e.g. blood or emesis).[9,10,12,16,18] Providers were asked (yes or no) if they felt the intubation was difficult. Providers were also asked to generally classify the location of the ETI attempts (in the ambulance, at the scene on a stretcher, at the scene but not on a stretcher) and broadly categorize the status of the patient and indication for intubation at the time of ETI (cardiac arrest, medical condition not in cardiac arrest, traumatic arrest, traumatic condition not in arrest). Providers were asked to report the number of attempts at ETI and were informed that an attempt was defined as the passage of the laryngoscope past the lips.

Analysis

Assuming 10% missing or inappropriately completed data entry and a difficult ETI rate of 20% (based on previous work with ETI data from these agencies), we determined we would need 1,200 cases total to evaluate a maximum of 10 variables in our multivariable model. This allowed for identification of a sufficient number of difficult ETI cases to develop a robust clinical decision tool without an exhaustive number of factors for providers to recall when using the prediction tool in the clinical setting.[19] We split the data into derivation and validation subsets according to a random allocation sequence using the =RANDBETWEEN(0,1) function in Excel v 15.5.5 (Microsoft Corp, Redmond, WA) .

We compared data between those defined as "difficult ETI" and "not difficult ETI." A priori, we established a list of variables that have been shown to be associated with difficult ETI in a variety of settings. Recalling all elements from the list may be challenging for providers; therefore, we sought to include those with the greatest propensity for predicting difficult ETI, and using backward elimination we incorporated factors with a $p<0.1$ in the multivariable logistic regression for the derivation cohort. We also performed a sensitivity analysis examining alternative models that included all variables, those with both individual variables, and with combining similar variables (e.g., generating a new variable for limited neck movement including both patients with cervical collars and those with other causes of limited neck mobility). As pediatric patients represent a unique patient population where providers may not routinely perform ETI, we also retested the models, excluding pediatric patients.[20,21] Receiver operating characteristics (ROC) curves were created to determine the area under the curve (AUC) for each model along with the sensitivity and specificity by number of factors present. We used the Hosmer-Lemeshow test to determine the goodness-of-fit for each model. We sought a model that would maximize specificity for the prediction of difficult ETI to allow providers

to best identify those cases and tailor their approach to these difficult airways. The most parsimonious model maximizing specificity and having the greatest AUC was then applied to the validation set. We then calculated AUC, sensitivity and specificity for the validation set. All analyses were completed with Stata v 12 (Stata Corp, College Station, TX).

RESULTS

Characteristics of Study Subjects

From January 2011 to October 2014, we collected data on 1,294 cases of which 1,102 were used for the derivation (n=558) and the validation (n=534) sets (Figure 1). Difficult ETI was identified in a similar proportion of the derivation (N=155, 27.3%) and validation (N=135, 25.3%) cohorts.

The proportion of patients estimated to have a weight >150kg was greater in the difficult ETI population of both the derivation and validation cohorts (Table 1). Age, patient status (e.g., cardiac arrest), and location of ETI were similar between those with and without difficult ETI in both cohorts. Patients with difficult ETI had a greater number of difficult airway characteristics (DAC) in both the derivation and validation cohorts [median (interquartile range)]: 2 (1-3) vs. 1 (0-2), and 2 (1-3) vs. 1 (0-2).] The majority of airways were successfully managed with ETI on the first attempt; however, approximately one in five airways were ultimately managed with a SGA in both the derivation and validation sets (Table 2).

Main Results

Before combining any categories of variables, multiple variables were predictive of difficult ETI in various iterations of the model including GCS >3, trismus/jaw clenched, inability to palpate the landmarks of the neck, blood in the airway and emesis in the airway. After combining variables assessing neck mobility and those identifying fluids in the oropharynx (blood and emesis), five factors were predictive of difficult ETI in the derivation model (adjusted odds ratio, 95% CI): GCS>3 (2.15, 1.19-3.88), limited neck movement (2.24, 1.28-3.93) trismus/jaw clenched (2.24, 1.09-4.6), inability to palpate the landmarks of the neck (5.92, 2.77-12.66), and fluid in the oropharynx (2.25, 1.51-3.36) (Table 3). This was the most parsimonious of the tested models and exhibited good fit (Hosmer-Lemeshow test p = 0.167) with an AUC of 0.68 (95% CI [0.64-0.73]) (Figure 2). This model had 91.5% specificity (95% CI [88.4-94]) for identifying difficult ETI if

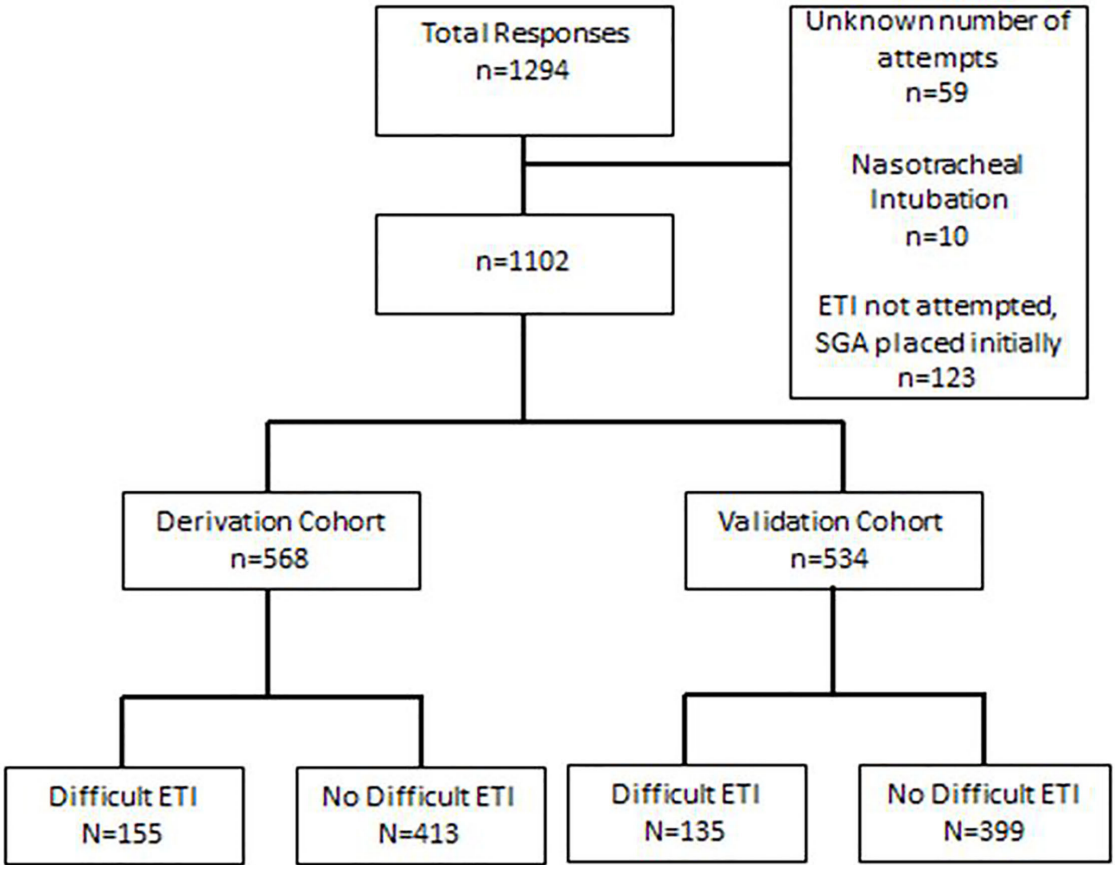
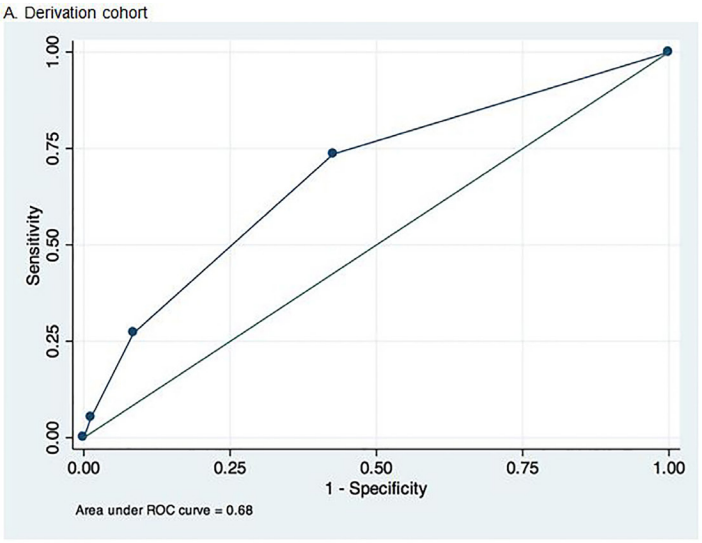


Figure 1. Study flow diagram of patients in study of factors indicative of difficult-airway identification.
ETI, endotracheal intubation; *SGA*, supraglottic airway.

Table 2. Number of attempts and successful airway for the derivation and validation cohorts.

	Derivation, n = 568	Validation, n =534
Number of attempts		
1	343 (60)	323 (61)
2	157 (28)	156 (29)
>2	68 (12)	55 (10)
Median number of attempts (IQR)	1 (1 - 1)	1 (1 - 2)
Successful airway		
None	64 (11)	49 (9)
ETI	386 (69)	372 (70)
SGA	110 (20)	109 (21)

ETI, endotracheal intubation; *SGA*, supraglottic airway.



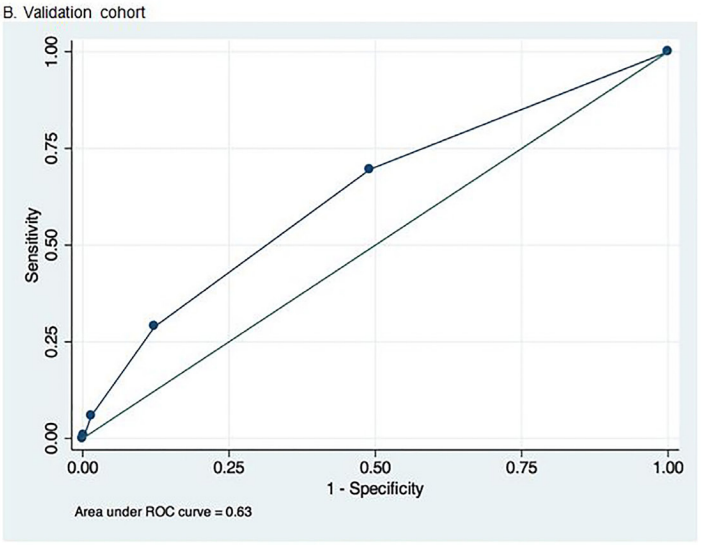


Figure 2. Receiver operator characteristic (ROC) curves for the derivation and validation cohorts in study to identify predictive factors for difficult airway.

≥2 factors were present and 98.8% specificity (97.2-99.6) if ≥3 factors were present. As a result, this model was used for the validation cohort.

When applied to the validation set, the model had an AUC of 0.63 (0.58-0.68) (Figure 2) and specificities of 87.7% (84.1-90.8) and 98.5% (96.8-99.4) for identifying difficult ETI when ≥2 or ≥3 factors were present respectively (Table 4). Over 70% of cases were correctly classified if ≥2 factors were present and calibrations curves were similar between observed and expected values (Figure 3). Removing pediatric patients did not significantly alter the sensitivity, specificity, or accuracy.

LIMITATIONS

Our work had several limitations. While our data were collected prospectively, providers were required to complete a specific form for data collection and therefore were aware of the nature of the study. This may have introduced a reporting bias such as in the number of ETI attempts. Providers may have also been more likely to report difficult airway characteristics if the case required several attempts at intubation. However, it is possible this awareness helped to improve providers' recognition of the presence of specific airway-related factors and the reporting of these factors. While we chose to measure the preselected variables, there may be other aspects of the scene (e.g., limited space around the patient, poor lighting, etc.) that may have influenced the provider's decision to perform ETI. We did not assess these environmental factors. We did not evaluate provider-specific factors, such as provider experience or procedural competency. To ensure confidentiality during data collection, we did not identify the agency performing the ETI. As such, we were unable to assess for clustering in our analyses. We also were unable to determine if the same patient occurred multiple times within the dataset although we believe this would occur infrequently.

All intubations were performed by EMS personnel in Pennsylvania who perform a median of 1-2 intubations per year.[15] Our provider population consists of ALS, ground-based agencies that are not permitted to use medications to facilitate ETI (e.g. rapid sequence intubation [RSI]). RSI may be available to select providers in specific areas but is not universally available to ALS providers. We believe our setting, where RSI is not available, to be similar to many EMS settings in the United States, although future work will be needed to examine this scoring system in agencies with RSI capabilities. We did not include cases where ETI was not attempted, and therefore did not collect data on these cases. In cases where only SGAs or BVM were used it is unknown if the airway was managed with these techniques because the provider

Table 3. Odds ratios for variables identified in the derivation cohort.

Characteristic	OR (95% CI)	p-value
Unadjusted univariate odds ratios for all predictor variables in the derivation cohort		
Age (decile)	0.92 (0.83-1.01)	0.083
Gender		
Male	Referent	
Female	1.1 (0.76-1.6)	0.61
Weight	1.46 (1.11-1.92)	0.007
Patient status		
Cardiac arrest	Referent	
Medical condition (not in cardiac arrest)	0.68 (0.37-1.25)	0.215
Traumatic arrest	0.99 (0.38-2.59)	0.918
Traumatic condition (not in arrest)	1.58 (0.56-4.45)	0.385
Location of ETI		
Ambulance	Referent	
Scene, not on a stretcher	0.83 (0.56-1.25)	0.378
Scene, on a stretcher	0.98 (0.37-2.61)	0.967
DACs		
None	0.28 (0.18-0.42)	<0.001
GCS>3	1.94 (1.1-3.42)	0.021
Limited neck movement	2.79 (1.64-4.72)	<0.001
Cervical collar in place	1.99 (0.78-5.04)	0.147
Other limited neck mobility (e.g. kyphosis)	2.75 (1.54-4.91)	0.001
Gag reflex present	0.94 (0.47-1.86)	0.849
Trismus, jaw clenched	2.15 (1.09-4.24)	0.027
Neck or facial trauma	1.34 (0.33-5.42)	0.683
Unable to palpate landmarks of the neck	5.53 (2.66-11.47)	<0.001
Fluid in the airway	2.25 (1.53-3.29)	<0.001
Blood	2.21 (1.29-3.78)	0.004
Emesis	1.95 (1.3-2.92)	0.001
Adjusted odds ratios for variables identified in the derivation cohort		
GCS>3	2.15 (1.19-3.88)	0.011
Limited neck movement	2.24 (1.28-3.93)	0.005
Trismus, jaw clenched	2.24 (1.09-4.6)	0.028
Unable to palpate landmarks of the neck	5.92 (2.77-12.66)	<0.001
Fluid in the airway (e.g. blood, emesis or both)	2.25 (1.51-3.36)	<0.001

OR, odds ratio, *CI*, confidence interval; *ETI*, endotracheal intubation; *DAC*, difficult airway characteristics; *GCS*, Glasgow coma scale.

anticipated the airway to be difficult for some other reason. As we did not collect data on these cases, we were unable to include them in our model.

There may be select populations where further refinement of this tool is required. For example, a low percentage of our intubation attempts were in pediatric patients with distinct anatomy. Pediatric ETI is a relatively infrequent event, occurring in <1% of pediatric EMS responses, and previous work has questioned the utility of pediatric intubation in the prehospital setting.[20,21] Further work will be needed to evaluate this tool in specific populations such as pediatric patients. Also, a large proportion of patients in our study sample were in cardiac arrest, which limited assessment of patients not in cardiac arrest. However, we believe this cohort accurately

Table 4. Details of the derivation and validation cohorts.

Cutpoint	Sensitivity (95% CI)	Specificity (95% CI)	Correctly classified	AUC (95% CI)
Derivation cohort*				
≥0	100 (97.6-100)	0 (0-0.9)	27.29	0.68 (0.64-0.73)
≥1	73.5 (65.9-80.3)	57.4 (52.5-62.2)	61.8	
≥2	27.1 (20.3-34.8)	91.5 (88.4-94)	73.94	
≥3	5.2 (2.3-9.9)	98.8 (97.2-99.6)	73.24	
Validation cohort#				
≥0	100 (97.3-100)	0 (0-0.9)	25.28	0.63 (0.58-0.68)
≥1	69.6 (61.1-77.2)	50.9 (45.9-55.9)	55.62	
≥2	28.9 (21.4-37.3)	87.7 (84.1-90.8)	72.85	
≥3	5.9 (2.6-11.3)	98.5 (96.8-99.4)	75.09	
≥4	0.7 (0-4.1)	99.7 (98.6-100)	74.72	

AUC, area under the curve; *CI*, confidence interval.
* No patients in the derivation cohort had 4 or 5 factors.
# No patients in the validation cohort had 5 factors.

represents the majority of out-of-hospital patients intubated by EMS providers without RSI capabilities. ETI is a technically challenging skill with a steep learning curve that requires continued practice to maintain proficiency.[22] Future work may be needed to assess this prehospital difficult airway identification tool, in specific provider populations.

DISCUSSION

ETI in the prehospital setting is complicated by several factors including the austere environment, provider experience, and the critically ill patient population. ETI is one of the most common procedures in critically ill prehospital patients, occurring in 8-10/1,000 EMS responses with an overall success rate of 77%.[20,23,24] Using this internally validated tool, prehospital providers can predict difficult ETI cases with over 87% specificity if ≥2 of the following characteristics are present: GCS>3; limited neck movement; trismus/jaw clenched; inability to palpate the landmarks of the neck; and fluid in the oropharynx. We are unaware of any previous efforts to design such a tool for predicting difficult ETI in the prehospital setting. While there have been several publications describing predictors of difficult intubation, none have been derived and validated as a predictive model for use by prehospital providers.[13,25] A tool developed by a group of French anesthesiologists was evaluated in a small prehospital subgroup; however, generalization is limited as intubations were all performed by emergency physicians.[26]

Previous work has helped to identify several characteristics that, in isolation, may help to predict difficult airways. These include blood in the airway, vomit in the airway, short neck, c-spine immobility, short mandible, obesity, airway edema, facial trauma, large tongue, limited Mallampati score, intra-incisor distance of <3 fingers, and thyromental distance of <2 fingers.[9,10,13,27] These studies, examining multiple characteristics, provided the basis for the factors selected in our analysis.

A previously published retrospective analysis examined 61 factors associated with unsuccessful ETI in the prehospital setting and identified several predictive factors including trismus/jaw clenched, weight, and the presence of a gag reflex.[10] While trismus/jaw clenched contributed to our model, weight and the presence of a gag reflex did not. Weight and gag have been identified in other studies and may still represent important characteristics when assessing patients requiring airway management in the prehospital setting.[9] Weight, for example, was significant in the univariate analysis, however did not appreciably contribute to the model. As such, weight and other factors were not included in the final model for our simplified difficult airway identification tool. Other identified factors included "inability to pass the endotracheal tube through the cords" and "inability to visualize the cords," although these incorporate aspects of laryngoscopy and occur after the provider has made the decision to perform ETI.[10] As a result, we did not include these factors in our model.

Incorporating difficult airway characteristics into a simplified, rapid, validated tool may help providers better identify this population *before* attempting ETI, thereby minimizing the risks associated with ETI. A rapid evaluation of patients for the aspects of this Prehospital Difficult Airway Identification Tool, or PreDAIT, may help providers better assess the potential for difficult intubation and manage the airway by other means. While this tool may be helpful in identifying those patients most likely to be a difficult intubation, (>87% specificity if ≥2 factors are present), difficult ETI cases can and do occur in patients with no

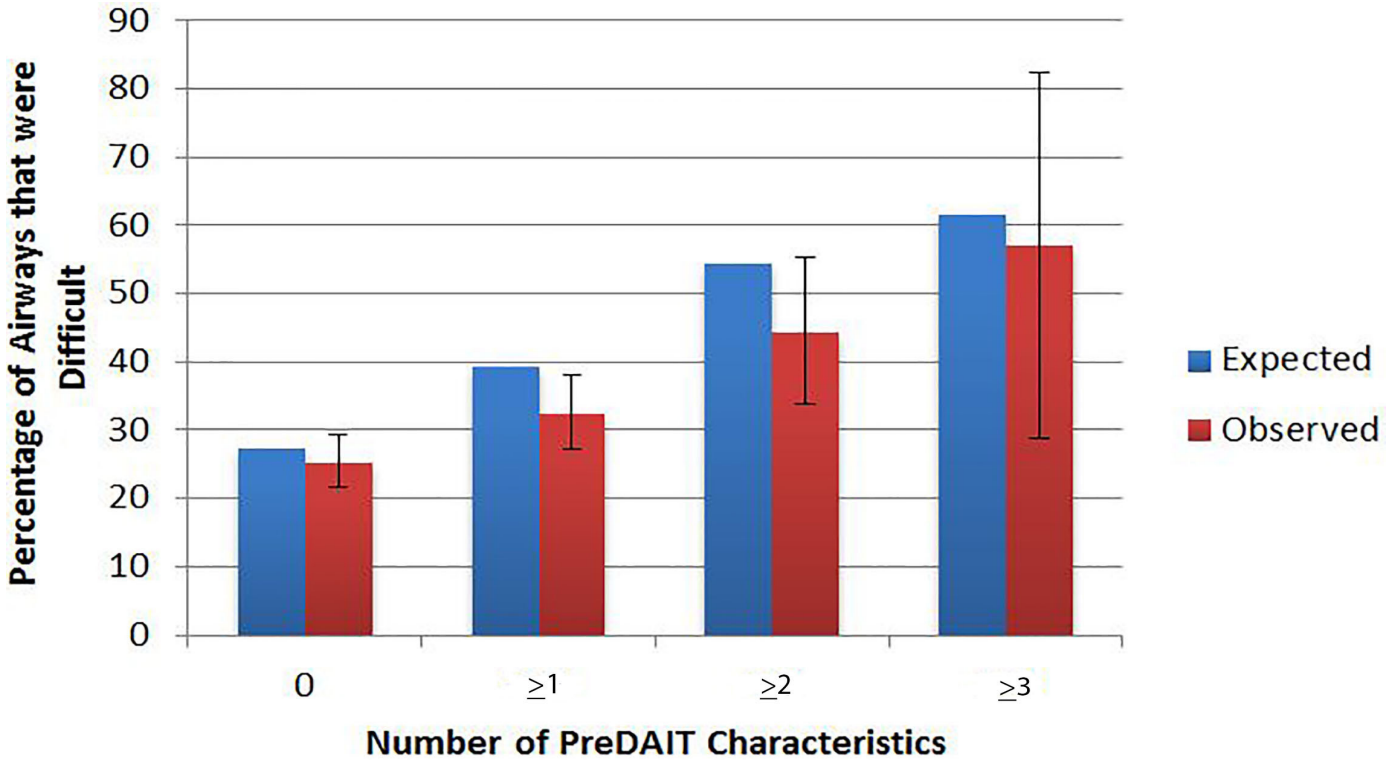


Figure 3. Calibration curve of the Prehospital Difficult Airway Identification Tool (PreDAIT).

PreDAIT characteristics. Of the difficult airway cases in the validation cohort, 30% had none of the five factors, highlighting the challenges with identifying *all* cases of difficult ETI. Although this tool identifies patients at greatest risk for unsuccessful ETI in our population, providers must still anticipate challenges with ETI and be facile with alternative management techniques in the event of unsuccessful ETI efforts.

We feel this tool may be helpful with the timing of airway interventions and could be used by medical directors to refine prehospital airway management guidelines. For example, in cases where zero PreDAIT factors are present, directors may suggest performing ETI per standard protocols. In cases with one identified PreDAIT factor, providers may still perform ETI but have adjuncts readily available in the event of unsuccessful initial ETI attempts. In situations with two or more identified PreDAIT factors, alternate airway management could be recommended (e.g. using a SGA as the initial airway management strategy, awaiting critical care providers with advanced techniques such as video laryngoscopy and/or RSI, or performing BVM ventilation until hospital arrival).

While ETI by direct laryngoscopy has long been used as the primary method of airway management, several other alternatives exist such as BVM ventilation, non-invasive positive pressure ventilation, video laryngoscopy (VL) and SGAs. VL has been advocated as a means of improving intubation success and may be a valuable adjunct in difficult airway cases.[28-31] While our work was not designed to determine the impact of VL on intubation outcomes due to low use of VL in our area (only 3.5% of cases), the positive impact of VL on ETI success in other studies highlights the potential utility of VL in cases where patients have several identified PreDAIT factors (i.e., greater probability of difficult ETI). Similarly, SGAs have successfully been used in the prehospital setting as first-line interventions in select populations[4,5] and in cases of unanticipated difficult airways.[14] While our work identifies variables predictive of difficult ETI, previous work has found that similar variables such as presence of a gag reflex are also associated with unsuccessful SGA placement.[16] In combination with our tool, providers may consider this and elect to defer advanced airway maneuvers (ETI or SGA) in the prehospital setting if in proximity to the hospital.

CONCLUSION

We prospectively derived and internally validated a simple tool identifying five factors predictive of difficult ETI: GCS>3; limited neck movement; trismus/jaw clenched; inability to palpate the landmarks of the neck; and fluid in the oropharynx. The PreDAIT may help providers identify difficult ETI in the prehospital setting. Future studies should externally validate this model in other EMS systems.

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Efficacy and Safety of Tranexamic Acid in Prehospital Traumatic Hemorrhagic Shock: Outcomes of the Cal-PAT Study

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Introduction: The California Prehospital Antifibrinolytic Therapy (Cal-PAT) study seeks to assess the safety and impact on patient mortality of tranexamic acid (TXA) administration in cases of trauma-induced hemorrhagic shock. The current study further aimed to assess the feasibility of prehospital TXA administration by paramedics within the framework of North American emergency medicine standards and protocols.

Methods: This is an ongoing multi-centered, prospective, observational cohort study with a retrospective chart-review comparison. Trauma patients identified in the prehospital setting with signs of hemorrhagic shock by first responders were administered one gram of TXA followed by an optional second one-gram dose upon arrival to the hospital, if the patient still met inclusion criteria. Patients administered TXA make up the prehospital intervention group. Control group patients met the same inclusion criteria as TXA candidates and were matched with the prehospital intervention patients based on mechanism of injury, injury severity score, and age. The primary outcomes were mortality, measured at 24 hours, 48 hours, and 28 days. Secondary outcomes measured included the total blood products transfused and any known adverse events associated with TXA administration.

Results: We included 128 patients in the prehospital intervention group and 125 in the control group. Although not statistically significant, the prehospital intervention group trended toward a lower 24-hour mortality rate (3.9% vs 7.2% for intervention and control, respectively, p=0.25), 48-hour mortality rate (6.3% vs 7.2% for intervention and control, respectively, p=0.76), and 28-day mortality rate (6.3% vs 10.4% for intervention and control, respectively, p=0.23). There was no significant difference observed in known adverse events associated with TXA administration in the prehospital intervention group and control group. A reduction in total blood product usage was observed following the administration of TXA (control: 6.95 units; intervention: 4.09 units; p=0.01).

Conclusion: Preliminary evidence from the Cal-PAT study suggests that TXA administration may be safe in the prehospital setting with no significant change in adverse events observed and an associated decreased use of blood products in cases of trauma-induced hemorrhagic shock. Given the current sample size, a statistically significant decrease in mortality was not observed. Additionally, this study demonstrates that it may be feasible for paramedics to identify and safely administer TXA in the prehospital setting. [West J Emerg Med. 2017;18(4)673-683.]

INTRODUCTION

Trauma accounts for more than five million deaths worldwide annually, equating to 9% of total world mortality.[1] In the United States, traumatic injury is the leading cause of death among individuals aged 1 to 44 years old.[2] The direct economic burden as a result of trauma is substantial in the U.S. In 2010, costs associated with unintentional traumatic injury exceeded $113 billion, including both medical and work-loss associated costs.[3]

Following acute traumatic injury, significant blood loss threatens the body's ability to maintain hemodynamic stability. Nearly 25% of patients arriving to the emergency department (ED) present with an acute coagulopathy that may complicate management.[4,5] Up to 40% of mortality due to trauma-related injuries results from hemorrhagic shock.[6,7] Further, mortality secondary to hemorrhagic shock represents the largest fraction of deaths, both within the prehospital setting and within the first hour of trauma care.[6] Historically, paramedics have not had access to medications that specifically assist in the treatment of hemorrhagic shock secondary to trauma.[6,8] However, evidence suggests that early treatment of acute coagulopathies and hemorrhagic shock may significantly reduce preventable death.[6,9-11]

TXA, an antifibrinolytic agent, has been evaluated in two previous large-scale studies for the treatment of trauma-induced hemorrhagic shock. In 2010 the "Clinical Randomization of an Anti-fibrinolytic in Significant Hemorrhage 2" (CRASH-2) trial, was conducted in the civilian international setting and assessed the impact of TXA administration in patients with signs of hemorrhagic shock on trauma-related death, occlusive events and blood product transfusions. CRASH-2 demonstrated the potential effectiveness of TXA for use in trauma-related injuries with a 1.5% reduction in all-cause mortality at 28 days.[12] TXA was also determined to significantly reduce the risk of death due to bleeding, both immediately after injury and at 28 days.[12] In 2011 a subgroup analysis of the CRASH-2 trial showed that early treatment in the hospital setting with TXA, less than one hour from the time of injury, resulted in a 2.4% decrease in death due to bleeding.[13] Another CRASH-2 economic subset analysis highlighted the fact that using TXA can be highly cost effective.[14]

In 2012 the "Military Application of TXA in Trauma Emergency Resuscitation" (MATTERs) study evaluated TXA administration in patients receiving at least one unit of packed red blood cells. Results suggested that hospital administration of TXA reduced all-cause mortality in comparison to those not administered TXA (17.4% vs 23.9%, respectively; $p = .03$).[15] From these two large investigations, it appears that TXA may show potential benefit in the treatment of hemorrhagic shock.

In previous studies, TXA was primarily administered within the hospital setting.[12,15] Two small studies have demonstrated the feasibility of TXA administration in the prehospital setting.[16,17] However, both studies were based on a smaller sample size of 40 and 13 patients, which limited the generalizability of their findings.[16,17] The goal of the California Prehospital Antifibrinolytic Therapy (Cal-PAT) study is to assess the safety and impact on mortality of prehospital TXA administration by paramedics in cases of traumatic injury with signs of hemorrhagic shock. The ultimate goal is to provide reliable evidence to support TXA utilization in the prehospital setting. This preliminary report from the ongoing Cal-PAT study assessed mortality impact, total blood product usage, and incidence of known side effects associated with the use of TXA. Further, this study evaluated paramedic ability to accurately identify TXA candidates and effectively administer TXA within the framework of North American emergency medicine standards and protocols. Though previous large-scale studies were completed in the civilian international setting and combat setting, this study intended to address TXA administration within the protocols set forth by United States EMS agencies, including current paramedic training standards and response paradigms.[12,15]

Population Health Research Capsule

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

What was the research question?
What is the impact and feasibility of prehospital TXA use in trauma-induced hemorrhagic shock within the framework of North American EMS standards?

What was the major finding of the study?
TXA use was associated with a decrease in blood product use and no apparent change in adverse events in traumatic hemorrhagic shock.

How does this improve population health?
Traumatic injury is a major cause of death in both developed and developing nations. TXA represents a cost-effective measure that may reduce loss of life due to exsanguinating injury.

METHODS

Cal-PAT Study Overview

The Cal-PAT study is an ongoing multi-centered, prospective, observational cohort study with a retrospective chart review comparison, designed to determine the effect of early administration of TXA in trauma patients with signs of hemorrhagic shock. TXA administration is currently underway in the prehospital setting (initiated March 15, 2015) and within the ED (initiated June 1, 2014). The study was started in two Southern California counties: San Bernardino and Riverside. In early 2016 Alameda County joined the study, followed by Napa County in mid-2016.

All patients ≥18 years old who have sustained blunt or penetrating trauma with signs and symptoms of hemorrhagic shock are considered for TXA treatment upon meeting the inclusion criteria (Table 1) in this ongoing study. Patients are enrolled into two prospective cohorts (known collectively as the intervention group), with a third group formed through chart-review comparison (known as the control group) (Table 2). The intervention group includes patients who received TXA and are divided into two subgroups based upon location of the administration of the first TXA dose, either prehospital intervention group or in-the-hospital intervention group. Approximately 200 patients will be enrolled in each subgroup of the intervention group for a total of 400 patients. The current study focused on comparing the prehospital intervention group with the control group. The analysis of the hospital intervention group will be discussed in future papers.

The control group consists of patients identified through chart review and has an approximate goal of 400 patients or a total that matches the combined totals of the prehospital and hospital intervention groups. Control group patients must meet the same inclusion and exclusion criteria as the intervention group and were matched based upon injury severity scores (ISS), hemodynamic profiles, and mechanism of injury. Control group patients were chosen randomly within the trauma registry of a single hospital without knowing the mortality, total blood loss, and/or side effect(s) to minimize biases and ensure data quality. Further, control group patients were transported by the same participating regional emergency medical services (EMS) agencies as intervention group patients.

TXA is administered in the prehospital setting by licensed paramedics on advanced life support (ALS) ground ambulances and registered nurses (RNs) on helicopter transport units, and in the hospital setting by licensed RNs under physician supervision. TXA is delivered in two doses following the protocol used in the CRASH-2 trial.[12] The first dose is one gram of TXA in 100 ml of 0.9% normal saline infused over 10 minutes via intravenous or intraosseous access. It is administered as soon as possible by first responders or at participating hospitals. A green-colored wristband labeled "TXA" attached to their right wrist and/or TXA written on their chest identifies patients who receive TXA. Following arrival at a participating trauma center, patients who receive prehospital TXA are identified and re-assessed by the trauma team members for signs of hemorrhagic shock. Patients who still meet the inclusion criteria (Table 1) receive a second dose of one gram of TXA in 100 ml of 0.9% normal saline infused over eight hours via intravenous infusion.[12] Patients who no longer meet inclusion criteria upon arrival to the hospital do not receive a second TXA dose. Patients receiving TXA in the prehospital setting make up the prehospital intervention group (Table 2).

The primary outcome of this study is mortality, measured at 24 hours, 48 hours, and 28 days. Additional outcomes include the

Table 1. Inclusion and exclusion criteria provided to first responders in the field and clinicians at receiving trauma centers, in study of efficacy of tranexamic acid (TXA) in prehospital and hospital setting. Patients receiving TXA are enrolled into the intervention group.

Inclusion criteria	Exclusion criteria
The prehospital and hospital use of TXA should be considered for all trauma patients that meet any of the following criteria: •Blunt or penetrating trauma with signs and symptoms of hemorrhagic shock •Systolic blood pressure of less than 90 mmHg at scene of injury, during air and/or ground medical transport, or upon arrival to designated trauma centers •Any sustained blunt or penetrating injury within three hours •Patients who are considered to be high risk for significant hemorrhage oEstimated blood loss of 500 milliliters in the field accompanied with a heart rate >120 oBleeding not controlled by direct pressure or tourniquet Major amputation of any extremity above the wrists and above the ankles	•Any patient <18 years of age •Any patient with an active thromboembolic event (within the last 24 hours) – i.e. active stroke, myocardial infarction or pulmonary embolism •Any patient with a hypersensitivity or anaphylactic reaction to TXA •Any patient more than three hours post-injury •Traumatic arrest with more than five minutes of cardiopulmonary resuscitation without return of vital signs •Penetrating cranial injury •Traumatic brain injury with brain matter exposed •Isolated drowning or hanging victims •Documented cervical cord injury with motor deficits

TXA; tranexamic acid.

Table 2. Classification of enrolled patients in study examining efficacy of administering TXA in prehospital vs hospital setting.

Intervention group		Control group
Prehospital intervention group	Hospital Intervention group	
Patients who received their first dose of TXA in the prehospital setting and their second dose of TXA upon arrival to the receiving trauma center (if patient continued to meet inclusion criteria).	Patients who received both doses of TXA upon arrival to the trauma center. *Data from this group was not included on the current report	Patients were chosen randomly through a chart review comparison using the trauma registry at each included hospital to identify patients with similar injury severity scores, hemodynamic profiles, and mechanism of injury to patients receiving TXA.

TXA; tranexamic acid.

total blood product units transfused during resuscitation efforts and during the hospital stay as well as any known adverse events associated with TXA administration such as vascular occlusive events, including deep vein thrombosis (DVT), myocardial infarction (MI) and pulmonary thromboembolism (PTE), and neurological events including stroke and seizure. Other characteristics collected include the mechanism of injury (blunt or penetrating), gender, age, and ISS.

Data were collected in San Bernardino and Riverside County. San Bernardino County consisted of 10 EMS agencies transporting to two trauma centers and Riverside County consisted of eight EMS agencies transporting to four trauma centers. The average EMS transport time by ground in San Bernardino County is approximately 22 minutes; Riverside County has similar demographic and geographic make-up.[18] Comparable transport times may be expected in this region.

Patients in the prehospital intervention group (as opposed to the hospital intervention group) were matched with control group patients. Post-hoc analysis assessed characteristics and outcomes of patients who received one dose of TXA in comparison to two doses of TXA. A patient may have received one dose of TXA if they arrived to the trauma center and no longer satisfied inclusion criteria (Table 1). We excluded patients dead on arrival, those who received TXA for non-trauma indications, or those who were determined to be <18 years old upon arrival (Figure).

Initial patient selection (Table 1) was determined in the prehospital setting by licensed paramedics on ALS ground ambulances and RNs on helicopter transport units. Prehospital teams were educated on the inclusion and exclusion criteria of this study and had access to real-time consultation with physicians at the participating trauma centers to address any concerns in real-time regarding patient selection or TXA administration. Paramedics and RNs underwent training that included an educational film providing background on TXA, routes of administration, and known side-effect profile. This was followed by small-group educational sessions and hands-on workshops. All protocols were approved by the California Emergency Medical Services Authority (EMSA) with close supervision and oversight at both the local and state level.

Statistical Analyses

We conducted all statistical analyses using the SAS software for Windows version 9.3 (Cary, North Carolina, USA) and R version 3.3.1. Descriptive statistics were presented as means and standard deviations for continuous variable, as well as frequencies and proportions for categorical variables. Two groups, the prehospital intervention group and the control group, were compared with regard to clinical outcomes, including 24-hour, 48-hour, and 28-day mortality, total blood product usage measured in units, and known adverse events at hospital discharge. We conducted these comparisons of clinical outcomes between the prehospital intervention and control groups using Chi-square (or Fisher's exact test if the expected cell count <5) for categorical variables, and independent t-test for the total blood product usage. A post-hoc comparison was conducted within the prehospital intervention groups to compare the outcome between the one- and two-dose of TXA groups. We conducted a propensity score matching method using R package "MatchIt" to select patients from the control group to match the counterpart in the intervention group based on mechanism of injury, ISS and age. All statistical analyses were two-sided. We considered p-values <0.05 to be statistically significant.

RESULTS

A total of 156 patients were identified in the original prehospital intervention group. We excluded 28 patients due to the following reasons: dead on arrival (n=4); classified as non-traumas or transferred out of the participating counties (n=19); and <18 years of age (n=5). The remaining 128 patients were included in the prehospital intervention group final analysis (see Figure for sample size flow chart). The median time for paramedics to administer TXA from the estimated time of injury was 34 minutes (interquartile range [24 min, 45 min]). More than half (59.4%, n=76) were patients who had experienced a penetrating traumatic injury, and the other 40.6% (n=52) were those who had experienced a blunt-force traumatic injury.

A total of 333 patients were identified for the original control group and included in the database. The proportion of penetrating trauma was 21.6%, which is significantly less than the proportion of penetrating in the prehospital intervention group (59.4%). To eliminate the confounding effect of mechanism of injury (blunt

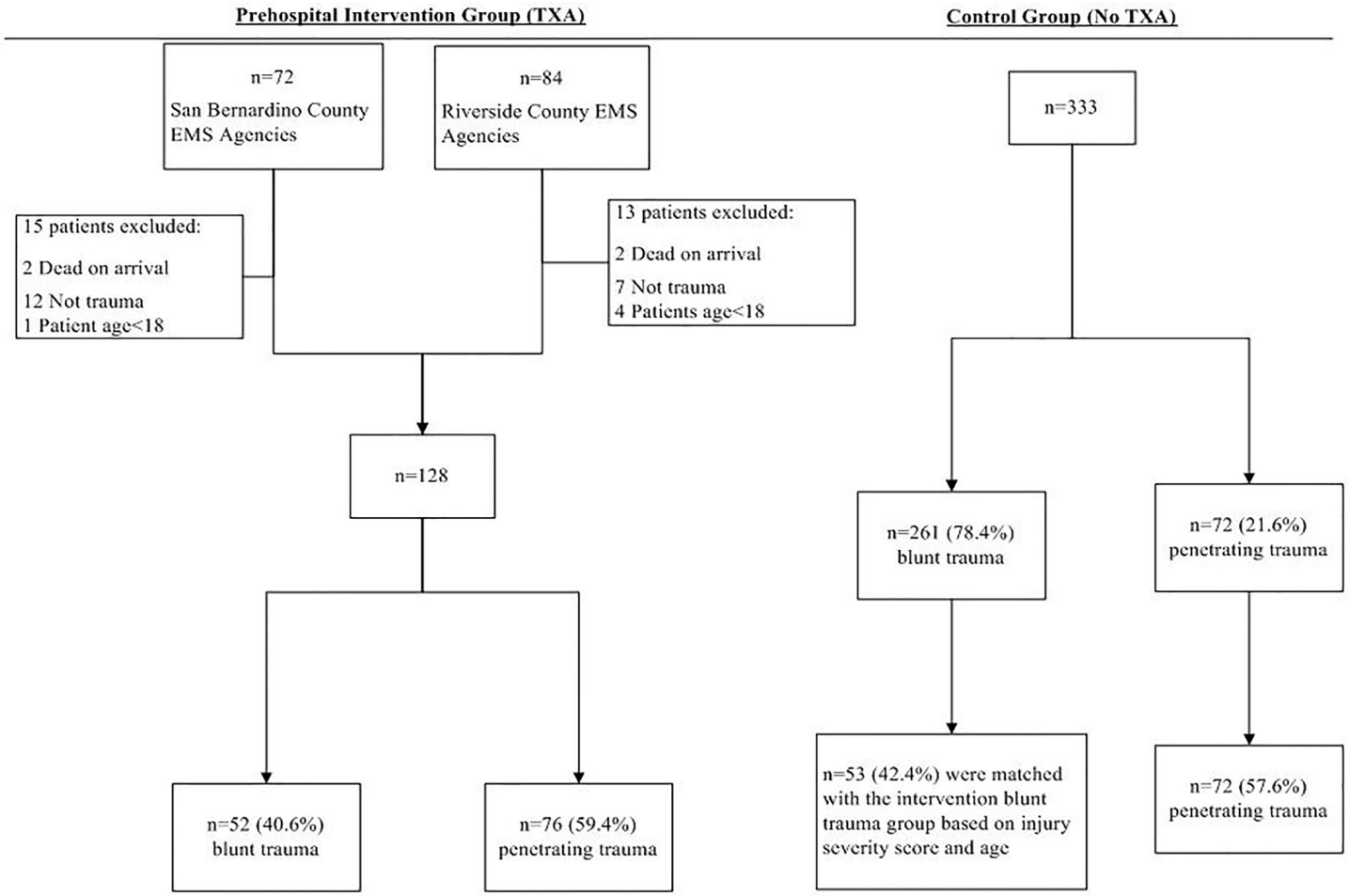

Figure. Patient exclusion flow chart that compares patient selection in the prehospital intervention group and control group. *TXA*, tranexamic acid; *EMS*, emergency medical services.

vs. penetrating), patients from the blunt trauma group were matched based on ISS and age with the intervention blunt group. As a result, we included a total of 53 (42.4%) blunt trauma and 72 (57.6%) penetrating trauma as the final control group (n=125). (See Figure for sample-size flow chart.)

Table 3 presents the results of comparing patients' characteristics between the control and prehospital intervention groups. Both groups had similar percentages of penetrating trauma (control: 57.6%; intervention: 59.4%, p=0.77), similar percentages of males (control: 83.2%; intervention: 80.5%, p=0.57), and similar age (control: 39.06; intervention: 38.23, p=0.68).

Table 3 also presents the results of the comparison between clinical outcomes of the control and prehospital intervention groups. In the prehospital intervention group, use of TXA was associated with a lower 24-hour mortality rate (control: 7.2%; intervention: 3.9%, p=0.25), 48-hour mortality rate (control: 7.2%; intervention: 6.3%, p=0.76), and 28-day mortality rate (control: 10.4%; intervention: 6.3%, p=0.23), although the difference was not statistically significant. The prehospital intervention group received significantly less blood products (in units) than the control group (control: 6.95 units; intervention: 4.09 units; p=0.01), although the ISS was higher in the control group (control: 17, intervention 13; p =.0014.) Lastly, there was no significant difference in the frequency of thromboembolic events in the prehospital intervention group or control group. (Two patients with DVT prior to hospital discharge were noted in each group.) There were no PTE, MI, stroke, or seizure events recorded in either group.

We conducted a post-hoc subgroup analysis of the prehospital intervention group to identify the difference between one dose and two doses of TXA (Table 4). There was no difference with respect to the mechanism of injury, gender, age, and ISS between these two subgroups (all p-values>0.05). Regarding clinical outcomes, there was no statistically significant difference between the one-dose and two-dose prehospital subgroups regarding 24-hour mortality (one dose: 4%; two doses: 3.8%, p=0.95), 48-hour mortality (one dose: 6.7%; two doses: 5.7%, p=0.82) and 28-day mortality (one dose: 6.7%; two doses: 5.7%, p=0.82). There was no difference regarding the known

Table 3. Patient outcomes comparing the control group and prehospital intervention group. The control group is matched to prehospital subgroup patients.

	Control group (n=125)	Prehospital intervention group (n=128)	p-value
Mechanism of injury			0.7745
Blunt trauma	53 (42.4%)	52 (40.6%)	
Penetrating trauma	72 (57.6%)	76 (59.4%)	
Gender			0.5733
Female	21 (16.8%)	25 (19.5%)	
Male	104 (83.2%)	103 (80.5%)	
Age, years, mean ± SD	39.06 ± 16.66	38.23 ± 15.48	0.6819
Injury severity score, mean ± SD	17 ± 10.74	12.96 ± 9.03	0.0014
Mortality at 24 hours			0.2519
Dead	9 (7.2%)	5 (3.9%)	
Mortality at 48 hours			0.7628
Dead	9 (7.2%)	8 (6.3%)	
Mortality at 28 days			0.2316
Dead	13 (10.4%)	8 (6.3%)	
Total blood products used (in units), mean ± SD	6.95 ± 9.93	4.09 ± 8.33	0.0135
Adverse events at hospital discharge**			0.6839
Deep vein thrombosis	2 (1.6%)	2 (1.6%)	
None	123 (98.4%)	126 (98.4%)	

*All percentages were column percentages. In other words, the percentages added up to 100% by column for each variable.
**The calculation of p-values for adverse event at hospital discharge was based on Fisher's exact test.

adverse events at hospital discharge. The two patients with DVTs were in the two-doses subgroup. Lastly, the two-doses subgroup was administered more units of blood products (one dose: 2.45 units; two doses: 6.39 units, p=0.0079).

DISCUSSION

The ongoing Cal-PAT study was conceived through a collaborative effort between local fire department services, first responder agencies, and multiple high-volume, university-affiliated trauma centers located throughout California. The overall goal is to assess the safety of prehospital TXA administration and impact on mortality in patients with signs of hemorrhagic shock following a traumatic injury. Initial analyses focus on the prehospital aspects of TXA administration. Hospital administration of TXA will be addressed in future analyses as the Cal-PAT study continues.

The preliminary results from the ongoing Cal-PAT study suggest that early prehospital administration of TXA may be warranted in suspected cases of trauma-related hemorrhagic shock. This study strengthens TXA literature surrounding the prehospital safety and efficacy of TXA administration through addressing short- and long-term outcomes with a larger sample size (n=128) as compared to two previous studies (n=13 and n=40).[16,17] Further, initial analyses demonstrated a trend of reduced mortality with TXA administration, which was consistent with the findings of the CRASH-2 trial and MATTERs study.[12,15] These results suggest that TXA may have future potential as a valuable tool for U.S. civilian EMS. To our knowledge, this is the first large-scale study to systematically examine prehospital TXA administration in the U.S.

Data trends suggest that TXA may reduce mortality at both 24 hours and 48 hours in cases of traumatic injury with signs of hemorrhagic shock. TXA is believed to exert this effect through its antifibrinolytic properties.[19,20] In patients who have sustained significant blood loss, a state of fibrinolysis and hyper-fibrinolysis can be found in up to two-thirds of patients.[8,12,19,21] This can threaten clot integrity and result in increased blood loss, morbidity, and mortality.[19] TXA may act to prevent and reverse coagulopathies and reestablish hemodynamic stability. However, TXA appears to exert effect beyond 24 hours, after the risk of bleeding has decreased.[6] The ability of TXA to decrease plasmin levels, reducing the magnitude of the pro-inflammatory effect exerted by plasmin, may be responsible for the decreased mortality observed at greater than 48 hours.[22,23] Although the exact mechanism is not clear, evidence demonstrates that the therapeutic mechanism may be multifactorial in nature.

The CRASH-2 trial showed no increase in total blood products used in patients administered TXA, while the MATTERs study showed an increase in blood products used.[12,15] The current study showed a statistically significant decrease in

Table 4. Prehospital intervention group analysis by dose(s) of TXA received. A patient may receive one dose of TXA if they no longer satisfy inclusion criteria upon arrival to a receiving trauma center.

	Prehospital 1 dose of TXA (n=75)	1 Prehospital + 1 hospital dose of TXA (n=53)	P-value
Mechanism of injury			0.8461
Blunt	31 (41.3%)	21 (39.6%)	
Penetrating	44 (58.7%)	32 (60.4%)	
Gender			0.5407
Female	16 (21.3%)	9 (17%)	
Male	59 (78.7%)	44 (83%)	
Age, years, mean ± SD	38.19 ± 16.84	38.3 ± 13.49	0.9671
ISS, mean ± SD	11.85 ± 8.43	14.53 ± 9.67	0.0989
Mortality 24 hours			0.9481
Dead	3 (4%)	2 (3.8%)	
Mortality 48 hours			0.8168
Dead	5 (6.7%)	3 (5.7%)	
Mortality 28 days			0.8168
Dead	5 (6.7%)	3 (5.7%)	
Total blood product (in units), mean ± SD	2.45 ± 6.38	6.39 ± 10.12	0.0079
Adverse event at hospital discharge**			0.1695
Deep vein thrombosis	0	2 (3.8%)	
None	75 (100%)	51 (96.2%)	

TXA, tranexamic acid; *EMS*, emergency medical services.
**The calculation of p-values for adverse event at hospital discharge was based on Fisher's exact test.

total blood product usage following TXA administration. This suggests that TXA may exert an immediate effect through its antifibrinolytic properties. Alternatively, this decreased usage of blood products observed in the current study may be attributed to a difference in injury severity between the intervention and control group, as noted by the difference in overall ISS score. It may also reflect the practice of more restrictive blood product usage observed in trauma care over the last decade.

Further, the decrease in the amount of blood products used by patients administered TXA in the Cal-PAT study could be explained by the fact that TXA was given in the prehospital setting, as opposed to the hospital upon patient arrival, as seen in the CRASH-2 trial and MATTERs study.[12,15] Early administration of TXA in the prehospital setting may have allowed more time for a patient to be affected by the therapeutic effects of TXA. A post-hoc analysis of CRASH-2 data suggests that early administration of TXA to trauma patients within one hour of injury significantly reduced mortality due to hemorrhagic shock.[12] The current study noted a <1 hour median time for paramedics to administer TXA from the estimated time of injury. Demonstrating the feasibility of rapid TXA administration by first responders is essential toward reducing the time to the first dose. Bringing TXA to the point of injury may maximize the therapeutic effect of TXA in cases of suspected trauma-induced hemorrhagic shock.[13]

Despite the proposed importance of rapid administration of TXA toward maximizing mortality benefit, administration of TXA must not delay total transport time.[13] Emphasis in the prehospital setting should focus primarily on extrication and resuscitation. However, once peripheral intravenous access or intraosseous access is achieved, TXA can feasibly be administered. According to current U.S. EMS protocols, attempts to establish venous or intraosseous access must be made on all patients at risk for hemodynamic compromise prior to arrival at the hospital; therefore, TXA administration in the prehospital setting should not significantly increase transport time. A previous study suggested that TXA may be administered without increasing transport time.[16] TXA is also stable at room temperature allowing for convenient storage on ambulances and helicopters. Ongoing education concerning TXA administration and indications was integrated into local and regional paramedic continuing education curriculum.

Further, TXA is an inexpensive drug that is highly cost effective. One gram of TXA, often supplied in 10ml ampules or vials, used for this study costs between $16 to $50 depending on whether TXA was purchased for prehospital or hospital use. In comparison, the raw cost for one unit of packed red blood cells is approximately $210.74, with the mean charge to the patient of $343.63.[24] Following TXA administration, the Cal-PAT study

demonstrated an approximate three-unit decrease in total blood products used; this equates to a cost reduction of approximately $500 per patient. The economic impact of TXA would be applicable across a broad spectrum of socioeconomic levels. Results from the Cal-PAT study may better elucidate EMS system characteristics within the U.S.,in which TXA may confer the greatest impact.

Regarding known adverse events associated with TXA administration, we noted an equal frequency of events between the control and prehospital intervention group. This may indicate that TXA administration does not significantly increase the risk for thromboembolic events. These preliminary results are consistent with CRASH-2 trial results, but do not align with MATTERs study outcomes, which showed a slight increase in thromboembolic events in patients administered TXA.[12,15] It may be noted, however, that patients included in the MATTERs study exhibited a higher injury burden, which is also associated with an increased incidence of thromboembolic events.[15]

Within the prehospital intervention group, we observed one case of a hemispheric ischemic stroke. The patient involved was a young male victim of a head-on high-energy motor vehicle collision. Upon arrival to the trauma center, physical exam showed multiple open and closed orthopedic long-bone fractures; neurological findings were unremarkable. This patient had been administered two doses of TXA per protocol. Forty hours after admission, while recovering from surgeries in the critical care unit, the patient experienced a decline in neurological status with notable fixed and dilated pupils. Repeat computed tomography (CT) of his head revealed a new large ischemic infarct with moderate mass effect, a 9mm shift, and right middle cerebral artery distribution. Suspecting traumatic vascular injury, a CT angiography (CTA) study was ordered; however, it was not completed as the family opted to instate a do-not-resuscitate (DNR) order. Without this definitive imaging study, a thromboembolic complication secondary to TXA could not be ruled out; however, it was considered remote since its relationship with respect to presentation and timing make this unlikely. The proposed cause of death in this case was vascular injury including dissection secondary to traumatic injury.

We observed a steady increase in the number of appropriate patients enrolled during the 15 months since implementation, a trend consistent with other similar studies.[8] Correct identification of TXA candidates was an initial obstacle. Paramedics indicated that a small percentage of patients, roughly 3% (n=5) of the initial intervention group, lacked adequate identification and/or were unresponsive to questioning; as such, paramedics judged these patients' ages based on physical appearance to be >18 years old when in fact these patients were <18 years old. We subsequently excluded these patients from analyses. Further, these events triggered immediate protocol reviews, as well as continued and repeated education for first responders arranged by EMS coordinators in each EMS agency. Additionally, real-time consultation with physicians at the participating trauma centers was available and continues to be available to paramedics in this ongoing study to aid in determining if patients meet the inclusion criteria for TXA administration. Investigators also conducted quality control within 24 hours after each case, and meetings with all hospitals and EMS agencies involved were held and continue to be held monthly to review cases and update protocols.

The literature also notes that although TXA is known to reduce blood loss in cardiopulmonary and orthopedic surgeries, the exact dosing scheme has been unclear, ranging from 2.5 to 100mg/kg and 0.25mg/kg/hr to 4mg/kg/hr for maintenance doses.[25-28] Previous studies have shown no significant difference in mortality benefit between low and high doses of TXA.[29,30] In emergency situations, a fixed one-gram dose followed by a one-gram maintenance dose (if a patient continued to satisfy inclusion criteria), has been deemed most practical.[12] In the Cal-PAT study, this dosing protocol generated two prehospital subgroups (one dose vs. two doses of TXA); 58.6% of patients in the prehospital intervention group received only the first dose of TXA. This may have occurred when a patient no longer satisfied the inclusion criteria for TXA administration upon arriving at a participating trauma center, or due to lack of compliance or adherence to research protocol. Initial analyses suggested that there might be little difference in mortality between those receiving one dose versus two doses of TXA. If sufficient antifibrinolytic and anti-inflammatory effects occur with only a single dose, this challenges the apparent need for a maintenance dose. The exact half-life and duration of the maintained therapeutic level of TXA is unclear in present literature; however, reports have indicated two to three hours and approximately eight hours respectively, depending on the dosage.[31-33] Further studies are warranted to clarify the optimal dosing protocol for TXA in cases of trauma-related hemorrhagic shock.

LIMITATIONS

Initial implementation of TXA administration between the prehospital and hospital groups did not occur simultaneously (March 15, 2015, vs. June 1, 2014, respectively). The delayed onset of TXA administration in the prehospital group was due to the need for approval by local and state EMS regulatory authorities, as well as personnel training for administration in the prehospital setting. We do not believe that this difference in start date affected the quality of this study.

This study was limited by design. The prospective cohort design in comparison to a randomized control design did not allow us to administer TXA in a blinded fashion. Physicians were aware that TXA had been administered, which may have introduced a slight bias related to the level of care provided. However, we anticipate this to have minimal effect on study outcomes. The cross-matched study design and initial matching of patients by mechanism of injury further resulted in a statistically significantly greater ISS in the control group in comparison to the prehospital intervention group. We believed that mechanism of injury was most important to match; age

and ISS were affected by this prioritization. As the sample size increases during this ongoing study, this discrepancy may likely be reduced. Additionally, in order to reduce biases the selection of the matched control group was random and the biostatistician did not know the outcome of interest, such as 24-hours, 48-hours, and 28-day mortality status.

Another limitation may be the difficulty associated with accurately recognizing signs of trauma-related hemorrhagic shock in the prehospital setting. High injury acuity and/or inexperience may have resulted in some EMS providers improperly including or excluding TXA candidates. As such, patients who would have qualified for this study may not have received TXA, while others who did not qualify may have received TXA. Incidences of improper exclusion were noted during the initial months after implementation and future incidences were reduced through active troubleshooting, quality control, and paramedic education. EMS teams were also backed by real-time physician consultation to provide added assistance; this teamwork approach was instituted to minimize the possibility of inappropriate TXA administration.

At the time of this report, the majority of outcomes from the Cal-PAT study do not demonstrate statistical significance. The initial conclusions presented were based upon trends; data must be interpreted with attention to this. As the sample size grows, results may have an increased likelihood of achieving statistical significance.

CONCLUSION

Preliminary evidence from the Cal-PAT study suggests that TXA administration may be safe in the prehospital setting with no significant change in adverse events observed and an associated decreased use of blood products in cases of trauma-induced hemorrhagic shock. Given the current sample size, a statistically significant decrease in mortality was not observed. Additionally, the feasibility of prehospital identification and administration of TXA by paramedics has been demonstrated. Paramedics were able to administer TXA safely and effectively on scene and while en route to the hospital. Future continuation of data collection will enable us to explore the necessity for a second dose of TXA administered upon arrival to the hospital.

The current study indicates that TXA may be a viable option to reduce mortality in civilian prehospital trauma care within the United States. With the completion of the Cal-PAT study, we hope to further develop TXA prehospital administration protocols and support widespread implementation of TXA in the prehospital setting.

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Evaluating the Laboratory Risk Indicator to Differentiate Cellulitis from Necrotizing Fasciitis in the Emergency Department

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Introduction: Necrotizing fasciitis (NF) is an uncommon but rapidly progressive infection that results in gross morbidity and mortality if not treated in its early stages. The Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score is used to distinguish NF from other soft tissue infections such as cellulitis or abscess. This study analyzed the ability of the LRINEC score to accurately rule out NF in patients who were confirmed to have cellulitis, as well as the capability to differentiate cellulitis from NF.

Methods: This was a 10-year retrospective chart-review study that included emergency department (ED) patients ≥18 years old with a diagnosis of cellulitis or NF. We calculated a LRINEC score ranging from 0-13 for each patient with all pertinent laboratory values. Three categories were developed per the original LRINEC score guidelines denoting NF risk stratification: high risk (LRINEC score ≥8), moderate risk (LRINEC score 6-7), and low risk (LRINEC score ≤5). All cases missing laboratory values were due to the absence of a C-reactive protein (CRP) value. Since the score for a negative or positive CRP value for the LRINEC score was 0 or 4 respectively, a LRINEC score of 0 or 1 without a CRP value would have placed the patient in the "low risk" group and a LRINEC score of 8 or greater without CRP value would have placed the patient in the "high risk" group. These patients missing CRP values were added to these respective groups.

Results: Among the 948 ED patients with cellulitis, more than one-tenth (10.7%, n=102 of 948) were moderate or high risk for NF based on LRINEC score. Of the 135 ED patients with a diagnosis of NF, 22 patients had valid CRP laboratory values and LRINEC scores were calculated. Among the other 113 patients without CRP values, six patients had a LRINEC score ≥ 8, and 19 patients had a LRINEC score ≤ 1. Thus, a total of 47 patients were further classified based on LRINEC score without a CRP value. More than half of the NF group (63.8%, n=30 of 47) had a low risk based on LRINEC ≤5. Moreover, LRINEC appeared to perform better in the diabetes population than in the non-diabetes population.

Conclusion: The LRINEC score may not be an accurate tool for NF risk stratification and differentiation between cellulitis and NF in the ED setting. This decision instrument demonstrated a high false positive rate when determining NF risk stratification in confirmed cases of cellulitis and a high false negative rate in cases of confirmed NF. [West J Emerg Med. 2017;18(4)684-689.]

INTRODUCTION

Necrotizing fasciitis (NF) is a rare but life-threatening soft tissue infection characterized by rapidly progressive necrosis of subcutaneous tissues and deep fascia planes, with resulting skin gangrene and severe systemic infection.[1] The median mortality rate for NF is 32.2% but varies throughout the literature from 8.7% to 76%.[2,3] Patients with NF must be promptly and aggressively treated with surgical intervention to reduce morbidity and mortality.[2,4,5] Mortality associated with NF that is not treated with surgical debridement approaches 100%, even with antibiotic treatment.[1] The extremities, groin, and abdomen are the sites most frequently affected by the disease.[4]

Early diagnosis of NF is difficult due to the low rate of incidence, lack of knowledge of various presentations, and elusive clinical presenting signs and symptoms.[1] The Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score was developed as a diagnostic tool to potentially aid practitioners in early detection of NF.[6] A LRINEC score between 0 and 13 can be calculated based on levels of serum leukocytes, glucose, sodium, C-reactive protein (CRP), creatinine, and hemoglobin. All six components of the LRINEC score are required for valid calculation. LRINEC scores ≥8 fall in the high-risk category, LRINEC scores of 6-7 are moderate risk, while scores ≤5 are considered low risk.[6] Previous evidence suggested that a patient with a LRINEC ≥6 should be further evaluated for NF diagnosis.[6]

Validation studies determined the LRINEC score to have low predictive value.[7,8] Burner and colleagues reported that the LRINEC score was not sufficiently sensitive to rule out NF.[9] Additionally, CRP value is not routinely collected in the emergency department (ED), which presents a barrier for the effective utilization of the LRINEC score as a predictive tool.

Soft tissue infections, including cellulitis and NF, are difficult to differentiate due to similarities at initial onset.[9,10] Pain and progressive erythema are common presenting symptoms of both these infections.[10,11] However, the sequela of NF is far more severe than cellulitis including sepsis, loss of limbs, and death. Further, diabetes is a known risk factor for developing these soft tissue infections. Regarding the LRINEC score, Burner and colleagues reported a higher discrimination ability among the diabetes population in cases of correctly predicted NF.[9]

To our knowledge, no previous studies have assessed the performance of the LRINEC score against confirmed cases of cellulitis. This study further aimed to evaluate the predictive ability of the LRINEC score among confirmed cases of NF. Findings from this study may aid emergency physicians (EP) in better understanding the clinical application of the LRINEC score and its accuracy as a frontline screening tool for NF risk stratification in the ED.

Population Health Research Capsule

What do we already know about this issue?
The insufficient sensitivity of the Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score makes it an inadequate tool to safely "rule out" necrotizing fasciitis (NF) in the ED.

What was the research question?
To evaluate the predictive ability of the LRINEC score for NF risk stratification in confirmed cellulitis and NF cases.

What was the major finding of the study?
LRINEC score showed high false positive rates in confirmed cellulitis cases and high false negative rates in confirmed NF cases.

How does this improve population health?
NF is a rare disease and the consequences of delayed recognition may be catastrophic. At present, use of LRINEC score cannot be supported as an adequate means to safely exclude NF in the ED setting.

METHODS

We conducted a 10-year retrospective chart review in the ED that included patients seen at Arrowhead Regional Medical Center (ARMC) from January 1, 2005, to December 31, 2015. ARMC is a 456-bed acute care teaching facility and the only American College of Surgeons-certified Level II trauma center in San Bernardino County, California.[8] The ED at ARMC is the second busiest in the state of California with more than 116,000 annual visits.[12] The institutional review board at ARMC approved this study.

Patients who were ≥18 years old seen at ARMC between January 2005 and December 2015 were assessed for inclusion in this study. We identified patients with cellulitis as the primary or additional diagnosis via ICD-9 discharge diagnosis. Diagnoses of cellulitis were made by EPs following clinical assessment and laboratory findings obtained while in the ED. Exclusion criteria for cellulitis cases included all cases of cellulitis with abscesses that were managed by incision and drainage in the ED, and those patients missing any of the six clinical measures necessary to calculate the LRINEC score (c-reactive protein [CRP], total white blood cell count [WBC], hemoglobin, sodium, creatinine, and glucose).

Patients with a diagnosis of NF were identified via ICD-9 discharge diagnosis. A diagnosis of NF was confirmed through a chart review identifying patients with NF as the primary diagnosis or additional diagnosis, surgical reports that clearly indicated the presence of necrosis in the fascia and subcutaneous tissue, or pathology reports that noted fascial necrosis. Exclusion criteria for NF cases were those directly admitted to the hospital without involvement of the ED, hospital-acquired infections, and transferred patients with prior diagnosis.

Two groups were formed following data collection: cellulitis group (no NF) and NF group. We calculated a LRINEC score ranging from 0-13 for each patient in both groups; LRINEC scores ≥8 fell into the high-risk category, LRINEC scores of 6 or 7 fell into the moderate-risk category, and LRINEC scores ≤5 were considered low risk.[6] All six clinical measures (CRP, total WBC, hemoglobin, sodium, creatinine, and glucose) must have been ordered in the ED for LRINEC calculation to be valid. CRP values for the LRINEC score were either 0 for a negative CRP measurement or 4 for a positive CRP measurement. In cases where a patient was missing a CRP value, a LRINEC score of 0 or 1 without a CRP value would have placed the patient in the "low risk" group per the original guidelines,[6] and a LRINEC score of 8 or greater without a CRP value would have placed the patient in the "high risk" group per the original guidelines.[6] Patients missing CRP values were added to these respective groups.

Since the initial number of patients for the cellulitis group outnumbered those in the NF group, cellulitis patients were randomly selected from only the first week of each month during the study period. Additional variables collected in the cellulitis group were the status of comorbidities, including diabetes.

The primary objective was the predictive ability of the LRINEC decision instrument in patients with a confirmed discharge diagnosis of cellulitis. The secondary objective was the predictive ability of the LRINEC score in patients with a confirmed diagnosis of NF. The impact of comorbidities, including diabetes, on the screening value to the LRINEC score was further assessed in patients with a confirmed discharge diagnosis of cellulitis. Other analyzed factors included each individual value of the LRINEC criteria (CRP, total WBC, hemoglobin, sodium, creatinine, and glucose). We also reviewed and analyzed patients' demographic data, duration of hospitalization, etiology, underlying systemic disease, bacteriologic and radiologic studies, complications, and treatment outcome.

Residents familiar with study protocol gathered data via retrospective chart review of identified cellulitis and NF cases. Data abstractors had knowledge of the patient's diagnosis (cellulitis or NF) and were instructed to collect raw data. Data abstractors did not calculate LRINEC scores. All abstracted data were entered into an Excel database. An attending physician was available for consultation/clarification if there were any problems. LRINEC score calculation and classification (low-, moderate-, and high-risk) for each patient were undertaken by the biostatistician.

We conducted all statistical analyses using the SAS software for Windows version 9.3 (Cary, NC). Descriptive statistics were presented as means and standard deviations for continuous variables, along with frequencies and proportions for categorical variables. An independent t-test was conducted to compare the clinical measures between the cellulitis and NF patients. We conducted a Chi-square test to identify the association between the three LRINEC score groups (low, moderate, and high risk) and NF status. Fisher's exact test was conducted if the expected cell count in each cell was <5. We performed a subgroup analysis to assess the discrimination ability of LRINEC score between diabetes and non-diabetes groups. All statistical analyses were two-sided. P-value<0.05 was statistically significant.

RESULTS

A total of 3,000 patients were randomly selected from more than 30,000 patients for inclusion in the cellulitis group. We chose 948 patients with CRP values for the cellulitis group. Further breakdown noted 474 diabetes and 474 non-diabetes patients within the cellulitis group. We identified 135 patients for inclusion in the NF group. CRP values were available for 22 (16.3%) patients and we calculated the corresponding LRINEC scores. Furthermore, among the 113 patients without CPR values, six had LRINEC scores ≥ 8 without CRP value, and 19 had LRINEC scores ≤ 1 without CRP value. A total of 47 (the sum of 22, 6 and 19) patients were classified into "low risk," "moderate risk," and "high risk" based on LRINEC score.

Table 1 presents the LRINEC scores for the cellulitis group and NF group separately. Based on the LRINEC score risk stratification, among the cellulitis group, 89.2% (n=846 of 948) of the patients were considered as low risk (score ≤5), 6.5% (n=62 of 948) as moderate risk, and 4.2% (n=40 of 948) as high risk for NF. In sum, 10.7% (102 of 948) were misclassified as "at risk" for NF despite a confirmed diagnosis of cellulitis. Among the NF group, 63.8% (n=30 of 47) of the patients were considered as low risk (score ≤5) for NF, 2.1% (n=1 of 47) as moderate risk, and 34% (n=16 of 47) as high risk.

Additionally, we conducted a subgroup analysis of the NF group to identify the discrimination ability of LRINEC between diabetes and non-diabetes patients (Table 2). For the diabetes subgroup with a diagnosis of NF, 43.8% (n=7 of 16) were misclassified as low risk for NF based on LRINEC score. The misclassification rate was more pronounced in the non-diabetes group, with 74.2% (n=23 of 31) misclassified as low risk for NF based on LRINEC score.

Table 1. Laboratory risk indicator for necrotizing fasciitis (LRINEC) score for necrotizing fasciitis and cellulitis.

	NF (n=135)	Cellulitis (n=948)	p-value
LRINEC Groups			<.0001
High risk: LRINEC ≥8	16 (34%)	40 (4.2%)	
Moderate risk: LRINEC 6 and 7	1 (2.1%)	62 (6.5%)	
Low risk: LRINEC ≤5	30 (63.8%)	846 (89.2%)	
	Missing = 88		
WBC (*1000 per mm3)	18.32 ± 9.16	9.52 ± 5.39	<.0001
Hemoglobin (g/dL)	12.87 ± 2.36	12.57 ± 2.21	0.149
Sodium (mmol/L)	131.77 ± 6.05	137.69 ± 3.84	<.0001
Creatinine (umol/L)	160.66 ± 155.05	91.7 ± 93.72	<.0001
Glucose (mmol/L)	13.61 ± 11.13	9.27 ± 5.41	<.0001
CRP (mg/dL)	178.06 ± 165.42	61.68 ± 92.09	0.0035
Age, years	47.31 ± 13.05	50.33 ± 13.78	0.0166

LRINEC, laboratory risk indicator for necrotizing fasciitis; *NF*, necrotizing fasciitis; *WBC*, white blood cell; *CRP*, c-reactive protein.
All percentages may not add up to 100% by each column due to rounding.
To change the creatinine from umol/L to mg/dl, use the formula mg/dl=88.4*umol/L.
To change glucose from mmol/L to mg/dL, use the formula mg/dL=0.055 mmol/L.
To change CPR from mg/dl to mg/L, use the formula mg/L=0.1* mg/dL.

For the diabetes subgroup with a diagnosis of cellulitis, 5.5% (n=12 of 474) were misclassified as moderate and 2.5% (n=12 of 474) were misclassified as high risk for NF based on LRINEC score. The misclassification rate was more pronounced in the non-diabetes group with 7.6% (n=36 of 474) misclassified as moderate risk and 5.9% (n=28 of 474) misclassified as high risk for NF based on LRINEC score.

In comparing laboratory values between the cellulitis and NF groups, we found statistically significant differences between the WBC (p<0.0001), serum sodium level (p<0.0001), creatinine level (p<0.0001), glucose level (p<0.0001) and CRP level (p=0.0035). However, no difference was detected in hemoglobin levels between the cellulitis and NF group (p=0.149). When stratifying based on diabetes status, WBC, sodium, creatinine, glucose, and CRP were significantly different between the cellulitis and NF groups, while hemoglobin was not significantly different.

DISCUSSION

The current study suggests that the LRINEC score may not be an accurate tool for NF risk stratification and differentiation between cellulitis and NF in the ED setting. Among patients with confirmed diagnoses of cellulitis, 10.7% were categorized as moderate to high risk for NF based on the LRINEC score. The high incidence of false positives adds a new dimension to investigations seeking to assess the validity of the LRINEC score. To our knowledge, no study has been conducted to evaluate the efficacy of the LRINEC decision instrument against a large sample of patients with a confirmed diagnosis of cellulitis.

Additionally, among patients with confirmed diagnoses of NF, 63.8% were categorized as low risk for NF based on the LRINEC score. Based on the initial LRINEC validation study by Wong et al., this decision instrument carries a positive predictive value of 92% and negative predictive value of 96%.[6] However, a subsequent retrospective analysis of the LRINEC score noted a sensitivity of only 77% when assessing against confirmed cases of NF.[9] In addition, multiple other studies reported inadequate sensitivity of the LRINEC score to rule out NF in cases of confirmed NF.[8,9,13]

Based on the results of the current study, using the LRINEC score for NF risk stratification in cases of confirmed cellulitis at our institution could have resulted in a misleading differential diagnosis, leading to a more rigorous clinical workup and treatment protocol that are normally associated with NF. The possibility of invasive intervention would have been higher, further exacerbating the emotional, physical, and financial burdens for these patients. Over 30,000 patients with a diagnosis of cellulitis were originally assessed for inclusion in this study. If the LRINEC score had been used in isolation to direct the clinical management of these patients, 10.7%, or more than 3,000 individuals, would have been subjected to inappropriate management.

Additionally, the current study assessed the LRINEC decision instrument misclassification rate among diabetes

Table 2. Laboratory risk indicatory for necrotizing fasciitis (LRINEC) score for necrotizing fasciitis and cellulitis by diabetes status.

	Diabetes subgroup			Non-diabetes subgroup		
	NF (n=16)	Cellulitis (n=474)	p-value	NF (n=31)	Cellulitis (n=474)	p-value
LRINEC groups			0.0012			<.0001
High risk: LRINEC ≥8	9 (56.3%)	12 (2.5%)		7 (22.6%)	28 (5.9%)	
Moderate risk: LRINEC 6 and 7	0 (0%)	26 (5.5%)		1 (3.2%)	36 (7.6%)	
Low risk: LRINEC ≤5	7 (43.8%)	436 (92%)		23 (74.2%)	410 (86.5%)	
	Missing = 41			Missing = 47		
WBC (*1000 per mm3)	18.13 ± 10.57	9.76 ± 4.94	<.0001	18.22 ± 6.33	9.27 ± 5.8	<.0001
Hemoglobin (g/dL)	13.11 ± 2.33	12.93 ± 2.03	0.4827	12.38 ± 2.35	12.21 ± 2.32	0.6003
Sodium (mmol/L)	133.08 ± 5.35	138.04 ± 3.47	<.0001	129.65 ± 6.47	137.33 ± 4.15	<.0001
Creatinine (umol/L)	159.27 ± 158.23	77.04 ± 77.23	<.0001	159.15 ± 158.38	106.36 ± 105.78	0.0225
Glucose (mmol/L)	7.54 ± 3.76	6.42 ± 2.15	0.013	22.2 ± 12.62	12.12 ± 6.14	<.0001
CRP (mg/dL)	167.64 ± 153.64	62.6 ± 87.92	0.0194	200.4 ± 199.61	60.75 ± 96.17	0.0002
Age, years	45.93 ± 14.16	46.46 ± 14.66	0.7725	49.5 ± 10.53	54.21 ± 11.61	0.0053

LRINEC, laboratory risk indicator for necrotizing fasciitis; *NF*, necrotizing Fasciitis; *WBC*, white blood cell; *CRP*, c-reactive protein.
To change the creatinine from umol/L to mg/dL, use the formula mg/dL=88.4*umol/L.
To change glucose from mmol/l to mg/dL, use the formula mg/dL=0.055 mmol/L.
To change CPR from mg/dL to mg/L, use the formula mg/L=0.1* mg/dL.

patients versus non-diabetes patients. The misclassification rate was 8% and 13.5% among diabetic and non-diabetic patients among the cellulitis group, respectively. Similarly, among the NF group, the misclassification rate was 43.8% among diabetic patients and 74.2% among non-diabetic patients. It appears that the LRINEC scoring tool more accurately assessed NF risk stratification among diabetic patients in comparison to the non-diabetic patients. This finding is consistent with Burner et al., who reported a better discrimination ability of the LRINEC score for NF cases among the diabetic population.[9]

LIMITATIONS

This study was limited by the inability to calculate a complete LRINEC score in the majority of patients with suspected NF due to a lack of CRP measured in the ED. The non-specific nature of CRP as a marker of systemic inflammation in numerous disease processes reduces its relevance as a routinely ordered test.[14,15] Similar limitations were reported from several other studies attempting to validate the LRINEC score.[9,14] In the current study, a LRINEC score could only be calculated in 22 patients with a confirmed NF diagnosis as they were the only cases with all six components measured in the ED (CRP, total WBC, hemoglobin, sodium, creatinine, and glucose). To increase sample size and strengthen the generalizability of findings in the current study, we further included 25 additional patients who were in the low-risk or high-risk group even without the CRP values.

Another limitation is the small sample size. However, the majority of present literature consists of small sample size studies and case reports. Given that NF is a rare disease process, generating a large sample size was a significant obstacle.

CONCLUSION

In the ED setting, the LRINEC score may not be an accurate tool to determine NF risk stratification or to differentiate between cellulitis and NF. This decision tool demonstrated a high false positive rate when classifying NF risk stratification in confirmed cases of cellulitis and a high false negative rate in cases of confirmed NF. Emergency physicians should be cognizant of the limitations of the LRINEC score and continue to carry a high index of suspicion in patients who present with pain out of proportion, signs of skin necrosis, and subcutaneous gas on imaging studies.

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Index to Predict In-hospital Mortality in Older Adults after Non-traumatic Emergency Department Intubations

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Introduction: Our goal was to develop and validate an index to predict in-hospital mortality in older adults after non-traumatic emergency department (ED) intubations.

Methods: We used Vizient administrative data from hospitalizations of 22,374 adults ≥75 years who underwent non-traumatic ED intubation from 2008-2015 at nearly 300 U.S. hospitals to develop and validate an index to predict in-hospital mortality. We randomly selected one half of participants for the development cohort and one half for the validation cohort. Considering 25 potential predictors, we developed a multivariable logistic regression model using least absolute shrinkage and selection operator method to determine factors associated with in-hospital mortality. We calculated risk scores using points derived from the final model's beta coefficients. To evaluate calibration and discrimination of the final model, we used Hosmer-Lemeshow chi-square test and receiver-operating characteristic analysis and compared mortality by risk groups in the development and validation cohorts.

Results: Death during the index hospitalization occurred in 40% of cases. The final model included six variables: history of myocardial infarction, history of cerebrovascular disease, history of metastatic cancer, age, admission diagnosis of sepsis, and admission diagnosis of stroke/ intracranial hemorrhage. Those with low-risk scores (<6) had 31% risk of in-hospital mortality while those with high-risk scores (>10) had 58% risk of in-hospital mortality. The Hosmer-Lemeshow chi-square of the model was 6.47 (p=0.09), and the c-statistic was 0.62 in the validation cohort.

Conclusion: The model may be useful in identifying older adults at high risk of death after ED intubation. [West J Emerg Med. 2017;18(4)690-697.]

INTRODUCTION

The vast majority (75%) of older adults with serious illness visit the emergency department (ED) in the last six months of their lives.[1] Many of these patients often prioritize the quality of their life and quality of dying over simply living as long as possible and fear health states worse than death.[2,3] However, a recent systematic review revealed that the majority (56%-99%) of older adults in the ED do not have advance directives available at the time of ED presentation.[4] Even if advance care planning occurred before ED arrival, it is rarely recorded in the medical record,[5] and patients' values and goals may change based on changing health states necessitating emergency physicians (EP) to revisit patients' goals.[6]

EPs often face much uncertainty about the potential benefit of advanced medical interventions in patients near the end of their lives.[7] During the brief and time-pressured ED encounter, it is often difficult to discern which treatments are not beneficial, especially for seriously ill older adults.[8,9] EPs wish to provide value-concordant care[10] but do not feel adequately trained to discuss goals of care with patients,[11] especially when prognosis is uncertain.[12]

Endotracheal intubation, often performed in this population, was designed to sustain life for patients in acute, reversible respiratory failure.[13] However, large proportions of seriously ill older adults suffer poor outcomes such as death on a ventilator or chronic severe debility.[14-16] Patients and caregivers providing consent in the acute setting are not well informed about the potential harm of this procedure and subsequent critical care since EPs themselves do not possess accurate prognostic information at the time of intubation. Patient-oriented decision aids have been used in the ED for a variety of conditions to facilitate shared decision-making with patients,[17] yet none is available to help older adults near the end of life decide whether or not to be intubated or continue mechanical ventilation that was initiated prior to ED arrival.

We sought to understand factors associated with in-hospital mortality of older adults receiving non-traumatic ED intubation. Our objective was to create an index to predict in-hospital mortality in older adults intubated in the ED for indications other than trauma. By creating an index to predict in-hospital mortality, we hope to provide EPs with the necessary prognostic information to conduct a high quality, shared decision-making discussion with patients and/or their caregivers about whether or not to undergo ED intubation or continue mechanical ventilation that was already started prior to ED arrival.

Population Health Research Capsule

What do we already know about this issue?
Emergency physicians (EP) intuitively understand the potential harm of ED intubation for older adults, but we are unable to accurately predict the in-hospital mortality for shared decision-making.

What was the research question?
Can we develop an index to risk stratify older adults for short-term mortality with the information available before intubation?

What was the major finding of the study?
We developed an index to risk stratify older adults that correctly sorts those who die from those who lived 62% of the time.

How does this improve population health?
EPs can use this information to paint the picture of potential harm of ED intubation for older adults to aid in the shared decision-making process.

METHODS

Study Design and Setting

This is a retrospective cohort study using patient-level administrative data from Vizient Clinical Data Base/Resource Manager™ (CDB/RM™). We obtained de-identified data regarding hospitalization after ED intubations. Vizient (formerly known as the University HealthSystem Consortium) is a consortium of more than 117 principal members (academic medical centers) and more than 300 affiliate hospitals across the United States, representing 95% of the nation's non-profit academic medical centers. Nearly 300 of these hospitals participate in the CDB/RM™, comprised of patient-level administrative data. The mission of Vizient is to allow participating institutions to use the consortium data to accelerate organizational clinical performance.[18] Data include patient demographics (age, sex, race, ethnicity), type of admission (elective, urgent, or emergent), procedure codes, diagnosis codes, length of stay and in-hospital mortality. Participating institutions submit all patient data monthly, and Vizient reviews each data submission for quality. Diagnoses were coded using the *International Classification of Diseases, Ninth Revision, Clinical Modifications (ICD-9-CM)*.[19] There is no funding source or sponsors in this study. Our institutional review board. approved this study.

Cohort Selection

We included adults aged ≥75 years who underwent ED intubation at a CDB/RM™ participating site and had a subsequent ED-originated hospital admission between

January 1, 2008, and December 31, 2015. We excluded older adults with trauma as their admission diagnosis and those with out-of-hospital cardiac arrest or intubation.

Study Sample

We identified 22,374 individual patient records from CDB/RM™ that met our study criteria. We used Stata's runiform command to randomly select one half of the records to be in the development cohort (n=10,789). We tested the reproducibility and calibration of our model with the remaining one half of the records, the validation cohort (n=11,585).

Outcome

Our primary outcome of interest was in-hospital death during the index hospitalization.

Factors of Interest

We considered four classes of variables available in CDB/RM™ as potential predictors of in-hospital mortality after ED intubation. We were interested in variables that would be available to EPs at the time of decision-making about intubation, as well as those that are available in CDB/RM™, including the following: patient demographics (sex, race, and age [categorized as: 75-79, 80-84, 85-89, and ≥90]; co-morbidity present on admission; origin of ED arrival (home, nursing home, hospice, other hospitals); and admission diagnosis determined by the EP. Using a Stata macro designed by Stagg et al,[20] we used 13 co-morbidities included in the Charlson comorbidity index for our present-on-admission condition: history of myocardial infarction (MI); congestive heart failure (CHF); peripheral vascular disease (PVD); cerebrovascular disease (CVD); dementia; chronic obstructive lung disease (COPD); connective tissue disease (CTD); diabetes (DM); moderate-to-severe chronic kidney disease (CKD); hemiplegia/paraplegia; moderate-to-severe liver disease (LD); cancer (CA); and AIDS.[20] We considered the location from which patients came to the ED as a predictor in our model because in prior studies older adults arriving to the ED from locations other than their home have been shown to be at higher risk of death.[21]

We considered seven admission diagnoses using the *ICD-9 CM codes*: sepsis (*ICD-9-CM* codes 038* 995.9* 785.52); gastrointestinal (GI) bleed (*ICD-9-CM* codes 578*); CHF (*ICD-9-CM* codes 428*); pneumonia (PNA) (*ICD-9-CM* codes 507* 481* 482* 483* 485* 486*); respiratory failure (*ICD-9*-CM codes 518* 786* 491*); altered mental status/seizure (*ICD-9-CM* codes 780*); and cerebrovascular accident/intracranial hemorrhage (CVA/ICH) (*ICD-9-CM* codes 430* 431* 432* 433* 434* 436* 437*). These admission diagnoses were chosen based on the top seven diagnoses by frequency in our cohort. We chose *ICD-9-CM* codes to define each of these conditions based on codes used in past studies.[22,23] We grouped conditions based on our clinical judgment (e.g., combining chronic bronchitis and symptoms involving respiratory system). Admission diagnoses are typically determined by the clinician's best assessment at the time of admission and may not be the final diagnoses of the hospitalization. We chose to include them despite this limitation because some are clinically highly correlated to such patients' mortality (e.g., devastating CVA), and even if our index could not be used prior to intubation such information will still be helpful in discussions between clinicians and caregivers to decide whether to continue the aggressive medical interventions. We chose not to include socioeconomic variables (e.g., income, insurance status) in the development of our model since such variables may not be readily available to the clinician prior to ED intubation.

Statistical Analysis

We used multivariable logistic regression using the least absolute shrinkage and selection operator (LASSO) method [24] to develop our model. This model selection technique is attractive for prognostic model building because of its ability to shrink large regression coefficients to reduce overfitting (by forcing less important variable coefficients to zero); it then automatically performs variable selection with fewer predictor variables. It has been considered by some to be superior to conventional methods (e.g. stepwise selection).[25] To improve the clinical utility of the final model, we chose to remove variables not significantly predictive of (change in AUC>0.0035) or associated with ($p<0.05$) in-hospital mortality after ED intubation. We used Stata version 14.1 (StataCorp, Texas, U.S.A.) with a LASSO macro designed by Mander.[26]

To determine an individual's mortality risk, we developed a point-based risk scoring system using methods similar to other studies.[27] Points were assigned to each risk factor in the final model by dividing each beta coefficient by the lowest beta coefficient in the final multivariable model and then rounding to the nearest tenth decimal point. We then assigned a risk score to each individual in the development and validation cohorts by summing the points for each risk factor present for that individual. We stratified the scores into three risk groups similar to prior studies[28,29] and based on our clinical judgment: low-(<6 points, 31% mortality), medium-(6 to 10 points, 40% mortality), and high-risk groups (>10 points, 58% mortality) for each cohort, and we calculated in-hospital mortality.

We assessed model calibration by examining the relationship between the expected and observed mortality for the high-risk group since we were most interested in correctly identifying the highest risk group, which is critical information to be communicated to the patient and/or their surrogates (e.g. futility of care). We tested model calibration (the ability of the model's estimated risk to agree with actual outcomes within groups of subjects in similar predicted risk) with Hosmer-Lemeshow goodness-of-fit test using quintile of risk

stratification. We used quintile of in-hospital mortality risk (calculated the risk of death and categorized the patients into five equal groups based on their risk of death) to highlight the low- and high-risk groups. We chose to use quintiles of risk based on the distribution of risk within our cohort and prior similar study.[27] To assess calibration, we used "lfit" post-estimation command after regression modeling on Stata version 14.1 (StataCorp, Texas, U.S.A.) to compare the "expected" number of in-hospital deaths based on our model's estimates to the "observed" number in our cohort. We assessed these comparisons within quintiles of in-hospital mortality risks (Table 3). To assess model discrimination (the ability of the model to correctly identify those who died from those who survived) we calculated a c-statistic.

RESULTS

Of the 10,789 participants in the development cohort, 46% were male and 65% were non-Hispanic White. Overall 49% had a CCI ≥3, and 40% of participants died during the index hospitalization. The characteristics of the development and validation cohorts were similar (Table 1).

The model included one demographic variable (age group), three co-morbidity variables (MI, CVD, and metastatic CA), and two admission diagnosis variables (sepsis and stroke/intracranial hemorrhage). All variables that did not meet predictive significance (change in AUC>0.0035) or statistical significance ($p<0.05$) were removed during the model-building process, including the ED arrival location and some of the CCI variables. Table 2 depicts the adjusted odds ratio for in-hospital mortality from the model and the points assigned to each factor.

Our model correctly sorted patients who died from patients who lived 62% of the time in both derivation and validation cohorts (c-statistic of 0.62). Further, our model demonstrated excellent calibration (Hosmer-Lemeshow chi-square = 6.47 / $p=0.09$) with virtually identical mortality rates in the development and validation cohorts for all predicted risk groups (Table 3). Of the 1,106 participants predicted to die in the highest risk quintile of validation cohort, 1,096 participants actually died (>99.1%). In-hospital mortality ranged from 30% in the lowest-risk quintile to 57% in the highest-risk quintile in the development cohort and from 30% in the lowest-risk quintile to 57% in the highest-risk quintile in the validation cohort.

DISCUSSION

By using CDB/RM™, we developed and validated an index to predict in-hospital mortality for U.S. adults ≥75 years receiving non-traumatic ED intubation. Our rule demonstrated excellent calibration with minimal under-/over-estimation of risk within our cohort for the highest risk score group (926 expected death and 910 observed death, <3% difference) and fair predictive ability (correctly sorted patients who died from patients who lived 62% of the time) as demonstrated by increasing risk of in-hospital mortality by point score. Older adults in the highest risk group (>10 points) had 58% (range 56-84%) probability of in-hospital mortality. After validation in the clinical settings, our simple index may be a valuable tool for EPs to identify older adults at high risk of in-hospital mortality after an ED intubation.

ED intubation for older adults is a life-changing event. The most common reasons for acute respiratory failure in older adults are CHF (43%), PNA (35%), and COPD (32%),[30] and they are associated with high in-hospital mortality (>20%,[31] 53%,[32] and 40%[33] respectively.). Among the survivors, as many as 13% will require prolonged mechanical ventilation (defined by ≥21 days for ≥6 hours per day).[34] In older adults, 35% will never meet the criteria for weaning from the ventilator at this stage and have 65% probability of dying in the long-term care facility, with median survival ranging from 2.1 to 4.4 months.[35] Even if successfully weaned from the ventilator, 40% will sustain severe functional disability after the hospital discharge unless the baseline functional status is completely normal.[36] The degree of potential harm from continuing critical care after ED intubation is clearly not well communicated to older adults since 74% of older adults would not choose treatment if the burden of treatment were high and the anticipated survival were to come with severe functional impairment.[37] Further, >50% of older adults consider "rely[ing] on a breathing machine to live" worse than death.[3]

The first step to informing older adults about the potential harm of ED intubation and subsequent critical care is discussing the probability of in-hospital mortality. Our hope is that this index will allow EPs to accurately describe to older adults and their caregivers the potential for harm. With the prediction of in-hospital mortality, EPs can better facilitate the shared decision-making process to provide care concordant with patient/caregiver's goals. It may help older adults unlikely to benefit from ED intubation and ongoing critical care to avoid medical treatment that is not going to prolong their lives and instead may jeopardize their chance of a peaceful death.

Despite seeing many critically ill seniors, EPs often face prognostic uncertainty when providing care to seriously ill older adults. There is also a great deal of uncertainty concerning which medical procedures are likely to help these seriously ill elders versus those that are only going to cause harm.[38] Previous studies suggested the grim prognosis (30.2% in-hospital mortality for non-traumatic patients with average age of 65) of older adults intubated in the ED,[16] but the information to risk stratify them based on available information was limited. To our knowledge, this investigation provides the first evidence to inform the probability of in-hospital mortality in older adults intubated in the ED for indications other than trauma. We carefully selected each

Table 1. Demographic and potential predictors of the development and validation cohorts and unadjusted mortality odds ratios in a study assessing the feasibility of creating an index to risk stratify older adults for in-hospital mortality after intubation.

	Development cohort (n =10,789)		Validation cohort (n = 11,585)	
Category	Weighted %	Unadjusted OR (95% CI)	Weighted %	Unadjusted OR (95% CI)
Age				
75 - 79 Years	34%	Reference	34%	Reference
80 - 84 Years	31%	1.28 (1.16-1.41)	30%	1.32 (1.20-1.45)
85 - 89 Years	23%	1.48 (1.33-1.64)	23%	1.44 (1.30-1.59)
>= 90 Years	12%	1.74 (1.54-1.98)	13%	2.05 (1.81-2.31)
Sex				
Men	46%	Reference	45%	Reference
Women	54%	1.01 (0.94-1.10)	51%	0.99 (0.92-1.07)
Race				
White	65%	Reference	66%	Reference
Black	21%	0.71 (0.65-0.79)	22%	0.81 (0.70-0.92)
Others	14%	1.00 (0.92-1.08)	12%	1.06 (0.96-1.18)
Comorbid conditions				
History of myocardial infarction	14%	1.19 (1.07-1.32)	14%	1.26 (1.14-1.40)
Congestive heart failure	42%	0.71 (0.65-0.77)	42%	0.69 (0.64-0.74)
Peripheral vascular disease	10%	1.15 (1.01-1.32)	10%	1.23 (1.09-1.40)
Dementia	3%	0.71 (0.55-0.90)	3%	0.72 (0.57-0.91)
Cerebrovascular accident	21%	1.80 (1.64-1.97)	22%	1.77 (1.62-1.93)
Chronic obstructive lung disease	33%	0.63 (0.58-0.68)	33%	0.65 (0.60-0.70)
Connective tissue disease	3%	1.00 (0.79-1.27)	3%	1.18 (0.95-1.45)
Diabetes	34%	0.85 (0.78-0.92)	33%	0.82 (0.75-0.88)
Chronic kidney disease	31%	0.88 (0.81-0.96)	30%	0.86 (0.79-0.94)
Hemiplegia / paraplegia	6%	1.21 (1.10-1.34)	6%	1.31 (1.14-1.51)
Moderate liver disease	1%	1.68 (1.15-2.45)	1%	1.49 (1.04-2.14)
Metastatic cancer	4%	2.10 (1.68-2.55)	3%	1.71 (1.40-2.10)
Origin of ED arrival				
Home	75%	Reference	74%	Reference
Nursing home	7%	0.94 (0.84-1.05)	7%	0.84 (0.72-1.44)
Hospice	0.02%	0.92 (0.17-5.09)	0.03%	6.18 (0.63-60.53)
Other hospitals	24%	1.10 (0.87-1.40)	24%	1.12 (1.03-1.22)
Admitting diagnosis				
Sepsis	11%	1.38 (1.21-1.56)	11%	1.41 (1.25-1.60)
Gastrointestinal bleed	1%	1.15 (0.91-1.44)	1%	0.83 (0.58-1.18)
Congestive heart failure	1%	0.78 (0.55-1.10)	2%	0.52 (0.36-0.74)
Pneumonia	4%	0.83 (0.71-0.97)	3%	1.08 (0.88-1.33)
Respiratory failure	31%	0.56 (0.52-0.59)	32%	0.52 (0.48-0.57)
Altered mental status	15%	0.72 (0.67-0.78)	15%	0.71 (0.64-0.79)
Cerebrovascular accident / intracranial hemorrhage	10%	2.4 (2.17-2.58)	10%	2.34 (2.05-2.66)

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

Table 2. Adjusted beta coefficients / odds ratios and points assigned to each risk factor for older adults intubated in the emergency department.

Risk factor	Beta coefficient (95% CI)	Odds ratio (95% CI)	Points
Co-morbid condition			
Myocardial infarction	0.284 (0.162-0.105)	1.33 (1.18 - 1.50)	1.2
Cerebral vascular disease	0.33 (0.20 - 0.462)	1.40 (1.22 - 1.59)	1.4
Metastatic cancer	0.923 (0.691-1.155)	2.52 (2.00 - 3.18)	4
Age			
75 - 79 Years	Reference	Reference	0
80 - 84 Years	0.23 (0.122 - 0.338)	1.26 (1.13 - 1.4)	1
85 - 89 Years	0.4 (0.280 - 0.511)	1.48 (1.32 - 1.67)	1.7
≥90 Years	0.6 (0.456 - 0.737)	1.82 (1.59 - 2.10)	2.6
Admission diagnosis			
Sepsis	0.441 (0.309 - 0.572)	1.55 (1.36 - 1.77)	1.9
Stroke / intracranial hemorrhage	0.723 (0.547-0.899)	2.10 (1.73 - 2.46)	3.1
Total possible points			12.3

CI, confidence interval.

Table 3. In-hospital mortality in the development and validation cohorts.

	Development		Validation		Death	
Quintile of risk	n	Mortality (range)	N	Mortality (range)	Observed	Expected
1	3175	30% (28 – 33%)	3484	30% (28 – 33%)	1014	1056
2	619	35% (34 – 35%)	626	35% (34 – 35%)	236	217
3	1919	38% (37 – 41%)	2096	38% (37 – 41%)	785	793
4	1619	43% (42 – 47%)	1729	43% (41 – 47%)	771	749
5	1833	57% (48 - 81%)	1958	57% (48 -84%)	1096	1106
Point score						
Low (<6)	3175	31% (23 - 33%)	3484	31% (28 - 33%)	1014	1055
Medium (6-10)	4489	40% (38 - 55%)	4817	40% (40 - 55%)	2492	2456
High (>10)	1501	59% (51 - 81%)	1592	58% (56 - 84%)	910	926

potential predictor based on the type of information likely to be available before the decision to intubate.

Although we demonstrated that our index is likely to identify high-risk patients (58% of in-hospital mortality in the highest risk group), the threshold of futile intervention will vary for different patients. Thus, some older adults or clinicians may require a much higher level of certainty in risk (>99% risk of in-hospital mortality) in order to refrain from ED intubation and ongoing critical care – a medical procedure developed to help patients avoid death. Therefore, once our index is externally validated, an effort should be made to shape how this evidence is presented to the patients and their caregivers. Now that we have an index to accurately identify high-risk patients, the most effective method to communicate this information must be investigated to enhance the shared decision-making process.[39]

LIMITATIONS

Our investigation has notable limitations. First, our index was developed using administrative data, which are subject to standard limitations including accuracy of data received (e.g., dementia is under-diagnosed) and limited clinical information (e.g. physiological measurements and laboratory data).[40,41] Since some clinical parameters such as pre-ED frailty can be a strong predictor of mortality after critical illness,[42] the lack of such information in our database posed a major limitation. Second, we were unable to include the individuals for whom intubation was

considered but not performed in this cohort because such individuals could not be identified using our database. Although they are not included, these individuals likely have much higher mortality and are beyond the scope of our study.

Third, we were unable to include pre-existing do-not-resuscitate orders or caregiver's stated preferences of the patient in the ED as part of our index due to our administrative data source. Fourth, we were unable to assess whether our index performs comparatively to the clinician's overall clinical assessment (i.e., clinician gestalt) due to our data source limitation. Fifth, the hospitals that participate in Vizient CDB/RM™ are disproportionally academic and may not be representative of all U.S. hospitals. Sixth, the index has yet to be validated in a clinical setting. Seventh, we were unable to exclude patients who had surgery during the index hospitalization. Such a subpopulation may have had a higher mortality at baseline compared to all others within our cohort. Finally, the difference in predicted mortality from 31% in low-risk patients to 58% in high-risk patients may or may not alter an EP's decision to intubate. Rather, we hope that such information is useful for EPs to facilitate the shared decision-making discussions with the patients and caregivers.

CONCLUSION

In summary, we have developed an index to predict in-hospital mortality in older adults intubated in the ED for indications other than trauma. Patients with a score >10 had a 58% (range 56-83%) probability of in-hospital mortality. This index can provide useful information for EPs to discuss the potential harm/benefit of ED intubation and continuing mechanical ventilation with older adults and their caregivers to provide care concordant with their values and preferences.

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A User's Guide to the *ALiEM Emergency Medicine Match Advice* Web Series

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ALiEM EM Match Advice is a web series hosted on the Academic Life in Emergency Medicine website. The intended audience includes senior medical students seeking a residency in emergency medicine (EM) and the faculty members who advise them. Each episode features a panel of three EM program directors who discuss a critical step in the residency application process. This article serves as a user's guide to the series, including a timeline for viewing each episode, brief summaries of the panel discussions, and reflection questions for discussion between students and their faculty advisors. [West J Emerg Med. 2017;18(4)698-704.]

INTRODUCTION

Emergency medicine (EM) is a competitive specialty. The National Residency Matching Program® (NRMP) offered 1,895 positions in EM in the 2016 Main Residency Match® (the Match), with a fill rate of 99.9% overall and 78.4% by allopathic U.S. senior medical students.[1] The residency application process is a stressful time for medical students who must make difficult decisions about selecting away rotations, submitting applications, scheduling interviews, and creating a rank order list. Medical students access a variety of sources of information for advice about the Match process. In addition to their faculty advisors, students consult anonymous online blog sites, near-peers, and each other – all sources with variable expertise and information quality.

In 2014 Academic Life in Emergency Medicine (ALiEM) launched *EM Match Advice*, a video-based web series designed to assist senior medical students in their preparation for the Match process in EM. Each episode features a discussion of an important aspect of the Match by a panel of three EM program directors (PD). Episodes are recorded using Google Hangout on Air® and archived on YouTube™. These have since been converted to podcasts offered on SoundCloud™. A different panel of PDs is invited for each recording to present diverse opinions that reflect the variety of training opportunities available to EM-bound students across the country. To date, there are 12 episodes in the series with contributions by 36 current or recent EM PDs.

This article will briefly review the content of each episode of *ALiEM EM Match Advice* in the form of a user's guide for students and EM faculty advisors who may freely access this web series online.

EPISODE SUMMARIES

1. Is Emergency Medicine Right for You?

URL: https://www.aliem.com/2016/em-match-advice-emergency-medicine-right/
Publication Date: September 7, 2016
Panelists: Larissa Velez (University of Texas Southwestern), Brian Levine (Christiana Care), Michele Dorfsman (University of Pittsburgh)

Summary

The panelists reflect on their experiences practicing EM, highlighting the key characteristics of emergency physicians (EP), the best parts of the profession, and the challenges to be expected of a career in EM.

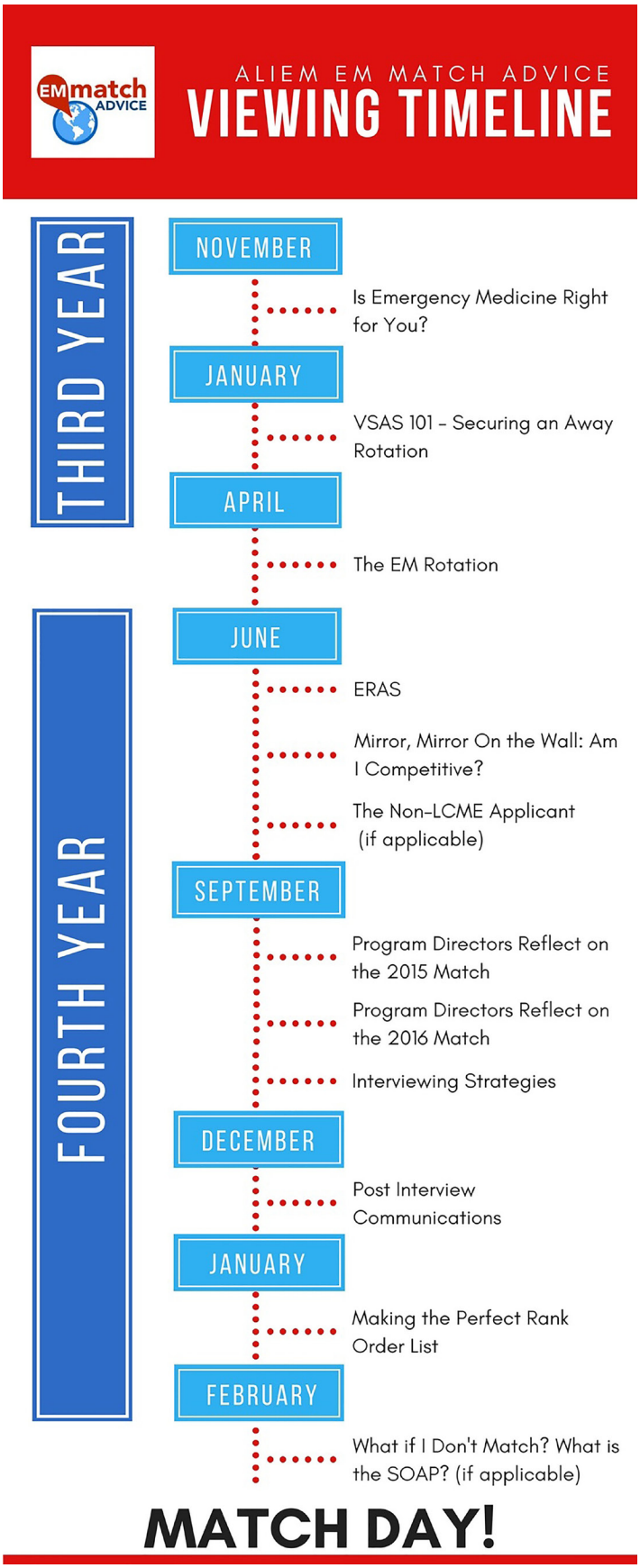

Figure. *ALiEM EM Match Advice* viewing timeline.

EPs tend to have broad clinical interests and often enjoy most core clinical rotations as medical students. They are team-oriented, like variety in their practice, prefer being busy while at work, are comfortable making quick decisions with limited information, and gain satisfaction from brief, intense relationships with patients. Highlights of the profession include caring for patients of all ages, socioeconomic groups and cultural backgrounds and acquiring expertise in resuscitation, acute care, and life-sustaining procedures.

Students should be cautioned that a career in EM is not simply an easy lifestyle choice. High-intensity shifts can be exhausting, and burnout is real. Switching between day and night shifts is physically challenging. EM is not "all action" and students should anticipate that resuscitations comprise only a small percentage of the cases on an average shift.

Reflection Questions

- Which tasks do I look forward to performing while at work?
- Am I uncomfortable with uncertainty?
- How do I deal with interruptions and task-switching?

2. VSAS 101: Securing an Away EM Rotation

URL: https://www.aliem.com/2015/em-match-advice-vsas-101/
Publication Date: May 22, 2015
Panelists: Susan Stroud (University of Utah), Cullen Hegarty (Regions Medical Center/HealthPartners), Scott Sherman (Stroger/Cook County Hospital)

Summary

The panelists discuss the process of securing EM away rotations using the AAMC Visiting Student Application Service® (VSAS). Rotating at a program away from one's home institution is a valuable experience that can provide exposure to a different style of EM and may even strengthen a student's residency application. In addition, many residency programs expect to review grades and evaluations from an applicant's home and away EM rotations prior to extending them an interview invitation.

In this episode, the panelists describe the key elements of a VSAS application, including additional or supplemental application materials that may be requested. Logistics such as application fees and timelines are reviewed. Students should work with their advisors and EM clerkship directors when preparing their VSAS application and should be as flexible as possible when selecting schools and rotation dates in VSAS.

Some schools do not participate in VSAS and must be contacted directly. It is very difficult for students at medical schools outside the U.S. to obtain away rotations in EM; international students should focus their applications on schools that partner with their own medical school, if such partnerships exist.

Reflection Questions
- Will an away rotation in EM strengthen my application? How many away rotations should I do?
- How can I use my EM away rotation(s) to help me decide which type of residency program is right for me?
- How should I schedule the clerkships in my fourth year of medical school?

3. The EM Rotation
URL: https://www.aliem.com/2014/em-match-advice-em-rotation-eras-competitive/
Publication Date: August 20, 2014
Panelists: Lainie Yarris (Oregon Health and Sciences University), Maria Moreira (Denver Health), Jan Shoenberger (LAC-USC)

Summary

In this episode, panelists describe the honors-level performance on the EM rotation. Students should strive to function like an intern by being self-directed, taking ownership of their patients, and anticipating the needs of their team. It is important to maintain a friendly, humble, upbeat, and professional demeanor. Students should understand the criteria on which they are being graded, and should keep in mind that they are being assessed at all times during the rotation.

Reflection Questions
- What does it mean to "function like an intern?"
- What does it mean to "pass the 3AM test?"
- How can I balance being professional and likeable?

4. ERAS: Electronic Residency Application Service
URL: https://www.aliem.com/2014/em-match-advice-em-rotation-eras-competitive/
Publication Date: August 20, 2014
Panelists: Gene Hern (Alameda County - Highland), Laura Hopson (University of Michigan), Joshua Broder (Duke University)

Summary

The panelists discuss key considerations for completing the residency application.

Standardized letters of evaluation (SLOEs) for EM, EM rotation grades, and the Medical Student Performance Evaluation (MSPE) tend to be of highest importance to programs when selecting which students to interview, while the personal statement is generally less important.[2-4]

The application should craft a narrative about the student and demonstrate a high attention to detail. Address any file irregularities or potential red flags carefully and in consultation with a trusted and experienced advisor.[5] During interviews, applicants should be prepared to discuss any item that was included on their application.

Reflection Questions
- What narrative does my application tell?
- What are the weaknesses of my file, and how can I address these in my application?
- What details of my application are interviewers most likely to ask about?

5. Mirror, Mirror on the Wall: Am I Competitive?
URL: https://www.aliem.com/2014/em-match-advice-em-rotation-eras-competitive/
Publication Date: August 20, 2014
Panelists: Andrew Perron (Maine Medical Center), Madonna Fernandez-Frackelton (Harbor-UCLA), Kevin Biese (University of North Carolina, Chapel Hill)

Summary

In this episode, panelists discuss the importance of accurately assessing a student's application in order to help them apply to an appropriate number and mix of residency programs. Students should seek feedback on their competitiveness from a reliable source such as the residency PD, clerkship director, or a trusted advisor in EM who has knowledge about the Match process. Peers and near-peers do not have the expertise to accurately assess an applicant's competitiveness.

The number of residency program applications recommended for a given student depends on the overall competitiveness of their file, any geographic preferences for training, and participation in the Match paired with another applicant (i.e., "Couples Match"). Most applicants should consider applying to approximately 30 programs; highly competitive applicants should apply to fewer programs, and less competitive applicants or those in the Couples Match may need to apply to more programs.[1,6-8]

Reflection Questions
- What are the strengths of my application? Which programs are likely to value those strengths most?
- Based on my overall competitiveness, to how many programs should I apply?

6. The Non-LCME Applicant
URL: https://www.aliem.com/2015/em-match-advice-series-the-non-lcme-applicant/
Publication Date: September 16, 2015
Panelists: Merle Carter (Einstein Healthcare), Doug Finefrock (Hackensack University Medical Center), Damon Kuehl (Virginia Tech Carilion)

Summary

This episode highlights the special considerations of "non-LCME applicants" entering the allopathic EM Match. The non-LCME applicant is defined as any candidate not in their final year of training at an LCME-accredited medical school in the

U.S., Puerto Rico, or Canada.[9] The episode is divided into segments that address the specific considerations of osteopathic applicants, international applicants, and military applicants, and offers pearls and pitfalls for each.

Approximately 20% of EM positions available in the Match are filled by non-LCME applicants. One key recommendation for the non-LCME applicant is to "make your application look like that of an LCME applicant": take the USMLE examinations, seek away EM rotations at hospitals with allopathic EM residency programs, and attempt to obtain letters of recommendation written in the SLOE format.

Reflection Questions

- For osteopathic students: Will I apply to the allopathic match, osteopathic match, or both?
- As a non-traditional applicant, how can I highlight my unique characteristics and life experiences?
- How do I identify programs that regularly match non-LCME applicants?

7. Program Directors Reflect on the 2015 Match

URL: https://www.aliem.com/2015/em-match-advice-reflections-from-the-2015-em-residency-match/
Publication Date: June 27, 2015
Panelists: Francis DeRoos (University of Pennsylvania), Megan Boysen Osborn (University of California, Irvine), Jason Wagner (Washington University in St. Louis)

Summary

In the 2015 Match, EM had a 79% fill rate by LCME seniors and very few positions available through the NRMP SOAP® (Supplemental Offer and Acceptance Program), making EM a moderately competitive specialty.[10] Panelists in this episode discuss their impressions of the 2015 EM Match.

One emerging trend has been an increase in the number of applications per applicant.[10] Applicants should consult with their EM advisor for a recommendation on the appropriate number of applications to submit. Avoid over-applying and over-interviewing; these approaches are costly and do both applicants and programs a disservice. Students should cancel scheduled interviews early if they are no longer interested in interviewing at a program in order to release these spots for other applicants.

Reflection Questions

- How competitive is my file?
- How many applications should I submit?

8. Program Directors Reflect on the 2016 Match

URL: https://www.aliem.com/2016/em-match-advice-reflect-2016/
Publication Date: July 10, 2016
Panelists: Michael Bond (University of Maryland), Christopher Doty (University of Kentucky), Diane Rimple (University of New Mexico)

Summary

Panelists discuss the 2016 EM Match and offer advice to future applicants. One continuing trend in 2016 is an increase in the number of applications per applicant; as in the previous episode, "Program Directors Reflect on the 2015 EM Match," the panel emphasizes that applicants should refer to an EM advisor for a recommendation on the correct number of applications to submit based on their competitiveness.[1] Panelists emphasize that there is no objective, meaningful ranking of EM residency programs endorsed in our specialty; applicants must create their own customized list of highly desirable programs based on what attributes they personally value.

Reflection Questions

- What do I value most in a potential residency program?
- From which faculty members should I request letters of recommendation?

9. Interviewing Strategies

URL: https://www.aliem.com/2014/em-match-advice-interviewing-strategies/
Publication Date: August 29, 2014
Panelists: Christine Babcock (University of Chicago), Linda Regan (Johns Hopkins University), Philip Shayne (Emory University)

Summary

The panelists discuss interview scheduling, preparation for the interview day, and specific dos and don'ts of the interview trail.[11-13] Interviews should be scheduled as soon as possible after receiving an invitation. Based on NRMP data, applicants should aim for a goal of 10-14 interviews to maximize the probability of matching. More interviews may be necessary for a less competitive applicant or for the Couples Match.[14]

On interview day, applicants should be prepared to discuss their strengths and weaknesses, their reasons for pursuing EM, why they have chosen to interview at a particular residency program, and how they have dealt with situations that presented challenges or conflict. Applicants should come prepared with questions tailored to each type of interviewer; for example, ask resident interviewers questions about faculty teaching and ask the program director "big picture" questions about the program's mission or future.

Do: act professionally in all interactions and situations, be engaged, have thoughtful questions for interviewers, and take notes after your interview day. Do not: cancel an interview with less than two weeks notice, speak negatively about other programs, or feel obligated to answer a Match-illegal or inappropriate question such as marital status or family planning.[15]

Reflection Questions

- How will I prepare for each interview day?
- How should I respond to an illegal or inappropriate interview question?

- What questions will I ask a junior resident? A senior resident? A faculty member? The program director? The department chair?

10. Post Interview Communications
URL: https://www.aliem.com/2014/em-match-advice-post-interview-communications/
Publication Date: November 15, 2014
Panelists: James Colletti (Mayo Clinic), Jessica Smith (Brown University), Jeff Schneider (Boston Medical Center)

Summary

The panelists discuss the etiquette of post-interview communication between applicants and programs. Programs must adhere to the NRMP Code of Conduct, which stipulates that post-interview communication to applicants must not be disingenuous or coercive.[16-18] Likewise, it is essential for the applicant to protect and nurture their professional identity by ensuring that all communications with programs are courteous, polite and honest.

The panelists agreed that, although not all programs will be expecting it, it is generally a good idea to write genuine, content-specific thank you notes or e-mails to the PD and coordinator(s) from each program. It is appropriate for an applicant to reach out after their interview to obtain more information from the PD, faculty or residents; this type of post-interview communication is encouraged and likely has no effect on rank list position.[19, 20] Similarly, returning to a program for a "second look" visit may be arranged through the program coordinator but is unlikely to have any effect on the candidate's position on the rank list. Avoid inundating the PD or other program representatives with excessive e-mail correspondence.

Panelists agree that it is generally unnecessary to inform programs of how highly they will be ranked on an applicant's rank order list, though it may be advantageous to share such information with a student's number one choice. Such statements should only be made honestly; EM is a small community and integrity is vital to an applicant's professional identity and future success.

Reflection Questions

- How will I communicate with programs after interview day?
- How can I develop and protect my professional identity?
- Should I return to a program for a second look?

11. Making the Perfect Rank Order List
URL: https://www.aliem.com/2014/em-match-advice-making-perfect-rank-order-list/
Publication Date: October 7, 2014
Panelists: Colleen Roche (George Washington University), Jonathan Davis (Georgetown University), Brian Stettler (University of Cincinnati)

Summary

The panelists discuss important considerations for creating a rank order list, including how the Match algorithm works and an approach to synthesize and prioritize the information obtained on interview day.

The Match algorithm favors the applicant. There is no way to "game" the system, so the best way for an applicant to structure the rank order list is to place programs in exact order of preference.[21]

It is easy to be overwhelmed by specific program details on interview day.[22] Focus instead on the program's "3 Ps:" its overarching philosophy, passion, and people. Applicants should ask themselves: Will this program inspire me to come to work? Will my career goals be supported? Which interview day excited or inspired me the most?

Although geography is an important consideration, avoid compromising the right fit and best educational experience for geography alone.[23-25] Imagine opening the envelope on Match day: which program name is most exciting to see on the paper inside?

Reflection Questions

- What are my career goals? Which program or programs will support these goals?
- What are the program attributes that are most important to me?

12. What if I Don't Match? What Is the SOAP?
URL: https://www.aliem.com/2016/em-match-advice-what-if-i-dont-match-what-is-the-soap/
Publication Date: January 17, 2016
Panelists: Daniel Egan (Mt. Sinai St. Luke's-Roosevelt), Tiffany Murano (Rutgers University New Jersey Medical School), Mary Westergaard (University of Wisconsin)

Summary

In this episode, panelists discuss the logistics of the NRMP Supplemental Offer and Acceptance Program® (SOAP) and the options available to an applicant who does not match into an EM residency program. The SOAP is a service of the NRMP that helps place unmatched applicants into unfilled residency slots.[26] Applicants will learn if they matched on the Monday of Match Week, and they should work with their medical school to navigate the SOAP process if unmatched. Unfortunately, very few, if any, EM positions are available through the SOAP.

Students who do not match should reflect on the following questions in consultation with an EM advisor: Was there a deficiency in my ERAS file (poor grades on clinical rotations, negative comments on letters of recommendation, low USMLE scores)? Was my list of programs too competitive? Did I apply broadly enough? Did I interview poorly?

Unmatched applicants who want to apply to EM the following year have three immediate options to consider: (1)

extend medical school by one year and reapply during the next Match cycle, (2) spend a year pursuing a graduate degree or a research project rather than entering internship, or (3) enter the SOAP for a preliminary, categorical or transitional year in another specialty. Be sure to address any application deficiencies during this time.

Reflection Questions

- Am I at risk of not matching into EM and why?
- What is my backup plan in the event that I do not match?

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Academic Primer Series: Five Key Papers about Study Designs in Medical Education

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Introduction: A proper understanding of study design is essential to creating successful studies. This is also important when reading or peer reviewing publications. In this article, we aimed to identify and summarize key papers that would be helpful for faculty members interested in learning more about study design in medical education research.

Methods: The online discussions of the 2016-2017 Academic Life in Emergency Medicine Faculty Incubator program included a robust and vigorous discussion about education study design, which highlighted a number of papers on that topic. We augmented this list of papers with further suggestions by expert mentors. Via this process, we created a list of 29 papers in total on the topic of medical education study design. After gathering these papers, our authorship group engaged in a modified Delphi approach to build consensus on the papers that were most valuable for the understanding of proper study design in medical education.

Results: We selected the top five most highly rated papers on the topic domain of study design as determined by our study group. We subsequently summarized these papers with respect to their relevance to junior faculty members and to faculty developers.

Conclusion: This article summarizes five key papers addressing study design in medical education with discussions and applications for junior faculty members and faculty developers. These papers provide a basis upon which junior faculty members might build for developing and analyzing studies. [West J Emerg Med. 2017;18(4)705-712.]

INTRODUCTION

A thorough understanding of study design is essential for creating successful studies.[1] While there are multiple approaches to designing an experiment, one must understand the limitations inherent in each technique, as well as potential biases and challenges that may result from a selected approach. One must be thoughtful and cognizant of this prior to beginning a project, as errors in study design and data collection can severely compromise a study's results. Additionally, it is important to understand these limitations when evaluating a study as a peer reviewer, as well as when applying and interpreting studies for clinical or educational use.

While the Accreditation Council for Graduate Medical Education (ACGME) requires residents to participate in research, the degree of involvement in the process and training can be variable.[2] After completing residency, junior faculty members may start their careers without having had sufficient training or mentorship in study design for medical education.[3,4] They may then struggle to successfully produce high-quality scholarship.

The Faculty Incubator was created by the Academic Life in Emergency Medicine (ALiEM) team to provide early-career educators with a community of practice where they can discuss and debate topics relevant to the 21st century medical educator. To that end, we created a one-month module focused on study design.

This paper is a narrative review that highlights some important literature that may assist junior educators seeking to learn more about study designs in medical education.

METHODS

In the eighth month of the ALiEM Faculty Incubator (October 1-31, 2016), we discussed the topic of study design for medical education. We monitored the proceedings of this group of educators from October 1-31, 2016. Our online discussions involved both junior faculty members and faculty mentors. While discussions occurred, we gathered the titles of papers that were cited, shared, and recommended within our online discussion forum and compiled these into a list. We also asked all of the monthly mentors for additional suggestions on relevant literature.

Once the augmented list was completed, we then conducted a three-round voting process, inspired by the Delphi methodology similar to our previous papers, to build consensus on which papers to feature.[5-8] The first round asked the group to rate the article on a scale of 1 to 7. The second round used the existing, blinded data from round 1 to determine whether the article should be included or not. The final round asked the group to select the top five articles for inclusion, with consensus determined by the top five papers receiving a clear majority of the voting. This was not a traditional Delphi methodology since our selection panel was comprised of both novices (i.e. junior faculty members, participants in the Faculty Incubator) and experts in the field (i.e., experienced clinician educators, all of whom have published >10 peer-reviewed medical education publications, who serve as mentors and facilitators of the ALiEM Faculty Incubator). However, we intentionally used this method to involve both junior and experienced clinician educators to ensure we selected papers that would be of use to a spectrum of educators throughout their careers. There were four novice and four experienced medical educators involved in the analysis. All eight members were emergency medicine specialists. All members participated in all rounds of voting with 100% response rates for all rounds.

RESULTS

Our ALiEM Faculty Incubator discussions in combination with expert recommendations yielded a total of 29 articles. Our approach allowed us to create a rank-ordered listing of all of the papers in order of perceived relevance, from the most to the least relevant. The top five papers were expanded upon below. Our ratings of all 29 papers are listed in the table, along with their full citations.

DISCUSSION

The following is a list of papers that we determined to be of interest and relevance to junior faculty members and faculty developers. The accompanying commentaries explain the relevance of these papers to junior faculty members, while highlighting considerations for senior faculty members when using these publications for faculty development workshops or sessions.

1. Bordage G and Dawson B. Experimental study design and grant writing in eight steps and 28 questions. *Med Educ*. 2003;37(4):376-85.[9]

Summary

Creating a research question, designing a study, and writing a grant proposal are important skills for the physician educator-researcher. This article provides an eight-step, 28-question guide for researchers to follow at the beginning of the design process to ensure that all elements of design have been carefully considered. The guide incorporates the author's prior work, explaining common reasons why manuscripts are accepted or rejected from medical education journals.[10] It examines how to define a relevant research question, study design and appropriate statistics, the importance of sample size and sampling procedure, budget and personnel requirements, and writing grant proposals. While this process is best applied to experimental studies the principles outlined are applicable to a wide array of other research designs.

Relevance to Junior Faculty Members

It can be difficult for a novice researcher to choose an appropriate research question and properly design a study. Using this 28-question approach, this paper may provide guidance to junior faculty members who are planning research studies. By

Table. The complete list of study design literature collected by the authorship team.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Bordage G, Dawson B. Experimental study design and grant writing in eight steps and 28 questions. *Med Educ*. 2003;37(4):376-385.[9]	6.4 (1.1)	87.5%	100%	1
Crites GE, Gaines JK, Cottrell S, et al. Medical education scholarship: An introductory guide: AMEE Guide No. 89. *Med Teach*. 2014;36(8):657-74.[11]	5.5 (0.9)	87.5%	100%	2
Yarris LM, Deiorio NM. Education research: a primer for educators in emergency medicine. *Acad Emerg Med*. 2011;18 Suppl 2:S27-35.[13]	5.6 (1.2)	87.5%	87.5%	3
Ramani S, Mann K. Introducing medical educators to qualitative study design: twelve tips from inception to completion. *Med Teach*. 2016;38(5):456-63.[16]	5.5 (1.4)	75%	75%	4
Tavakol M, Sandars J. Quantitative and qualitative methods in medical education research: AMEE Guide No 90: Part II. *Med Teach*. 2014;36(10):838-48.[17]	5.8 (1.3)	75%	62.5%	5
Dine CJ, Shea JA, Kogan JR. Generating good research questions in health professions education. *Acad Med*. 2016 Oct 4. [Epub ahead of print].[20]	5.6 (1.3)	62.5%	25%	
Tavakol M, Sandars J. Quantitative and qualitative methods in medical education research: AMEE Guide No 90: Part I. *Med Teach*. 2014;36(9):746-56.[18]	5.6 (1.2)	50%	25%	
Artino AR Jr, La Rochelle JS, Dezee KJ, et al. Developing questionnaires for educational research: AMEE Guide No. 87. *Med Teach*. 2014;36(6):463-74.[21]	5.4 (0.9)	62.5%	12.5%	
Watling CJ, Lingard L. Grounded theory in medical education research: AMEE Guide No. 70. *Med Teach*. 2012;34(10):850-61.[22]	5.0 (1.2)	12.5%	12.5%	
Bordage G, Lineberry M, Yudkowsky R. Conceptual frameworks to guide research and development (R&D) in health professions education. *Acad Med*. 2016 Sep 20. [Epub ahead of print].[23]	4.8 (1.0)	25%	12.5%	
O'Brien BC, Ruddick VJ, Young JQ. Generating research questions appropriate for qualitative studies in health professions education. *Acad Med*. 2016 Oct 4. [Epub ahead of print][24]	5.5 (1.2)	25%	0%	
Bordage G. Conceptual frameworks to illuminate and magnify. *Med Educ*. 2009;43(4):312-9.[25]	5.1 (1.5)	25%	0%	
Chen HC, Teherani A. common qualitative methodologies and research designs in health professions education. *Acad Med*. 2016 Sep 20. [Epub ahead of print][26]	5.0 (1.3)	12.5%	0%	
Bhanji F, Cheng A, Frank JR, et al. Education scholarship in emergency medicine part 3: a "how-to" guide. *CJEM*. 2014;16 Suppl 1:S13-8.[27]	4.9 (1.8)	62.5%	0%	
Sharma R, Gordon M, Dharamsi S, et al. Systematic reviews in medical education: a practical approach: AMEE guide 94. *Med Teach*. 2015;37(2):108-24.[28]	4.9 (0.6)	37.5%	0%	
O'Brien BC, Harris IB, Beckman TJ, et al. Standards for reporting qualitative research: a synthesis of recommendations. *Acad Med*. 2014;89(9):1245-51.[29]	4.6 (1.9)	25%	0%	
Sullivan GM, Sargeant J. Qualities of qualitative research: part I. *J Grad Med Educ*. 2011;3(4):449-52.[30]	4.6 (1.2)	25%	0%	
Paradis E. The tools of the qualitative research trade. *Acad Med*. 2016 Sep 20. [Epub ahead of print][31]	4.5 (0.9)	25%	0%	
Artino AR Jr, Durning SJ, Creel AH. AM last page. Reliability and validity in educational measurement. *Acad Med*. 2010;85(9):1545.[32]	4.5 (1.4)	0%	0%	
Sargeant J. Qualitative research part II: participants, analysis, and quality assurance. *J Grad Med Educ*. 2012;4(1):1-3.[33]	4.3 (1.2)	37.5%	0%	

SD, standard deviation.

Table. Continued.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Bergman E, de Feijter J, Frambach J, et al. AM last page: A guide to research paradigms relevant to medical education. *Acad Med*. 2012;87(4):545.[34]	4.3 (1.5)	25%	0%	
Cook DA, Beckman TJ, Bordage G. Quality of reporting of experimental studies in medical education: a systematic review. *Med Educ*. 2007;41(8):737-45.[35]	4.3 (1.5)	12.5%	0%	
Dicicco-Bloom B, Crabtree BF. The qualitative research interview. *Med Educ*. 2006;40(4):314-21.[36]	4.0 (1.1)	0%	0%	
Cook DA, Bordage G, Schmidt HG. Description, justification and clarification: a framework for classifying the purposes of research in medical education. *Med Educ*. 2008;42(2):128-33.[19]	4.0 (1.2)	0%	0%	
Blanchard RD, Artino AR Jr, Visintainer PF. Applying clinical research skills to conduct education research: important recommendations for success. *J Grad Med Educ*. 2014;6(4):619-22.[37]	3.8 (1.7)	0%	0%	
Kuper A, Lingard L, Levinson W. Critically appraising qualitative research. *BMJ*. 2008;337:a1035.[38]	3.6 (1.1)	12.5%	0%	
Phillips AW, Friedman BT, Durning SJ. How to calculate a survey response rate: best practices. *Acad Med*. 2016 Sep 20. [Epub ahead of print][39]	3.1 (0.8)	0%	0%	
Ahmed R, Farooq A, Storie D, et al. Building capacity for education research among clinical educators in the health professions: A BEME (Best Evidence Medical Education) Systematic Review of the outcomes of interventions: BEME Guide No. 34. *Med Teach*. 2016;38(2):123-36.[40]	3.0 (1.4)	12.5%	0%	
Azer SA. The top-cited articles in medical education: a bibliometric analysis. *Acad Med*. 2015;90(8):1147-61.[41]	2.0 (0.8)	0%	0%	

SD, standard deviation.

considering these important design questions, junior faculty may improve the strength of their research, produce more meaningful outcomes, and have better publication success.

Considerations for Faculty Developers

Faculty developers may find this paper to be a valuable resource for junior faculty members as they become more involved in research and grant writing. The list provides a more manageable approach to research, allowing the faculty developer to expand upon this with both experiential examples and further directions. This could also be used as pre-reading for a research course or as a resource for mentees.

2. Crites GE, Gaines JK, Cottrell S, et al. Medical education scholarship: an introductory guide: AMEE Guide No. 89. *Med Teach*. 2014;36(8):657-74.[11]

Summary

Faculty members who wish to advance their careers must produce scholarship. This article provides guidance for planning a scholarly project and advancing one's career. It begins with a brief overview of the different types of scholarship with particular emphasis on the scholarships of discovery and teaching.[12] Next, the authors provide specific advice in the planning of a scholarly project. This advice includes best practices on finding a mentor. Then, the reader is advised to set clear goals with particular guidance provided on how to develop a good research question, as well as a seven-step scholarship plan. The authors recommend the use of educational theories or conceptual frameworks to guide the scholarly plan. The authors also provide advice on which particular research methods to employ, depending on the type of scholarship the reader is attempting to produce. The final steps that the authors recommend are for the reader to determine whether their scholarly project is adequate and, if so, how to present the results of the scholarly project. The authors emphasize throughout the article the importance of understanding one's promotion and tenure requirements at one's institution.

Relevance to Junior Faculty Members

This paper is a must-read for junior faculty members. It provides invaluable advice regarding creation of a scholarly project, as well as general advice for junior faculty members

to help advance their career. There is specific advice on the importance of obtaining a mentor and how to be a good mentee. Most importantly, the paper is well-referenced so that if the reader has further questions regarding a particular topic, finding further information is very easy.

Considerations for Faculty Developers

This paper provides valuable tips for faculty developers on how to be effective mentors, as well as advice to provide mentees on establishing and maintaining successful relationships. Additionally, this can serve as a blueprint for how to advise junior faculty on the creation of scholarly projects, emphasizing the role of the mentor at each step.

3. Yarris LM, Deiorio NM. Education research: a primer for educators in emergency medicine. *Acad Emerg Med*. 2011;18 Suppl 2:S27-35.[13]

Summary

Yarris and Deiorio provide a nice overview of education research for more-novice researchers. They provide a sequential approach to research, beginning with formulating appropriate and testable study questions. They emphasize the importance of performing a thorough literature review and using the *FINER* (feasible, interesting, novel, ethical, and relevant) approach to developing the research question. The authors subsequently provide a brief review of the various study designs, giving equal weight to both quantitative and qualitative approaches. Finally, the authors provide an approach to dissemination, as well as an extensive list of potential journals dedicated to reporting research in medical education. Throughout the paper, the authors provide numerous examples, as well as approaches to overcoming barriers with each step along the research pathway.

Relevance to Junior Faculty Members

This article provides a valuable overview of the research process within medical education for more-novice researchers. Given the importance of selecting appropriate and testable hypotheses, junior faculty may find the sections on question design particularly valuable to ensure that the study concept is feasible and likely to be useful to the broader community. Additionally, the discussion of different approaches to study design can help with understanding limitations and the best approach to testing one's study question. Importantly, this paper discusses both quantitative and qualitative research methodology, explaining the differences between the approaches and how each could be applied to study design. Qualitative research is particularly valuable within medical education research yet is poorly taught in comparison with traditional, clinical research. In the latter portion of the article, the authors provide lists of potential funding sources, as well as outlets for dissemination of medical education scholarship, which can also be invaluable resources for junior faculty.

Considerations for Faculty Developers

Completion of scholarly activity by faculty is the most frequently encountered cause for a cautionary ACGME citation when emergency medicine residency programs undergo reviews.[14] For this reason, it is imperative that faculty focus on the completion of scholarly activity. Despite the teaching inherent in a faculty role, these educators may not be aware that certain products of teaching can be considered scholarship. This paper provides a simple primer that faculty developers may use to guide faculty to begin generating educational scholarship. The primer covers various formats used within educational scholarship. While brief, this overview is valuable for guiding faculty in the beginning phase of their scholarship. The article concludes with a comprehensive list of journals that accept educational scholarship to help faculty disseminate scholarly products. When combined with the work on the scholarship of teaching by Glassick,[15] this article provides a foundation for faculty to get credit for more than simply teaching.

4. Ramani S, Mann K. Introducing medical educators to qualitative study design: twelve tips from inception to completion. *Med Teach*. 2016;38(5):456-63.[16]

Summary

Ramani and Mann provide a focused introduction to qualitative research in medical education. They simplify qualitative research into 12 steps to help guide the novice researcher. Initially, the authors set the groundwork for understanding how qualitative research is relevant to medical education given some of the skepticism about qualitative research. However, medical educators and clinicians are becoming increasingly accepting of qualitative research and the rigor it requires. The authors suggest the following 12 steps: 1) choose a framework (e.g. ethnography, phenomenology, grounded theory, or discourse analysis); 2) understand reflexivity in that the researcher and methods influence the data; 3) understand how to mitigate ethical concerns; 4) know how to sample the population; 5) match the source data to the framework and the intended study outcome; 6) understand how to perform data collection; 7) prepare the data for analysis; 8) analyze the initial data; 9) determine if initial analysis is necessary and resolve internal team thematic conflicts; 10) maintain rigor; 11) report the results; and 12) be aware that specific training in qualitative methods is often necessary.

Relevance to Junior Faculty Members

Understanding how and why to do qualitative research is often a daunting task for the novice researcher who may not have received formal training in these research methods. This article breaks this approach into reasonable steps. As each of the 12 steps requires a more in-depth

understanding than one article can provide, this paper serves as a nice initial framework for understanding qualitative methods. Junior faculty members interested in performing qualitative research are advised to expand upon this, using additional resources including many of the publications cited in this article.

Considerations for Faculty Developers

Qualitative methodology has taken the medical education field by storm in the past decade. Thus, any medical education interest group or journal club will undoubtedly fold qualitative research into their proceedings. Most junior faculty come from biomedical backgrounds, however, and may find these techniques quite foreign. It is therefore incumbent upon faculty development leaders to provide guidance and teaching centered on these types of research methods. Although this paper will not make a new junior faculty member immediately adept at conducting qualitative research, it can provide a structured approach to understand the processes taken by authors of such work. An overview paper like this may make the methods interesting enough to inspire a new faculty member to learn even more about these useful research methods.

5. Tavakol M, Sandars J. Quantitative and qualitative methods in medical education research: AMEE Guide No 90: Part II. *Med Teach*. 2014;36(10):838-48.[17]

Summary

This article is the second publication in a two-part series discussing the application of quantitative and qualitative research methodology in medical education.[17,18] While the first article focused more on the importance and differences between the two approaches,[18] this article provides a thorough overview of the major components of qualitative research.[17] The authors begin by discussing three common forms of qualitative research: phenomenology (the study of events and occurrences), ethnography (the study of specific cultural groups), and grounded theory (the study of viewpoints and shared meanings). Next, they discuss how to select appropriate populations and how sample size differs from the quantitative approach. Finally, the authors discuss measurement and analysis of the data, emphasizing numerous unique and important features to qualitative assessment.

Relevance to Junior Faculty Members

As noted earlier, qualitative methodologies may not be as familiar to researchers as the more traditional quantitative approaches seen in the basic sciences. However, an understanding of qualitative methodologies is very important, as it is particularly relevant within medical education research. Qualitative research provides an opportunity to both discover new theories and to inductively test existing models and theories. This paper provides an overview of the processes involved, as well as how the various components differ from quantitative methods. Readers may find the discussion of sampling, data measurement and analysis particularly valuable as a basis for further reading on the subject, as well as a primer to improve their understanding and critical appraisal when reviewing other qualitative studies.

Considerations for Faculty Developers

Rather than relying on hunches, medical educators must make decisions based on the best available evidence. Tavakol's is the second paper in this series to focus on qualitative methods, highlighting the importance of qualitative methods for consumers of the medical education literature. Faculty members may be less familiar with qualitative methods, since quantitative methods dominate traditional medical education curricula. Qualitative methods facilitate researchers in the "discovery" of medical education theory or in clarifying mechanisms for *why* phenomena occur.[19] Therefore, educators must be adept in this methodology to conduct and to understand studies in medical education. Faculty development for medical educators must include instruction or mentorship in many of the methodologies discussed in Tavakol's overview.

LIMITATIONS

As with our previous papers, we did not design this study to be an exhaustive, systematic search of the literature. We attempted to seek assistance with finding more papers by using expert consultation, which yielded some important recommended papers. Considering the depth and breadth of our final list, we feel that by using these adjunctive methods we have overcome the limitations of our unstructured collection of papers. Additionally, we used a mix of junior clinician educators and experts in the modified Delphi analysis. While the input from junior educators is valuable from an end-user perspective, it is possible that results may have differed if only experts had been used.

CONCLUSION

We present five key papers addressing research study design with discussions and applications for junior faculty members and faculty developers. These papers provide a basis from which junior faculty members might build upon for designing and analyzing studies.

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Academic Primer Series: Key Papers About Competency-Based Medical Education

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Introduction: Competency-based medical education (CBME) presents a paradigm shift in medical training. This outcome-based education movement has triggered substantive changes across the globe. Since this transition is only beginning, many faculty members may not have experience with CBME nor a solid foundation in the grounding literature. We identify and summarize key papers to help faculty members learn more about CBME.

Methods: Based on the online discussions of the 2016-2017 ALiEM Faculty Incubator program, a series of papers on the topic of CBME was developed. Augmenting this list with suggestions by a guest expert and by an open call on Twitter for other important papers, we were able to generate a list of 21 papers in total. Subsequently, we used a modified Delphi study methodology to narrow the list to key papers that describe the importance and significance for educators interested in learning about CBME. To determine the most impactful papers, the mixed junior and senior faculty authorship group used three-round voting methodology based upon the Delphi method.

Results: Summaries of the five most highly rated papers on the topic of CBME, as determined by this modified Delphi approach, are presented in this paper. Major themes include a definition of core CBME themes, CBME principles to consider in the design of curricula, a history of the development of the CBME movement, and a rationale for changes to accreditation with CBME. The application of the study findings to junior faculty and faculty developers is discussed.

Conclusion: We present five key papers on CBME that junior faculty members and faculty experts identified as essential to faculty development. These papers are a mix of foundational and explanatory papers that may provide a basis from which junior faculty members may build upon as they help to implement CBME programs. [West J Emerg Med. 2017;18(4)713-720.]

INTRODUCTION

While competency-based medical education (CBME) can trace its roots to the early 1970s, it has only been in the last 15 years that the concept has become mainstream within medical education.[1] This adoption likely stems from the combined influence of changing regulatory requirements, global interest in the adoption of competency frameworks, public demand for higher quality care, and increased physician and health system accountability.[2] Providing higher quality care and reducing practice variation are significant driving factors for the adoption of CBME as multiple studies demonstrate systemic failures to improve care[3] and evidence that residency training drives future performance.[4–6]

CBME has become a global phenomenon. In the United States, the Accreditation Council on Graduate Medical Education (ACGME) introduced six domains of clinical competence (patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, systems-based practice) in 1998.[7] In 2013, these original competencies were further refined through the Next Accreditation System and the creation of milestones within residency programs.[8] Similarly, Canada introduced the CanMEDS Framework that defines seven roles (medical expert, communicator, collaborator, manager, health advocate, scholar, and professional).[1] This framework is used in more than 58 jurisdictions in dozens of countries in five continents.[9] Additional frameworks exist in Australia[10] and Europe, including the United Kingdom (Tomorrow's Doctor),[11] and Scotland (the Scottish Doctor).[12]

The current status of residency education can be described as a structure- and process-based system. Within this model, trainees are exposed to learning content for a specific amount of time.[13] Assessment within the system focuses predominantly on knowledge acquisition. Application of knowledge, skills, and attitudes are rarely assessed within the traditional system, leading to inadequate demonstration of preparation for independent practice.[14] Adoption of CBME seeks to correct the shortcomings that exist within the current system. Principles of CBME include a shift toward the use of defined competencies required for practice, staged progression of increasing responsibility/independence, tailored learning, and programmatic assessment.[15] Early-career clinician educators will be expected to navigate the challenges currently facing healthcare while being called upon to translate these concepts into workable solutions that meet the needs of the profession and society

The Academic Life in Emergency Medicine (ALiEM) Faculty Incubator was created partly to give early-career educators a solid exposure to topics that are relevant to the 21st century medical educator. During our yearlong Faculty Development Incubator, CBME was the focus of one module. This paper is a synthetic, narrative review highlighting important literature that may assist junior educators who are seeking to learn more about the design and theoretical foundation of CBME.

METHODS

From August 1-31, 2016, the ALiEM Faculty Incubator discussed CBME. The online discussions involved both junior faculty participants and faculty mentors. As online discussions organically explored the topic of CBME, the titles of papers that were cited, shared, and discussed within the online discussion forum were curated.

This list of manuscripts was augmented with the following: 1) a Google Hangout On Air (GHOA) with Dr. Stan Hamstra of the ACGME, and 2) a call for important CBME papers on Twitter. We requested participants of the #FOAMed and #MedEd online communities to nominate other important CBME papers.

The authorship team then conducted a four-round voting process, inspired by the Delphi methodology similar to previous papers that covered educational scholarship,[16] team collaboration,[17] educational theory,[18] and educational consults.[19] This was not a traditional Delphi methodology since our selection panel comprised both novices (i.e. junior faculty members, participants in the Faculty Incubator) and experts in the field (i.e., experienced clinician educators, all of whom have published greater than 10 peer-reviewed publications, who serve as mentors and facilitators of the ALiEM Faculty Incubator). However, we intentionally sought to involve both junior and experienced clinician educators to ensure we selected papers that would be of use to a spectrum of educators. The first round asked the raters to use a seven-point scale to rate the relevance of the paper for our intended target audience. The second round asked them to recommend whether the manuscript might be worthwhile for which a summary would be written. The third round asked them to further refine the list more restrictively, only allowing our selection panel to vote for five papers. Due to a tie among three candidate papers in the third round, a fourth round of voting then was completed to determine which of these three papers would be included in our top five papers.

RESULTS

Our initial review of the ALiEM Faculty Incubator discussion on CBME thread yielded a total of five articles, which were mentioned by mentors and the junior Faculty Incubator participants. The expert GHOA discussion added another eight papers, and the social media calls yielded an additional 10 articles. There were two duplicates. The three-round voting procedure allowed our team to generate a rank-order listing of all these papers in order of relevance, from the most important to the least important. The citations and our ratings of the remaining 21 papers are listed in our Table.

DISCUSSION

Presented here is a summary and commentary of the top papers.

Table. The complete list of educational scholarship literature related to competency-based medical education that was collected by the authorship team.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in this round	Round 4 tie break round	Top 5 papers
Frank JR, Snell LS, Cate OT, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638-45.	6.5 (0.76)	100%	100%		1
Carraccio C, Englander R, Van Melle E, et al. Advancing Competency-Based Medical Education: A Charter for Clinician-Educators. *Acad Med*. 2016;91(5):645-9.	6.4 (0.74)	100%	100%		2
Carraccio C, Englander R, Gilhooly J, et al. Building a Framework of Entrustable Professional Activities, Supported by Competencies and Milestones, to Bridge the Educational Continuum. *Acad Med*. 2017;92(3):324-330.	6.1 (0.83)	100%	87.5%		3
Carraccio C, Wolfsthal SD, Englander R, et al. Shifting paradigms: from Flexner to competencies. *Acad Med*. 2002;77(5):361-7.	5.6 (0.92)	87.5%	50%		4
Nasca TJ, Philibert I, Brigham T, et al. The next GME accreditation system—rationale and benefits. *New England Journal of Medicine*. 2012 Mar 15;366(11):1051-6.	5.4 (1.19)	75%	37.5%	62.5%	5
ten Cate O, Hart D, Ankel F, et al. Entrustment decision making in clinical training. *Acad Med*. 2016 Feb;91(2):191-8.	5.8 (1.23)	62.%	37.5%	37.5%	Honorable Mention
Chan T, Sherbino J; McMAP Collaborators. The McMaster Modular Assessment Program (McMAP): a theoretically grounded work-based assessment system for an emergency medicine residency program. *Acad Med*. 2015;90(7):900-5.	5.6 (1.06)	75%	37.5%	0%	
Hodges BD. A tea-steeping or i-Doc model for medical education? *Acad Med*. 2010 Sep;85(9 Suppl):S34-44.	5.6 (1.51)	50%	0%		
ten Cate O, Scheele F. Competency-based postgraduate training: can we bridge the gap between theory and clinical practice? *Acad Med*. 2007;82(6):542-7.	5.6 (1.19)	75%	25%		
Konopasek L, Norcini J, Krupat E. Focusing on the Formative: Building and Assessment System aimed at student growth and development. *Acad Med*. 2016 Mar 29. [Epub ahead of print]	5.5 (1.07)	25%	0%		
Holmboe ES, Ward DS, Reznick RK, et al. Faculty development in assessment: the missing link in competency-based medical education. A*cad Med.* 2011;86(4):460-7.	5.4 (1.51)	50%	12.5%		
Asch DA, Nicholson S, Srinivas SK, et al. How do you deliver a good obstetrician? Outcome-based evaluation of medical education. *Acad Med*. 2014;89(1):24-6.	4.75 (1.49)	0%	0%		
Gofton WT, Dudek NL, Wood TJ, et al. The Ottawa surgical competency operating room evaluation (O-SCORE): a tool to assess surgical competence. *Acad Med*. 2012;87(10):1401-7.	4.75 (0.89)	0%	0%		
Batalden P, Leach D, Swing S, et al. General competencies and accreditation in graduate medical education. *Health Aff* (Millwood). 2002;21(5):103-11.	4.6 (1.19)	37.5%	12.5%		
McGaghie WC, Miller GE, Sajid AW, Telder TV. Competency-based curriculum development on medical education: an introduction. *Public Health Pap*. 1978;(68):11-91.	4.6 (1.69)	37.%	0%		
Gingerich A, Regehr G, Eva KW. Rater-based assessments as social judgments: Rethinking the etiology of rater errors. *Acad Med*. 2011;86(10):S1-7.	4.4 (0.92)	0%	0%		

Table. Continued.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in this round	Round 4 tie break round	Top 5 papers
Chen C, Petterson S, Phillips R, et al. Spending patterns in region of residency training and subsequent expenditures for care provided by practicing physicians for Medicare beneficiaries. *JAMA*. 2014;312(22):2385-93.	3.9 (1.89)	0%	0%		
Cook DA, Brydges R, Ginsburg S, et al. A contemporary approach to validity arguments: a practical guide to Kane's framework. *Med Educ*. 2015;49(6):560-75.	3.8 (1.67)	0%	0%		
Landrigan CP, Parry GJ, Bones CB, et al. Temporal trends in rates of patient harm resulting from medical care. *New Eng J Med*. 2010;363(22):2124-34.	3.8 (1.98)	0%	0%		
Messick S. Validity of psychological aassessment. *American Psychologist*. 1995;50(9):741-9.	3.5 (1.20)	0%	0%		
Jay A. How to run a meeting. *Harv Bus Rev*. 1976;54:1-12.	3.3 (2.43)	0%	0%		

1. Frank JR, Snell LS, Cate OT, et al. Competency-based medical education: theory to practice. *Med Teach*. 2010;32(8):638-45.[15]

Summary

This paper is best described as "proceedings" from an international conference convened to explore the emerging concepts of CBME. The specific aims were to review current literature, identify controversies, propose standard definitions, and identify future directions for academic exploration. The sections are broken down into the rationale for CBME, which delves into the principles that support CBME. The article contrasts the differences with traditional medical education, where CBME focuses on abilities, outcomes, learner-centeredness, and de-emphasizes time-based training. The second section focuses on definitions that are useful in CBME. The authors define competence as, "possessing the required abilities in all domains in a certain context at a defined stage of medical education or practice" (p 641).[15] They also distinguish between *dyscompetence*, which denotes that the learner is only partially unable to meet the goals, and *incompetence*, which implies that the learner is deficient in *all* areas of the skill or ability. The final section is a discussion of both advantages and hurdles that are to be expected with the implementation of CBME.

Relevance to Junior Faculty Members

This article is pertinent to junior faculty. It provides a background, explaining the societal and education influences of the CBME movement The International CBME Collaborators do stellar work in focusing the reader on the rationale for a CBME curriculum. This article's table is filled with many pearls that translate the principles of CBME to the practical elements of a curriculum. The definitions provided are also important to help eliminate confusion and ensure a common lexicon when discussing CBME. Probably the most useful section in the article is the final section on the perils and promise of CBME. The main drawback to the implementation of CBME seems to be that the resources required.

Considerations for Faculty Developers

Faculty developers should use this foundational paper to orient junior faculty to the key definitions relevant to CBME. The paper also provides an effective contrast between traditional medical education curricula and CBME. With its thorough but readable review of the literature that informs the origins of the CBME movement, this manuscript would be an excellent choice as pre-reading (i.e., background) material for any faculty development course seeking to introduce junior faculty to the principles of CBME.

2. Carraccio C, Englander R, Van Melle E, et al. Advancing Competency-Based Medical Education: A Charter for Clinician-Educators. *Acad Med.* 2016;91(5):645-9.[20]

Summary

This paper presents a charter, developed by the ICBME Collaborators, with the goal of establishing a conceptual model to be used when discussing, developing and implementing CBME. There is burgeoning international support for adoption of CBME in medical education. Although there is little formal evidence supporting this model, advocates cite it as the product of sound education theory and note the shortfalls of the current system of

medical education. It is important to understand that there are major barriers to adoption, including logistical concerns, and the implementation process and outcomes must be carefully and transparently evaluated. The foundation of CBME entails a focus on outcome abilities, defined by patient and societal needs, and a de-emphasis on time-based training.[21] The charter then lays out 13 fundamental principles that are the foundation of CBME implementation.

The principles can be broadly categorized into themes. First is a refocusing of the relationship between medical providers and the populations they serve. The education of future medical providers should be determined by the needs of the populations they will serve, and there must be transparency for all stakeholders both within medical education and surrounding outcomes. Secondly, the role of the learner needs to be redefined. They must be empowered to take control of their education. As the primary focus of education and training shifts to desired outcomes for learners, effective and efficient assessment is key to timely and appropriate progression of learners through their education. These transitions will be based on achievement of competence rather than time. Moreover, the traditional stages of medical education should be supplanted with a more seamless educational trajectory that extends throughout one's career. Thirdly, commitment from medical educators is imperative. They are responsible for teaching, assessing and role modeling the competencies that learners are being taught, and they must be provided with faculty development to keep them up to date on these competencies. They are also responsible for balancing patient safety with teaching and learner development. Finally, as CBME is implemented it must be studied and shared. Assessment of programs will provide feedback as to the effectiveness of training programs and direct future educational innovations. Additionally, open sharing of educational programs locally, internationally and among interprofessional training programs will allow for high-quality training programs while minimizing the resource-intensive nature of educational innovation.

Relevance to Junior Faculty Members

Governing bodies within medical education are transitioning from training organized by time to outcome-based training. The content, structure, and functionality of training programs will continue to change as the definition of a competent physician is explored and defined, and learners are expected to achieve a wider set of abilities. It is important to understand what CBME is, what it looks like in its idealized form, and the principles that it is built on. It is through this lens that frameworks for assessing learner performance such as competencies, milestones and entrustable professional activities (EPA) make sense. This shift in what is defined as success in training will require innovative curricula and new methods of evaluation. As junior faculty are often recruited for assistance in correcting perceived deficits within a program, a good understanding of CBME will facilitate creation of high-quality educational products. Conversely, looking at a training program through the filter of CBME principles may highlight areas of possible improvement and guide junior faculty into areas of personal interest. Finally, just as the study of medicine builds on a solid foundation of human anatomy, medical education should build on a solid foundation of medical education theory.

Considerations for Faculty Developers

For faculty developers this paper provides guidelines to consider when developing new (or modifying existing) curricula using a competency-based design. Principles such as "serving the health needs of a population," "commitment to transparency" and "balancing learner needs with patient safety" among others have significant influence on how a curriculum is designed and operates. This paper argues for organizing principles of CBME that faculty developers must consider in their curricular innovations. The argument concludes that the adoption of these principles will lead to a robust and effective curriculum.

3. Carraccio C, Englander R, Gilhooly J, et al. Building a Framework of Entrustable Professional Activities, Supported by Competencies and Milestones, to Bridge the Educational Continuum. ***Acad Med.*** **2017;92(3):324-30.[22]**

Summary

This paper provides an introduction to two main features of CBME: entrustable professional activities and milestones. EPAs are sentinel tasks (i.e., work) tailored to a specific discipline (i.e., specialty) and performed in an authentic environment (e.g., the emergency department [ED], not in a simulated fashion). Typically, EPAs contain multiple competencies from multiple domains. This unique assessment tool uses a scale of entrustment (i.e., progression from close to indirect supervision to independence) to assess the competence of a trainee.[23–25] As learners' progress towards more complex stages of training, their performance on multiple EPAs that sample multiple domains of competence help to determine the level of supervision required. Separate from EPAs, milestones describe specific performance at a specific stage of training relevant to a specific competency. Much smaller than an EPA, and not necessarily a clinical task, milestones provide a marker of progression, providing guidance to both trainees and faculty about progression towards global attainment of competence (i.e. readiness for unsupervised practice). For example, the ability to recognize and care for a critically ill patient in the ED would represent an EPA. A milestone would consist of progressively increasing levels of sophisticated management, beginning with the recognition of abnormal vitals signs and progressing to development of a protocol to improve the management or transfer of a critically ill patient.[26] The authors document the overlapping features between EPAs and milestones and their approach to integrating the two components.

Relevance to Junior Faculty Members

Through a discussion of EPAs, this paper emphasizes the importance of assessing learners throughout various experiences with an integrated pathway. Learners progress along individual trajectories of increasing competence and independent practice for specific sentinel abilities. For example, an undergraduate medical student is expected to be a secondary participant in resuscitation, while a junior resident will perform key critical procedures and the senior resident will lead the entire team. Thus, one must be cognizant of matching performance on an EPA to a specific stage of training. Similarly, EPAs are typically content specific, meaning performance of one EPA does not predict performance on another. How a learner performs on a spectrum of EPAs (excelling, or requiring further attention) allows a faculty member to co-produce with the learner a tailored learning plan moving forward. As an example, if a learner is able to perform a central line insertion without direct supervision, but is struggling with communicating with consultants, the learner should be given increasing independence with the former, while providing closer monitoring and feedback for the latter, so as to maximize both the learner's time and instructor's teaching efforts.

Considerations for Faculty Developers

The implementation of the Next Accreditation System in the United States introduced the concept of educational milestones – measurable markers of progression. When combined with EPAs all of the competencies (milestones) and work (EPA) of a specialty can be assessed using a systematic process that emphasizes authentic performance. Changes to assessment will be the most obvious innovation or change in a new CBME model. Unfortunately, many frontline teaching faculty may not be prepared for the implementation of CBME and EPAs.[27] Early success will require significant faculty development in assessment. Faculty developers will find this article useful in illustrating the alignment between the milestones and EPAs. Furthermore, this article provides a feasible example of how to apply EPAs across the trajectory from medical school to practice. Providing this example to faculty members will help to promote understanding of how competencies, milestones, and EPAs align within a well-designed assessment system.

4. Carraccio C, Wolfsthal SD, Englander R, et al. Shifting paradigms: from Flexner to competencies. *Acad Med*. 2002;77(5):361-7.[13]

Summary

This paper reviews the literature on CBME as it stood in the early 21st century. CBME was first introduced in the medical literature in the 1970s. The forces behind this paradigm shift from structure and process-based to competency-based paradigms was driven by the cultural climate of the 1960s and 1970s. Advocacy for this shift was seen in a variety of professions and education levels. Pressures from the public, public health leaders, and professional organizations for increasing accountability helped push this paradigm change. The movement started with emphasizing the differences between what the current models were (structure- and processed-based paradigms) and the ideals of competency-based educational programs. During the 1970s, the medical literature focused on defining the competencies and less on determining competency components, evaluation of the competencies, and the overall assessment of the process. The authors suggest that lack of assessment strategies may have led to delays in implementing a full competency-based curriculum in medical education.

It was not until the turn of the century that CBME implementation in the health professions became a reality. Initiatives by various institutions focused on engaging faculty, administration, and learners in adopting competency-based education. The authors encourage more medical education research to support the outcomes of CBME.

Relevance to Junior Faculty Members

This article gives a historical perspective on the actual definition and implementation of CBME in medical education. Key differences between structure- and process-based education programs and competency-based programs (Table 1, page 362)[13] are described. The paper provides insight as to why there was a lag between widespread implementation of CBME from its development in the 1970s. Defining the four steps of CBME curriculum design is a critical insight for junior faculty members. The lessons from the late 20th century highlight the importance of faculty, learner, administrative, and key stakeholder engagement to create change in medical education.

Considerations for Faculty Developers

This article represents one of the earliest reviews of the transition to CBME within the U.S. medical education system. While competency constructs have been further refined since the publication of this article, educators will find it helpful to review the methodology for identifying and describing competence and how it informs curriculum design (page 363).[13] Understanding the difference between the CBME framework and the current system can be difficult. This article provides an often-cited table (Table 1, page 362)[13] that illustrates the differences between the historical structure- and process-based system and the emerging competency-based system.

5. Nasca TJ, Philibert I, Brigham T, et al. The next GME accreditation system—rationale and benefits. *N Engl J Med*. 2012;366(11):1051-6.[8]

Summary

The Accreditation Council for Graduate Medical Education (ACGME) initially accredited graduate medical education residency programs on multiple factors, including program structure, quality of formal teaching, service to education balance,

resident and faculty feedback, and financial benefits to residents. The ACGME developed the Next Accreditation System (NAS), which has been fully implemented since 2014. This new system prioritizes education outcomes as a significant determinant in residency program accreditation. With the inception of the NAS, discipline-specific milestones are used to assess trainees in the categories of patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice. Furthermore, on-site reviews every four to five years informed by templated program information forms have been replaced by annual data collection informed by self-critique and backed by a 10-year site visit. With the changes in the accreditation process, individual programs are allowed to innovate. Finally, the NAS allows disciplines to change the milestones as stakeholders' expectations of the specialty change with time.

Relevance to Junior Faculty Members

With the full implementation of the NAS, junior faculty have specific milestones to anchor their assessments of trainees, and education innovation is encouraged by the ACGME. Junior faculty will benefit by understanding the framework of the previous accreditation system and what the vision for the future entails with the implementation of the NAS.

Considerations for Faculty Developers

This is a now-classic article about the changes that the ACGME underwent in the first two decades of the new millennia. This paper outlines the ACGME milestones project and the rationale for the change, making manifest the abstract nature of competencies. To complement this paper, it is important to draw linkages between the thoughts displayed in this paper and the outcomes-based education (OBE) movement that occurred in the 1970s.[28] Of note, within general education (and certainly elementary and secondary education), OBE has been a controversial subject.[28,29] Reading education literature on the pitfalls elementary and secondary school teachers have encountered may provide faculty developers with a new lens through which to view their own implementation and design challenges with CBME. A good primer on OBE from the medical education literature is the five-part AMEE Guide series (No. 14)[30–34]

HONORABLE MENTION

ten Cate O, Hart D, Ankel F, et al. Entrustment Decision Making in Clinical Training. *Acad Med*. 2016;91(2):191-8.[35]

While not in the top five papers, this paper discusses an important principle of CBME – entrustment (i.e., the delegation of responsibility to a trainee to complete a task via indirect supervision). Entrustable professional activities are a new education concept that are highly influential in CBME assessment. This paper provides 1) a definition of entrustment, 2) a description of entrustment (supervision) levels and the trainee-supervisor dyad, 3) factors involved in entrustment decisions, and 4) a process for using grounding summative assessments in an entrustment model.

LIMITATIONS

As with our previous papers, we did not design this study to be an exhaustive, systematic search of the literature. We used expert consultation and an open social media call via Twitter using hashtags #MedEd & #FOAMed to expand our search. Given this approach, it is possible that we introduced an availability bias into our sample, though this is unlikely given the breadth of the submissions considered. In addition, we did not restrict submissions from alternative publications or the grey literature. As with prior publications within this series, we aimed to provide a succinct review of high-yield papers for faculty members to use as a starting point to explore the important concepts within CBME. Finally, we make no claims that this is a definitive list of all the papers that are the exclusive body of literature all educators should know, but rather we feel that these are five papers that we have determined via the process described to isolate some readings that novice educators and those teaching them may find most useful. We feel that we may have selected a valid grouping of papers, since the majority of our top five papers are highly cited papers with a cumulative total of more than 500 citations.

CONCLUSION

We provide a reading list on the topic of CBME that may serve as a primer for junior faculty members engaged in medical education. Faculty developers will find this list useful as a foundational series of articles addressing the history of the development of the CBME movement, defining themes within CBME, important principles to consider in the design of curricula, and a rationale for changes to accreditation that are inevitable with the adoption of CBME.

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Academic Primer Series: Key Papers About Peer Review

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Introduction: Peer review, a cornerstone of academia, promotes rigor and relevance in scientific publishing. As educators are encouraged to adopt a more scholarly approach to medical education, peer review is becoming increasingly important. Junior educators both receive the reviews of their peers, and are also asked to participate as reviewers themselves. As such, it is imperative for junior clinician educators to be well-versed in the art of peer reviewing their colleagues' work. In this article, our goal was to identify and summarize key papers that may be helpful for faculty members interested in learning more about the peer-review process and how to improve their reviewing skills.

Methods: The online discussions of the 2016-17 Academic Life in Emergency Medicine (ALiEM) Faculty Incubator program included a robust discussion about peer review, which highlighted a number of papers on that topic. We sought to augment this list with further suggestions by guest experts and by an open call on Twitter for other important papers. Via this process, we created a list of 24 total papers on the topic of peer review. After gathering these papers, our authorship group engaged in a consensus-building process incorporating Delphi methods to identify the papers that best described peer review, and also highlighted important tips for new reviewers.

Results: We found and reviewed 24 papers. In our results section, we present our authorship group's top five most highly rated papers on the topic of peer review. We also summarize these papers with respect to their relevance to junior faculty members and to faculty developers.

Conclusion: We present five key papers on peer review that can be used for faculty development for novice writers and reviewers. These papers represent a mix of foundational and explanatory papers that may provide some basis from which junior faculty members might build upon as they both undergo the peer-review process and act as reviewers in turn. [West J Emerg Med. 2017;18(4)721-728.]

INTRODUCTION

Peer review is a key component of academic publishing, and aims to provide rigor and relevance to the publishing process.[1] While the primary aim of the peer-review process is to select and prepare manuscripts for publication, the service of peer review also provides professional development, reward, and opportunities for further scholarship to the reviewer. However, faculty new to peer review may feel intimidated or unprepared to engage in this scholarly activity.

While peer review draws upon skills that many faculty already have, it does require content and process knowledge that is rarely formally taught to novice reviewers. Quality peer review does not necessarily correlate with traditional markers of experience, such as academic rank, research training, or grant funding.[2] While peer review has traditionally been a solitary practice, models are emerging that facilitate a mentored or team-based approach. These approaches allow junior faculty to receive mentorship in the one-to-one mentored model, and engage in a community of practice in a team-based approach.[3,4] However, a foundational understanding of the elements of a quality peer review and the peer-review process can be helpful prior to engaging in peer review.

The Faculty Incubator was created by the Academic Life in Emergency Medicine (ALiEM) team to provide early-career educators with a community of practice where they can discuss and debate topics relevant to the 21st century medical educator. To that end, we created a one-month module focused on peer review.

This paper is a narrative review that highlights some important literature that may assist junior educators who are seeking to learn more about the peer-review process.

METHODS

In the seventh month of the ALiEM Faculty Incubator (September 2016), we discussed the topic of peer review. We monitored the proceedings of this group of educators from September 1-30, 2016. Our online discussions involved both junior faculty members and faculty mentors. While discussions occurred, we gathered the titles of papers that were cited, shared and recommended within our online discussion forum and compiled these into a list.

This list was then augmented by the following: 1) A YouTube Live session with experts Drs. Jonathan Ilgen & Lalena Yarris, who are both medical educators and editors at *Academic Emergency Medicine Education & Training* and the *Journal of Graduate Medical Education*; 2) A YouTube Live session with Drs. Ellen Weber & Michael Callaham who are both editors of leading EM journals; and 3) a call for important papers regarding peer review on Twitter. We "tweeted" requests to have participants of the #PeerReview, #FOAMed and #MedEd online communities provide suggestions for important papers on the topic of peer review. Figure demonstrates an exemplar tweet.

Once the augmented list was completed, we then conducted a three-round voting process, similar to our previously described Delphi-inspired method to build consensus around which papers to feature.[5] This was a modified Delphi method since our selection panel was comprised of both novices (i.e., junior faculty members, participants in the Faculty Incubator) and experts in the field (i.e., experienced clinician educators, all of whom have published >10 peer-reviewed publications, who serve as mentors and facilitators of the ALiEM Faculty Incubator). However, we intentionally used this method so as to involve both junior and experienced clinician educators to ensure we selected papers that would be of use to a spectrum of educators throughout their careers.

RESULTS

Our ALiEM Faculty Incubator discussions in combination with expert recommendations and social media calls yielded a total of 24 articles. Our procedure allowed us to create a rank-order listing of all these papers in order of perceived relevance, from the most to the least relevant. The top five papers were expanded upon below. Our ratings of all 24 papers are listed in the Table, along with their full citations.

DISCUSSION

Our group determined the following papers to be of highest interest and relevance to novice reviewers and faculty developers. The accompanying commentaries are meant to explain the relevance of these papers to junior faculty members, and also highlight considerations for senior faculty members when using these works for faculty development workshops or sessions.

1. Lovejoy TI, Revenson TA, France CR. Reviewing manuscripts for peer-review journals: a primer for novice and seasoned reviewers. *Ann Behav Med*. 2011 Aug 1;42(1):1-3.[1]

Summary

Lovejoy and colleagues provide an overview of the peer-review process for *Annals of Behavioral Medicine*, describing and providing examples of high-quality reviews for that journal. Although the focus of the process is specific to the behavioral and social-science focus of this journal, the general principles are largely applicable to most academic journals and fields. Specifically, the authors raise awareness of the need for more formal reviewer guidance and attempt to do so by way of this manuscript.

The authors begin by discussing the roles of the editors and editorial board for the journal and laying out the responsibilities of each. Of special interest to potential

Figure. Exemplar tweet soliciting relevant papers on peer review.

reviewers is the process by which action editors select reviewers, highlighting the importance for new reviewers to only identify actual areas of personal expertise. The majority of the article focuses on the actual process of reading a manuscript and drafting the review, including specific considerations pertaining to each of the separate sections of a manuscript. The authors provide a framework for critically appraising manuscripts by explicitly highlighting the roles of the reviewer in order to 1) offer opinions on the strengths and weaknesses of a manuscript, and 2) provide guidance to authors in how to improve scientific process and communication. To conclude, the authors summarize the "do's and don'ts" of the peer-review process in addition to providing an annotated example of a high-quality review from a paper published previously within the journal.

Relevance to Junior Faculty Members

This paper is relevant to junior faculty who wish to participate in peer review for service, personal professional development, and as a scholarly activity for career advancement. The paper provides an understanding of the peer-review process that is crucial to being able to perform the responsibilities of a reviewer. Although not the focus of the article, a common mistake made by novice peer reviewers is overextending themselves: This may include attempting to review beyond the limits of their actual expertise. A better approach is to select fewer areas of expertise in order to build a portfolio of timely, high-quality reviews, expanding knowledge with progression of one's career, leading to future review opportunities.

The largest area of relevance for junior faculty in this article is found in the step-by-step approach to performing a review. The authors provide a guide for reviewers, starting with accepting or declining an invitation to review and concluding with review submission. Additionally, reviewers should consider reading the articles at least once without marking or making comments, just to assess for readability and understanding.

This article then provides a concise yet complete series of considerations for each section of a manuscript, which can help guide the novice reviewer's thought process and ultimately drafting of the review. Additionally, the article provides two different options for organizing the review, highlighting the necessity to identify major versus minor concerns. Novice reviewers may find this article a useful guide, providing a framework for initial reviews that will likely become more intuitive with experience and time.

Considerations for Faculty Developers

This paper provides a useful "how-to" resource for faculty developers to prepare academic faculty for peer review. It is a broad and comprehensive overview that provides both step-by-step instructions on the process, and examples to highlight how to apply these instructions to an actual review.

2. Azer SA, Ramani S, Peterson R. Becoming a peer reviewer to medical education journals. *Med Teach*. 2012;34(9):698-704.[6]

Summary

As part of the *Twelve Tips* series, this paper provides valuable advice for the more novice peer reviewer. The authors discuss the importance of gauging your qualifications, any significant biases, and available time prior to agreeing to review (Tips 1, 3, 5, and 6). They also emphasize the role of the reviewer, not only in critically appraising the article itself, but also in determining how well the submission fits within the journal's style and mission (Tips 2 and 4). They address the importance of confidentiality and professionalism, highlighting the need to keep critiques constructive and reminding the reviewer that the purpose is to strengthen the paper (Tips 7, 8, and 9). The last three tips are, perhaps, the most valuable of all. Tip 10 addresses confidential comments to the editor, clarifying what should be included and the importance of consistency between these recommendations and those shared with the authors. Tip 11 emphasizes the differences between educational and basic scientific research, reminding those reviewing in education journals the differences in approaches and limitations. Finally, tip 12 provides a variety of strategies to improve one's peer-review skills. While isolated interventions have not significantly influenced peer-review skills,[7-10] using this combination of strategies may be more fruitful.

Table. The complete list of peer-review literature collected by the authorship team.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Lovejoy TI, Revenson TA, France CR. Reviewing manuscripts for peer-review journals: a primer for novice and seasoned reviewers. *Ann Behav Med*. 2011;42(1):1-3.[1]	6.7 (0.5)	100%	100%	1
Azer SA, Ramani S, Peterson R. Becoming a peer reviewer to medical education journals. *Med Teach*. 2012;34(9):698-704.[6]	6.5 (0.5)	100%	100%	2
Roediger HL III. Twelve tips for reviewers. Observer. April 2007. Available at: http://www.psychologicalscience.org/index.php/pupublicatio/observer/2007/april-07/twelve-tipsfor-reviewers.html. Accessed December 17, 2016.[14]	6.3 (1.0)	100%	28.6%	
DeMaria AN. What constitutes a great review? *J Am Coll Cardiol*. 2003;42(7):1314-5. [15]	5.9 (0.9)	86.7%	14.3%	
Eva KW. The reviewer is always right: peer review of research in medical education. *Med Educ*. 2009;43(1):2-4.[12]	5.9 (1.1)	100%	71.4%	4
Lucey B. Peer review: How to get it right—10 tips. The Guardian. September 27, 2013. Available at: http://www.theguardian.com/higher-education-network/blog/2013/sep/27/peer-review-10-tips-research-paper?CMP¼twt_gu. Accessed last December 17, 2016.[13]	5.7 (1.1)	100%	42.9%	5
Dumenco L, Engle DL, Goodell K, et al. Expanding group peer review: a proposal for medical education scholarship. *Acad Med*. 2016 Sep 27. [Epub ahead of print][4]	5.4 (1.4)	71.4%	28.6%	
Bordage G. Reasons reviewers reject and accept manuscripts: the strengths and weaknesses in medical education reports. *Acad Med*. 2001;76(9):889-96.[11]	5.3 (1.0)	100%	85.7%	3
Shea JA, Caelleigh AS, Panagaro L, et al. Review process and publication decision. *Acad Med*. 2001;76(9):911-21.[16]	5.4 (1.4)	85.7%	28.6%	
Triggle CR, Triggle DJ. What is the future of peer review? Why is there fraud in science? Is plagiarism out of control? Why do scientists do bad things? Is it all a case of: "all that is necessary for the triumph of evil is that good men do nothing"? *Vasc Health Risk Manag*. 2007;3(1):39-53.[17]	4.1 (1.3)	42.9%	0%	
Evans AT, McNutt RA, Fletcher SW, et al. The characteristics of peer reviewers who produce good-quality reviews. *J Gen Intern Med*. 1993;8(8):422-8.[18]	4.9 (1.3)	85.7%	0%	
Thoma B, Chan T, Desouza N, et al. Implementing peer review at an emergency medicine blog: bridging the gap between educators and clinical experts. *CJEM*. 2015;17(2):188-91.[19]	4.6 (0.8)	28.6%	0%	
van Rooyen S, Delamothe T, Evans SJ. Effect on peer review of telling reviewers that their signed reviews might be posted on the web: randomised controlled trial. *BMJ*. 2010;341:c5729.[20]	4.4 (1.5)	42.6%	0%	
Green SM, Callaham ML. Implementation of a journal peer reviewer stratification system based on quality and reliability. *Ann Emerg Med*. 2011;57(2):149-152.e4.[21]	4.3 (1.5)	28.6%	0%	
Sidalak D, Purdy E, Luckett-Gatopoulos S, et al. Coached peer review: developing the next generation of authors. *Acad Med*. 2016 May 17. [Epub ahead of print][22]	4.1 (1.1)	14.3%	0%	
Cooper LB, Bellam N, Vaduganathan M; JACC: Heart failure fellows. Educating the next generation of peer reviewers. *J Am Coll Cardiol*. 2016;67(17):2079-82.[23]	4.1 (1.7)	0%	0%	
Monrouxe L, Haidet P, Ginsburg S, et al. Good advice from the deputy editors of medical education. *Med Educ*. 2012 Sep;46(9):828-9.[24]	3.7 (1.6)	0%	0%	
Callaham M, McCulloch C. Longitudinal trends in the performance of scientific peer reviewers. *Ann Emerg Med*. 2011;57(2):141-8.[25]	3.7 (1.5)	0%	0%	

Table. Continued.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Callaham ML, Tercier J. The relationship of previous training and experience of journal peer reviewers to subsequent review quality. *PLoS Med*. 2007;4(1):e40.[26]	3.7 (1.8)	014.3%	0%	
Callaham ML, Knopp RK, Gallagher EJ. Effect of written feedback by editors on quality of reviews: two randomized trials. *JAMA*. 2002;287(21):2781-3.[9]	3.6 (1.0)	0%	0%	
Houry D, Green S, Callaham M. Does mentoring new peer reviewers improve review quality? A randomised trial. *BMC Med Educ*. 2012;12:83.[8]	3.4 (1.0)	0%	0%	
Callaham ML, Schriger DL. Effect of structured workshop training on subsequent performance of journal peer reviewers. *Ann Emerg Med*. 2002;40(3):323-8.[10]	3.3 (1.4)	0%		
Callaham ML, Wears RL, Waeckerle JF. Effect of attendance at a training session on peer reviewer quality and performance. *Ann Emerg Med*. 1998;32(3 Pt 1):318-22.[7]	3.1 (1.2)	0%		
Norman, G. Editorial—How bad is medical education research anyway? *Adv Health Sci Educ Theory Pract*. 2007;12(1):1-5.[27]	2.9 (0.9)	0%		

Relevance to Junior Faculty Members

As junior faculty members become involved in peer review, it is important to keep some core components in mind. This paper provides a concise table highlighting key questions for each component of the submission. The table in this paper can serve as a simple one-page guide for the more novice reviewer to help structure his/her reviews. The subsequent tips emphasize some of the less tangible, but equally important, components of the review process. From a professionalism standpoint, this paper reminds the potential reviewer that s/he should ensure that s/he is adequately qualified and unbiased, and able to provide constructive criticism, rather than simply highlighting faults. The paper also highlights the importance of providing an overview, general recommendations, and assessment of suitability for the journal in addition to the discussion of specific suggestions. Finally, the paper highlights numerous strategies for improving one's peer-review skills. Examples include attending peer-review workshops, reading papers highlighting strategies for producing high quality reviews, reading other reviewers' comments from the same paper, asking for feedback from the editor and colleagues, and reflection on one's experiences.

Considerations for Faculty Developers

This paper provides a helpful roadmap to guide and orient novice reviewers to the many steps and factors impacting the peer-review process, and many of these are concisely summarized in the Table. Tips 2 ("Familiarize yourself with the journal style") and 11 ("Know the differences between educational and scientific research") highlight the value of mentorship for novice reviewers, as these subtle differences in article types may not be immediately apparent to those who are less familiar with the medical education literature, and reviewers may feel ill-prepared to critique research approaches that fall outside of their more traditional biomedical training. Guiding novice reviewers to be introspective about both potential conflicts of interest (Tip 3) and bias (Tip 6) are essential mindsets, and allowing time for reflection (Tip 5) will encourage reviewers to provide the most thoughtful and nuanced suggestions for improvement.

3. Bordage G. Reasons reviewers reject and accept manuscripts: the strengths and weaknesses in medical education reports. *Acad Med*. 2001 Sep;76(9):889-96.[11]

Summary

This study sought to explore the strengths and weaknesses of submissions after analyzing peer-reviewer ratings and comments. A content analysis of the 151 peer-reviewed research manuscripts submitted to the 1997 and 1998 Association of American Medical College- sponsored *Research in Medical Education* (RIME) conference was performed. Peer reviewers for RIME come from around the world, and all accepted manuscripts are published in a supplement of *Academic Medicine.* Each masked submission was evaluated by four or five reviewers who work as medical educators. Anonymous comments and a review form are completed by each reviewer. Eight areas are rated on a five-point scale (excellent, good, fair, unsatisfactory and not acceptable). The eight areas rated are problem statement and

background, research design, sampling, instrumentation and data collection, results, conclusion, writing and importance. Finally, each reviewer is asked to use a four-point (definitely include; acceptable, probably include; questionable, probably exclude; definitely exclude) global rating and give additional comments on merits or shortcomings of submission.

Interestingly, nearly two fifths of the reviewers recommended rejection without any unsatisfactory ratings on the checklist. The top reason for rejection was inappropriate, incomplete or insufficiently described statistics. This was followed by over-interpretation of results. The top reason for manuscript acceptance was importance, timeliness, relevance, and critical pertinent problem. Both good and bad quality of writing was raised by many reviewers, stressing the importance of well-written manuscripts. Acknowledging limitations rather than ignoring them was also deemed important. As summarized by Bordage, "scientific writing demands both good science and writing good manuscripts."

Relevance to Junior Faculty Members

Bordage highlights important items that junior faculty should consider when taking part in the peer-review process. The ability of a reviewer to determine what is a well-written manuscript and what are appropriate statistics for a study seem most important. This article implies that peer reviewers should have a background in statistics in order to be able to interpret analysis and results as appropriate. A junior peer reviewer based on this study should also be able to critically appraise a research project for its well-performed design, timeliness and novel approach. The ability of the study to provide practical, useful implications should also be considered. The junior reviewer must also be able to provide written comments and feedback to the authors in order to provide guidance in what can be improved.

Considerations for Faculty Developers

This paper is a great launching point for a discussion on how to improve both peer review and quality of writing with junior scientists. By being aware of the common "fatal flaws" encountered in the field of medical education, it is possible to then pay more attention to these problems when reviewing papers. Faculty developers may want to use the lists generated by this paper to create some easy-to-use handouts for guiding junior faculty members when critically appraising their own work as well. Discussions around each of the most common grounds for rejection and acceptance can be used to scaffold journal club proceedings or internal peer-review processes of research units.

4. Eva KW. The reviewer is always right: peer review of research in medical education. Med Educ. 2009 Jan;43(1):2-4.[12]

Summary

This editorial, written by the editor-in-chief of *Medical Education,* discusses the importance of understanding and incorporating reviewer comments, even when the author does not entirely agree with them. The author highlights the importance of the peer-review process for improving a manuscript, emphasizing the value in both well-written, high-caliber reviews, as well as those in which the reviewer is unclear or incorrect in their interpretation. In the latter case, Eva emphasizes that peer reviewers are reading submissions much more carefully than the standard readership and that any confusion should prompt the author to reevaluate the text and address any ambiguity. He subsequently discusses the importance of peer review and provides several strategies for improvement, which include the provision of a guideline for reviewers, deliberate feedback, and maximizing opportunities to review.

Relevance to Junior Faculty Members

After devoting significant time and effort to a publication, junior faculty may become frustrated after receiving reviewer critiques, especially when the reviewer expresses confusion over what appeared so clear to the author. This paper reminds the junior faculty member that reviewer comments are valuable both by emphasizing what may have been missed, as well as those aspects which may be unclear to readers. It is advisable after receiving reviewer comments to set the manuscript aside for several days and return after the emotions have passed and empathize with the reviewer's comments and perspective. Junior faculty may also benefit by seeking feedback from colleagues and mentors prior to submission. Finally, when serving as a reviewer, junior faculty should review the existing guidelines and seek feedback to ensure that they continually improve their peer-review skills.

Considerations for Faculty Developers

This paper highlights several important concepts for faculty teaching peer-review skills to others. In particular, adopting the maxims of "Did I learn anything?" and "What could the authors have done to convince me of the argument they are trying to convey?" frames peer review as an activity rooted in the goal of providing actionable feedback to authors that will help them to improve their work (as opposed to simply giving summary judgments on the manuscript's overall quality). The *Medical Education* reviewer guidelines (www.mededuc.com) highlighted in this article also provide a useful rubric for the types of general issues that reviewers should consider when conducting a review.

5. Lucey B. Peer review: how to get it right—10 tips. *The Guardian*. September 27, 2013.[13]

Summary

Lucey succinctly details advice for peer review in plain language. His 10 tips are concise and capture the essentials of peer reviewing. The first tip is to "be professional," meaning participate in review because it is a professional obligation as well a means to enhance your own writing. Tips two through four are "be pleasant," "read the invite" [to review] and follow its specific instructions, and "be helpful." Don't only identify shortcomings but offer suggestions to fix identified problems. The fifth tip, "be scientific" emphasizes the reviewer's essential role. The reviewer contribution is expertise in scientific knowledge (not proofreading). Six, "be timely." Editors will notice when you stick to deadlines (and don't). Tip seven, "be realistic" about the reviewing role. The reviewer has an important contribution to make, but not the final say in the ultimate decision regarding publication of the paper. Eight, "be empathetic" in the review and treat others the way that you would want to be treated. Tip nine is "be open" to performing a review even if it is not an area of expertise. Generalists (i.e., non-subject specialists) make significant contributions to the readability and practicality of papers. Finally, tip ten is "be organized." The review is a communication that requires structure and logical flow. Follow the publisher's recommended review structure (if available). Specifically, start with an overview, give feedback on the paper structure, quality of data sources, investigation methods, methodology, flow of argument, and validity of conclusions. Comment on the paper style/voice and give specific suggestions for improvement.

Relevance to Junior Faculty Members:

Peer review is an essential part of an academic career and most junior faculty flounder a bit with the first reviews. This article emphasizes the "big picture" of peer review. It is important because it so clearly and simply states the appropriate responsibility and behavior of an excellent and thoughtful reviewer. It provides an easy-to-follow outline of issues that a reviewer must address when evaluating a paper. The most important emphasis of this paper for junior faculty is the advice to not only find flaws in a paper, but help find solutions. This is an essential skill in thinking critically, evaluating scientific literature and in ultimately developing an academic career.

Considerations for Faculty Developers

This is a pragmatic article that can be used as a springboard for discussing the role and integration of peer-review responsibilities for those new to the job. Faculty developers will find this a useful guide for reminding faculty members (who may have experienced the slings and arrows of blinded peer review) about how to provide positive and constructive peer reviews. This paper may be a useful prophylaxis against the negative feelings that can emerge between reviewees and reviewers, reminding us to be empathetic, helpful, and kind – rather than unremittingly blunt, mean, or sarcastic.

LIMITATIONS

As with our previous papers, we did not design this study to be an exhaustive, systematic search of the literature. We attempted to seek assistance with finding more papers by using expert consultation and an open social media call via Twitter using hashtags #MedEd & #FOAMed, which yielded some important recommended papers. Considering the depth and breadth of our final list, we feel that by using these adjunctive methods we have overcome the limitations of our unstructured collection of papers.

CONCLUSION

We provide a reading list on the topic of peer review that may be beneficial as a primer for junior clinician educators and as a potential reading list for senior faculty members leading faculty development efforts. We hope this paper may serve as a guide for clinician educators who are looking to further the development of their own peer-review skills.

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Academic Primer Series: Key Papers About Teaching with Technology

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Introduction: Modern learners have immediate, unlimited access to a wide variety of online resources**.** To appeal to this current generation of learners, educators must embrace the use of technology. However, educators must balance newer, novel technologies with traditional methods to achieve the best learning outcomes. Therefore, we aimed to review several papers useful for faculty members wishing to incorporate technology into instructional design.

Methods: We identified a broad list of papers relevant to teaching and learning with technology within the online discussions of the Academic Life in Emergency Medicine (ALiEM) Faculty Incubator. This list was augmented with suggestions by a guest expert (BT) and an open call on Twitter (tagged with the #meded and #FOAMed hashtags) yielding 24 papers. We then conducted a modified three-round Delphi process within the authorship group, including junior and senior faculty members, to identify the most impactful papers.

Results: We pared the list of 24 papers to five that were most highly rated. Two were research papers and three were commentaries or editorials. The authorship group reviewed and summarized these papers with specific consideration to their value to junior educators and faculty developers.

Conclusion: This is a key reading list for junior faculty members and faculty developers interested in teaching with technology. The commentary contextualizes the importance of these papers for medical educators, to optimize use of technology in their teaching or incorporate into faculty development. [West J Emerg Med. 2017;18(4)729-736.]

INTRODUCTION

Technology is changing the field of medical education.[1] The acquisition of knowledge was previously limited by one's access to experts, instructors or textbooks, but now learners have access to resources from around the globe. Learners can choose from digital textbooks, open-access journals, online encyclopedias, podcasts, blogs, free open-access medical education (FOAM), massive open online courses (MOOCs), the Khan academy, and TED talks.[2-7]

Educators have an ever-increasing variety of technologies to enhance their instructional design. They can deliver content synchronously or asynchronously (podcasts, vodcasts, blogs); and learners can be present in-person or virtually, creating the potential for online medical education to reach large audiences. Resources created by other educators can be leveraged on learning management systems (LMS) or used while implementing blended learning. Synchronous teaching sessions can be enhanced with simulation, videos, audience response systems, games, and live Twitter feeds.[8-10]

While such innovation in medical education has not traditionally been rewarded, promotion and tenure (P&T) committees have begun to consider social media and online metrics as evidence of scholarly merit in making promotional decisions.[11]

The Academic Life in Emergency Medicine (ALiEM) Faculty Incubator is an online faculty development initiative created to train early-career educators to teach in the 21st century. Rather than encouraging the use of technology for novelty's sake, educators in the ALiEM Faculty Incubator aim at helping participants to understand educational theory, research, curricular design, and program evaluation so that they can maximize use of the most effective instructional design for meeting their teaching objectives. This integrative, narrative review was written to share key insights from the Incubator by highlighting the most important literature on technology in medical education for junior educators and faculty developers.

METHODS

In the fifth month of the ALiEM Faculty Incubator (July 2016), we discussed teaching and learning with technology and exchanged key literature that members felt were relevant to this topic. We monitored the proceedings of this community of junior and senior faculty members from July 1-31, 2016, and compiled the papers mentioned in these discussions.

To ensure that we had a broad compendium of articles, we augmented our collection with papers suggested by the month's guest expert (BT) and an open call for additional papers using Twitter with the hashtags #MedEd and #FOAMed. We subsequently conducted a three-round modified Delphi process to select papers relevant for faculty members on the month's topic, based on the opinion of the selected panel members.[12-17] Our selection panel included both novices (i.e., junior faculty members participating in the Faculty Incubator) and more experienced experts and educators (i.e., experienced clinician educators, all of whom have published >10 peer-reviewed publications, who serve as mentors and facilitators of the ALiEM Faculty Incubator), including the guest expert (BT, invited based on his past publications in the subject of teaching with technology). By mixing the opinions of the two groups, we sought to ensure that we selected papers of use to a spectrum of educators at different stages of their careers.

RESULTS

The ALiEM Faculty Incubator discussions and social media calls yielded a total of 24 articles. The three-round voting procedure allowed our team to generate a rank-order listing of all these papers in order of importance for faculty members. The citations and ratings are listed in Table 1.

DISCUSSION

The following is an annotated bibliography of the top papers, as determined by the modified Delphi process. The accompanying commentaries explain these papers' relevance to faculty members using these articles for personal or other faculty development.

1. Roland D, Brazil V. Top 10 ways to reconcile social media and 'traditional' education in emergency care. *Emerg Med J.* 2015;32(10):819-22.[18]

Summary

New concepts and cultures within medical education make it difficult for educators to combine "technology-enhanced" education with traditional methods. This paper provides tips for reconciling the use of social media with more traditional education formats. The authors suggest that the principles for effectively using social media or podcasts in education are no different than other approaches: educators should provide clear learning objectives, assess learners, and evaluate teaching. Social media is one instructional strategy in education but cannot replace an entire curriculum.

Relevance to Junior Faculty Members

The paper provides valuable advice for junior faculty who are incorporating social media into their educational program. Junior faculty members should realize that newer, "technology-enhanced" methods of instruction are not automatically more effective. Many technologies are revisions of traditional methods and therefore must incorporate sound educational principles. For maximum efficacy, teaching with social media should use traditional educational objectives and program evaluation. Effective podcasting principles are similar to principles for an effective lecture. Curricula that incorporate social media should ensure that learners have study plans that include a wide range of topics, avoiding overemphasis of the popular

Table. The complete list of educational scholarship literature involving social media and other online methods to enhance medical education, which were collected by the authorship team.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Roland D, Brazil V. Top 10 ways to reconcile social media and 'traditional' education in emergency care. *Emerg Med J*. 2015;32(10):819-22.[18]	6.3 (0.8)	100%	100%	1
Mehta NB, Hull AL, Young JB, Stroller JK. Just imagine: new paradigms for medical education. *Acad Med*. 2013;88(10):1418-23.[21]	5.5 (0.5)	87.5%	100%	2
Thoma B, Chan TM, Paterson QS, Milne WK, Sanders JL, Lin M. Emergency medicine and critical care blogs and podcasts: establishing an international consensus on quality. *Ann Emerg Med*. 2015;66(4):396-402.e4.[23]	5.2 (1.2)	100%	87.5%	3
Sherbino J, Arora VM, Van Melle E, Rogers R, Frank JR, Holmboe ES. Criteria for social media-based scholarship in health professions education. *Postgrad Med J*. 2015;91(1080):551-5.[20]	5.6 (0.9)	100%	87.5 %	4
Toohey SL, Wray A, Wiechmann W, Lin M, Boysen-Osborn M. Ten tips for engaging the millennial learner and moving an emergency medicine residency curriculum into the 21st century. *West J Emerg Med*. 2016;17(3):337-43.[8]	6.1 (0.8)	100%	87.5%	5
Chan TM, Grock A, Paddock M, Kulasegaram K, Yarris LM, Lin M. Examining reliability and validity of an online score (ALiEM AIR) for rating free open access medical education resources. *Ann Emerg Med*. 2016. [Epub ahead of print][27]	5.7 (1.5)	37.5%	0%	
Bullock A and Webb K. Technology in postgraduate medical education: A dynamic influence on learning. *Postgrad Med J*. 2015;91(1081):646-50.[30]	5.7 (0.9)	25%	0%	
Sandars J, Patel RS, Goh PS. The importance of educational theories for facilitating learning when using technology in medical education. *Med Teach*. 2015;37(11):1039-42.[31]	5.5 (1.4)	62.5%	12.5%	
Scott KR, Hsu CH, Johnson NJ, Mamtani M, Conlon LW, DeRoos FJ. Integration of social media in emergency medicine residency curriculum. *Ann Emerg Med*. 2014;64(4):396-404.[32]	5.5 (1.2)	62.5%	0%	
Prober CG and Khan S. Medical education reimagined: a call to action. *Acad Med*. 2013;88(10):1407-10.[3]	5.0 (2.0)	37.5%	0%	
Stuntz R and Clontz R. An evaluation of emergency medicine core content covered by free open access medical education resources. *Ann Emerg Med*. 2016;67(5):649-653.e2.[19]	5.0 (1.2)	62.5%	12.5%	
Flynn L, Jalali A, Moreau KA. Learning theory and its application to the use of social media in medical education. *Postgrad Med J*. 2015;91(1080):556-60.[33]	4.9 (1.5)	62.5%	0%	
Hillman T and Sherbino J. Social media in medical education: a new pedagogical paradigm? *Postgrad Med J*. 2015;91(1080):544-5.[34]	4.9 (1.3)	0%	0%	
Cook DA, Hamstra SJ, Brydges R, et al. Comparative effectiveness of instructional design features in simulation-based education: systematic review and meta-analysis. *Med Teach*. 2013;35(1):e867-98.[35]	4.7 (1.8)	12.5%	0%	
Cook DA, Hatala R, Brydges R, et al. Technology-enhanced simulation for health professions education: a systematic review and meta-analysis. *JAMA*. 2011;306(9):978-88.[36]	4.5 (1.6)	12.5%	0%	
Chan TM, Thoma B, Krishnan K, et al. Derivation of two critical appraisal scores for trainees to evaluate online educational resources: A METRIQ study. *West J Emerg Med*. 2016;17(5):574-84.[28]	4.5 (1.4)	0%	0%	
Chan TM, Thoma B, Radecki R, et al. Ten steps for setting up an online journal club. *J Contin Educ Health Prof*. 2015;35(2):148-54.[37]	4.4 (1.3)	0%	0%	

Table. Continued.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Nickson CP and Cadogan MD. Free open access medical education (FOAM) for the emergency physician. *Emerg Med Australas.* 2014;26(1):76-83.[38]	4.1 (1.4)	12.5%	0%	
Mallin M, Schlein S, Doctor S, Stroud S, Dawson M, Fix M. A survey of the current utilization of asynchronous education among emergency medicine residents in the United States. *Acad Med.* 2014;89(4):598-601.[39]	3.8 (1.2)	0%	0%	
Bennett S, Maton K, Kervin L. The 'digital natives' debate: a critical review of the evidence. *Br J Educ Tech*. 2008;39(5):775-786.[40]	3.8 (0.9)	0%	0%	
Thoma B, Chan T, Desouza N, Lin M. Implementing peer review at an emergency medicine blog: bridging the gap between educators and clinical experts. *CJEM.* 2015 Mar;17(2):188-91.[41]	3.5 (0.8)	0%	12.5%	
Gooi AC. Is the textbook dead? Examining the technologies used by medical students to learn. *MedEdPublish*. 2014;3:5.[42]	3.3 (1.1)	0%	0%	
Desai B. A novel use of Twitter to provide feedback and evaluations. *Clin Teach*. 2014;11(2):141-5.[43]	3.0 (1.0)	0%	0%	
Hiltz SR. Impacts of college-level courses via asynchronous learning networks: some preliminary results. *JALN.* 1997; 1(2).[44]	2.1 (1.0)	0%	0%	

topics at the expense of common, less-exciting subjects.[19]

Faculty members must help learners to consume FOAM in a manner similar to other medical literature. It may be valuable to assist learners in appraising resources or pre-selecting articles. In addition to serving as a method of receiving information, the authors highlight that social media may also have value as an outlet for reflection, feedback, and scholarly dissemination. Junior faculty should encourage learners to engage with social media and model examples of professionalism and confidentiality, as well as examples of quality academic scholarship.[20]

Considerations for Faculty Developers

Faculty developers should consider expanding their mentorship of junior faculty members to include reflection on the faculty members' social media presence. Mentorship can be provided on professionalism and the effectiveness of educational programs. Faculty development programs may include instruction on how to expand faculty members' social media knowledge and skills. Social media may also be used directly as a medium for faculty development. Social media allows for the distribution of faculty development content as well as the formation of virtual communities of practice.

2. Mehta NB, Hull AL, Young JB, Stroller JK. Just imagine: new paradigms for medical education. *Acad Med.* 2013;88(10):1418-23.[21]

Summary

Disruptive innovations are radical paradigms that offer a simpler, more convenient, customizable, or cheaper solution to a problem and may provide solutions to many of the current medical education system issues. The authors propose that MOOCs and digital badges may disrupt the educational system. MOOCs are repositories of online content that can reach large audiences across institutional boundaries. They can share large amounts of content at a low cost and would be capable of expanding and standardizing the delivery of high-quality education materials. Digital badges are digitally encoded elements that students can earn to reflect mastery of skills or specific achievements, in place of traditional grades. The authors' vision for undergraduate and graduate medical education would use a central online collaborative learning environment and award transferable digital badges for competency-based assessments and advancement. The authors propose that such a system would facilitate interdisciplinary medical education, lifelong learning skills, and customization of learning outcomes. With less time devoted to didactic teaching, faculty could focus on higher level small-group discussions, observed assessments with formative feedback, and the verification of competency.

Relevance to Junior Faculty Members:

Junior faculty may fail to consider how their work fits into the bigger picture, preventing meaningful change in the field.

This editorial allows those junior faculty to see how work on disruptive innovations such as FOAM, MOOCs, digital badges, blended learning methodologies, and assessment methods could fit into the larger narrative of medical education evolution. While the discussion is idealistic, it may inspire junior faculty by introducing them to new, relatively uncharted fields within medical education.

Considerations for Faculty Developers

The paper examines the larger scale challenges in medical education. The authors predict that disruptive innovations and technology will play an important role in future changes in medical education, especially with respect to competency-based medical education. The paper provides a rationale for embracing change and potentially disruptive innovations. Operationalization of digital badges is supported by the growing focus within the medical education literature regarding Entrustable Professional Activities (EPAs) and Statements of Awarded Responsibility (STARs).[22] Faculty developers should be familiar with these concepts in order to inform and inspire junior educators.

3. Thoma B, Chan TM, Paterson QS, Milne WK, Sanders JL, Lin M. Emergency medicine and critical care blogs and podcasts: establishing an international consensus on quality. *Ann Emerg Med.* 2015;66(4):396-402.e4.[23]

Summary

The use of FOAM has rapidly increased in popularity among learners. Despite this, the academic community has been hesitant to fully endorse these educational materials because of uncertainty regarding their quality. This paper is the first collaborative effort by experts to develop consensus regarding quality of online medical education resources. The authors used a modified Delphi of expert emergency medicine and critical care bloggers and podcasters to determine the relative importance of each quality indicator for blogs and podcasts, from a previously defined list of 151 quality indicators pertaining to credibility, content, and design.[24] The authors invited expert participants (22 podcasters and 24 bloggers) to participate in the surveys, based on their position as lead editor(s) of one of the highest rated emergency medicine or critical care blogs/podcasts as determined by the Social Media Index.[25] The experts reached greater than 70% consensus for 85 quality indicators (5 for blogs only; 41 for podcasts; 39 of these for both), with greater than 90% consensus for 31 of these (5 for bloggers; 17 for podcasters; 9 for both).

Relevance to Junior Faculty Members

This resource provides a method to assess the quality of non-traditional educational resources, which are increasingly used by learners. While the list is not exhaustive, these quality indicators can assist learners and educators in evaluating online resource quality. Junior faculty educators may consider these indicators when deciding upon FOAM resources for their learners and/or curricula. Furthermore, these indicators may be useful to junior faculty members who wish to develop quality FOAM.

Considerations for Faculty Developers

As P&T committees begin considering FOAM in an educator's portfolio of scholarly activity,[11] faculty developers should be familiar with potential metrics for assessing FOAM quality. This paper is one of a few derivation and Delphi studies proposing quality indicators for FOAM resources.[20, 26-28] The paper may also foster a discussion about the lack of critical appraisal for other traditional secondary resources such as textbooks or narrative reviews.

4. Sherbino J, Arora VM, Van Melle E, Rogers R, Frank JR, Holmboe ES. Criteria for social media-based scholarship in health professions education. *Postgrad Med J.* 2015;91(1080):551-5.[20]

Summary

Social media has rapidly emerged as a tool for disseminating medical innovations and education. Clinician educators engage in scholarship as part of their core mission.[29] However, traditional metrics for evaluating scholarly work are not readily applicable to social media-based scholarship. Furthermore, there are no publications identifying evaluation criteria or a formal definition for social media-based scholarship in medical education. While Thoma, et al. focused on quality metrics for blogs and podcasts, Sherbino et al. seeks to define criteria for them as scholarship.[20,23]

Fifty-two health professions educators from 20 organizations in four countries reviewed various themes in medical education scholarship that had been previously identified by an expert working group. The group unanimously agreed on four key features of social media-based scholarship: 1) it must be original (i.e., cannot simply re-broadcast material created elsewhere); 2) it must advance the field by building on best practice, research, or theory; 3) it must be disseminated and archived; and 4) it must provide the education community with the opportunity to give transparent feedback that informs a wider discussion.

Relevance to Junior Faculty Members

Junior faculty members are under pressure to produce academic scholarship to further their careers and advance towards promotion and tenure. Traditionally, such scholarship is in the form of peer-reviewed research. At the same time, medical learners are increasingly using non-traditional sources for learning. This creates disconnect between the needs of the learner and educator. Junior faculty may be interested in becoming thought leaders in social media-based medical

education but are held back by concerns about career advancement and academic recognition. By defining key qualities for this type of scholarship, junior faculty are provided with a framework to guide their scholarly efforts in these areas. As further consensus is achieved, social media-based scholarship in health professions education will become a more defined part of academic advancement and contribution for clinician educators.

Considerations for Faculty Developers

Scholarship has and will continue to evolve. Social media-based resources have proven to be robust and durable ways to disseminate ideas that meet many of the traditional definitions of scholarship. Traditional, pre-publication peer review is a notable exception to this, however. Rigid adherence to such traditional paradigms is likely to limit faculty creativity and institutional flexibility. Faculty developers should consider the emerging role of social media as a form of scholarship if they wish to keep ahead of competing institutions and recruit tech-savvy educators and innovators. This paper provides a framework for the potential recognition of this work. This paper also is relevant to faculty who serve on their institutions' P&T committees. The metrics identified by this paper will help guide the acceptance and assessment of digital scholarship to be used in making promotion decisions.

5. Toohey SL, Wray A, Wiechmann W, Lin M, Boysen-Osborn M. Ten tips for engaging the millennial learner and moving an emergency medicine residency curriculum into the 21st century. *West J Emerg Med.* 2016;17(3):337-43.[8]

Summary

This review article provides tips for engaging the millennial learner by optimizing the use of technology in resident education. The authors provide multiple suggestions for "flipping the classroom," including the importance of providing well-vetted, learner-responsible content (i.e., pre-class resources); maintaining active learner engagement through the use of team-based or problem-based learning; and using existing resources (e.g. MedEdPORTAL, *Journal of Education and Teaching in Emergency Medicine*, CORD Teaching Cases) when appropriate. When lectures are used, the authors suggest pre-reading, short lecture sessions, and active learning techniques (e.g. pause procedures, simulation, small-group discussions, audience response systems). Finally, the authors discuss optimizing the use of technology by having a central, cohesive repository for all residency information (e.g. learning management system); using technology to provide more effective feedback; and providing frequent learning opportunities through residency-run blogs and automated teaching pearls.

Relevance to Junior Faculty Members

Toohey et al. provide a number of valuable tips for the junior faculty member. With increasing emphasis on learner-centered education and the incorporation of online media into resident education, it is important to use these resources effectively. The authors emphasize active learning strategies supported by effective pre-reading when preparing didactics. Active learning can be achieved through numerous strategies including audience response systems, team-based learning, problem-based learning, and simulation.[9] When supervising residents on shift, the authors recommend rapid, real-time, formative feedback to avoid recall bias, enhance its impact on practice, and avoid surprising biannual summative assessments. Examples of technologically-enhanced, real-time feedback software include Instant Eval, New Innovations, MedHub, and MyEvaluations.com. When supervising resuscitations or procedures, optical head-mounted displays (e.g., Google Glass™, GoPro™ cameras) or video recording can further reduce recall bias and allow for the supervisor to focus on the patient, while allowing for valuable feedback to be provided later.

Considerations for Faculty Developers

The article provides strategies for incorporating technology into a residency curriculum. Faculty development is critical to the success of any educational program. This article could act as pre-reading for faculty development seminars or be added to a reading list for junior faculty members. The article specifically focuses on effective teaching strategies, using technology to organize and manage a residency curriculum, and using technology for providing learners with feedback.

LIMITATIONS

First, the selection of articles for the modified Delphi process did not incorporate an exhaustive, systematic search of the literature. Rather, the knowledge of experts in the field was combined with crowd-sourced feedback from the online community to generate the list of articles that were evaluated. We believe that this process was able to identify some of the key papers on the topic of interest while keeping the list a manageable length for the participants in the modified Delphi process. However, it is possible that key articles could have been missed or excluded. Furthermore, the authors only considered journal articles, rather than including all sources on the subject of teaching with technology, such as blogs and podcasts.

Second, in a pure application of the Delphi technique all participants would be experts in faculty development. We declined this approach, opting instead to recognize the expertise of a range of faculty members. By incorporating junior faculty, we felt that we were better able to determine what is most relevant to them.

Third, the inclusion of authors within the field may have introduced bias in the selection of the articles. Being experts in

the subject, the senior faculty were authors of many of the papers considered in the Delphi process. This limitation was balanced with the use of junior faculty who have not authored within the field and may have benefited article selection by accessing the expertise of these same authors.

Finally, given that all of the participants in the modified Delphi process were involved in the Faculty Incubator in some way, it is likely that they were not a representative sample of academic emergency medicine clinicians.

CONCLUSION

This paper describes some key papers that may be useful to junior faculty members and faculty developers interested in teaching with technology. We believe that it will be helpful for clinician educators who seek to use technology effectively as the field of medical education continues to evolve at a rapid pace.

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Pain Perception in Latino vs. Caucasian and Male vs. Female Patients: Is There Really a Difference?

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Introduction: Pain is a common emergency department (ED) complaint. It is important to understand the differences in pain perception among different ethnic and demographic populations.

Methods: We applied a standardized painful stimulus to Caucasian and Latino adult patients to determine whether the level of pain reported differed depending on ethnicity (N=100; 50 Caucasian [C], 50 Latino [L] patients) and gender (N=100; 59 female, 41 male). Patients had an initial pain score of 0 or 1. A blood pressure cuff was inflated 20 mm HG above the patient's systolic blood pressure and held for three minutes. Pain scores, using both a 10-cm visual analog scale (VAS) and a five-point Likert scale, were taken at the point of maximal stimulus (2 minutes 50 seconds after inflation), and at one- and two-minute intervals post deflation.

Results: There was a statistically significant difference between the Likert scale scores of Caucasian and Latino patients at 2min 50sec (mean rank: 4.35 [C] vs. 5.75 [L], $p<0.01$), but not on the VAS (mean value: 2.94 [C] vs. 3.46 [L], $p=0.255$). Women had a higher perception of pain than males at 2min 50sec on the VAS (mean value: 3.86 [F] vs. 2.24 [M], $p<0.0001$), and the Likert scale (mean rank: 5.63 [F] vs. 4.21 [M], $p<0.01$).

Conclusion: Latinos and women report greater pain with a standardized pain stimulus as compared to Caucasians and men. [West J Emerg Med. 2017;18(4)737-742.]

INTRODUCTION

Pain is one of the most common complaints in emergency departments (ED) nationwide. The perception of pain in others is, therefore, an important component of patient assessment and treatment. There are difficulties in studying pain since it is subjective, which raises the question of what is a clinically significant change in pain. Todd et al. found that reporting less than a 13 mm change in pain severity on the 100 mm visual analogue scale (VAS) was not clinically significant.[1]

Inequalities in analgesic administration to ED patients of different ethnic and demographic groups have been well documented, but there is limited data on objective differences in pain perception between these ethnic groups or between the two genders. Such differences would be clinically relevant as they could rationally affect the decision to use analgesics and the doses administered. This is especially important today when non-Caucasian minority groups comprise roughly one-third of the U.S. population, a

number that is projected to nearly double by the year 2050, according to the U.S. Census Bureau.[2]

The majority of available evidence comparing differences in pain perception between men and women is in agreement. According to a comprehensive literature review published in the *Journal of Pain* in 2009, women have consistently shown a greater sensitivity to pain, both in the clinical and experimental setting.[3] In one randomized double-blinded study published in *Anesthesia & Analgesia*, researchers sought to electrically induce pain in healthy young subjects to study gender differences in nociception. Cutaneous stimulation of the earlobe allowed measurement of pain detection thresholds and maximal pain tolerance. They found, with statistical significance, that male subjects had greater stimulus thresholds (lower nociception) compared to female subjects, and a greater pain tolerance.[4]

The little data available on pain differences among different ethnic groups is conflicting. The studies that are available are heterogeneous in both patient population and methodology, leading to inconclusive evidence. In a 2010 retrospective chart review of approximately 800 patients presenting to a multi-cultural and highly diverse inner-city hospital with a long-bone fracture, examiners sought to determine the differences between self-reported pain scores by ethnic group and English-speaking status. In this study, it was found that pain score did not vary by race, ethnicity or language.[5] On the contrary, the *Journal of Palliative Care* published a systematic review of the literature in 2014, studying the relationship between ethnicity and the pain experience in cancer patients, and came to a different conclusion. The authors reviewed literature published between 1998 and 2013, included 11 studies, and found that a significantly greater proportion of Hispanics (50%) and Blacks (49%) presented with severe pain at first consultation at a cancer center compared to White (33%) patients.[6,7] After adjustment for age, sex, stage of cancer, and comorbidities, both Hispanic and Black patients were nearly twice as likely to report severe pain relative to White patients.

The purpose of this prospective study was to better understand the differences in pain perception among our patient population in a community hospital ED. Our objective was to apply a standardized painful stimulus to both Caucasian and Latino patients presenting to the ED to determine whether the level of pain reported and the words used to describe the painful stimulus differed depending on ethnicity and gender. We also sought to examine subjective differences in the manner that pain was described by the different demographic groups.

Population Health Research Capsule

What do we already know about this issue?
Pain is a common complaint in emergency departments. Inequalities in analgesic administration to ED patients of different ethnic and demographic groups have been well documented.

What was the research question?
Are there objective differences in pain perception among ethnic groups or between the two genders?

What was the major finding of the study?
Latinos and women report greater pain with a standardized pain stimulus as compared to Caucasians and men.

How does this improve population health?
There appears to be a difference in pain perception among ethnic groups and genders. We can improve patient care if we understand the intricacies involved in identifying and treating pain.

METHODS

Study Setting and Population

This prospective clinical trial was conducted in the two EDs and the medical clinic of our community teaching hospital in a northeastern city in Pennsylvania (combined ED volume of 79,000 patients per year). We enrolled 10% of subjects from the medical clinic. Latino and Caucasian adult patients of both genders (age 18 years and older) who were being seen for a non-painful condition were approached and asked to participate in the study by one of the two investigators. Prior to participating in the study, patients had to have a pain score of 0 or 1. In addition, participants were asked to self-assess their pain tolerance on a 10-point Likert scale, with 1 being "very sensitive to pain," and 10 being "able to tolerate extreme pain."

Study Design

A standard blood pressure cuff, appropriate to the patient's size, was inflated 20 mm HG above their recorded systolic blood pressure and held for three minutes. Two minutes and 50 seconds after inflation, patients were asked to note their degree of discomfort on a 10 cm VAS and a five-point (0-4) Likert scale. Patients were also queried regarding descriptors of their pain, using those in the short-form McGill Pain Questionnaire (Figure 1). The cuff was then deflated, and at one- and two-minute intervals post deflation the patients repeated the VAS and Likert scale. Consent and survey instruments were available in both English and Spanish.

Throbbing	Aching
Shooting	Heavy
Stabbing	Tender
Cramping	Splitting
Gnawing	Sickening
Hot-burning	

Figure 1. McGill pain descriptors (modified short-form version).

Statistical Analysis

Due to the ordinal nature of the VAS, Likert scale and "tolerance" measurement variable, we performed a non-parametric Mann-Whitney (M-W) rank sums test on all data, with results expressed as mean ranks, z-scores and significance values. For comparative purposes only, we re-analyzed the VAS with the independent samples t-test for statistical comparisons of the means between gender and ethnic groups (males and females, Latinos and Caucasians), as these groups' scores demonstrated normally distributed data.[8,9] Results of the t-test were analogous to the M-W test (i.e., significant and non-significant outcomes were mirrored). Among the different ethnic and gender groups, the independent samples t-test was also used for comparison of mean values for the McGill pain scale, as the sum total of scores was roughly normally distributed.

RESULTS

There were 100 subjects, 50 Caucasian (C) and 50 Latino (L) patients who completed the study. Of the 59 female subjects, 28 were Caucasian and 31 were Hispanic. The 41 male subjects included 22 Caucasian males and 19 Hispanic males. The mean age was 43 years; Caucasians were slightly older than Latinos (48 years vs. 39 years, $p<0.05$), and there was no age difference between genders.

Caucasians vs. Latinos

Caucasians self-reported a higher degree of pain tolerance on the 10-point Likert scale than Latinos, which was statistically significant (M-W mean rank: 4.75 [C] vs. 5.35 [L], $p<0.01$). There was a statistically significant difference between the five-point Likert scale scores of Caucasian and Latino patients at the time of the maximal painful stimulus, 2min 50sec (M-W mean rank: 4.35 [C] vs. 5.75 [L], $p<0.01$), but not on the VAS (M-W mean rank: 4.69 [C] vs. 5.41 [L], $p<0.211$; t-test mean value: 2.94 [C] vs. 3.46 [L], $p<0.255$) (Figures 2-4). There were no differences in pain perception at one and two minutes post deflation. Perhaps surprisingly, both ethnic groups rated the 11 qualitative McGill pain descriptors almost identically; thus, there was no statistically significant difference (t-test: $p=0.18$).

Genders

There were no differences between the two genders in self-assessment of pain tolerance on the 10-point Likert scale

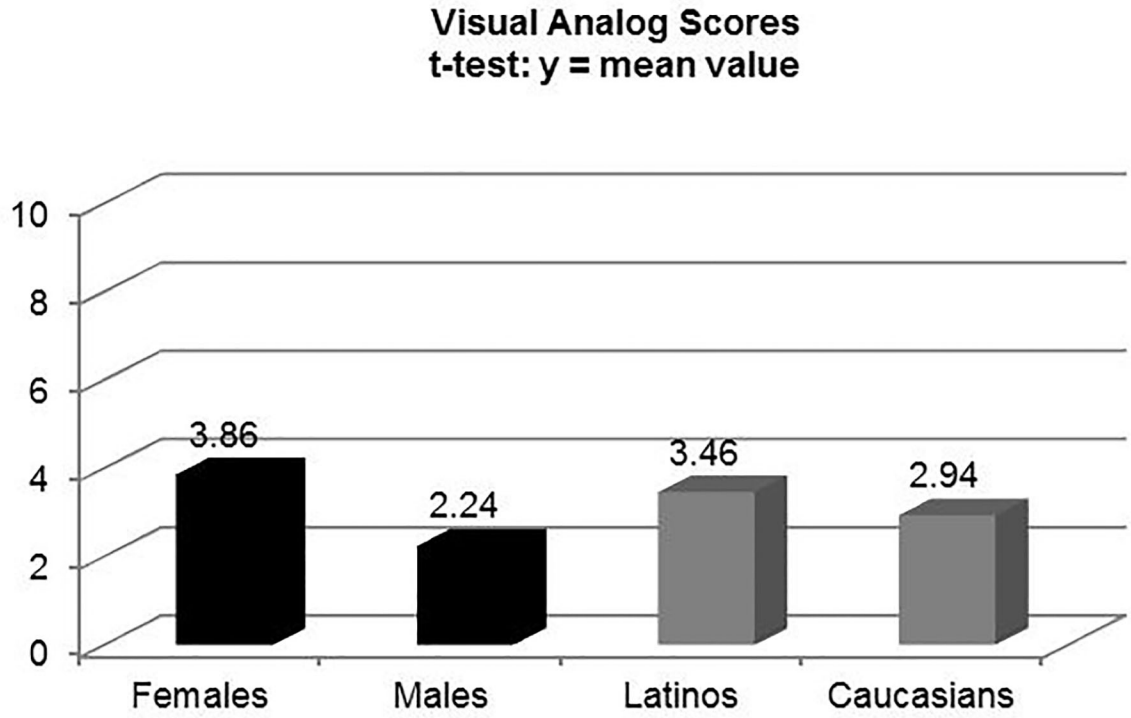

Figure 2. Pain perception of females (n =59) vs. males (n=41), and Latinos (n=50) vs. Caucasians (n=50) at time of maximal painful stimulus (2 min 50 sec) using the 10-cm visual analog scores (VAS). Mean values obtained using the independent samples t-test.

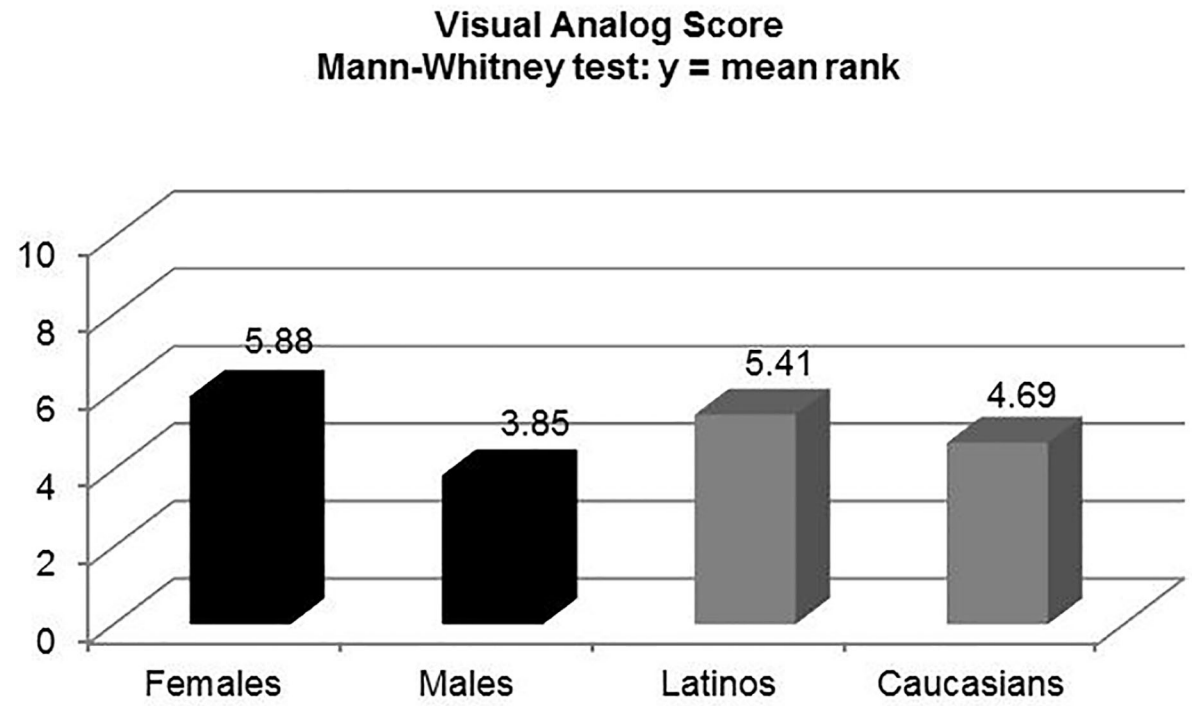

Figure 3. Pain perception of females vs. males and Latinos vs. Caucasians at time of maximal painful stimulus (2 min 50 sec) using the 10-cm visual analog scores (VAS). Mean ranks obtained using the Mann-Whitney rank sums test.

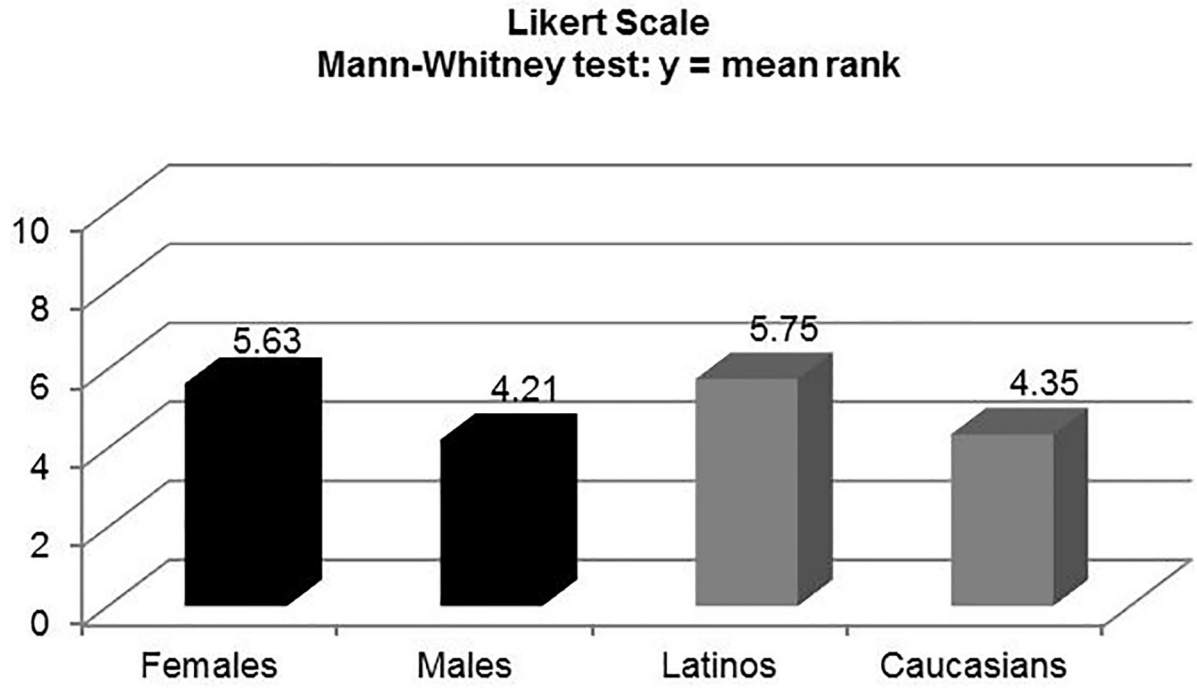

Figure 4. Pain perception of females vs. males and Latinos vs. Caucasians at time of maximal painful stimulus (2 min 50 sec) using the 5-point Likert scale (0-4). Mean ranks obtained using the Mann-Whitney rank sums test.

(M-W mean rank: 4.99 [M] vs. 5.09 [F], p<0.695). However, the cohort of women (Caucasians and Latinos combined) had a much higher perception of pain than the homologous male cohort at 2min 50sec (time of maximal painful stimulus) on both the VAS (M-W mean rank: 5.88 [F] vs. 3.85 [M], p<0.01; t-test mean value: 3.86 [F] vs. 2.24 [M], 95% confidence interval [CI] [0.78-2.47], p<0.0001), and the Likert scale (M-W mean rank: 5.63 [F] vs. 4.21 [M], p<0.01) (Figures 2-4). There were no statistically significant differences within each gender by ethnicity at the point of maximal stimulus (M-W mean rank: females [2.79 (C) vs. 3.19 (L), p=0.378]; males [1.94 (C) vs. 2.28 (L), p=0.355]). Similarly, there were no differences on either pain scale at one and two minutes post deflation, when the pain had greatly diminished. As was the case with Caucasians vs. Latinos, there was no statistically significant difference between males and females when comparing the mean values for the sum total of categories in the qualitative McGill pain scale (t-test: p=0.26).

DISCUSSION

In this prospective clinical trial, we found differences in the perception and reporting of pain both between genders and between Caucasians and Latinos. The goal in the ED is to treat the pain of each individual. However, since pain is subjective and often difficult to quantify, the emergency physician may want to consider how different groups have perceived and reported pain tolerance to a standard pain stimulus.

Caucasians vs. Latinos

Our study demonstrated a statistically significant difference between these two ethnic groups in self-reported pain tolerance. Consistent with this impression, Latinos reported their pain to be significantly greater on the Likert scale and a similar trend (not statistically significant) was noted on the VAS as well. Again, we could not determine the precise cause of this difference, but it did appear that the use of the VAS for Spanish-speaking subjects was less familiar and more difficult to explain than for the Caucasian group.

Ethnic differences in the perception and reporting of pain have occasionally been studied in the past. These studies have shown conflicting results, sometimes indicating no ethnic differences while others suggest African-American and Hispanic patients perceive and report more pain compared to Caucasians.[10-12] Again, the studies are extremely heterogeneous in patient population and methodology. There is also some evidence that the physician's perception of whether a patient is exaggerating symptoms was associated with the patient's ethnicity.[13]

Genders

Unlike the ethnicity-related results, men and women did not differ in the degree to which they assessed their own pain tolerance. However, our results clearly showed a clinically and statistically significant difference in the reported perception of pain by women as compared to men. Similar results have been reported in most but not all of previous studies.[14-17] Differences in study design and statistical methods may well explain why some studies had different results than our study: subjects in earlier trials were either normal volunteers or patients with chronic pain and were not limited to ED patients.

Women consistently demonstrate a trend towards being more sensitive to pain and higher expressions of pain intensity as compared with men; little data has been reported that show women to be more tolerant of pain than men.[14-17] Although the reasons for these gender differences are unclear, speculation has included inherent and acquired differences in emotionality and communication. Factors such as the gender of the experimenter (both investigators in the current study were female), the location of pain, and the type of scale used have also been hypothesized.

LIMITATIONS

Compared to previous investigations, the current study has some significant limitations as well as several unique strengths. First, we acknowledge a modest sample size of 50 in each ethnic group, which might hinder our ability to detect a true difference in patient response (a type B error). Secondly, the two investigators were not Spanish-speaking and that may have affected the accuracy of some patient responses despite the fact that the study instrument was printed in Spanish and English. Different blood pressures may have also influenced results because if the subject had a baseline higher blood pressure, then the cuff would have been inflated more. Subjects who frequently have their blood pressure taken may be more tolerant of this painful stimulus. In addition, comorbid conditions such as diabetes or peripheral vascular disease may have affected sensory perception, and medications such as calcium channel blockers may likewise have affected sensory perception. Chronic pain syndromes and use of chronic pain medication may also influence pain perception. Finally, the degree of pain caused by our stimulus was modest, as seen on both the VAS and Likert scale. Use of a more noxious stimulus might elicit different responses. Strengths of our study include the fact that we enrolled equal numbers of patients representing the two ethnicities, all patients presented to a community hospital ED or medical clinic, and all study participants were subjected to a standardized stimulus.

Future studies may be able to more accurately assess pain perception among various ethnic and demographic groups by blinding study participants to the fact that their pain score is being studied. A retrospective study and chart review is currently being planned at our institution. By blinding study participants, we can effectively eliminate observer bias and/or Hawthorne effect. After validating that there is in fact a

difference in pain perception among ethnic and demographic groups, the next step is to understand why these differences exist and to correlate these differences to the inequalities that exist in analgesic administration. If we can fully understand the intricacies involved in identifying and treating pain, we can ultimately improve patient care.

CONCLUSION

Latinos and women report greater pain with a standardized pain stimulus as compared to Caucasians and men. Both genders and ethnicities use similar terms to qualitatively describe the painful stimulus. Future studies are needed to evaluate if these differences exist when patients are blinded to that fact that their pain score is being studied.

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Feasibility of an ED-to-Home Intervention to Engage Patients: A Mixed-Methods Investigation

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Introduction: Older, chronically ill patients with limited health literacy are often under-engaged in managing their health and turn to the emergency department (ED) for healthcare needs. We tested the impact of an ED-initiated coaching intervention on patient engagement and follow-up doctor visits in this high-risk population. We also explored patients' care-seeking decisions.

Methods: We conducted a mixed-methods study including a randomized controlled trial and in-depth interviews in two EDs in northern Florida. Participants were chronically ill older ED patients with limited health literacy and Medicare as a payer source. Patients were assigned to an evidence-based coaching intervention (n= 35) or usual post-ED care (n= 34). Qualitative interviews (n=9) explored patients' reasons for ED use. We assessed average between-group differences in patient engagement over time with the Patient Activation Measure (PAM) tool, using logistic regression and a difference-in-difference approach. Between-group differences in follow-up doctor visits were determined. We analyzed qualitative data using open coding and thematic analysis.

Results: PAM scores fell in both groups after the ED visit but fell significantly more in "usual care" (average decline -4.64) than "intervention" participants (average decline -2.77) (β=1.87, p=0.043). There were no between-group differences in doctor visits. Patients described well-informed reasons for ED visits including onset and severity of symptoms, lack of timely provider access, and immediate and comprehensive ED care.

Conclusion: The coaching intervention significantly reduced declines in patient engagement observed after usual post-ED care. Patients reported well-informed reasons for ED use and will likely continue to make ED visits unless strategies, such as ED-initiated coaching, are implemented to help vulnerable patients better manage their health and healthcare. [West J Emerg Med. 2017;18(4)743-751.]

INTRODUCTION

Patient engagement is central to many health policy initiatives.[1-5] Engaged patients make more informed healthcare decisions, avert health crises and incur lower healthcare costs.[6,7] Interventions to increase patient engagement increase the use of preventive care, reduce hospital-based care and improve outcomes.[6,8-12] The Patient Activation Measure SF® (PAM) is a way to quantify patient engagement, which is defined as patients' knowledge, skills and confidence in managing their health and healthcare and the interventions that promote healthy behaviors.[13] Coaching interventions increase PAM scores, reduce hospital use, and improve medication and chronic disease self-management but have not been tested in the ED.[8,9,12]

Although ED use is increasing in older adults, those with limited health literacy represent a particularly high-risk group who are often under-engaged in managing their health and frequently turn to the ED for care.[14-18] Strategies aimed at engaging these patients at the critical ED juncture may help them stay engaged, better manage their health and avert future health crises. We tested the impact of a coaching intervention on patient engagement and follow-up doctor visits in chronically ill, older ED patients with limited health literacy. Because efforts to help patients manage their health are more effective if they align with patients' perspectives,[8,19] we also explored reasons for ED use in this high-risk population.

Population Health Research Capsule

What do we already know about this issue?
Coaching interventions increase patient engagement, improve medication and disease self-management and reduce hospital use but have not been tested in the ED.

What was the research question?
Can an ED-initiated coaching intervention increase patient engagement in older ED patients with limited health literacy?

What was the major finding of the study?
The ED-initiated coaching intervention significantly reduced declines in patient engagement observed after usual post-ED care.

How does this improve population health?
ED-initiated coaching interventions hold promise for helping high-risk and hard-to reach patients better manage their health and healthcare.

METHODS

Study Design

We conducted a randomized controlled trial (RCT) comparing an ED-to-home intervention ("intervention") to usual post-ED care ("usual care") on patient engagement and follow-up doctor visits and in-depth interviews exploring patients' healthcare-seeking decisions. The study was conducted from July 2013 to August 2014.

Study Setting

The intervention was tested in two communities. Site 1 ED (90,000 visits/year) is a tertiary referral center serving a community of 250,000 and a White (62%) and African-American (28%) population with various payers (40% public, 36% private). Site 2 ED (89,000 visits/year) is a tertiary referral center serving a metropolitan area of one million and African-American (59%), White (33%), publicly insured (44%) and uninsured (24%) patients.

Study Population

Older, chronically ill patients with limited health literacy insured by Medicare scheduled for ED discharge were eligible for study inclusion (Figure).

Study Protocol

Recruitment

The university institutional review board approved the study at both sites. Study procedures are outlined (Figure). Random assignment using a random number generator was provided to research associates (RAs) who determined patient eligibility by screening the ED electronic health record (EHR). RAs were blinded to assignment until baseline survey completion.

Health Literacy Screening

Following screening and informed consent, patients completed the Rapid Estimate of Adult Literacy in Medicine (REALM).[20,21] REALM is valid in diverse racial/ethnic groups[21] and older adults.[22] Categories include adequate (≥61 words correct; grade level ≥ 9) and limited health literacy (<61 words correct; grade level 0-8).

Intervention

The ED-to-home intervention was modeled on the Care Transitions Intervention℠ (CTI), an evidence-based program to increase patient engagement and reduce 30-day readmissions and healthcare costs in hospitalized patients.[23] Trained coaches from community area agencies on aging administered the intervention. Coaches helped patients 1) schedule follow-up doctor visits; 2) recognize disease worsening; 3) reconcile medications; and 4) communicate with providers.[10,23,24] Coaches visited patients' homes within

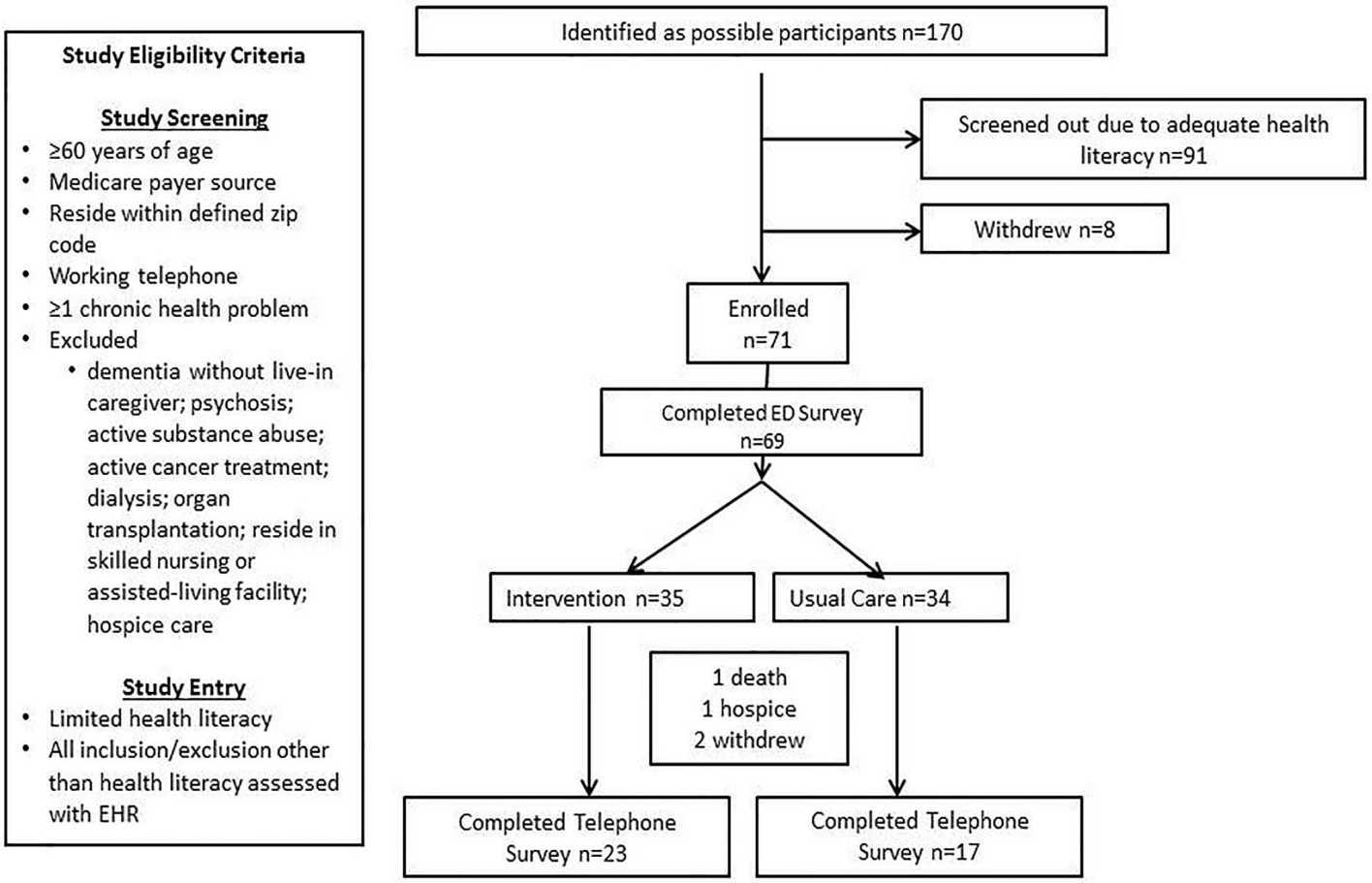

Figure. Recruitment procedures. Consolidated standards of reporting trials (CONSORT) flow diagram displaying progress of all participants through the trial.

three days of ED discharge, called three times over the ensuing month, and engaged patients by helping them set achievable goals.

Usual Care

Usual post-ED care included written and verbal discharge instructions and advice to follow up with a provider.

In-depth Interviews

Based on site, assignment and date of ED visit, a purposive sample (n=11; 6 "intervention," 5 "usual care") was invited to interview, and 9 agreed. Questions emphasized reasons for ED visit and access to post-ED care (Supplementary Appendix S1).

Data Sources

Baseline Survey

Participants completed a baseline ED survey to record PAM score, sociodemographic (age, gender, race), socioeconomic (education, employment, payer status) and health-related factors (self-rated health, number of chronic conditions).

Follow-Up Telephone Survey

Participants were called by the University Survey Center within 31-60 days of the ED visit to determine follow-up PAM score and doctor visits using Medicare Current Beneficiary Access-to-Care Survey items.[25] The survey was administered using best practices (e.g., 10 call attempts, rotating call attempts, refusal conversion).[26]

Patient Activation Measure

We used the 13-item PAM[27,28] to assess engagement including patients' knowledge, skills, and confidence in managing their health and healthcare. Degrees of agreement with statements, such as "When all is said and done, I am the person who is responsible for managing my health condition" and "Taking an active role in my own health care is the most important factor in determining my health and ability to function," are scored on a 0-100 point scale. The lowest scores suggest a person does not understand their role in healthcare, while the highest levels indicate greater activation and proactive, healthy behaviors. The

PAM is previously published and valid in older, chronically ill patients with limited health literacy.[29,30]

In-depth Interviews

Interviews (60-90 minutes) were conducted in patients' homes, audio-recorded and transcribed verbatim.

Outcome Measures

Outcomes included between-group differences in PAM scores and self-reported doctor visits. In-depth interviews identified factors influencing healthcare-seeking decisions.

Power Calculation

We conducted a pre-pilot power analysis based on an increase in primary care visits from 30-80% within 10 days of hospital discharge at one study site using the identical coaching intervention in hospitalized patients. Thirty-five participants in both groups were needed to detect similar differences in post-ED visit follow-up with power (1-β) of 80% and alpha of 0.05.

Quantitative Analysis

We conducted between-group comparisons in sociodemographic, socioeconomic, health status and doctor visits using chi-square and analysis of variance for categorical and continuous measures, respectively. We used an intention-to-treat approach for all analyses.

We assessed between-group differences in PAM scores between the baseline and follow-up time points in two ways. In our primary analysis, we assessed mean PAM score differences over time between the "intervention" and "usual care" groups using unadjusted linear regression. We then assessed between-group PAM score differences over time using a difference-in-differences (DID) approach that accounted for differential between-group loss to follow-up using inverse probability weighting. Inverse probability weighting adjusts for bias due to missing data by giving more weight to patients who resemble those lost to follow-up.[31] The DID approach ensures that background trends in outcomes unrelated to the program are not responsible for treatment effects by comparing outcomes in the treatment group to a group experiencing the same background trends but not exposed to the program. To account for the fact that patient measurements within a site were more likely to be similar than measurements between sites, all models were estimated with standard errors clustered by site. We conducted analyses using Stata v.13, with significance at $p<0.05$.

Qualitative Analysis

Interview transcripts were read independently by three members of the research team including qualitative methods experts and a health service researcher. Using thematic and constant comparative analysis, we coded data using procedures described by Charmaz.[32-35] Team members wrote memos to document and record study findings and track methodological, theoretical, and substantive decisions made during the analysis to ensure rigor of data analysis and interpretation. We used open coding to identify concepts important to participants, and provisional themes were presented to the entire team for feedback and verification. Codes were reviewed, discussed and arranged into wider thematic structures to make meaning of participant narratives.[36]

RESULTS

Of 170 patients consenting to health literacy screening, 71 had limited health literacy and were eligible for inclusion (36 "intervention," 35 "usual care"). All agreed to participate and 69 patients completed baseline ED surveys. Only baseline PAM scores were significantly different between "intervention" and "usual care" groups, respectively (64.0 ±16.9, 60.1±15.1, p=0.03) (Table 1).

Forty of 65 patients able to respond, completed the follow-up telephone survey (61%, 23 "intervention," 17 "usual "care" [Table 1; Figure]). Patients with lower baseline PAM scores (odds ratio=0.92, 95% CI=0.86-0.98) were less likely to complete the follow-up telephone survey.

Seventy-three percent of "intervention" patients (76% at Site 1; 70% at Site 2) completed coaching. Median time from ED-to-home visit was 2.5 days (range 1-12 days). The home visit lasted approximately 60 minutes, and each of the coaching phone calls lasted about 15 minutes.

Quantitative Findings

Coaching Impact on Patient Engagement

PAM scores fell in both groups after the ED visit but fell significantly more in "usual care" than "intervention" participants (-4.64 and -2.77, respectively; unadjusted linear regression, β=1.87, p=0.043) (Table 2). This finding remained statistically significant after inverse probability weighting to account for loss to follow-up (DID=1.96, t=23.42, p=0.027).

Follow-Up Doctor Visits

Most patients (61%) did not report a doctor visit within two weeks of the ED visit (Table 1). "Intervention" participants were more likely to report a follow-up within four weeks of ED visit (74% vs. 65%, respectively, p=0.53).

Qualitative Findings

Nine interviews (5 "intervention," 4 "usual care") were conducted: 5 from Site 1 (4 female, 3 "intervention") and 4 from Site 2 (3 female; 2 "intervention"). Participant ages ranged from 62-86 years, and all were African American with more than one chronic condition.

Patient Engagement and Decision to Seek ED Care

When participants decided to visit the ED, they were highly engaged and motivated to address their health concern.

Table 1. Participant characteristics at time of random group assignment and at the time of the follow-up survey.

	Participant characteristics at baseline (n=69)				Participant characteristics at follow-up (n=40)			
	Overall (n=69)	Intervention (n=35)	Usual care (n=34)	p-value	Overall (n=40)	Intervention (n=23)	Usual care (n=17)	p-value
Mean age ± SD	72.6 ± 8.8	72.0 ± 8.3	73.2 ± 9.4	0.55	71.5 ± 7.8	70.7 ± 7.2	72.5 ± 8.8	0.47
Gender, n (%)				0.92				0.24
Male	30 (43)	15 (43)	15 (44)		16 (40)	11 (48)	5 (29)	
Female	39 (57)	20 (57)	19 (56)		24 (60)	12 (52)	12 (71)	
Non-white, n (%)				0.52				0.69
Yes	53 (77)	28 (80)	25 (74)		34 (85)	20 (87)	14 (82)	
No	16 (23)	7 (20)	9 (26)		6 (15)	3 (13)	3 (18)	
Self-rated health, n (%)				0.10				0.13
Excellent; very good; good	40 (60)	23 (70)	17 (50)		25 (66)	16 (76)	9 (53)	
Fair or poor	27 (40)	10 (30)	17 (50)		13 (34)	5 (24)	8 (47)	
Mean chronic conditions count ± SD	3.9 ± 1.7	3.9 ± 1.5	3.9 ± 1.9	0.89	3.7 ± 1.5	4.0 ± 1.7	3.3 ± 1.2	0.22
Emergency severity index**				0.22				0.08
High acuity	32 (48)	19 (56)	13 (41)		20 (51)	14 (64)	6 (35)	
Less urgent	34 (52)	15 (44)	19 (59)		19 (49)	8 (36)	11 (65)	
Employment status, n (%)				0.98				0.74
Yes	4 (6)	2 (6)	2 (6)		3 (8)	2 (9)	1 (6)	
No	65 (94)	33 (94)	32 (94)		37 (93)	21 (91)	16 (94)	
Education, n (%)				0.80				0.89
High school or less	56 (81)	28 (80)	28 (82)		31 (78)	18 (78)	13 (76)	
Some college or more	13 (19)	7 (20)	6 (18)		9 (22)	5 (22)	4 (24)	
Percent seeing provider within 30 days, n (%)	--	--	--	--	28 (70)	17 (74)	11 (65)	0.53
Percent seeing provider within 2 weeks, n (%)	--	--	--	--				0.73
Yes					13 (39)	7 (37)	6 (43)	
No					20 (61)	12 (63)	8 (57)	
Mean number of providers seen within 30 days ± SD	--	--	--	--	1.7 ± 1.6	1.7 ± 1.6	1.6 ± 1.7	0.82

*The following 11 chronic conditions were measured in this count: heart attack, cancer, angina, diabetes, congestive heart failure, arthritis, stroke, depression, high blood pressure, atrial fibrillation, chronic obstructive pulmonary disease.
** Categorized as high acuity (ESI=1, 2) or less urgent (ESI= 3, 4, 5).

Decisions to visit the ED were well-thought out and driven by *individual characteristics*, including the nature and severity of symptoms, personal advice and prior *healthcare system experiences*. Representative quotes are described below.

Individual Characteristics

Unremitting pain and history of similar symptoms factored heavily into patients' decisions to use the ED. Pain and at least one other precipitating factor (e.g., history of similar symptoms, advice of trusted sources, including providers, friends, family) led to uncertainty, fear, and a decision to seek emergency care for all (9/9) participants.

> [2-4]: "I had a pain at the end of my spine and that hip bone that joined together …I had to go. I can't stand pain no way. And that's why I ended up going to emergency."

> [1-2]: "I was in a lot of pain for one thing. And I had, beforehand, had a blood clot. So I didn't know if another one had come back or not, so I thought maybe I needed to go to the emergency room."

Table 2. Unadjusted average patient activation measure (PAM) scores for the intervention and usual care groups during the baseline and follow-up periods, intention to treat (n=40).

	Usual Care (n=17)			Intervention (n=23)				
	Baseline	Follow-Up	Difference	Baseline	Follow-Up	Difference	β	p-value
PAM Score	59.976	55.335	-4.64	68.013	65.243	-2.77	1.87	0.043

Another participant sought ED care because of history of hyperglycemia.

> [1-5]: "I can tell when my sugar goes up because I get really dizzy. The emergency room was the best place to go because if I went to a primary doctor, they were going to send me to an emergency room anyway."

Participants often considered the advice of family, friends, or healthcare providers.

> [2-2]: "I couldn't straighten up, stand up, or sit down without having cramps. A friend of mine called the ambulance for me, and I was then rushed to the [ED]."

Healthcare System Experiences

Decisions to seek ED care were influenced by patients' prior healthcare system experiences. Perceptions of availability of care in the provider's office versus ED care were important. For most (6/9), obtaining a same-day appointment or speaking with a provider was not possible even if the patient believed the need was urgent. Patients' perceptions that the ED provides comprehensive care led (3/9) participants to seek emergency treatment.

> A participant with chest tightness and blood pressure of 235/96 [1-4]: "I went to [my doctor], but he was filled up. So I called him and asked him could I come back? And he said no. It would probably 4:00 or 5:00 if I got seen then. I said, "Well, I'm going to have to go to the emergency room because I'm sick. I feel bad."

> [2-4] [My] doctor would [not be able to see me at] "that particular time of day," so [I] "just went on to emergency."

Symptoms when providers' offices were closed influenced decisions to seek ED care. The following participant developed what she thought were minor symptoms on a weekend and decided to wait for symptoms to subside. Her son convinced her to seek immediate care.

> [2-1]: "And so I felt like something was sitting on my chest. So I got up and I got ready, and I went on to church. And [the pain] was still there and then I said, "Ah, it'll go." So I didn't go [to the ED]. My son came and he said, 'Either you let me take you [to the fire station around the corner], or I'll call 911.' That I didn't want, so I said, 'Well, okay, come and take me around there.' The [fire fighter] said, 'Well, we can't let you go with it…You're having chest pain.' I said, 'Yes, sir, but it feels like gas.' He said, 'Well, that's what heart attacks are like. They are mostly like gas, but then you're having a heart attack.' So, I agreed for them to take me to the emergency room because I really wanted to know what it was."

For participants attending large community-based clinics (health department or Veterans Affairs), timely contact with a provider usually was not possible. Appointments were viewed as a strategy to "maintain" health through check-ups and refilling prescriptions rather than addressing a healthcare concern. For these participants, ED care was considered a reasonable option.

> [2-2]: "If I had called [my primary care clinic] to tell them I had cramps they would have given me an appointment two or three months down the line… As a matter of fact, after I went [to the ED in June] and called for a [follow-up] appointment, the earliest appointment they could give me was in August."

In contrast to perceived lack of availability of timely outpatient care, participants perceived ED care as immediate and comprehensive because of staffing and availability of ancillary and specialty referral services.

> [1-3]: "In the ER they get right on it…They won't let me sit back and die. I know they are coming randomly and checking everything and they know what my levels are. I'm not dying because they would be in there."

> [1-4]: "I figured they had more equipment to do testing over [in the ED] than my primary care doctor did. They can do everything at once."

Participants' relationships with their doctor also heavily influenced healthcare-seeking decisions. If the provider was familiar with them and helped them navigate the system,

participants were more likely to contact their provider with health concerns and questions about where to seek care. One participant described a partnership with her provider:

> [1-1]: "[She] explained things and she insisted that you do things that you know you needed to do." This patient reported their provider was attentive to the participant's concerns, and arranged appointments for follow-up tests and regular screenings.

Intervention Impact on Patient Engagement

Three of five "intervention" patients indicated the coaching intervention helped them stay involved in their healthcare by increasing their understanding of chronic disease symptoms, appropriate use of medications and follow-up care. They appreciated having someone to call if they had questions. Patients reported receiving help with other needed services.

> [2-2]: "Knowing you could call someone, and you don't have to go through these channels with them. It makes you feel comfortable; not as stressful – there is this person that you know you can call and say 'this is what is going on'…and they could do something to help you."

Coaches also helped participants access other community services including transportation [1-2]:"because transportation is my biggest problems."

DISCUSSION

Patient engagement has been called the blockbuster drug of the century. When patients are more engaged, they have better health outcomes and lower healthcare costs.[1-5] Unfortunately, interventions aimed at engaging ED patients to help them better manage their health and healthcare have been largely ignored. This study is novel because it focused on chronically ill, older ED patients with limited health literacy, a high-risk population that is often under-engaged in their health and rely on the ED during a health crisis.[14] To our knowledge, this is the first study to assess the impact of an ED-initiated coaching intervention on patient engagement in a vulnerable ED population. The study documented three observations regarding patient engagement. First, chronically ill patients with limited health literacy are most engaged at ED presentation as assessed by PAM scores. Second, engagement falls in the weeks after the ED visit in all patients. Third, the ED-to-home "intervention" significantly reduced the post-ED fall in patient engagement relative to "usual care."

Baseline PAM scores were higher in this study than reported in a nationally representative sample of Medicare beneficiaries (64.6 versus 63.4 previously reported)[29] but fell to a mean of 61.0 in the weeks following the ED visit. Engagement is highest at ED presentation – a finding that is consistent with prior work that demonstrates patients use the ED when they feel their condition is emergent and are too worried about their condition to seek care in other settings.[16,37] Our in-depth interviews are consistent with these findings and provide insight into the critical individual and health-system factors that contribute to patients' decisions to use the ED, which include the onset and severity of symptoms, advice of trusted sources, inability to gain timely access to a provider, and perception that the ED provides immediate, comprehensive care.

We were unable to identify studies where interventions designed to increase patient engagement led to decreased PAM scores. In this study, the observed decline in PAM scores may have occurred because the baseline survey was conducted in the ED. It is likely patients become engaged to take actions about their health when their symptoms suggest something is wrong that requires emergent attention. Although highly engaged in their health during the health crisis, patients' engagement may decline as the crisis resolves without further health system contact.[38] Importantly, the ED-to-home intervention blunted the decline in post-ED PAM scores by approximately two points. The fact that similar longer-term PAM score changes are associated with improvements in physical activity, medication adherence, self-management knowledge, and functional health suggest the clinical significance of these findings.[38-40]

Coaches helped participants advocate for themselves to schedule timely follow-up doctor visits but did not make appointments for patients. Most patients did not see a provider within two weeks of ED visit, and between-group differences were not observed. It is possible that even if ED patients attempted follow-up, they were unable to obtain an appointment because of barriers previously described[41] and noted by our participants. Indeed, a recent systematic review noted that interventions designed to improve post-ED follow-up have variable effectiveness depending on the capacity and willingness of the local primary care network to accommodate ED patients.[42] It is also possible that although this intervention had a significant impact on patient engagement, it did not motivate individuals to attend follow-up doctor visits if they were not already inclined to do so.

LIMITATIONS

Among this study's limitations was the small pilot-sample size. Despite the small sample, statistically significant between-group differences in patient engagement were detected and the mixed-methods design allowed us to confirm quantitative findings through in-depth interviews. Second, the pre-pilot increase in follow-up doctor visits observed in hospitalized patients was not detected. Our study may have been underpowered to detect smaller but potentially clinically meaningful increases in post-ED outpatient follow-up visits. In addition, patients may have attempted but were unsuccessful in scheduling post-ED outpatient follow-up visits because of busy clinic schedules. This intervention was conducted in two EDs and the results may not generalize to other settings. In addition, PAM

scores fluctuate over time and this study captures only two time points.[7] However, the RCT design and DID approach suggests the observed between-group differences were a true "intervention" effect rather than chance occurrence. Finally, the PAM is proprietary, is not available for use without a license and may not be practical as a clinical tool in the time-sensitive, ED setting.

CONCLUSION

Patient engagement in chronically ill older patients with limited health literacy was highest at the time of an ED encounter and fell in the following weeks. Qualitative findings confirm and extend these findings, demonstrating that patients' decisions to visit the ED are the result of engaged decision-making. Our data suggest that an ED initiated coaching intervention reduced the degree of disengagement in healthcare after the ED visit. According to the National Quality Forum, "improved management of transitions of care into and out of the ED has the potential to improve person-centered care, quality, and cost efficiency."[43] Policy makers and health system managers should consider ED-initiated interventions like this to improve ED-to-home transitions and engagement in high-risk and hard-to-reach ED populations.

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Utility of the History and Physical Examination in the Detection of Acute Coronary Syndromes in Emergency Department Patients

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Chest pain accounts for approximately 6% of all emergency department (ED) visits and is the most common reason for emergency hospital admission. One of the most serious diagnoses emergency physicians must consider is acute coronary syndrome (ACS). This is both common and serious, as ischemic heart disease remains the single biggest cause of death in the western world. The history and physical examination are cornerstones of our diagnostic approach in this patient group. Their importance is emphasized in guidelines, but there is little evidence to support their supposed association. The purpose of this article was to summarize the findings of recent investigations regarding the ability of various components of the history and physical examination to identify which patients presenting to the ED with chest pain require further investigation for possible ACS.

Previous studies have consistently identified a number of factors that increase the probability of ACS. These include radiation of the pain, aggravation of the pain by exertion, vomiting, and diaphoresis. Traditional cardiac risk factors identified by the Framingham Heart Study are of limited diagnostic utility in the ED. Clinician gestalt has very low predictive ability, even in patients with a non-diagnostic electrocardiogram (ECG), and gestalt does not seem to be enhanced appreciably by clinical experience. The history and physical alone are unable to reduce a patient's risk of ACS to a generally acceptable level (<1%).

Ultimately, our review of the evidence clearly demonstrates that "atypical" symptoms cannot rule out ACS, while "typical" symptoms cannot rule it in. Therefore, if a patient has symptoms that are compatible with ACS and an alternative cause cannot be identified, clinicians must strongly consider the need for further investigation with ECG and troponin measurement. [West J Emerg Med. 2017;18(4)752-760.]

CASE REPORT

A 50-year-old man presented to the emergency department (ED) because he was experiencing chest pain after eating a large meal. He had discomfort in his central chest, which he described as "like indigestion." The pain did not radiate, was not associated with other symptoms, and resolved spontaneously after 30 minutes. The patient had no relevant medical history and no risk factors for ischemic heart disease. An electrocardiogram (ECG) obtained soon after his arrival in the ED was normal.

Is acute coronary syndrome (ACS) likely to be the cause of this man's chest pain? Can we use any features of his history and physical examination to determine the likelihood of ACS?

INTRODUCTION

Ischemic heart disease remains the leading cause of death in the United States, accounting for a quarter of all deaths.[1,2] Accurate recognition of acute myocardial infarction (AMI) in the ED is crucial, as the mortality rate of patients with missed AMI is at least double that of similar patients who are accurately diagnosed.[3] Missed AMI is also one of the most common reasons for medical malpractice claims in the U.S. [4-6]

Chest pain is the second most common reason for ED visits, accounting for 5.4% of all presentations, and many of these patients are admitted for evaluation for ACS.[7] The costs involved are staggering: In the U.S. in 2011, the cost for admitting patients with chest pain totaled $11.5 billion, representing 3% of the nation's healthcare expenditures.[8] Although the mortality rate for admitted patients is lower than for those whose AMI goes undetected, hospital admission presents its own risks, including infection and procedural complications.[9] A recent retrospective analysis revealed that there was a very low incidence of short-term adverse cardiac events in chest pain patients who were hospitalized after an ED workup determined they were low risk (i.e,, patients with non-concerning vital signs, non-ischemic ECG, and two negative troponins taken in the ED between 60 and 420 minutes apart).[10] This finding suggests that not every patient with chest pain will benefit from a full admission and that risk stratification can be improved. In this article, we review the evidence regarding the utility of the patient's history and physical examination in determining the risk of ACS in patients who present to EDs with chest pain.

UTILITY OF THE HISTORY OF PRESENT ILLNESS AND PHYSICAL EXAMINATION

Electrocardiography and troponin testing are considered the cornerstones of the diagnosis of AMI and ACS, but they are both insensitive at the time of ED evaluation.[11,12] The history of presenting illness (HPI) and physical examination provide an immediate source of information by which emergency physicians can stratify patients according to the need for further workup. Multiple guidelines have supported this approach,[13,14] but only a few groups have examined which features of the HPI are most correlated with cardiac causes in undifferentiated ED patients with chest pain. Of chief importance was an exploration of typical (i.e., severe and acute-onset chest pain, most often left-sided, provoked by effort and accompanied by anxiety, shortness of breath, and a choking sensation)[15] and atypical symptoms. Goodacre et al. prospectively enrolled 893 patients presenting with chest pain between 1999 and 2000.[16] They defined AMI according to guidelines from the World Health Organization (WHO) and ACS as one of the following: a positive stress test; a positive troponin level; an ischemic pattern on ECG; or subsequent AMI, death by cardiac cause, or revascularization within six months. Multivariate analysis found that AMI was most closely associated with chest pain that radiated to the shoulder (odds ratio [OR]=5.7, 95% confidence interval [CI] [1.5-21.4], p=0.009), radiated to both arms (OR=4.9, 95% CI [1.3–19.4], p=0.02), or was exacerbated with exertion (OR=3.3, 95% CI [1.3–8.4], p=0.014). ACS was most closely associated with radiation to the shoulder (OR=5.2, 95% CI [2.0–13.4], p=0.0008), left arm (OR=2.1, 95% CI [1.0-4.4], p=0.042), or both arms (OR=4.8, 95% CI [1.8–13.2], p=0.002) or pain that was exertional (OR=2.4, 95% CI [1.3-4.5], p=0.005). The same analysis found that the presence of chest wall tenderness decreased the likelihood of AMI (OR=0.2, 95% CI [0.05–0.97], p=0.045).

Milner and associates prospectively recorded the symptomatology and medical history of 531 patients presenting to an ED with chest pain. Their primary focus was on age-related differences in the presentation of ACS. Of the patients diagnosed with ACS, those older than 70 had a higher burden of comorbidities than did those younger than 70. The comorbidities included a history of MI (51% vs 31%, p=0.038), coronary heart disease (50% vs 73%, p=0.001), hypercholesterolemia (45% vs 32%, p=0.045), and heart failure (28% vs 10%, p=0.001). Further analysis showed that chest pain (OR=2.47, 95% CI [1.37–4.42], p=0.002), radiation to the arm (OR=1.78, 95% CI [1.03–3.09], p=0.040), and fatigue (OR=2.52, 95% CI [1.10–5.81], p=0.29) were all positively associated with ACS in younger subjects, yet none of these factors was significant in older subjects. An increasing number of typical symptoms was associated with ACS in those under 70 years of age. However, the "typicality" of presentation had no association with ACS in older patients. These findings suggest that older patients with ACS have a higher burden of traditional cardiac risk factors but present with few of the traditional symptoms.

In 2004, two internists conducted a systematic review of the literature to assess bedside findings useful in diagnosing AMI in patients with chest pain.[18] Their review included studies of patients admitted to inpatient wards and intensive care units as well as undifferentiated ED patients. This review included patients with stable cardiac disease in addition to a group that had experienced MI, but it did not examine the entire spectrum of ACS. Among patients with acute chest pain, the features that best predicted AMI were right arm or shoulder pain (LR+=4.7, 95% CI: 1.9–12), an S3 gallop (LR+=3.2, 95% CI [1.6–6.5]), and either a history (LR+=2.1, 95% CI [1.8–2.5]) or a finding of diaphoresis (LR+=2.9, 95% CI [1.3–6.6]). Adding an ECG was helpful, as new ST-elevations (LR+=22, 95% CI [16–30]), new ST-depressions (LR+=4.5, 95% CI [3.6–5.6]), and new Q waves (LR+=22, 95% CI [7.6–62]) all strongly predicted an AMI. The factors that decreased the likelihood of AMI were a normal ECG (LR+=0.2; 95% CI [0.1–0.3]) and reproducible chest wall tenderness (LR+=0.3; 95% CI [0.2–0.4]). Chest pain that was pleuritic (LR+=0.2; 95% CI [0.2–0.3]), sharp (LR = 0.3; 95% CI [0.2–0.5]), or positional (LR = 0.3; 95% CI [0.2–0.5]) also lowered the likelihood of AMI.

Bruyninckx and associates conducted a meta-analysis of patients with chest pain, looking for features that predicted AMI or ACS.[19] The studies included undifferentiated ED patients, admitted patients, and those being observed in chest pain units. They found very few features with LR≥3 or LR≤0.4. Pain in the right arm or shoulder was suggestive of ACS in both selected (LR+=3.78, 95% CI [2.17–6.60]) and undifferentiated patients (LR+=3.80, 95% CI [1.12–12.91]). The next most-predictive features were severe pain (LR+=1.68, 95% CI [1.40–2.02]) and neck pain (LR+=1.44, 95% CI [1.12–1.86]) in undifferentiated patients. The feature most closely associated with an alternative diagnosis was chest wall tenderness (LR+=0.17, 95% CI [0.11–0.28]).

Body and colleagues examined 804 patients who sought treatment in a university-affiliated ED in the United Kingdom for complaints suggestive of cardiac chest pain[20] (Table). Their primary outcome was AMI,[21] with a secondary outcome of an adverse cardiac event within the next six months. An adverse cardiac event was defined as death (from all causes), AMI, angiographic evidence of new stenosis ≥50% not amenable to intervention, or the need for revascularization within six months after the index ED visit. Revascularization was defined as a non-elective percutaneous coronary intervention or bypass grafting. AMI was diagnosed in 18.6% during the index ED visit, and 22.9% had experienced an adverse cardiac event by the time of follow-up six months later. The features of the HPI and physical exam that were most associated with AMI were observed diaphoresis in the ED (LR+=6.39, 95% CI [4.38–9.33]), reported vomiting (LR+=3.09, 95% CI [1.89–5.05]), and pain radiation to both arms/shoulders (LR+=2.58, 95% CI [1.53–4.34]) or to the right arm/shoulder (LR+=2.31, 95% CI [1.52–3.53]). Hypotension was also associated with AMI (LR+=2.92, 95% CI [1.34–6.37]), but it was rare (occurring in 6.8% of subjects with AMI). For all subjects with AMI or adverse cardiac events at six-month follow-up, the most predictive signs and symptoms were observed diaphoresis (LR+=5.11, 95% CI [3.42–7.63]), reported vomiting (LR+=2.97, 95% CI [1.82–4.85]), and radiation of pain to both shoulders/arms (LR+=2.57, 95% CI [1.55–4.29]) or to the right arm or shoulder (LR+=2.22, 95% CI [1.47–3.34]). Hypotension continued to be an insensitive (7.6%) but strong predictor of a cardiac cause of chest pain (LR+=4.93, 95% CI [2.21–10.98]). Many of the individual risk factors and features of the HPI had areas under their receiver operating curves very close to 0.5, making them only slightly better than a coin flip when determining whose chest pain had a cardiac cause. The authors concluded that many typical features of AMI and ACS have little diagnostic value, while several atypical features of the HPI provide significant assistance in identifying patients with cardiac causes of chest pain.

As an extension of that study, Greenslade and colleagues in Australia and New Zealand sought to determine whether the HPI and physical examination features associated with ACS and AMI were consistent across multiple patient populations.[22] They analyzed an existing dataset based on 1,868 patients who presented with chest pain to one of 12 academic ED across the Asia-Pacific region. Most of the study group—857 patients (45.9%)—were Caucasian, 730 (39.1%) were Chinese, 181 (9.7%) were Korean, and 100 (5.3%) were Indian. ACS was diagnosed in 358 (19.2%) of them. Chinese, Indian, and Korean patients were more likely than Caucasians to report "typical" symptoms (64–66% vs 23%, respectively), but it was only in patients of Indian descent that "typical" symptoms were predictive of ACS (OR=8.82, 95% CI [2.19–35.48]). The presence or absence of symptoms associated with the chest pain was consistently low across the various racial groups. For example, in Chinese patients, the presence of exertional pain (OR=0.41, 95% CI [0.32–0.53]), pleurisy (OR=0.26, 95% CI [0.19–0.35]), nausea (OR=0.52, 95% CI [0.42–0.67]), and shortness of breath (OR=0.59, 95% CI [0.48–0.73]) all decreased the likelihood of ACS. The only physical examination sign that was significantly associated with ACS was diaphoresis, which was true only in Chinese and Caucasian patients. The authors concluded that, although there are some racial differences in symptoms, they do not play a large role given that the HPI and physical examination have little diagnostic value overall for ACS.

UTILITY OF TRADITIONAL RISK FACTORS FOR CARDIAC DISEASE

The Framingham Heart Study is a landmark longitudinal experiment in population health. Designed by Dr. Thomas Dawber and funded through the National Heart, Lung, and Blood Institute, the purpose of the study was to identify the risk factors associated with cardiovascular disease.[23] The classic factors are hypertension, hyperlipidemia, smoking, diabetes, age, family history of early cardiac events, and male gender,[24] with human immunodeficiency virus infection emerging as a new risk factor.[25] These epidemiologic factors for coronary artery disease (CAD) have traditionally been used in the ED to help determine the likelihood of whether or not a given patient with chest pain had ACS.[13,14,26] This application is based on the assumptions that patients with CAD are more likely to have ACS and that population-level factors can be extrapolated to an individual patient. Several studies have examined the value of these risk factors in the ED evaluation of patients with chest pain.

Jayes and associates prospectively collected data from 5,773 patients evaluated in the EDs of six hospitals, who had the typical symptoms suggestive of ischemic disease.[27] For the 1,743 who did not have clinically obvious coronary disease, medical histories and traditional risk factors were recorded. In male patients, only a history of diabetes (relative risk [RR]=2.4, 95% CI [1.2–4.8]) or family history of myocardial infarction (RR=2.1, 95% CI [1.4–3.3]) significantly increased the risk of ACS. None of the classic risk factors assisted in the

Table. Characteristics of each predictive clinical feature as a diagnostic test for ACS in the emergency department.

Predictor	Sensitivity (%)	Specificity (%)	PPV[1] (%)	NPV[2] (%)	LR+[3]	LR-[4]	Reference
Pain Characteristics							
Chest pain	56.8	33.5	10.8	84.6	0.85	1.3	a
	70.2	42.1	45.2	67.5	1.3	0.9	b
Pain radiates to both shoulders/arms	13.5	94.8	37.0	82.8	2.3	0.9	c
Pain radiates to right shoulder/arm	18.9	91.8	34.6	83.2	2.6	0.9	c
Neck/jaw pain	23.5	84.8	18.0	88.7	1.6	0.9	a
	14.9	90.2	50.8	60.9	1.5	0.9	b
Back pain	11.6	86.7	11.0	87.4	0.9	1.0	a
	6.5	93.0	38.9	59.4	0.9	1.0	b
Central pain	85.1	34.1	22.8	91.0	1.3	0.4	c
Sharp quality	11.9	75.4	6.4	85.9	0.5	1.2	a
Pleuritic	6.5	81.5	4.8	86.1	0.4	1.1	a
Timing of the pain							
Acute onset (<1 hr)	75.9	32.3	13.7	90.5	1.1	0.7	a
Gradual onset (>1 hr)	21.1	71.2	9.4	86.5	0.7	1.1	a
Worse with exertion	53.3	71.1	20.6	91.5	1.8	0.7	a
Change in pattern of stable angina	27.4	86.4	22.1	89.4	2.0	0.8	a
Associated symptoms							
Diaphoresis	28.3	79.2	16.1	88.7	1.4	0.9	a
	25.1	81.6	48.2	61.6	1.4	0.9	b
	36.5	94.3	22.9	85.4	6.4	0.7	c
Reported vomiting	21.1	76.9	11.4	87.4	0.9	1.0	a
	21.9	79.7	42.3	60.0	1.1	1.0	b
	16.2	94.8	41.4	83.2	3.1	0.9	c
Dyspnea	47.0	61.3	14.6	89.1	1.2	0.9	a
	41.9	62.0	42.9	61.1	1.1	0.9	b
Palpitations	6.0	91.5	32.5	58.9	0.7	1.0	b
Fatigue	13.0	85.8	38.4	59.2	0.9	1.0	b
Indigestion	15.8	84.5	41.0	59.6	1.0	1.0	b
Dizziness/faintness	19.5	73.4	33.3	57.3	0.7	1.1	b
Hypotension	6.8	97.7	40.0	82.1	3.0	1.0	c
ECG Findings							
Acute ischemic ECG changes	71.0	81.3	46.5	92.5	3.8	0.4	c
ST-segment depression >0.5 mm	17.3	97.2	46.4	89.3	6.1	0.9	a
T-wave inversion	14.9	93.9	25.6	88.7	2.4	0.9	a
Left bundle-branch block	7.1	97.2	26.4	88.1	2.5	1.0	a

[1]PPV refers to positive predictive value, the probability of disease given a positive test and the study's disease prevalence.
[2]NPV refers to negative predictive value, the probability of not having disease given a negative test result and the study's disease prevalence.
[3]Positive likelihood ratio, the change in probability of disease when the related feature is present.
[4]Refers to negative likelihood ratio, the change in probability of disease when the stated feature is absent.
[a]Hess EP, Brison RJ, Perry JJ, et al. Development of a clinical prediction rule for 30-day cardiac events in emergency department patients with chest pain and possible acute coronary syndrome. *Ann Emerg Med*. 2012;59(2):115–25.
[b]Milner KA, Funk M, Richards S, Vaccarino V, Krumholz HM. Symptom predictors of acute coronary syndromes in younger and older patients. *Nursing Res*. 2001;50(4):233–41.
[c]Body R, Carley S, Wibberley C, et al. The value of symptoms and signs in the emergent diagnosis of acute coronary syndromes. *Resuscitation*. 2010;81(3):281.
[d]Body R, McDowell G, Carley S, Mackway-Jones K. Do risk factors for chronic coronary heart disease help diagnose acute myocardial infarction in the Emergency Department? *Resuscitation*. 2008;79(1):41–5.
[e]Han JH, Lindsell CJ, Storrow AB, et al. The role of cardiac risk factor burden in diagnosing acute coronary syndromes in the emergency department setting. *Ann Emerg Med*. 2007;49(2):145–52.

Table. Continued.

Predictor	Sensitivity (%)	Specificity (%)	PPV[1] (%)	NPV[2] (%)	LR+[3]	LR-[4]	Reference
Right bundle-branch block	5.4	95.8	15.3	87.8	1.3	1.0	a
Q waves	11.6	91.3	15.8	88.0	1.3	1.0	a
Number of Risk Factors							
≥1	92.6	12.2	23.0	83.1	1.1	0.6	d
	95.2	9.8	6.8	91.4	1.1	0.5	e
≥2	58.1	37.0	19.0	81.6	0.9	1.1	d
	80.7	29.6	9.0	92.3	1.1	0.7	e
≥3	27.7	66.7	13.6	80.0	0.8	1.1	d
	53.0	60.9	10.7	92.4	1.4	0.8	e
≥4	11.5	90.3	21.3	81.7	1.2	1.0	d
	20.4	88.1	15.1	92.3	1.7	0.9	e

[1]PPV refers to positive predictive value, the probability of disease given a positive test and the study's disease prevalence.
[2]NPV refers to negative predictive value, the probability of not having disease given a negative test result and the study's disease prevalence.
[3]Positive likelihood ratio, the change in probability of disease when the related feature is present.
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[c]Body R, Carley S, Wibberley C, et al. The value of symptoms and signs in the emergent diagnosis of acute coronary syndromes. *Resuscitation*. 2010;81(3):281.
[d]Body R, McDowell G, Carley S, Mackway-Jones K. Do risk factors for chronic coronary heart disease help diagnose acute myocardial infarction in the Emergency Department? *Resuscitation*. 2008;79(1):41–5.
[e]Han JH, Lindsell CJ, Storrow AB, et al. The role of cardiac risk factor burden in diagnosing acute coronary syndromes in the emergency department setting. *Ann Emerg Med*. 2007;49(2):145–52.

risk stratification of female patients. In this population, the magnitude of the RRs associated with these historical risk factors was small compared with those calculated for a simple complaint of chest pain (RR=12.1), an abnormal ST-segment (RR=8.7), or an abnormal T wave on the ECG (RR=5.3). The authors concluded that traditional risk factors had little weight in the overall assessment of ED chest-pain patients for acute cardiac ischemia, especially compared with the chief complaint and the ECG.

This question was revisited by Han and co-workers through a post-hoc analysis of the Internet Tracking Registry of Acute Coronary Syndromes (i*trACS).[28] Their study included risk factor data from 10,806 patients during their first visit to a U.S. ED for suspected ACS. Cocaine and methamphetamine users as well as those with incomplete records were excluded. ACS was defined as a composite endpoint of death or revascularization within 30 days, diagnostic-related group codes, or positive cardiac markers (creatine kinase [CK-MB] or cardiac troponin) on index hospitalization and was present in 8.1% of the study population. Age was a strong risk factor in this group, so the investigators stratified the results into three groups: <40 years, 40 to 65 years, and >65 years. In those younger than 40, having no risk factors had a negative likelihood ratio (–LR) of 0.17 (95% CI [0.04–0.66]), while having more than four factors had a positive likelihood ratio (LR+) of 7.39 (95% CI [3.09-17.67]). In the intermediate age category, having no risk factors had a –LR of 0.53 (95% CI [0.40–0.71]), and having four or more risk factors had a LR+ of 2.13 (95% CI [1.66–2.73]). In those over the age of 65, having no factors had a –LR of 0.96 (95% CI [0.74–1.23]); the presence of four or more factors had a LR+ of 1.09 (95% CI [0.64–1.62]). The authors concluded that their observations provide evidence for an age-related decrease in the utility of traditional risk factors in judging the likelihood that an ED patient has ACS.

In 2008, Body and associates enrolled a study population of 796 patients over the age of 25 who presented to their university-affiliated ED with suspected cardiac chest pain.[29] The subjects' risk factors and hospital course were recorded, and all patients were followed up at six months. Nineteen percent of them met the AMI criteria set forth by the American Heart Association and the European Society of Cardiology, and 12% of those with AMI had no risk factors for cardiac disease. There was no correlation between increasing number of risk factors and increasing incidence of AMI (Table). The area under the receiver operating curve (AUROC) for cardiac risk factors was 0.59 and the risk factor burden was no better than chance for predicting AMI (p=0.59). Univariate logistic regression analysis of the individual risk factors found that smoking history had the strongest association with AMI, but

even this had a small OR of 2.31 (95% CI [1.60–3.23]). The authors concluded that traditional risk factors for coronary heart disease were not clinically useful for predicting which patients had AMI in the ED.

Hess and his research team described the presentations of 2,718 patients assessed in three academic EDs between 2007 and 2010, looking at in-hospital and cardiac events 30 days after discharge.[30] They collected extensive information on subjects, ranging from past medical history, the history of present illness, ECG findings, and patient outcomes (ACS, AMI, revascularization, in-hospital mortality, and death after discharge). Factors in the history that were most predictive of ACS were pain similar to a previous episode of ACS (OR=3.35, 95% CI [2.65–4.24]), radiation to both arms (OR=2.82, 95% CI [1.91–4.17]), worsening chest pain with exertion (OR=2.81, 95% CI [2.23–3.54]), and a change in the pattern of usual angina over the prior 24 hours (OR=2.39, 95% CI [1.83–3.12]). Pain that was pleuritic (OR=0.31, 95% CI [0.20–0.48]), sharp in quality (OR=0.42, 95% CI [0.30–0.59]), or gradual in onset (OR=0.66, 95% CI [0.50–0.87]) decreased the likelihood of ACS. Hypercholesterolemia (OR=2.35, 95% CI [1.83–3.02]), hypertension (OR=2.00, 95% CI [1.56–2.58]), diabetes (OR=1.75, 95% CI [1.35–2.25]), and smoking (OR=1.33, 95% CI [1.06–1.67]) were all weakly predictive of ACS. Known CAD (OR=3.25, 95% CI [2.57–4.11]), angina (OR=2.87, 95% CI [2.26–3.64]), previous AMI (OR=2.14, 95% CI [1.68–2.72]), and peripheral vascular disease (OR=1.99, 95% CI [1.14–3.49]) also increased the likelihood of ACS.

One question arises out of these investigations: why have atypical symptoms become more important than in previous studies? Part of the answer is that the definition of cardiac disease has changed as the technology used to detect it has improved. For example, CK/CK-MB testing is no longer part of the ED workup because it is insensitive compared with troponin testing,[31] and the presence of a Q wave is not used to determine the management of AMI.[32] As troponin testing has become increasingly sensitive, clinicians are detecting more mild disease, so some patients who would have been diagnosed with unstable angina in the past are now considered to have NSTEMI.[33,34] Ndrepepa and associates requested simultaneous conventional and ultra-high-sensitivity troponin testing of ED patients with chest pain. They observed that a small amount of cardiac troponin T, detectable only with the high-sensitivity process, was a powerful predictor of long-term all-cause and cardiac mortality and supported reliable stratification of mortality risk in patients with CAD.[34] However, the presence of small amounts of troponin did not predict nonfatal MI, stroke, or the need for revascularization. The high-sensitivity assay extends the prognostic value of troponin measurements to patients with symptomatic CAD, for whom conventional assays are insensitive. The detection of elevated levels of cardiac troponin T with high-sensitivity assays in samples from patients who do not have myocardial necrosis indicates an adverse cardiovascular risk profile and can be used as an index of cardiovascular risk in general.

Assuming no significant change in the underlying prevalence of cardiac disease, these results suggest that enhanced technologies allow clinicians to detect larger and larger proportions of patients with the disease, beyond the "textbook" cases to the atypical and protean presentations. As the definition of disease widens and a resulting increase in number of patients with cardiovascular disease occurs, the spectrum of clinical presentations must also change. Recent studies of ED patients with chest pain, with a newer emphasis on the predictive power of atypical symptoms, likely reflect this wider range of detectable disease and presentations.

THE (IN)ACCURACY OF PHYSICAN GESTALT

One response to the poor ability of the HPI and physical exam to identify ACS is to argue that clinician gestalt—a physician's accumulation of experience combined with data gathered during a patient encounter—is still reliable for this assessment. To assess the accuracy of clinicians' sense of the diagnosis and outcome, Kline and colleagues retrospectively examined a cohort of adults who came to an ED with complaints of shortness of breath or chest pain.[35] The investigators excluded patients whose ECGs showed evidence of acute ischemia or infarction; those thought to require admission by the treating physician; and those with serious physical features such as shock, altered mental status, hemorrhage, sepsis, or arrhythmia. The treating clinicians documented their assessment of the cause of patients' symptoms, and those notes were stratified by level of experience and training (board-certified emergency medicine faculty, third-year resident physicians, and physician assistants). ACS was ultimately diagnosed in 23 (2.7%) of the 840 subjects enrolled. Clinician assessments were stratified as being completed by board-certified physicians (n=560 [67%]), senior residents (202 [24%]), and physician assistants (78 [9%]). Clinician gestalt had a weak correlation with ultimate diagnoses at follow-up (Spearman rho=0.41, 95% CI [0.35–0.47]). The AUROC of gestalt for ACS was somewhat better than chance, at 0.64 (95% CI [0.51–0.77]). The three clinician groups had similar levels of accuracy. The poor overall performance of gestalt in this study was thought to be a result of over-testing and low specificity.

Another investigation by Body and associates prospectively enrolled 458 ED patients presenting with suspected cardiac chest pain, 81 (17.7%) of whom had AMI.[36] By 30-day follow-up, an additional 19 patients had experienced a major adverse cardiac event (death, AMI, or catheterization). Treating physicians were asked to record their gestalt at the time of presentation on a five-point Likert scale: definitely not ACS, probably not ACS, not sure, probably ACS, and definitely ACS. Clinician gestalt had an

AUROC of 0.76 (95% CI [0.70–0.82]). Admitting any patient for whom the probability of ACS was marked as definite, probable, or not sure by the treating physician (i.e., discharging everyone in whom the diagnosis was felt to be probably not or definitely not ACS) had a high sensitivity (95.1%) but low specificity (31.8%) for AMI. Adding a troponin and an ECG to clinician gestalt increased the sensitivity to 100%, though specificity decreased somewhat (28.0%). When a high-sensitivity troponin and an ECG were added when clinicians thought the chest pain was definitely or probably caused by cardiac ischemia, the sensitivity remained high (100%) with an improvement in specificity (46.6%). The authors concluded that gestalt had moderate ability to correctly identify patients with ACS and that, when added to an ECG and cardiac troponin (using a contemporary or high-sensitivity assay), it could identify a proportion of patients at very low risk for ACS (23.1% and 41.7%, respectively).

Carlton and colleagues focused on clinician gestalt where it might help the most—in the assessment of patients with a non-diagnostic ECG.[37] They enrolled 912 patients with chest pain and a non-diagnostic ECG in an academic ED. Treating physicians were asked to rate the "typicality" of each patient's chest pain for the diagnosis of ACS and to indicate their level of experience (novice [<1 year of experience] vs experienced [>2 years of practice]). The typicality of the patient's chest pain had low correlation with a final diagnosis of ACS: the AUROC for both novice and experienced providers was 0.54 to 0.55 ($p<0.05$ for both). This did not change when the physicians examined patients found to have significant CAD on catheterization. The AUROC for both experienced and inexperienced clinicians was low (AUROC: 0.43–0.56, $p>0.05$ for all comparisons). The researchers concluded that clinicians' judgment is of little diagnostic value compared with the ECG and troponins and recommended that future work should focus on high-sensitivity assays and rapid rule-out protocols to accurately identify very low-risk and no-risk patients who may be discharged safely from the ED.

CASE RESOLUTION AND DISCUSSION

The patient had no prior medical problems and had experienced central, indigestion-like pain that was acute in onset. From the Table, the LR+ are 1.3, 1.0, and 1.1 (respectively). To obtain the total effect of several LRs, we multiply the component LRs: 1.3 x 1.0 x 1.1 = LR_{tot} = 1.43. Using 0.16 as our pre-test probability of disease (AMI, cardiac revascularization, or death),[30] our post-test probability of disease becomes 0.27. Even with a relatively benign story and no cardiac risk factors, this patient will require further testing before he can be discharged safely. Adding in our patient's normal ECG (LR+ = 0.2) does lower his risk, and our new post-test probability of disease is still 0.06. The patient in the vignette did well, but most physicians would feel that a 6% probability of ACS is too high.[38]

To be considered a "strong" test with the ability to rule in or rule out diagnoses, a test should have LRs greater than 10, or smaller than 0.1. LRs of this size will generally alter the post-test probability of disease by 45%.[38] To be of any clinical utility, tests should at least have LRs greater than 3, or less than 0.4. Note that tests that perform at this level will only change the post-test probability of disease by about 20%.[39] As can be seen from the Table, very few factors meet even this lower threshold. Of those features that have greater predictive value, some are rare (e.g., hypotension) and therefore don't apply to most ED patients. In practice, we know that it is the accumulation of many small factors that tips our internal balance, indicating when it is worthwhile to pursue a particular diagnosis. But in the case of chest pain and ACS, a patient may have many negative predictors of ACS, or have no positive predictors for ACS, yet their remaining risk may still be higher than what many clinicians would accept (i.e., 1% or less).[38] Unless there is a clear alternative cause, further testing is virtually required in all ED patients with chest pain. Therefore, despite their prominence in international guidelines, the HPI, Framingham risk factors, and physician gestalt all appear to have limited value for "ruling in" or "ruling out" ACS.

CONCLUSION

A few factors are consistently associated with an increased likelihood of ACS: pain accompanied by diaphoresis or vomiting, radiation of the pain (especially to both arms), and pain aggravated by exertion. Similarly, the features that decreased the risk of ACS were reproducible chest wall tenderness, or pain that was pleuritic, sharp, or positional. These features are useful in identifying a low- or no-risk subgroup of ED patients with chest pain as a part of a rational rule-out strategy that includes troponin measurement and ECG testing. Acute care providers should strongly consider these factors when risk stratifying patients with chest pain.

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Perspectives on Home-based Healthcare as an Alternative to Hospital Admission After Emergency Treatment

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Introduction: The study objective was to explore emergency physicians' (EP) awareness, willingness, and prior experience regarding transitioning patients to home-based healthcare following emergency department (ED) evaluation and treatment; and to explore patient selection criteria, processes, and services that would facilitate use of home-based healthcare as an alternative to hospitalization.

Methods: We provided a five-question survey to 52 EPs, gauging previous experience referring patients to home-based healthcare, patient selection, and motivators and challenges when considering home-based options as an alternative to admission. In addition, we conducted three focus groups and four interviews.

Results: Of participating EPs, 92% completed the survey, 38% reported ordering home-based healthcare from the ED as an alternative to admission, 90% ranked cellulitis among the top three medical conditions for home-based healthcare, 90% ranked "reduce unnecessary hospitalizations and observation stays" among their top three perceived motivators for using home-based care, and 77% ranked "no existing process in place to refer to home-based care" among their top three perceived barriers. Focus group and interview themes included the need for alternatives to admission; the longer-term benefits of home-based healthcare; the need for streamlined transition processes; and the need for highly qualified home-care staff capable of responding the same day or within 24 hours.

Conclusion: The study found that EPs are receptive to referring patients for home-based healthcare following ED treatment and believe people with certain diagnoses are likely to benefit, with the dominant barrier being the absence of an efficient referral process. [West J Emerg Med. 2017;18(4)761-769.]

INTRODUCTION

Clinicians, researchers, and government agencies recognize the need to move toward value-based healthcare delivery that supports population health, better matches the needs of an aging population, and reduces the emerging burden of healthcare costs for the U.S.[1] Since the release of the Medicare Access and CHIP Reauthorization Act (MACRA) final rule in 2016, providers are increasingly incentivized by Medicare to assume more risk, not only to save money but to provide care that is more person-centered, higher quality, and more affordable. Seniors are also

shifting from traditional fee-for-service Medicare to Medicare Advantage plans, the latter of which often provide access to additional benefits such as medications and other services.[2]

Of the $3 trillion spent per year on healthcare in the U.S., $2 trillion is spent on chronic disease, with inpatient medical care accounting for 31% of nationwide health spending ($1 trillion per year).[3] Emergency departments (ED) are the primary entry point for hospital admissions. In effect, emergency physicians (EP) act as gatekeepers in the decision to admit patients to hospitals.[4] Specifically, over half of all hospital admissions and nearly 70% of senior admissions occur through the ED.[5,6]

Currently, EPs are generally afforded only three disposition options for patients presenting to the ED: (1) discharge, (2) observe, or (3) admit. While admission may represent the most appropriate option for many acute conditions, there also exist risks of "default" admissions, where there are simply no other options for a needed course of therapy or monitoring following ED evaluation and management. In some instances, admission may not be the best match for ongoing management of multiple chronic conditions, especially in the frail elderly where there is an elevated risk of in-hospital nosocomial infections, delirium, and falls.[7]

There is an emerging need to provide EPs with home-based healthcare alternatives to hospital admission, particularly for the elderly. The first objective of the study was to investigate the level of EP's awareness about their ability to refer patients to home-based healthcare, and the EPs' experience, if any, in invoking a home-health referral. The next objective was to uncover EP motivations for considering the use of home health for ED patients versus hospital admission, the type of patients EPs select, and time requirements for an initial home-health visit. The final objective was to gain knowledge, through conducting focus groups and interviews that paired EPs with key ED clinicians and decision makers about the incentives or barriers for using home care as an alternative to hospital admission. An analysis of the potential cost basis for home-based care as an alternative to hospitalization is presented elsewhere.[8]

Population Health Research Capsule

What do we already know about this issue?
We know that most hospital admissions originate in the ED. We also know that repeated hospitalizations for older adults elevate the risk of nosocomial infections, delirium, and falls.

What was the research question?
What is the emergency physician's (EP) perspective on disposition to home-based care following evaluation and management in the ED?

What was the major finding of the study?
EPs are receptive to referring patients for home-based care, but few have access to processes for doing so.

How does this improve population health?
It shows the potential to reduce hospital admissions from the ED, which could allow more patients—especially seniors—to be cared for at lower cost in the comfort and safety of their own homes.

METHODS

Study Design and Participants

We used an email survey, a focus group, and interview methodologies to explore knowledge of and willingness to use appropriate and safe home care as an alternative to hospital admission. The research setting included two EDs in an academic healthcare system. One hospital was an urban academic teaching hospital (Level I trauma center) with an annual census of 48,000 visits. The second was a suburban community hospital with an annual census of 27,000 visits. An Emergency Medicine Physician Survey was electronically distributed to all 52 attending physicians practicing in the health system's EDs between August and September 2014. A total of 48 (92.3%) physicians responded to the survey.

For the focus groups and interviews, study participants included three EPs, with the addition of ED leadership overseeing operations and quality, registered nurses (RNs) and social workers (SWs) employed in the ED. The focus of this research was confined to patients being evaluated in the ED.

Selection of Focus Group Participants

The answers on the physician survey were, in part, used to develop the focus group interview guides. We selected physician participants if, on the survey, they indicated previous experience with referrals to home care as an alternative to admission. Of the 48 EPs who responded, 18 (37.5%) indicated prior experience with referring patients directly from the ED. All focus group participants were selected on their availability to participate during the time frame of December 2014 through February 2015. The study was approved by the institution's Human Research Protection Program.

Study Procedures and Data Analysis

Survey

We developed survey questions following qualitative data gathered from more than 40 telephone interviews with

emergency physicians and nurses, hospital and home-health leaders, case managers, primary care physicians, and health plan administrators from across the U.S. Survey answer choices such as barriers to home-health referrals and conditions amenable to home health were gleaned from these preliminary interviews. We designed the survey questions to gauge EPs' awareness of and prior experience with referring to home-based care as an alternative to hospital-based care. Physicians were invited to complete the survey via e-mail. The survey consisted of five questions. The first question determined whether EPs had prior experience discharging patients to home-based healthcare directly from the ED. If they answered yes, the next question asked their reasons for this decision. The following two questions ascertained what motivations EPs had for considering a home-based referral, as well as the types of clinical diagnoses they would consider eligible. Finally, the survey inquired about the necessary response time the home-based care staff would need to provide for EPs to consider care at home a safe option.

Focus Groups

The primary research team conducted three focus groups and four interviews, each approximately one hour in duration, using a discussion guide. Focus groups and interviews were audiotaped and then transcribed verbatim. The research team conducted thematic analysis using a *horizontal* approach.[9] Four members of the research team independently read all focus group and interview transcripts to identify patterns of recurrent concepts. The team then sorted and coded the transcriptions, categorizing comments into major and minor themes based on frequency of similar comments from participants. Major themes and concepts were finalized by consensus.

RESULTS

Emergency Physician Survey

Of the 48 respondents, 30 (62.5%) EPs indicated no prior experience ordering home-based care from the ED. When respondents were asked to indicate the three most important reasons or concerns that might influence their decision to discharge patients to home-based care (10 options were provided), the most common concern reported was "no existing process in place to refer to home-based care," with 37 (77.1%) physicians rating this in their top three responses. The second most common response was "unavailability of a care coordinator/case manager*"*; 35 (72.9%) physicians rated this reason among their top three. See Figure 1.

Next, physicians were asked to indicate the three most important motivators (or advantages) when considering home-based care (five options were provided). The most common motivator reported was to "reduce unnecessary hospitalizations and observation stays," with 43 (89.6%) physicians rating this advantage among their top three. The second most common motivator was "reduce risks associated with hospitalization,*"* with 38 (79.2%) rating this in the top three. See Figure 2.

Physicians were then asked to indicate the top three medical conditions they would consider for home-based care (six options were provided). The three most common medical conditions reported were cellulitis (43 respondents, 89.6%), *urinary tract* infection (38, 79.2%), and diabetes (33, 68.8%). See Figure 3.

The final question asked physicians to indicate how soon a home-based follow-up evaluation by a clinician would need to occur (four options were provided). The most common response indicating the specific time frame within which a physician believed a follow-up evaluation would need to occur was "within 24 hours*"* (21 respondents, 43.8%), followed by "within 8 hours*"* (13, 27.1%). See Figure 4.

Focus Group Thematic Analysis

Three focus groups were convened with three participants each: (1) with three EPs, (2) with three EP leaders and, (3) with two SWs and one RN. The four individual interviews were conducted with three EPs and one ED RN. The majority of participating EPs had at least some experience in transitioning patients to home health following evaluation in the ED and believed it was a good option to have available. The major themes derived from the focus groups are discussed below and categorized in the table.

Table. Four areas of need identified by focus groups queried about the feasibility of transitioning patients from the emergency department to home-based healthcare.

Knowledge and education regarding:	Efficacy and outcome data for:	Streamlined ED processes	Responsive and qualified home care
Alternatives to admission	Short- and longer-term clinical outcomes	Easy to initiate	Providers can respond within a short time
What home care can provide	Patient and family satisfaction	Efficient ED workflows	Clinicians have skills and expertise to deliver quality care
Accessing home care alternatives	Patient safety	Effective clinician hand-offs	

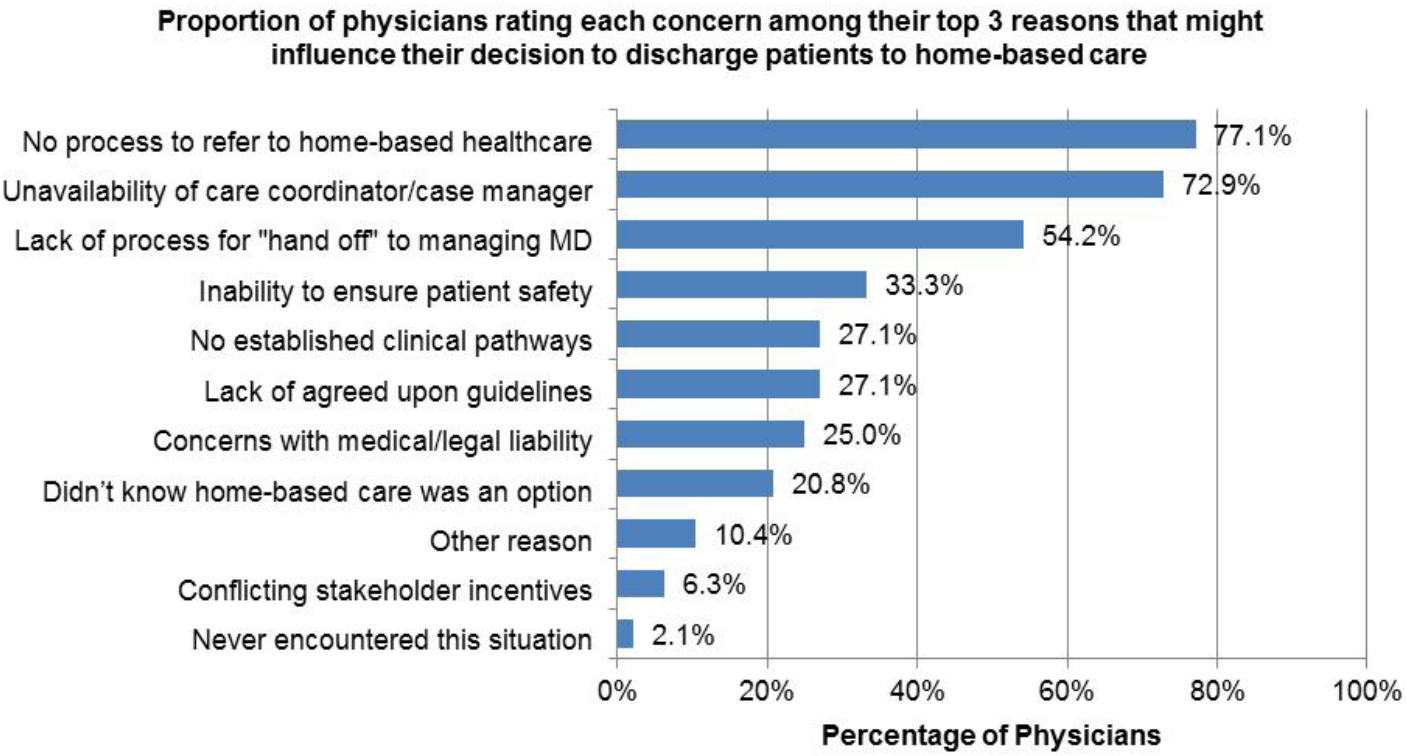

Figure1. Physician rating of top three reasons influencing decision to choose home-based care.
Other reasons listed: Feasibility to get PICC line and appropriate antibiotics delivered (1); Just not something that most of us are familiar with (1); Lack of emergency physician support to execute plan (1); Takes too much time to arrange in a busy ED (1); Unclear if patient's funding covers services (1).

Recognition of a Need for Awareness and Education Regarding Alternatives to Admission

Participants indicated a gap in education of EPs and nursing staff regarding what options exist for home care and the types of services and treatment that can be provided, stating, for example, that "there is a simple lack of awareness [that] we can do it this way" and "awareness is a major factor." In addition, clinicians wanted to know how to access these services from the ED. One participant stated, "There is no book on case management. There are concepts, there's a lot of on-the-job training, and it is very situationally different."

Participants identified the need, due to staff turnover, for ongoing education of new employees and ED residents in regard to home-based care options. Most agreed that to sustain momentum the education also needed to include frequent reminders because "learning goes away after a few months." The prevailing message was summed up by this physician participant: "In the event of a patient who everyone agrees doesn't necessarily need to be admitted, but has no good alternative, we, the ED physicians, are also not wanting to admit these people. We would love to have an adequate alternative."

Data on the Short- and Longer-Term Benefits of Home-Based Care

Participants felt there were short- and longer-term benefits of home- and community-based care, stating, for example, "Whatever can be addressed at home should be"; "From a social perspective, people do, in my opinion, tend to heal better at home, assuming they have a normal home"; and "There is a realization of so much of what we do in the hospital can really be done at home with appropriate care-takers, and keeping them in the hospital wasn't going to do a whole lot different than sending them home with some help." Recognized benefits of home-based care were accompanied by acknowledgment of risk in sending home patients who still need monitoring or interventions. Most physicians felt the patients would be safe as long as they were assured of timely follow-up. "If I could know they'd be seen the next day, I still would [send them home]," and "If I feel that the family and patient are comfortable, I'm not that concerned about medical/legal ramifications."

The Need for Streamlined ED Processes to Transition Patients Home

Participants acknowledged the critical need for streamlined processes to transition patients home from the

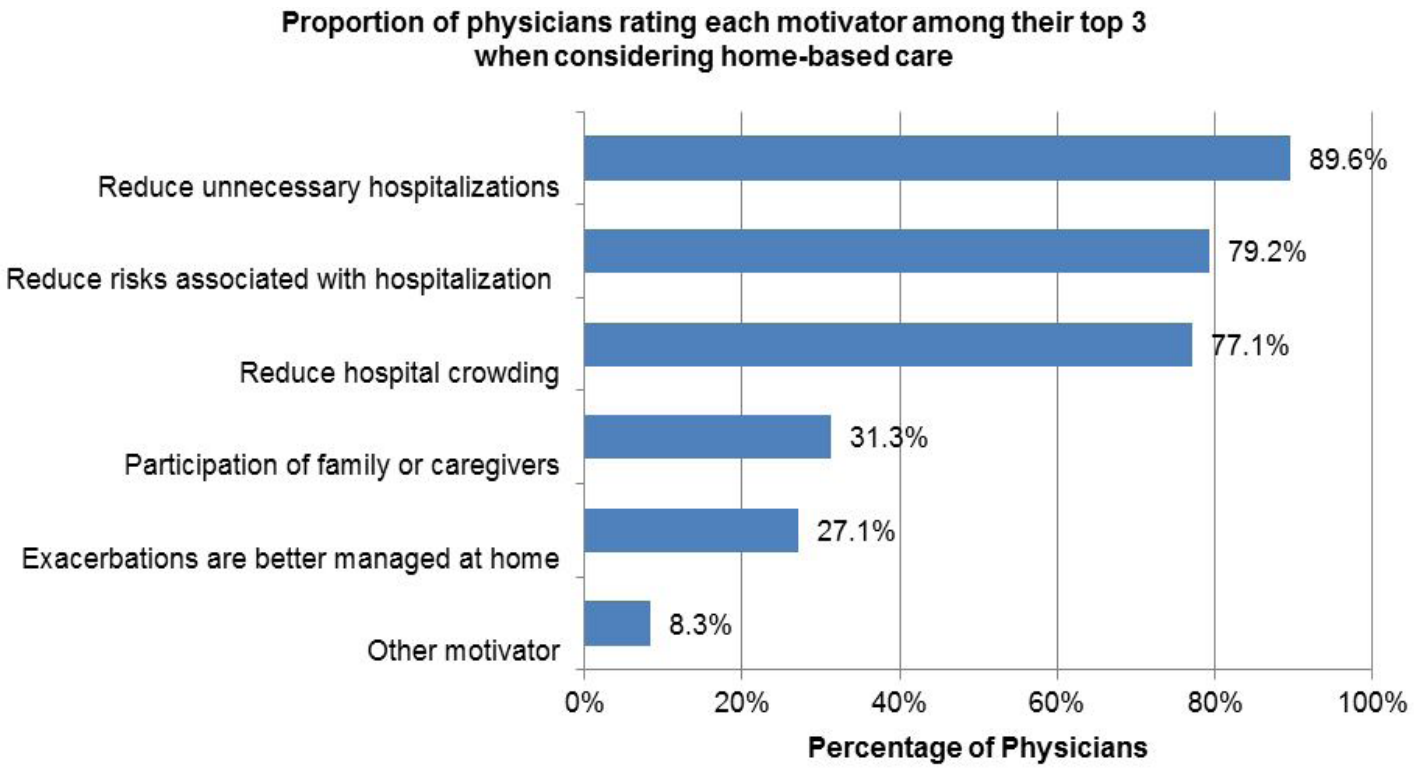

Figure 2. Physician rating of top three motivators when considering home-based care.
Other motivators listed: Lower cost for equivalent care (1); Patient preference for care location (1); Preferred by patients and families (1); Reduced healthcare costs (1).

ED. Currently both process and operational barriers exist. In particular, ED operations include time constraints, and participants indicated adding on time-consuming or complicated processes significantly reduces the likelihood the practice would be adopted. ED-to-home transitions must be easy, streamlined, and time-efficient. One physician stated, "A lot of our patients can be taken care of at home, but just due to logistics … sometimes it becomes a challenge." Another EP said, "Often, we're really busy down there, and we often take the path of least resistance." Others expressed standardized order sets, protocols, or algorithms would be helpful.

The strongest recommendation for streamlining was that EDs have someone on site to arrange the transition. The availability of ED case managers—a hard-to-fill position in the hospital due to lack of applicants—was said to be a real problem.

Many explained they'd had difficulty getting assistance even from inpatient case managers. These were several of the comments: "The physical presence of a case manager or social worker in the ED is critical"; "We can avoid the inpatient admission with a series of home health visits. We can actually do this. But without the intermediary of a case manager or social worker involved in the ED, this is very difficult to orchestrate"; "I think we just need a steady case manager presence"; and "Some of them [case managers] have amazing concepts of what can be done at home."

The Need for Home-Based Care that is Responsive and Provides Qualified Staff

The need for home-based care to be responsive and provide qualified staff was viewed as extremely important. Some participants discussed challenges in ensuring a qualified home-health workforce. Concern over current compensation structures that may be driving less experienced staff to seek home care jobs was expressed: "Maybe home health doesn't pay well. Maybe they need to be more comparable to hospitals to have good employees."

Additional concepts that arose were clinical oversight immediately following the ED encounter, avenues for reimbursement, and regulatory limitations.

Participants also discussed barriers that exist in the broader healthcare ecosystem. Regulations and reimbursement can influence where patients are treated. In order to create new options, participants said, for example, that we "must figure out financial incentives." Participants articulated that

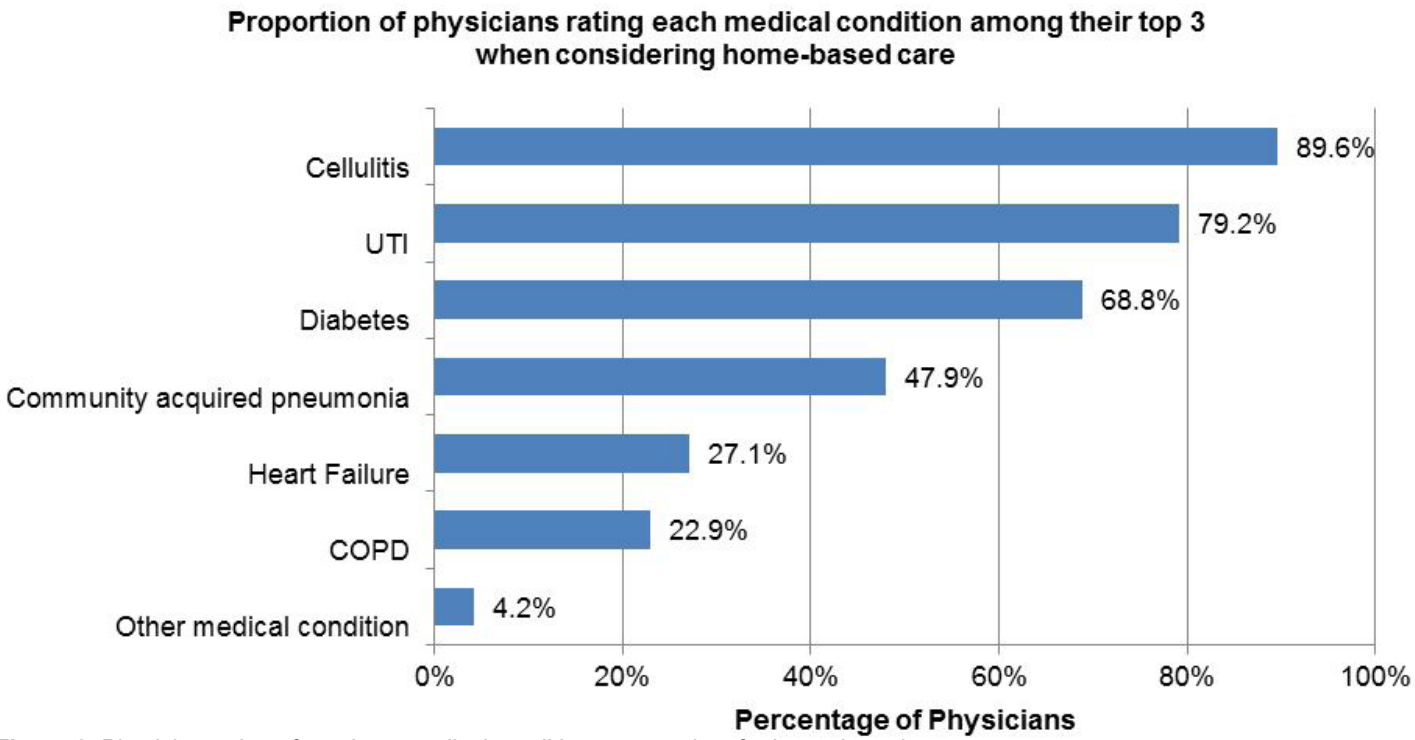

Figure 3. Physician rating of top three medical conditions appropriate for home-based care.
Other medical conditions listed: Orthopedic injuries (1); Osteomyelitis (1).
COPD, chronic obstructive pulmonary disease; *UTI*, urinary tract infection.

disposition alternatives are limited by what services and treatments get reimbursed and what is easily accessed. Traditional community-based healthcare options (e.g., home health agencies and infusion clinics) typically operate during regular business hours, with little or no responsiveness during the evenings, nights, or weekends. Participants indicated that providing needed care in the most appropriate setting, ED-to-home options need to be available 24 hours a day, 7 days a week. Participants admitted that currently "EDs do not have other good alternatives to admission," and until those options exist EPs will more often than not default to a hospital admission, even if patients do not require hospital-level care. Participants with experience in ED-to-home transitions found the process "easier if the home health agency is part of the health system."

The need for a supportive hospital administration was also seen as key to overcoming system barriers because admissions are the main revenue source for hospitals, and efforts to reduce admissions may not be met with support.

In the focus groups, one broad category of possible candidates for home healthcare instead of admission were patients needing intravenous antibiotics for diagnoses such as cellulitis, uncomplicated community-acquired pneumonia, and urinary tract infections. Other diagnoses often mentioned were congestive heart failure and lower extremity deep vein thrombosis. Others indicated that in general the elderly would do better at home whenever possible, and that home care would be a good alternative for patients who were refusing admission and requesting to go home. Most participants agreed that at present the decision to arrange for home care to avoid an admission is made on a case-by-case basis.

DISCUSSION

Substituting more acute home-based care for hospital-based care has been widely adopted in single-payer systems overseas and to a lesser extent domestically within integrated delivery networks and Veterans Administration hospitals.[10-12] Studies conducted both in the U.S. and abroad show that providing healthcare services in the home is safe, effective, satisfying to patients and clinicians, and lower in cost.[7, 13-16] One such effort is the Hospital at Home® model, which shifts acute care out of the hospital and into the home for select patient cohorts. This model substitutes hospital-level care for a similar level of home-based care.[7] Broader adoption of this model, especially in non-integrated healthcare systems, has historically been hampered in the U.S. by reimbursement and regulations that have not strongly incentivized short-term, higher-intensity care in the home. Although the body of research on substitutive models demonstrated feasibility, providers seeking hospital-level reimbursement were not successful.[17]

Home-based healthcare, which includes home health, provides skilled nursing and therapy services following an acute hospitalization. It is a widely used lower-cost option compared to

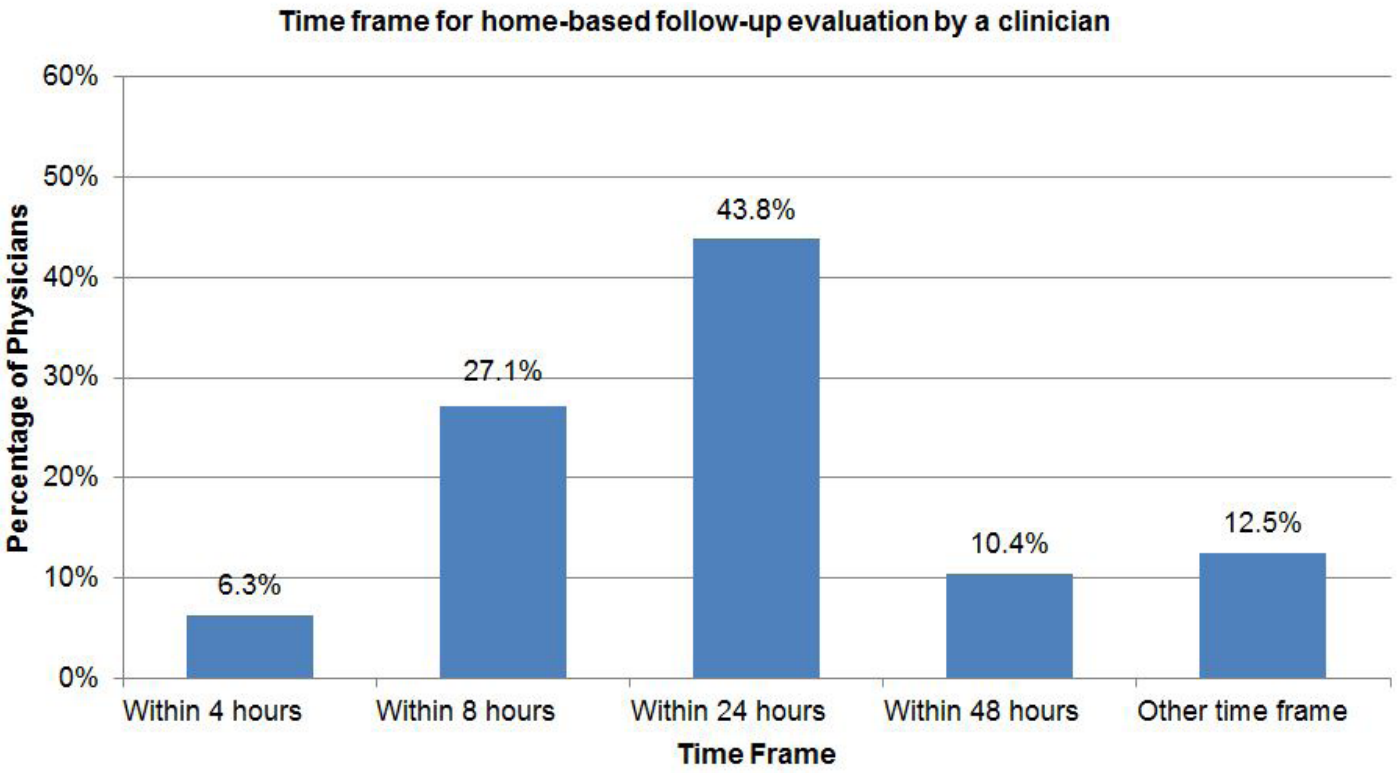

Figure 4. Physicians' preferred time frame for home-based follow-up clinician evaluation.
Other time frames listed: within 12 hours (4); next day (1); case dependent, for example, airway issues (pneumonia/congestive heart failure/chronic obstructive pulmonary disease) likely require earlier care at 8-12hrs, cellulitis 24-48hrs, etc. (1).

both hospitalization and in-home care by a physician. In the U.S., home health is covered as a benefit, provided to both Medicare and Medicaid beneficiaries. The Medicare home health benefit requires both a skilled need and patients meeting home-bound criteria. Although home health services in the U.S. are growing, use of this care delivery option is not widely employed as an alternative for hospital-based care directly following care in the ED. However, the benefit does provide coverage for skilled home-based healthcare services and treatments, including those necessary following ED treatment.

Prior to the present study, little was known regarding the extent to which EPs might recommend home-based delivery of acute medical care. Furthermore, it was not well known whether EPs were aware of what health services are available in the home and whether care at home is a safe and effective option. The present study provides insight into EPs' knowledge and attitudes toward the option of using home-based healthcare directly from the ED. Nearly three quarters of physicians indicated the main barrier was a lack of processes and help to arrange the transition to home care. Given the number of sick and injured patients coming into the ED, physicians expressed a need for a well-trained support network within the ED, including staff with clear guidelines and infrastructure necessary to transition patients smoothly from ED to the home. EPs expressed a strong motivation to reduce unnecessary admissions and the associated risks of hospitalizations. They also identified the types of patients they consider candidates for home care and the time frame during which they would need the patients to be seen at home.

Focus group participants also identified several barriers that must be overcome to make the ED-to-home option more viable. A knowledge gap exists in that 12 of the physicians either did not know home-based care was an option from the ED, had never encountered the situation, or were not familiar enough with the process to be comfortable using it. Participants acknowledged they encounter patients receiving care in the hospital that could as easily be provided in the home. The main challenges were (1) a lack of time in the ED to arrange home health, (2) a lack of knowledge on how to arrange for home health, and (3) a lack of understanding of the kind of services home health can provide.

In light of recent healthcare outcomes research that has begun to quantify the hazards of hospitalization,[18-20] there is growing belief that certain patients, especially the elderly, might fare better at home. If these higher-risk patients are able to avoid hospitalization, it may reduce their exposure to resistant pathogens, noise, unfamiliar environments, and risk of falls and delirium, and can reasonably be translated into better outcomes and patient satisfaction.

LIMITATIONS

Several limitations should be considered in the context of this study. First, because the sample size for the survey was small and limited to the relatively narrow setting of an academic medical center, generalizations to nationwide perspectives are beyond the scope of this study. Additionally, individuals selected for interviews that led to development of survey questions were professionals paid for their time to participate. However, these individuals were not informed that their answers would be used to create survey questions.

The survey was intended to uncover thematic areas, first in a local setting, with the potential for surveying a broader sample, and providing the potential for modification and adjustment of the questions. The interview and focus groups were a small convenience sample of self-selected individuals limited to a single institution. These included only three EPs, and therefore may similarly not be representative of the broader population of EPs and ED RNs and SWs. Regional differences in practice patterns, availability of home-based care, and variability in the number and types of personnel staffing EDs may have further biased the responses of the study participants. Surveying a larger, more geographically diverse group of EPs could provide a more balanced perspective.

CONCLUSION

This study revealed that EPs are generally receptive to referring patients for home-based healthcare following ED treatment to reduce the incidence of "default" hospital admissions. EPs also believe patients with certain diagnoses are likely to benefit and may avoid many of the iatrogenic risks of hospitalization. However, few EPs know specifically what services are available in the home and lack knowledge of the process for invoking an "ED to home-based healthcare" transition. While limited statistical inferences can be drawn from the current survey, the results of this study do serve as a conversation starter, and also form the basis for the design of a larger, nationwide survey. Because the study highlights a general willingness on the part of the EP community, future research should therefore further investigate, on a broader scale, what system-level changes could potentially realize the opportunity for EPs to be provided with a broader range of transition options from the ED. Future research should also explore patient and physician satisfaction with alternative disposition options as well as relevant outcome data (e.g. ED bounce-back rates, need for subsequent hospitalization, etc.). With the emergence of value-based payment reform, more incentives are emerging for both physicians and hospitals to provide these additional options in furtherance of high-value care in the most appropriate setting.

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Replacement of Dislodged Gastrostomy Tubes After Stoma Dilation in the Pediatric Emergency Department

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Introduction: A dislodged gastrostomy tube (GT) is a common complaint that requires evaluation in the pediatric emergency department (ED) and, on occasion, will require stoma dilation to successfully replace the GT. The objective of this study was to describe the frequency that stoma dilation is required, the success rate of replacement, complications encountered, and the techniques used to confirm placement of the GT after dilation.

Methods: We conducted a retrospective medical record review of children 0-18 years who presented to the pediatric ED from February 2013 through February 2015 with a dislodged GT that required stoma dilation by pediatric emergency physicians with serially increasing Foley catheter sizes prior to successful placement of the GT.

Results: We reviewed a total of 302 encounters in 215 patients, with 97 (32%) of the encounters requiring stoma dilation prior to replacing a GT. The median amount of dilation was 2 French between the initial Foley catheter size and the final GT size. There was a single complication of a mal-positioned balloon that was identified at the index visit. No delayed complications were encountered. We performed confirmation of placement in all patients. The two most common forms of confirmation were aspiration of gastric contents (56/97 [58%]) followed by contrast radiograph in 39 (40%).

Conclusion: The practice of serial dilation of a gastrostomy stoma site to allow successful replacement of a gastrostomy tube in pediatric patients who present to the ED with a dislodged gastrostomy tube is generally successful and without increased complication. All patients received at least one form of confirmation for appropriate GT placement with the most common being aspiration of gastric contents. [West J Emerg Med. 2017;18(4)770-774.]

INTRODUCTION

The most common minor complication for patients with a gastrostomy tube (GT) is dislodgement.[1] It is estimated that 2% will become displaced within the first 10 months after placement and 37% dislodged within five years.[2,3] Of the patients who present to a pediatric emergency department (ED), 62% of GT-related complaints are dislodged tubes and most of these require replacement prior to discharge.[1] Parents who feel uncomfortable with the replacement of the GT at home or those who had a difficult time replacing the GT themselves bring their child to the ED for evaluation.[4] It is well described that replacement, with or without confirmation imaging, is a procedure commonly performed successfully in the ED.[1,4,5] There is an

estimated complication rate between 1-4% with GT replacements performed in the ED.[4,6] These complications include over-filled or mal-positioned balloon, gastric outlet obstruction, and peritonitis.[1,4] However, if the stoma site has partially closed, the GT may be difficult to replace. One of the techniques that allows for successful replacement is serial dilation of the stoma with progressively larger Foley catheters prior to replacing the GT.[5] It has been estimated that nearly 33% of pediatric stoma sites require dilation prior to replacing the GT,[1] but no study describes the success rate of GT placement after stoma dilation or the complications that occur after dilation. Of the replaced GTs in pediatric patients in the ED, it is estimated that 35% of cases will have imaging to confirm GT placement.[4] As a secondary outcome, we describe the types of confirmation obtained and the percentage of patients who received confirmation when stoma dilation had been performed.

Population Health Research Capsule

What do we already know about this issue?
Dislodged gastrostomy tubes commonly present to the pediatric emergency department and some will require serial dilation to replace the tube successfully.

What was the research question?
What is the success rate of gastrostomy tube placement after stoma dilation and what, if any, complications occur after dilation?

What was the major finding of the study?
Serial dilation of a gastrostomy stoma site to allow successful replacement of a gastrostomy tube is generally successful and without increased complication.

How does this improve population health?
Performing serial dilation by emergency physicians with successful replacement of the gastrostomy tube could potentially decrease ED length of stay and surgical consultations.

METHODS

We conducted a retrospective electronic chart review of all children ages 0-18 years who presented to our pediatric ED from February 2013-February 2015 for replacement of a dislodged GT that required serial dilation for successful replacement by a pediatric emergency physician (EP). The pediatric ED is a Level I trauma center with approximately 25,000 visits annually. Our hospital switched to a new electronic medical record (EPIC) mid-February; therefore, this start date was used rather than a typical calendar year. Charts were identified using a search of chief complaints that included feeding tube or gastrostomy tube, the Current Procedural Terminology (CPT) code 43760 for a change of gastrostomy tube, and diagnosis code V55.1 attention to gastrostomy. We excluded children if the stoma site did not require dilation, when the GT was replaced by another feeding tube besides a GT (nasogastric tubes, gastrojejunostomy tubes, or Foley catheters that were left in place at the time of discharge from the ED), and when the GT was replaced by either pediatric surgery, parents, or the pediatric gastroenterology service prior to any attempts being made by pediatric EPs. For those patients with multiple visits for recurrent dislodgement of the GT, we included all visits unless the repeat visit was deemed to be a result of a complication from the index visit.

Using a standard data collection form, a single researcher (SB) extracted all data from the electronic medical record. Data collected included demographic data, age of stoma tract, length of time the GT had been dislodged prior to arrival, initial Foley catheter size, final GT size, immediate complications, and techniques used to confirm GT placement. Delayed complications were investigated by reviewing each chart for any return ED visits with a diagnosis that included abdominal pain, abdominal distention, vomiting, or intolerance of GT feedings after the index visit. We used descriptive statistics within Excel to analyze the data. Our institutional review board approved this study.

RESULTS

We reviewed a total of 215 patient charts with 302 encounters for GT-related complaints. Of those, 261 (86%) had a dislodged feeding tube and 97 encounters (32%) required stoma dilation prior to replacement of the GT (Figure). The most commonly placed initial Foley catheter size was 10 French with a median increase in dilation by 2 French between the initial Foley size and the final GT size (Table 1). Thirteen patients (13%) required dilation 1 Foley size (2 French) larger than the target GT size to allow successful GT placement.

Of the 97 encounters, 96 (99%) of the GTs were successfully replaced by a pediatric EP after serial stoma dilation and on the first replacement attempt. One patient was found to have a mal-positioned and over-filled balloon on confirmation contrast imaging that required a second replacement attempt by a pediatric EP. The balloon was repositioned and filled with 3 ml instead of the previous 4

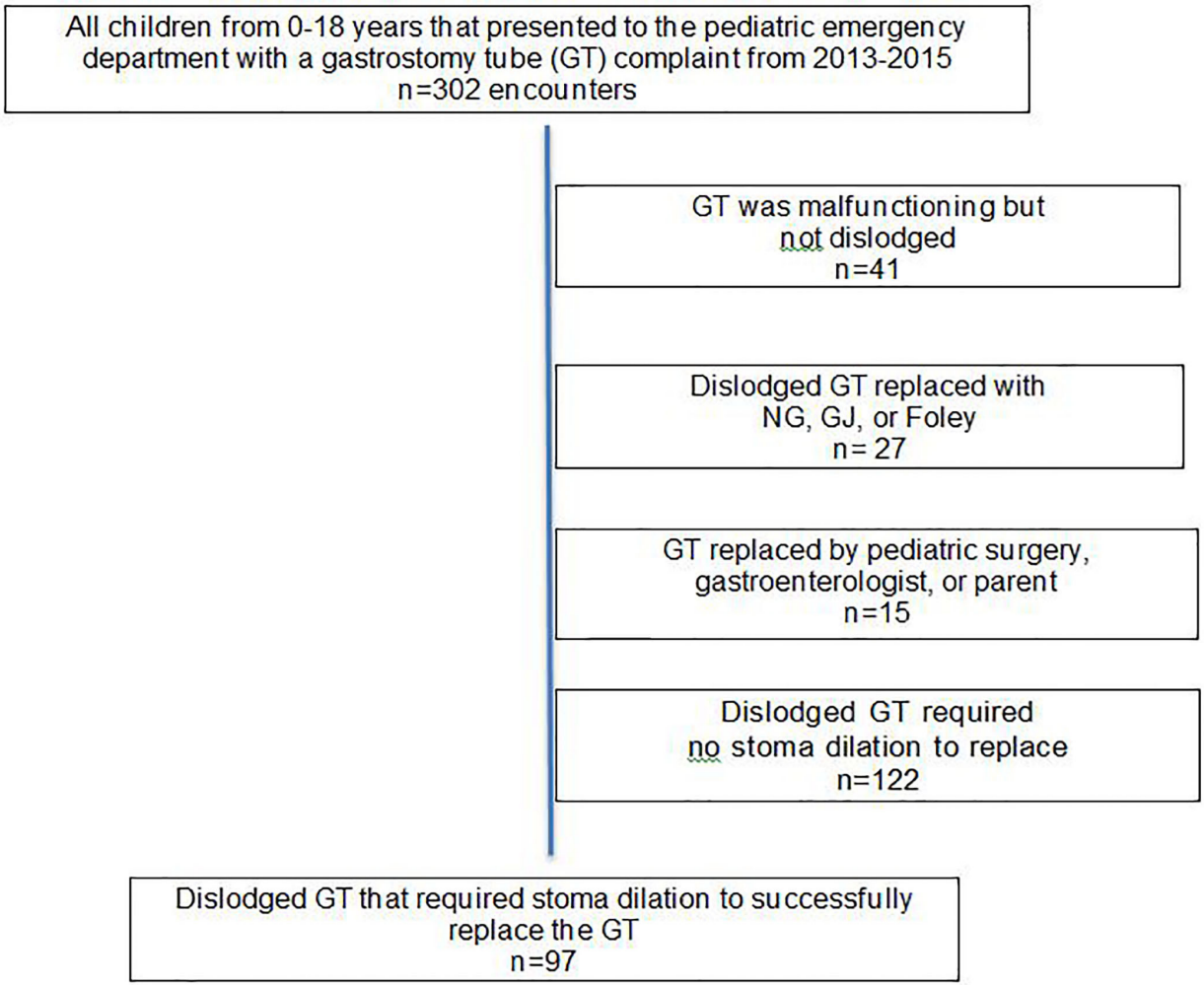

Figure. Flow diagram of pediatric patients who presented to the ED with gastrostomy tube complaint. *GT,* gastrostomy tube.

ml of normal saline. Gastric contents were aspirated after adjusting the GT and the patient was discharged home during that index visit. We considered this case an immediate complication giving a complication rate of 1/97 patients (1%, 95%CI [0.03-5.6]). In addition, there were no failed replacement attempts by pediatric EPs that required consultation with pediatric surgery or pediatric gastroenterology during the index visit.

There were no delayed complications or return ED visits with symptoms that could be reasonably associated with the stoma dilation. The only return visit was a patient who returned four days later with abdominal pain and vomiting. This patient was admitted for chronic ileus related to underlying anal stenosis and was admitted to pediatric surgery for anal dilation. Upon review of the hospital chart, the dilation of the stoma and replacement of the GT during the index ED visit was not thought to be a contributing factor to the symptoms at the return visit.

The methods used to confirm successful GT replacement were described as a secondary comparative outcome. All patients had at least one form of confirmation mentioned in the chart. The two most common forms of confirmation were aspiration of gastric contents in 56 (58%) of the patients and contrast radiograph in 39 (40%) of the patients (Table 2). Of the 97 encounters, 30 (31%) had two forms of confirmation, nine (9%) had three forms of confirmation and one (1%) had four forms of confirmation. For the one patient who had the immediate complication, two forms of confirmation were used during the index visit.

DISCUSSION

The percentage of dislodged GTs that presented to our pediatric ED was slightly higher compared to previous publications (86% v 62%).[1] However, approximately one third of our patients required dilation of the stoma to

Table 1. Demographics and description of gastrostomy stoma dilation (n=97).

		Range of values
Median age of patient (mo)	34	2 months – 17 years
Median age of GT stoma tract (mo) *	12	2 months – 17 years
Median time GT dislodged prior to ED evaluation (hrs) *	3	1 - 22 hours
Mode initial Foley size (Fr) *	10	8- 14 Fr
Mode final GT size (Fr)	12	10-18 Fr
Median increase from initial Foley to final GT size (Fr) +	2	0 – 8 **

*One patient with missing information.
+Unable to calculate for the one patient with missing information regarding initial Foley size.
**Increase of 0 was seen in three patients with the initial Foley size and final GT size being the same, but all those patients required dilation with a Foley size 2 French larger than the final GT to successfully replace the GT.

successfully replace the GT, and this seems to be similar to previous pediatric reports.[1] Complication rates are estimated to be around 1-4 % for all GTs placed in the ED, and stoma dilation in our pediatric study did not result in a higher rate of complication.[4,6] The one immediate complication in our study population is a known complication for any inserted GT and cannot be solely attributed to the stoma dilation itself. Furthermore, none of the patients had return ED visits with delayed complications that could be attributed to the dilation of the stoma tract. Given the high frequency of dislodged GTs and the fact that stoma dilation can be performed without increased complication rate, it seems reasonable that stoma dilation to successfully replace a GT in a pediatric patient should be within the scope of emergency medicine practice.

Previous reports mention that approximately one third of the GTs replaced in the ED receive confirmation of placement with contrast radiographs.[4] We had a slightly higher rate of confirmation radiographs in our study after stoma dilation. A majority of our patients received a single form of placement confirmation and a majority of those had aspiration of gastric contents as their only form of confirmation. Making a recommendation for confirmatory imaging when the stoma is dilated is beyond the scope of this article; however, the rate of complications after stoma dilation seems to be similar to previously reported rates of complication for any GT replacement. Therefore, it seems reasonable that performing dilation of the stoma should not change a physician's practice of confirming GT placement. In other words, it is reasonable for a physician to continue performing the confirmation technique of their choice regardless of the stoma being dilated prior to GT placement.

Table 2. Methods of confirmation regarding placement of gastrostomy tube (n=97).*

Form of GT confirmation	No. of encounters (%)
Aspiration of gastric contents	56 (58%)
Contrast radiograph	39 (40%)
Tolerating feed	33 (34%)
Listened for air inflation	17 (18%)
Normal abdominal exam	2 (2%)

*Total number of encounters in the table will equal more than 97 since 40 of those encounters obtained two or more forms of confirmation.

Stoma sites can start to tighten within hours of the GT falling out, and the technique of using a catheter to keep the stoma open followed by serial stoma dilation has been previously described by Willworth.[5] When the GT cannot be replaced because the stoma site is closing, a Foley catheter should be placed in the stoma as soon as possible to keep the stoma from tightening further or completely closing. If the largest catheter that can be placed without traumatizing the stoma site is smaller than the target GT size, dilation of the stoma tract is required. Serial dilation involves removing the initial Foley catheter followed by immediate replacement with the next largest Foley catheter (2 French increase) until the target GT-size Foley catheter is reached. A small portion of our study population required dilation 1 Foley larger than the target GT. Although this has not been studied, it seems reasonable to conclude that the balloon adds a small amount of diameter beyond the designated size of the catheter. Therefore, placing a Foley catheter that is 2 French larger beyond the target GT size will dilate the stoma to a size that could account for the balloon width. After placement of each Foley catheter, clamping or kinking the catheter is necessary to keep the gastric contents from leaking. There is no specific or accepted time that each Foley needs to stay in the stoma prior to changing to the next larger Foley. None of the charts in our study mentioned how long each Foley stayed in the stoma site. Anecdotally, it was noticed that the length

of time each Foley stays in the stoma is directly related to the volume of patients in the ED at the time.

LIMITATIONS

This study was a retrospective chart review, a methodology with inherent risk of missing patients who could have been included or missing data that could have altered our conclusions. However, the impact of this missed data is estimated to be minimal. We encountered a single complication, and stating a complication rate based on a small number of adverse outcomes or making conclusions about causation between stoma dilation and the single complication encountered could be seen as problematic. When evaluating delayed complications, only return ED visits to our institution were reviewed. It is possible that patients could have presented to other hospitals with abdominal complications that could be attributed to stoma dilation; however, it is customary for complex pediatric patients to be transferred back to our tertiary care ED after presenting to a regional hospital. This is a single-center study at a tertiary pediatric ED and the results may be difficult to generalize to other institutions or clinicians who may feel uncomfortable with this procedure in a pediatric patient. Each pediatric EP who treated the patients in our study chose the technique of GT placement confirmation with which they were comfortable. Whether more or fewer confirmatory studies should be done after stoma dilation would require further study.

CONCLUSION

The practice of serial dilation of a gastrostomy tube stoma site to allow successful replacement of a gastrostomy tube in pediatric patients who present to the ED with a dislodged gastrostomy tube is generally successful and without increased complication. All patients received at least one form of confirmation for appropriate GT placement with the most common being aspiration of gastric contents.

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A Comparison of Urolithiasis in the Presence and Absence of Microscopic Hematuria in the Emergency Department

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Introduction: Urolithiasis is a common medical condition that accounts for a large number of emergency department (ED) visits each year and contributes significantly to annual healthcare costs. Urinalysis is an important screening test for patients presenting with symptoms suspicious for urolithiasis. At present there is a paucity of medical literature examining the characteristics of ureteral stones in patients who have microscopic hematuria on urinalysis versus those who do not. The purpose of this study was to examine mean ureteral stone size and its relationship to the incidence of clinically significant hydronephrosis in patients with and without microscopic hematuria.

Methods: This is a retrospective chart review of patient visits to a single, tertiary academic medical center ED between July 1, 2008, and August 1, 2013, of patients who underwent non-contrast computed tomography of the abdomen and pelvis and urinalysis. For patient visits meeting inclusion criteria, we compared mean stone size and the rate of moderate-to-severe hydronephrosis found on imaging in patients with and without microscopic hematuria on urinalysis.

Results: Out of a total of 2,370 patient visits 393 (16.6%) met inclusion criteria. Of those, 321 (82%) had microscopic hematuria present on urinalysis. Patient visits without microscopic hematuria had a higher rate of moderate-to-severe hydronephrosis (42%), when compared to patients with microscopic hematuria present (25%, p=.005). Mean ureteral stone size among patient visits without microscopic hematuria was 5.7 mm; it was 4.7 mm for those patients with microscopic hematuria (p=.09). For ureteral stones 5 mm or larger, the incidence of moderate-to-severe hydronephrosis was 49%, whereas for ureteral calculi less than 5 mm in size, the incidence of moderate-to-severe hydronephrosis was 14% ($p < 0.0001$).

Conclusion: Patients visiting the ED with single-stone ureterolithiasis without microscopic hematuria on urinalysis could be at increased risk of having moderate-to-severe hydronephrosis compared to similar patients presenting with microscopic hematuria on urinalysis. Although the presence of hematuria on urinalysis is a moderately sensitive screening test for urolithiasis, these results suggest patients without hematuria tend to have more clinically significant ureteral calculi, making their detection more important. Clinicians should maintain a high index of suspicion for urolithiasis, even in the absence of hematuria, since ureteral stones in these patients were found to be associated with a higher incidence of obstructive uropathy. [West J Emerg Med. 2017;18(4)775-779.]

INTRODUCTION

Urolithiasis is a very common medical condition that affects 5-15% of the worldwide population[1] and results in over 1.2 million emergency department (ED) visits in the United States each year.[2] An important goal in the evaluation of urolithiasis is the detection of concomitant ureteral obstruction, which can result in irreversible renal damage and be associated with life-threatening infection. The evaluation of urolithiasis is largely influenced by the results of a urinalysis (UA). While the presence of microscopic hematuria favors a diagnosis of urolithiasis in a patient presenting with symptoms suggestive of ureteral colic, it is estimated that 10-20% of patients with urolithiasis can present without microscopic hematuria on UA.[3] To the best of our knowledge, there are no large studies examining whether the presence or absence of microscopic hematuria has any influence on the likelihood of a patient having concomitant clinically significant hydronephrosis. In this study, we sought to compare the rates and severity of hydronephrosis in patients with non-contrast computed tomography- (CT) diagnosed urolithiasis in the presence and absence of microscopic hematuria on urinalysis.

Population Health Research Capsule

What do we already know about this issue?
Urolithiasis is a very common emergency department (ED) diagnosis accounting for a large number of ED visits in the U.S. each year.

What was the research question?
How does the rate and severity of hydronephrosis in CT-diagnosed urolithiasis compare between ED patients with and without microscopic hematuria on urinalysis?

What was the major finding of the study?
ED patients with CT-diagnosed urolithiasis and an absence of microscopic hematuria on urinalysis had a significantly higher rate of moderate-to-severe hydronephrosis compared to patients with microscopic hematuria on urinalysis.

How does this improve population health?
Emergency physicians should maintain a high index of suspicion for clinically significant urolithiasis despite an absence of microscopic hematuria on urinalysis in patients presenting to the ED with symptoms of renal colic.

METHODS

We conducted a retrospective chart review of patient visits to a single, tertiary academic medical center ED between July 1, 2008, and August 1, 2013. We complied with optimal methods for retrospective chart reviews.[4] All patient visits in adults aged 18 years or older that included a non-contrast CT of the abdomen and pelvis (CT abd/pelvis) and microscopic UA within this time frame met inclusion criteria. We excluded patient visits with any of the following: absence of ureteral calculi on non-contrast CT abd/pelvis radiology report; no UA data or missing UA data; missing non-contrast CT abd/pelvis radiology report; presence of more than one ureteral calculus; presence of a ureteral stent or nephrostomy tube; or presence of any intraabdominal or pelvic mass resulting in ureteral obstruction. We defined a ureteral stone as a calculus residing anywhere from the ureteropelvic junction to the ureterovesicular junction. All CTs were performed using either a Siemens Somatome Sensation 64-slice scanner, or a Philips Brilliance 128- or 256-slice scanner. A radiology faculty member at the University of California, Irvine Medical Center interpreted all CTs during the study period.

Two blinded, trained data abstractors (RT and DS) recorded the following on a data abstraction form: number of red blood cells (RBCs) per high power field (hpf) on UA; size and location of the ureteral stone; and the presence and severity of hydronephrosis (none, mild, moderate, or severe per attending radiology final report). We held periodic meetings to resolve any discrepancies and/or questions regarding the extraction of data from these reports. If the presence of hydronephrosis was not documented (n=39 charts) on the radiology report, we assumed that there was none. If hydronephrosis was documented, but without a clarifying severity (n=16 charts), we assumed that the patient fell into at least the moderate group. If the hydronephrosis was described as "mild to moderate" (n=19), we included these patients in the "moderate" hydronephrosis group. Two separate, non-blinded reviewers (MBO and JM) audited all included charts for accuracy.

We divided patient visits into two groups based on the presence or absence of microscopic hematuria on UA, as defined by guidelines established by the American Urological Association.[5,6] We considered a UA with equal to or greater than four RBC per hpf to have microscopic hematuria present, and fewer than four RBC per hpf to be absent microscopic hematuria.

We calculated the average ureteral stone size, the incidence of moderate-to-severe hydronephrosis, and the incidence of any level of hydronephrosis ("minimal" or greater) for each of our patient groups (those with and those without hematuria). We performed all calculations using Microsoft Excel or Vassar Stats.[7]

RESULTS

Out of a total of 2,370 patient visits that we reviewed, 393 met inclusion criteria. The median age of our patient population was 43 years (range: 18-91, interquartile range [IQR] [32-54])

and 69% were male. Among these, 321 (82%) had concomitant microscopic hematuria and 72 (18%) did not have microscopic hematuria on UA.

A higher proportion of patient visits without hematuria had moderate-to-severe hydronephrosis (n = 30, 42%) when compared to those with hematuria (n = 81, 25%) (p = .005 via chi-squared, negative likelihood ratio = 1.8) Stated another way, and acknowledging the limitations of the narrow patient population studied, the sensitivity of hematuria on urinalysis for detecting a ureteral calculus was 73% (95% confidence interval [CI] [64%-81%]) in the group of patients with moderate-to-severe hydronephrosis and 85% (95% CI [80%-89%]) in patients with mild or no hydronephrosis (p = .005). See Figure for a summary of results.

There was no difference in the proportion of patient visits with any amount of hydronephrosis (minimal, mild, moderate, or severe) with microscopic hematuria (n = 288, 90%) versus without microscopic hematuria (n = 65, 90%) (p = 0.92). The average ureteral stone size among all patients was 4.9 mm. The average size of ureteral stones for patient visits with microscopic hematuria was 4.7 mm (95% CI [4.4-5.0**;** range 1-20]) and 5.7 mm (95% CI [4.6-6.7; range 1-25]) in patient visits without microscopic hematuria, (p = 0.09 via two tailed t-test). For those patients with no, minimal, or mild hydronephrosis, the average stone size was 4.1 mm (CI [3.8-4.4, range: 1-20]); for those patients with moderate-to-severe hydronephrosis, the average stone size was 6.9 mm (CI [6.1-7.7, range: 1-25]) (p < 0.0001 via two tailed t-test). For ureteral calculi equal or greater than 5 mm in size, the incidence of moderate-to-severe hydronephrosis was 49%, whereas for ureteral calculi less than 5 mm in size, the incidence of moderate or more severe hydronephrosis was 14% (p < 0.0001).

DISCUSSION

Urolithiasis is a very common diagnosis in the ED accounting for 5%-8% of ED visits and adding up to $5 billion in healthcare costs annually in the United States.[8] While most ureteral stones will pass without consequence, the challenge for emergency physicians (EP) is to identify those patients who are at higher risk for complications, such as obstructive uropathy. Microscopic hematuria on UA is a good screening test in the workup of suspected ureteral colic, but its sensitivity ranges between 69% and 84%,[3,9] similar to the rate found in our study of 82%.

Our retrospective chart review demonstrated that microscopic hematuria was less sensitive in detecting urolithiasis in patients with more severe disease (obstructive uropathy). It is unclear why a greater degree of obstructive uropathy would correlate with a lower incidence of microscopic hematuria. One hypothesis is that larger ureteral stones may obstruct bleeding

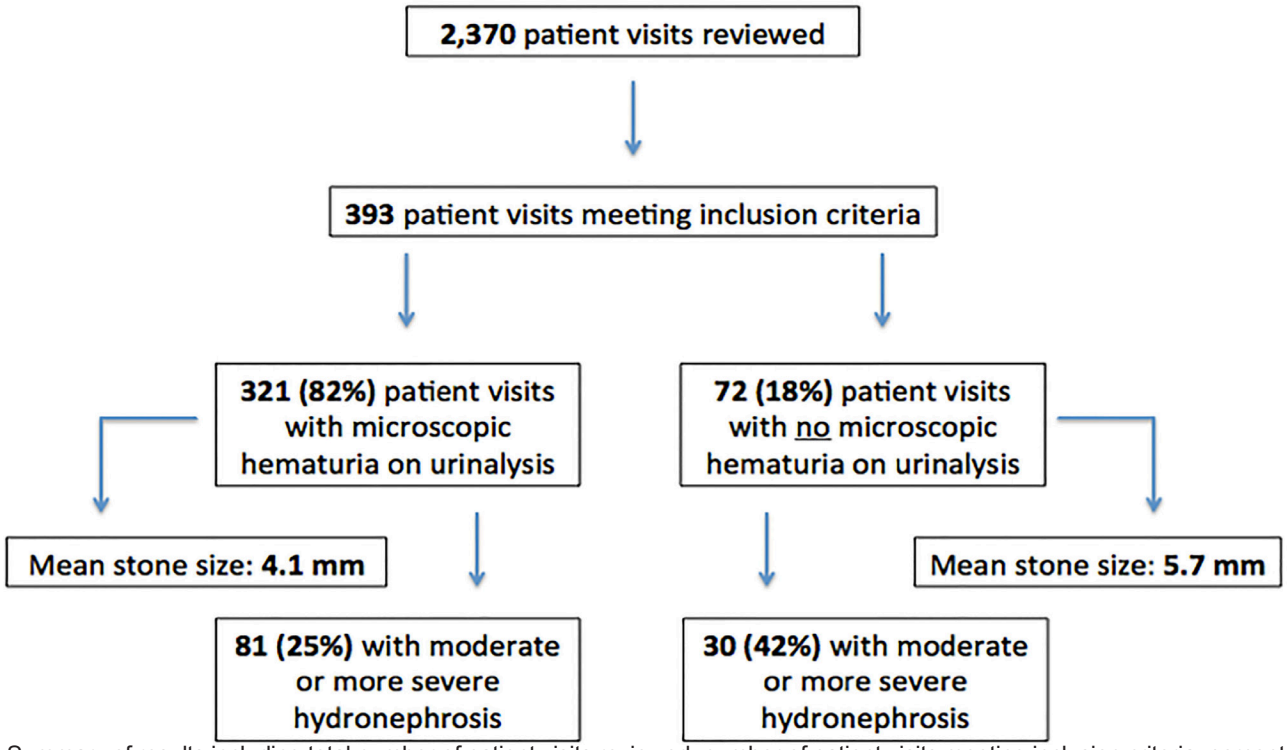

Figure. Summary of results including total number of patient visits reviewed, number of patient visits meeting inclusion criteria, percentage of included patient visits with and without microscopic hematuria on urinalysis, mean stone size and percentage of moderate-to-severe hydronephrosis among included patient visits with and without microscopic hematuria on urinalysis.

resulting in the absence of hematuria on UA; however, no studies have proven this. Additional factors that may influence or confound the presence or absence of microscopic hematuria on UA in patients with suspected urolithiasis include dehydration, females on their menstrual period, stone position,[10] and the time interval between pain onset and urine collection.[12] A recent study by Sahin et al. examined the value of several parameters for predicting successful medical expulsion therapy in urolithiasis and found stone size, localization, degree of hydronephrosis, proximal ureteral diameter and ureteral wall thickness to be highly predictive, and patient age, BMI and stone density not predictive.[13] Regardless, EPs may want to exercise caution in the management of patients with suspected ureteral colic without microscopic hematuria on UA, as our findings suggest these patients are at increased risk of more severe hydronephrosis.

The presence or absence of microscopic hematuria on UA is a point of interest, as its absence may prompt EPs to order more diagnostic CTs to narrow the differential diagnoses. At present, non-contrast helical CTs are the criterion reference of urinary stone diagnosis, with a measured sensitivity of 97-100%, specificity of 94-96%, and negative predicative value of 97%.[14-16] However, non-contrast CT urography can underestimate ureteral stone size by up to 12%.[17] CTs are also expensive, increase ED lengths of stay, and expose patients to ionization radiation.[20-23] The expense can be further inflated by the workup of incidental and unrelated findings found on CT.[11,18,19]

We did not find a statistically significant difference between ureteral stone size in patients with and without microscopic hematuria. Our sample size may have been too small to detect one, although previous studies have also failed to demonstrate a significant correlation between stone size and the presence of hematuria.[10] We did find, however, a significant difference in the mean size of ureteral stones resulting in minimal-to-mild hydronephrosis (4.1mm) versus those resulting in moderate-to-severe hydronephrosis (6.9 mm, $p < 0.0001$). Furthermore, stones that were 5mm or larger were associated with a higher incidence of moderate-to-severe hydronephrosis (49%) than those stones that were smaller than 5mm (14%, $p < 0.0001$). These findings suggest that the severity of an obstructive complication may increase significantly with ureteral stones around 5 mm in diameter or larger. This knowledge carries important clinical implications as it might aid EPs in better estimating a patient's likelihood of an obstructive complication and consequently whether or not urological consultation is warranted.

LIMITATIONS

Limitations of our study include its retrospective nature, though it strictly adheres to methods designed to minimize bias in emergency medicine retrospective chart reviews as outlined by Gilbert, Lowenstein, et al.[4] We also examined a narrow patient population of ED visits with CT-proven urolithiasis only. This was intended to ensure all patients included in the study had direct visual evidence a ureteral calculus, however at the expense of excluding all patients clinically diagnosed with ureterolithiasis (i.e., no CT obtained). EPs are more likely to obtain a CT for patients with renal colic symptoms and no hematuria on UA given greater diagnostic uncertainty, and thus a selection bias for patients without hematuria on UA may have skewed our patient sample. Furthermore, the growing use of point-of-care ultrasound as an alternative imaging modality for diagnosing hydronephrosis at the bedside with reported sensitivities of 85-94% and specificity of 100% contributed additional confounding as these patients too were excluded if no CT was obtained.[24-26] Some patient visits over the data collection time period may have been repeat visits by the same patient. Several patient visits that otherwise would have met inclusion criteria were excluded based on the absence of either UA data or a CT urography report. Some CT urography reports neglected to qualify the degree of hydronephrosis, and others varied in the verbiage used to describe the degree of hydronephrosis. Additionally several patient visits were excluded on the basis of having more than one ureteral stone seen on CT urography given that if hematuria were present on UA it could not be attributed to any one stone.

CONCLUSION

Patient visits to the ED with a single ureteral stone on non-contrast CT abd/pelvis and no microscopic hematuria on UA are more likely to have moderate-to-severe concomitant hydronephrosis than patient visits with microscopic hematuria on UA. Future study should focus on patient-centered outcomes among those found to have clinically significant hydronephrosis without microscopic hematuria on urinalysis in order to better guide the workup and prognostication of this patient group. Additionally, further scientific investigation into the pathophysiological mechanisms responsible for hematuria in urolithiasis would greatly benefit physician interpretation of microscopic hematuria in this patient population.

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