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Western Journal of Emergency Medicine:

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Contents continued on page i

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Table of Contents
continued

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Integrating Emergency Care with Population Health
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Table of Contents
continued

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Is Serum Lactate Necessary in Patients with Normal Anion Gap and Serum Bicarbonate?

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Introduction: There has been an increase in patients having serum lactate drawn in emergency situations. The objective of this study was to determine whether or not it was necessary to obtain a lactate level in patients with a normal serum bicarbonate level and anion gap.

Methods: This is a retrospective chart review evaluation of 304 patients who had serum lactate and electrolytes measured in an emergency setting in one academic medical center.

Results: In 66 patients who had elevated serum lactate (>2.2mmol/L), 45 (68%) patients had normal serum bicarbonate (SB) (greater than 21 mmol/L). Normal anion gap (AG) (normal range <16 mEq/l) was found in 51 of the 66 patients (77%).

Conclusion: We found that among patients with elevated serum lactate, 77% had a normal anion gap and 68% had normal serum bicarbonate. We conclude serum lactate should be drawn based on clinical suspicion of anaerobic tissue metabolism independent of serum bicarbonate or anion gap values. [West J Emerg Med. 2015;16(3):364–366.]

INTRODUCTION

A variety of laboratory parameters can help identify patients with severely compromised or strained metabolism. Among these are the anion gap (AG), serum bicarbonate (SB), pH, and serum lactate (SL) levels. There are two possible strategies for the diagnostic detection of lactic acidosis. The first strategy is to order a lactate level upon any clinical suspicion of acidosis. The second strategy is to order routine chemistry and then if there is abnormality order follow up tests such as a serum lactate.

While the presence or absence of an AG has classically been used as a screening tool for lactic acidosis, there are some potential problems with this stepwise strategy.[1] Firstly, it has been recently suggestedthat the upper limit of a "normal" AG should be lowered to six because of a technological change in the process that measures electrolyte concentrations.[1] This is currently not accepted. Using a lower AG threshold would increase the number of subsequently ordered lactates. Secondly, lactic acidosis is a marker of life-threatening illness, and any delay between recognizing an increased AG level and then ordering and confirming a lactate level may add unnecessary risk to the patient. In one retrospective cohort study, Adams et al. evaluated all emergency department (ED) patients seen over a seven-month

period in whom a lactate level was measured for any reason. The authors considered an AG >12 abnormal and conducted sensitivity analyses of the AG for detecting the presence of a lactate >2.5mmol/L. The AG was 52.8% sensitive, 81.0% specific, and with a negative predictive value of 89.7% for lactic acidosis.[1] Critically ill patients have impaired acid-base regulation and are thought to generate more unmeasured cations, such as magnesium and calcium, thereby affecting the AG. Furthermore, hypo-albuminemia affects the AG and is also prevalent in the ED population.[1,2] From these prior studies, it appears that the AG cannot be considered a surrogate for lactate testing.

METHODS

We attempted to answer the question, is it necessary to draw a serum lactate if a patient has normal anion gap and normal serum bicarbonate? Our hypothesis was that it may not be necessary to draw serum lactate if a patient had no electrolyte suggestion of metabolic acidosis. Perhaps we could save time and money and draw less lab tests for patient evaluation. This was a retrospective chart review study of patients who received the index test (venous lactate level) in the ED or as an inpatient for any clinical reason. The a priori dependent variables used in the analysis were age, gender, date of test, time of lactate drawn, serum lactate level, time of electrolytes drawn, bicarbonate level, anion gap, and creatinine. Data extraction was performed by all co-investigators who were aware of the study hypothesis (non-blinded) and who were all educated on data extraction and input on a prepared electronic template. We did not assess inter-rater reliability. Only patients with complete data were included. We performed data acquisition using a computer-generated search for consecutive patients in whom a serum lactate was drawn.[4,5] Serum lactate was drawn at the physician's order based on suspicion of shock or abdomen disease that could lead to shock. Our institutional review board approved the study.

The setting was a large, urban teaching hospital with over 700 beds. Participants were all patients who had a serum lactate level obtained in the ED or as an inpatient. We performed chart review for analysis of 304 consecutive patients who had a serum lactate level starting in 2010. A total of 165 patients had their tests drawn in the ED, and 139 had their tests drawn as inpatients. Two hundred one patients had electrolytes and serum lactate drawn simultaneously. The median for the time difference between SL and electrolytes drawn is zero (25th percentile for median = 0 and 75th percentile for median = 2 hours). We used the normal ranges as now used in our hospital laboratory. Normal serum bicarbonate is 21-32mmol/L; normal anion gap is 5-15. We report only patients who had serum bicarbonate (SB) < 21mmol/L and anion gap (AG) greater than 16mEq/L, and normal serum lactate is less than 2mmol/L. Results were expressed as either mean values ± standard error of the mean, median (25th percentile to 75th percentile) as absolute numbers or as percentages. We assessed statistical difference between means by Student's t test (unpaired, two tails). We tested ratios or percentages by chi square test. Differences were considered significant at values of $p < 0.05$.

RESULTS

Demographics and lab values of the 304 patients analyzed are found in Table 1. Serum lactate, bicarbonate and anion gap levels averaged 1.99mmol/L, 26.1mmol/L, and 14.5mEq/L, respectively. Patients with serum lactate levels equal to or greater than 2.2mmol/L (n=66) had statistically significant lower bicarbonate and anion gap than those with normal serum lactate (Table 1). Significant negative associations were found between serum lactate and serum bicarbonate ($p < 0.001$). Only 35 (11.5%) of all 304 patients had an anion gap greater than 16.

In the 66 patients (Table 2) who had elevated serum lactate (>2.2mmol/L), 45 (68.1%) had serum bicarbonate greater than 21 mmol/L (normal range 21-32mmol/L). Anion gap less than 16 (normal range 5-15mEq/L) was found in 51 of the 66 patients (77.2%). In the 22 patients with SL greater than 4mmol/L there were 10/22 (45.5%) with SB greater than 21 and 12/22 (54.6%) with AG less than 16mEq/L. Our findings indicate that a serum lactate may be elevated despite normal serum bicarbonate and anion gap values.

DISCUSSION

Serum lactate is now used commonly in hospitals to assist with diagnosis and management of patients presenting with signs and symptoms of sepsis and/or shock. Prior studies have shown elevated levels are consistent with metabolic changes of decreased tissue perfusion.[3] Other commonly done tests

Table 1. Patient demographics and serum electrolyte levels.

Serum lactate levels (mmol/L)	Age (years)	Serum lactate (mmol/L)	Serum bicarbonate (mmol/L)	Anion gap (mEq/L)
All patients (n=304)	68.3 ± 1.1	1.99 ± 0.13	26.1 ± 0.30	14.5 ± 0.30
SL < 2.2 mmol/L(n=238)	67.3 ± 1.2	1.21 ± 0.03	27.1 ± 0.3	13.5 ± 1.5
SL ≥ 2.2 mmol/L (n=66)	72.2 ± 2.2 p=0.06	4.78 ± 0.5	23.1 ± 0.8 p=0.0001	18.2 ± 3.3 p=0.043

SL, serum lactate
Shown are mean values ± SEM for n observations.

Table 2. Distribution of patients with low serum bicarbonate and high anion gap levels according to serum lactate levels.

Serum lactate levels (mmol/L)	Serum bicarbonate <21mmol/L n (%)	AG levels >16mEq/L n (%)
All subjects (n=304)	41 (13.4%)	35 (11.5%)
SL <2.2mmol/L (n=238)	20 (8.4%)	20 (8.5 %)
SL ≥2.2mmol/L (n=66)	21 (31.8%)[a]	15 (22.8%)[b]
SL ≥4mmol/L (n=22)	12 (54.5%)	10 (45.4%)

SL, serum lactate; *AG*, anion gap
[a] Statistically significant differences between patients with serum lactate levels lower than 2.2 and patients with serum lactate equal or higher than 2.2mmol/L, all patients had serum bicarbonate levels lower than 21mmol/L (Chi square=24.7; p=0.00006).
[b] Statistically significant differences between patients with serum lactate levels lower than 2.2 and patients with serum lactate equal or higher than 2.2mmol/L, all patients had AG levels greater than 16mEq/L (Chi square=14.6; p=0.00013).

such as anion gap and serum bicarbonate can be abnormal in patients with similar pathophysiology. Most patients arriving in EDs will have emergency measurement of electrolytes. In this study we asked if it is necessary to draw a serum lactate in patients who do not show signs of metabolic acidosis by elevation of anion gap and decreased serum bicarbonate. In our series of 304 consecutive patients who had SL measured we found 86.6% with SB greater than 21mmol/L and 88.5% with AG less than 16mEq/L. Thus, we conclude serum lactate should be drawn based on clinical suspicion of anaerobic tissue metabolism independent of serum bicarbonate or anion gap values.

There are several possible reasons why SL could be high while anion gap and serum bicarbonate remain normal. One possibility is that cellular metabolism could be changing when the blood is being drawn. Another possibility is that serum lactate could be more sensitive than anion gap or serum bicarbonate. Or perhaps what we are currently describing as normal serum lactate, <2mmol/L, is too low and normal should readjusted to 3mmol/L.

We believe it is important to critically evaluate increasingly common laboratory testing to provide high quality, evidence-based, and high-value care.

LIMITATIONS

Our study has several limitations. As a retrospective chart review, we may have missed appropriate patients in the electronic medical record. In 201 of the 304 patients lab tests were done simultaneously. It is possible with resuscitation that there were changes in lab values. Patients were identified by having had a serum lactate result; thus, the clinicians had an index of suspicion for altered cellular metabolism.

CONCLUSION

Our findings revealed a high percentage of patients with abnormal serum lactate and yet normal serum bicarbonate and anion gap. Seventy-seven percent of patients with elevated lactate have normal AG and 68% have normal bicarbonate. Our study indicates that lactate levels can be elevated independent of anion gap and serum bicarbonate levels, and thus should be drawn based on clinical suspicion of cellular hypoxemia.

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Case Series of Patients with Ruptured Abdominal Aortic Aneurysm

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Introduction: Traditionally, patients with suspected ruptured abdominal aortic aneurysm (rAAA) are taken immediately for operative repair. Computed tomography (CT) has been considered contraindicated. However, with the emergence of endovascular repair, this approach to suspected rAAA could be changing.

Methods: We present retrospective data in a case series of 110 patients with rAAA. Patients were managed at a single tertiary medical center over a five-year period. At this site, there was an established multidisciplinary protocol in which patients with suspected rAAA undergo CT with consideration for endovascular aortic repair (EVAR).

Results: Our results demonstrated a mortality of 30% with our institutional protocol for CT in suspected rAAA. Comparing patients who ultimately had EVAR with open repair, those able to have endovascular aneurysm repair (EVAR) had lower mortality, shorter hospital stays for survivors, and a greater likelihood of being discharged to home than those with open repair. While survivors were more likely to have had EVAR, surviving patients were younger, had a significantly lower creatinine at presentation, and required fewer blood transfusions than those who died.

Conclusion: Based on this case series, an institutional approach endorsing CT for presumed rAAA appears to be reasonable. Our results suggest that EVAR may be beneficial in appropriately-selected patients and that CT may potentially facilitate superior management options for patient care. [West J Emerg Med. 2015;16(3):367–371.]

INTRODUCTION

The traditional dogma is explicit regarding the management of probable ruptured abdominal aortic aneurysm (rAAA). A patient presumed to have rAAA should be taken for immediate surgical repair, rather than undergo confirmatory computed tomography (CT).[1] Tintinalli notes that, even when reaching the operating room, half of patients with rAAA die, and therefore argues "imaging modalities should be restricted to patients who are considered unlikely to have a ruptured AAA."[2]

However, in the age of endovascular repair, traditional dogma may be crumbling. CT may facilitate endovascular aortic repair (EVAR), and emergent unstable patients with rAAA are increasingly considered candidates for EVAR.[3-5] EVAR is associated with lower mortality, shorter hospital stay, and greater likelihood of discharge to home, although patient selection complicates these conclusions.[3,5-10]

In light of the emerging role of EVAR in rAAA – and in turn, the role for CT in presumed rAAA – we present preliminary data from a single-center experience with deviation from this established dogma.

METHODS

This brief report presents a case series of patients with ruptured abdominal aortic aneurysm from September 2005 to November 2010. These patients were managed by the vascular surgery group at a large tertiary medical center where CT with contrast was considered standard care prior to surgical intervention as part of a multidisciplinary protocol initiated in 2002. The Figure below illustrates the Albany Medical Center protocol for rAAA.

Consistent with Worster and Bledsoe's summary of proper methods for retrospective chart review,[11] we obtained the patient list from an existing database of vascular surgery patients. Selection criteria included all inpatients admitted through emergency department (ED) with a diagnosis of rAAA from billing records, regardless of whether surgical intervention was ultimately pursued. Our sample was all patients who met the inclusion criteria. Abstractors were trained prior to data collection, with subsequent performance monitoring. Two medical students blinded to the study's purpose extracted data from medical records. A standardized data extraction form was used, with variables defined in advance and a standardized sequence for identifying data. This study was approved by the local institutional review committee.

We performed data analysis with a combination of Excel and stata. Demographic statistics were calculated median and IQRs. For comparison between groups on nominal data, we used either chi-squared or Fischer exact test, as appropriate. Then an F-test was first used to determine equality of variances, followed by unpaired, two tailed Student's t-tests to compare subsets of patients.

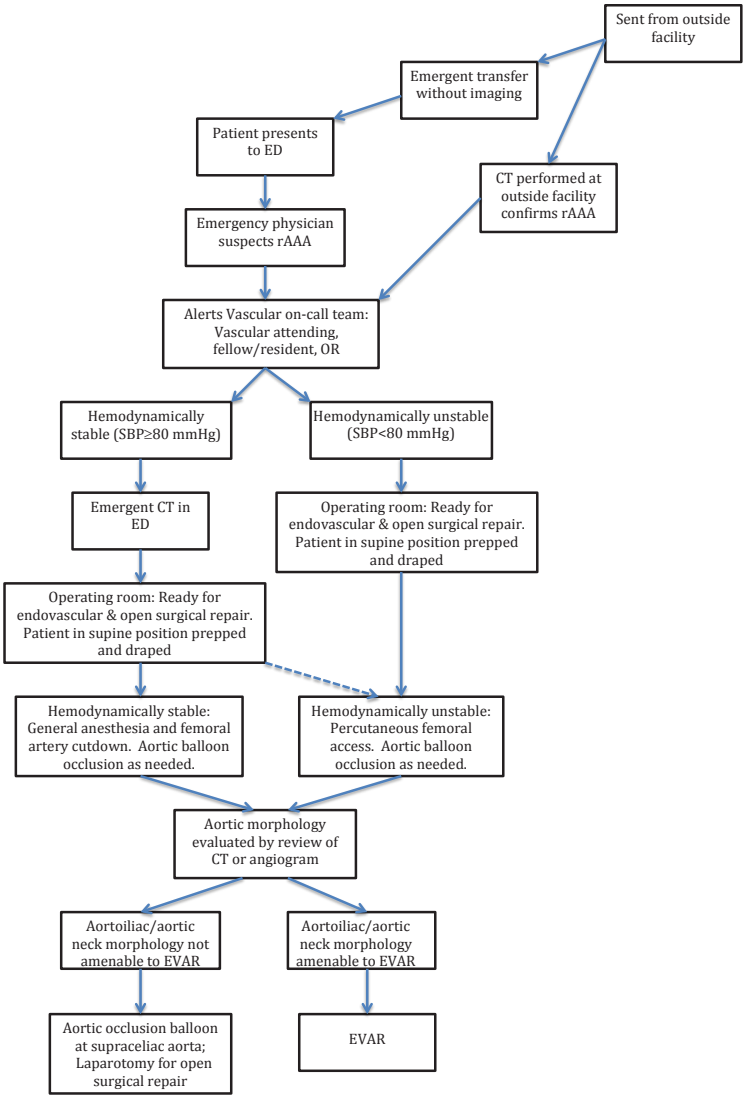

Figure. Albany Medical Center protocol for ruptured abdominal aortic aneurysm (rAAA).
ED, emergency department; *CT,* computerized tomography, *OR,* operating room; *SBP,* systolic blood pressure; *EVAR,* endovascular aneurysm repair
Albany Vascular Group standardized protocol for EVAR of ruptured rAAA. (Modified from Mehta M, Taggert J, Darling RC 3rd, et al. Establishing a protocol for endovascular treatment of ruptured abdominal aortic aneurysms: Outcomes of a prospective analysis. *J Vasc Surg*. 2006;44(1):1-8.).

RESULTS

The case series included 110 patients with a median age of 74 years (IQR = 65–81 years). The age range was 39–95 years. It included 35 females and 75 males. The median measured AAA size in largest dimension was 7.75cm (IQR=6.45–9.4cm). Of the subjects, 82 had no prior aortic repair, 21 had prior aortic repair, and 7 were not recorded. Out of 105 patients with a recorded blood pressure, 40 were hypotensive (38.1%), defined as less than 90/60mmHg. Additionally, of 102 patients with a recorded heart rate, 30 were tachycardic (29.4%). Defining acute shock by hypotension or tachycardia, 60 out of the 106 patients that had a blood pressure or heart rate recorded were in shock (56.6% of patients). Median intensive care unit (ICU) length of stay was four days (IQR=1–8days), with 18 patients having zero ICU days reported and a range from 0-46 days. Median hospital length of stay was 10 days (IQR=3–19days), including ten with zero days (early deaths) and a range from 0-92 days. The ultimate outcome included 33 total deaths, for a mortality rate of 30%. Of the 77 survivors, 39 were discharged to home, 7 were discharged with home health services, 22 were discharged to rehab, 8 were discharged to a skilled nursing facility, and one was transferred to the Veterans Affairs health system.

In this case series, 57 patients had EVAR and 48 patients had open repair. The open repairs included three patients who started with EVAR and necessitated conversion to open, or 5% of the cases planned as EVAR. Those who underwent EVAR had smaller aneurysms compared to the open repair group. In the open repair cohort, significantly more units of packed red blood cells (pRBCs) were transfused (p=0.018), and creatinine rose significantly higher (p=0.019) as noted in Table 1. EVAR patients had appreciably lower mortality rates than open repair (p=0.028).

We then compared the 33 patients with rAAA who died with 77 survivors, as seen in Table 2. The rates of prior repair were comparable for those who lived and those who died (p=0.779), but those who died were significantly older (p<0.001), had higher initial creatinine (p=0.02), and required almost twice as many units of pRBCs as survivors (p=0.002). Those who died trended towards a higher peak creatinine (p=0.06). There were no differences between the two groups in relation to sex, highest heart rate, or lowest systolic blood pressure (p=0.503, p=0.375, p=0.378, respectively). Mortality did not correlate with AAA size (p=0.582). Open repair patients had appreciably higher mortality rates than EVAR in a 2x2 contingency table (p=0.028).

Notably, of the 33 patients who died, nearly two thirds died on the day of presentation or the first full hospital day. The data suggest that this early mortality population skewed some results. It contributed to the shorter ICU and hospital stays, and to the greater transfusion needs in the group who died. In contrast, early mortality may have blunted the association of higher peak creatinine in those who died, which only reaches significance when the early mortality group is excluded (p<0.001). The majority of deaths are in this early mortality group.

Table 1. Comparison of endovascular and open repair.

	EVAR (IQR)	OPEN (IQR)	Significance
Aneurysm size (cm)	7 (5.5–8.3)	8.75 (7.2–10.3)	p=0.014
pRBCs transfused (units)	4 (1–8)	8 (5.5–12)	p=0.018
Peak creatinine (mg/dL)	1.3 (1–1.75)	2.2 (1.35–3.2)	p=0.019
Hospital days (survivors)	9 (4-16)	13.5 (3.5–23.5)	p=0.028
Mortality (%)	17.9	37.5	p=0.028

EVAR, endovascular aneurysm repair; *OPEN*, open repair; *pRBC*, packed red blood cells

Table 2. Comparison of patients with ruptured abdominal aortic aneurysm: survivors and mortality.

	Survivors (IQR)	Mortality (IQR)	Significance
Age (years)	71 (62-79)	78 (73–86.5)	p<0.001
Prior AAA Repair (%)	20.8	22.7	p=0.779
Entry creatinine (mg/dL)	1.2 (0.9–1.5)	1.55 (1.25–1.95)	p=0.024
ICU Days	5 (2–9)	1 (0–4.5)	p=0.042
Hospital days	12 (3-22)	1 (0–11.5)	p=0.009
pRBCs transfused (units)	4 (2-8)	8 (6–13.5)	p=0.002
Male (%)	70.1	63.6	p=0.503
Highest heart rate	88 (77–104.5)	87 (81–112)	p=0.375
Lowest systolic blood pressure	110 (91–127.5)	97 (70–128)	p=0.378
AAA size (cm)	7.55 (6.45–9.15)	8.2 (6.6–10.6)	p=0.582
Highest creatinine (mg/dL)	1.5 (1.1–2.6)	1.85 (1.3–3.7)	p=0.055

AAA, abdominal aortic aneurysm; *ICU*, intensive care unit; *pRBC*, packed red blood cells

There is much room for further study. More robust evidence might verify the benefits of EVAR and clarify when it is most appropriate, perhaps by randomized controlled trial (although likely to be unblinded). But this case series indicates that the traditional dogma should be questioned, and that sites may safely pursue pre-surgical CT in patients with potential ruptured aneurysms.

DISCUSSION

This brief report describes a case series of patients with rAAA at a tertiary medical center where the standard approach

is for CT, despite the traditional dogma. We summarize the patient population and outcomes. Notably, the mortality rate of 30% is less than the mortality reported by others, including 50% reported by Tintinalli.[2,3,12]

Patients with rAAA managed with EVAR had more favorable outcomes in this study. Our results are consistent with prior evidence that EVAR in emergency situations is associated with lower mortality, shorter hospital stays for survivors, and a greater likelihood of being discharged home.[3,7,9,12] Presumably, our results bolster the argument that EVAR may be beneficial in appropriately-selected patients.

Aside from the association between EVAR and survival, our study demonstrated that patients who survived rAAA were younger, had a significantly lower creatinine at ED presentation, and required fewer pRBC transfusions. Mortality did not correlate with AAA size. Both ICU stay and the hospital length of stay were significantly longer for survivors, but this is skewed by the fact that a large number of mortalities occurred early.

Some have theorized an advantage of EVAR is the possibility of using local rather than general anesthesia.[10,13-15] But in our case series, a survival advantage to EVAR persists even though all cases are performed under general anesthesia. Unlike open repair, EVAR avoids laparotomy and aortic cross clamping, both of which are associated with significant physiologic burden.[7,10] This may account for our results, and the lower peak creatinine and reduced transfusion requirements might be markers of this.

LIMITATIONS

Our brief report addresses the experience at a single center with CT preceding surgical interventions for rAAA. It may not be generalizable to sites without 24-hour radiology or vascular surgeons with significant experience with EVAR.

Demographics, lab values and other data were limited by the modest number of patients included. This could have underpowered certain analyses and underestimated the significance of some results. Despite this, we obtained noteworthy results.

In this nonrandomized observational case series, differences in survival between EVAR and open repair may be due to differences in the patient populations. Specifically, the nature of aneurysms necessitating open repair – rather than the actual operative intervention itself – may underlay some differences seen. Retrospective data can be complicated by potential limitations or ambiguities in the available records. Therefore, we considered all patients with rAAA, including transfers and those seen primarily at our site. We were not able to control for the degree of hemodynamic instability.

Furthermore, some of the findings were skewed because two thirds of the non-surviving patients died early (on the day of presentation or first full day of hospitalization). This early mortality group may have driven the associations between mortality and shorter lengths of stay or greater transfusion needs. But a correlation between higher peak creatinine and mortality emerges when this early mortality group is excluded. Such subgroup analysis should be interpreted with caution due to the small numbers.

CONCLUSION

Traditional dogma is that patients with rAAA should not undergo CT imaging, but have immediate open surgery. However, in our institution, the standard is for CT imaging in the initial evaluation of rAAA.

From our preliminary case series, an institutional approach endorsing CT for presumed rAAA appears to be reasonable. This brief report demonstrates results at one site when routine CT is used. In this report, interpretation is not confounded by use of regional anesthesia in EVAR. The experience at our institution has been positive and encourages the use of preoperative CT in cases of rupture, even when patients may be unstable.

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Racial Differences in Opiate Administration for Pain Relief at an Academic Emergency Department

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Introduction: The decision to treat pain in the emergency department (ED) is a complex, idiosyncratic process. Prior studies have shown that EDs undertreat pain. Several studies demonstrate an association between analgesia administration and race. This is the first Midwest single institution study to address the question of race and analgesia, in addition to examining the effects of both patient and physician characteristics on race-based disparities in analgesia administration.

Methods: This was a retrospective chart review of patients presenting to an urban academic ED with an isolated diagnosis of back pain, migraine, or long bone fracture (LBF) from January 1, 2007 to December 31, 2011. Demographic and medication administration information was collected from patient charts by trained data collectors blinded to the hypothesis of the study. The primary outcome was the proportion of African-Americans who received analgesia and opiates, as compared to Caucasians, using Pearson's chi-squared test. We developed a multiple logistic regression model to identify which physician and patient characteristics correlated with increased opiate administration.

Results: Of the 2,461 patients meeting inclusion criteria, 57% were African-American and 30% Caucasian (n=2136). There was no statistically significant racial difference in the administration of any analgesia (back pain: 86% vs. 86%, p=0.81; migraine: 83% vs. 73%, p=0.09; LBF: 94% vs. 90%, p=0.17), or in opiate administration for migraine or LBF. African-Americans who presented with back pain were less likely to receive an opiate than Caucasians (50% vs. 72%, p<0.001). Secondary outcomes showed that higher acuity, older age, physician training in emergency medicine, and male physicians were positively associated with opiate administration. Neither race nor gender patient-physician congruency correlated with opiate administration.

Conclusion: No race-based disparity in overall analgesia administration was noted for all three conditions: LBF, migraine, and back pain at this institution. A race-based disparity in the likelihood of receiving opiate analgesia for back pain was observed in this ED. The etiology of this is likely multifactorial, but understanding physician and patient characteristics of institutions may help to decrease the disparity by raising awareness of practice patterns and can provide the basis for quality improvement projects. [West J Emerg Med. 2015;16(3):372–380.]

INTRODUCTION

Analgesia administration in the emergency department (ED) involves complex decisions based on multiple conscious and subconscious factors. Disparities in healthcare are propagated by subconscious stereotypical beliefs about patients (implicit bias), the patient-physician interaction, and patient factors including attitude, intention, self-efficacy, and disclosure.[1] One hypothetical model proposes that provider interpersonal behaviors such as warmth, question-asking style, and patient-physician participatory style may influence patient cognitive factors such as their attitudes towards their care, physician, and encounter, disclosure of pertinent social and medical information, behavioral intentions during the encounter, and autonomy in taking action (self-efficacy).[2] Other factors such as the reported level of pain and the availability of objective evidence of injury also contribute to physician beliefs and actions.[3,4] Complicating the decision to prescribe or administer opiate analgesia are the dual concerns of oligoanalgesia, and the rising abuse of prescription narcotic medications.

A review of the literature found several studies that demonstrated a racial disparity in analgesia and opiate administration in the ED.[5-8] The first of these studies, published by Todd et al.[7] in 1993, found that Hispanics with isolated long bone fractures (LBF) were twice as likely as non-Hispanic whites to receive no pain medication at their academic institution, which was not explained by patient language, intoxication, or injury severity. The same author, practicing at a different academic institution in 2000, found African-American patients with LBF were less likely than Caucasians to receive analgesia, even with similar pain scores.[8]

In contrast, other studies have failed to show a racial disparity in analgesia administration for LBF.[9-12] Such disparate findings in the literature suggest that a correlation between race and analgesia may, to a degree, be attributable to institutional or regional variation throughout the country or different study methodologies.[9] It is plausible that increased attention to the Agency for Healthcare Research and Quality's (AHRQ) annual National Healthcare Disparities Report has led to narrowing the racial gap of analgesia administration for LBF, a relatively objective finding, over time.[13] There is also a growing body of literature suggesting that physician characteristics and possibly the interplay between physician and patient characteristics may impact the administration of analgesia in the ED.[14-16]

The purpose of this study was to assess ED analgesia-prescribing habits on both a department-wide and physician level at an academic institution. This study examines patient and physician characteristics, including patient race that may play a role in a physician's decision to administer analgesia. Three diagnoses (i.e., back pain, LBF, migraine) that have varying degrees of objective sources of pain are included for comparison purposes.

METHODS

Study Design and Setting

This was a retrospective chart review of patients seen between January 1, 2007, and December 31, 2011, at the adult ED of an urban university hospital in a Midwestern metropolitan area. The ED has 22 beds and the annual census ranged from 34,018 in 2007 to 37,362 in 2011 of which 64% were African- American and 51% were male. Forty-eight percent of our population was on Medicaid or was uninsured. The 30 physicians in this group were comprised of 16 full-time and 14 part-time attending physicians who practiced in the ED during this timeframe. All full-time attending physicians were trained in emergency medicine (EM), while some part-time attending physicians were trained in other medical specialties (e.g., internal medicine). The ED provides training for its EM residency program as well as rotations for non-EM specialties including internal medicine, psychiatry, anesthesia, orthopedics, and otolaryngology. Attending physicians are involved in every case and closely supervise residents. First-year residents (interns) must first discuss the patient and plan with the attending, prior to writing orders. Second- and third-year residents are allowed to write orders, including narcotic medications, prior to discussing patients with the attending. At the time of this study, there was no nurse-run pain protocol at triage. The university's institutional review board approved this study.

Selection of Participants

We used the International Classification of Diseases (ICD-9) codes to generate a list of medical record numbers and demographic information of all patients who presented to the ED with one of the following diagnoses: back pain or strain (ICD-9 724), migraine (ICD-9 346), or fracture of the humerus, femur, or tibia or fibula, (ICD-9 812, 821, 823, respectively; herein referred to as LBF). Inclusion criteria required participants to be aged 18 or older. We excluded patients with more than one fracture (such as humerus and tibia fracture) or multiple diagnoses.

Measurements

We collected data following the guidelines of Gilbert and Lowenstein et al. including trained data collectors, standard data collection sheets, and inter rater reliability.[17] Data collectors reviewed each patient's chart and recorded whether the patient received any analgesics by the physician or resident, and if so, whether the patient received an opiate of any dose. Other demographic information collected from the chart was triage acuity on a scale of 1-4 (where one was the highest acuity and four the least acute level), race, age and gender**.** Collectors were blinded to the hypothesis of the study. Their training included instruction on the structure of the electronic medical record, the definition of the study variables, and the data collection procedure. We performed an audit of each data collector's results based on a randomly selected

set of 10 charts to ensure the precision of each collector's measurements and the interpersonal reliability of the results. In all, 40 charts were reviewed, 10 from each data collector. There was perfect agreement between the information gathered by the collectors and the auditor's samples.

A patient was considered to have received analgesia if an analgesic drug was administered in the ED or prescribed at discharge. The list of medications considered analgesia, those considered an opiate, and several drugs that notably were not considered analgesia, is presented below (Table 1).

Outcomes

The primary objective was to compare the proportion of African-Americans who received analgesia (and if so, those who received an opiate) to Caucasians, for each diagnosis. A secondary analysis measured the modifying effect of patient and/or physician characteristics on the administration of analgesia. The following attributes of the attending physician who was responsible for the patient's care were examined: gender, congruence by race and gender (i.e., patient and physician had the same race or same gender), completion of an EM residency.

Analysis

We used a Pearson's chi-squared test to compare baseline demographic characteristics between Caucasians and African-Americans, the proportion of patients receiving any type of analgesia by race, and the proportion of patients who received an opiate by race among patients who had received some form of analgesia.

A multiple logistic regression model was created to identify patient and physician characteristics associated with opiate administration for the only diagnosis in which a racial disparity was observed. First, we employed a univariate analysis to estimate the odds ratios for each variable independently. The construction of a multiple logistic regression model then followed a two-step process in which we assessed statistically significant variables for inclusion in a final model based on how their inclusion affected the odds ratio for Caucasians with back pain to receive an opiate, as compared to African-Americans. Variables with no significant impact were excluded. In this way, the final multiple logistic regression model represents the most parsimonious model for estimating the effect of race on opiate administration, adjusting for likely confounders.

In addition, physician level differences in opiate prescribing for Caucasians and African-Americans were calculated for those who treated at least 25 patients during the study period. We ranked physicians according to opiate-prescribing differences to illustrate the range of prescribing practice, but we made no adjustments for any patient-level attributes, such as acuity. Reporting of this descriptive analysis was limited to the diagnosis group(s) for which disparities were found.

We performed all statistical tests using SPSS version 18.0 (Chicago, IL) with the assistance of an independent statistical consultant. Statistical significance was defined using a two-tailed test with an alpha level of $p<0.05$. A Bonferroni adjustment ws applied to the interpretation of the study's primary analysis regarding proportion of patients who received an opiate by two racial groups for three diagnoses; the adjusted alpha was 0.008.

Table 1. Non-opiate analgesia, opiate analgesia, and notable non-analgesia medications.

Non-opiate analgesia	Opiate analgesia	Non-analgesia
aspirin	tramadol	methocarbamol
ibuprofen	hydromorphone	cyclobenzaprine
naproxen	fentanyl	benzodiazepines
ketorolac	morphine	gabapentin
acetaminophen	hydrocodone	

RESULTS

Of the 2,461 patients who met inclusion criteria, 741 (30.0%) were Caucasians, 1,395 (56.7%) African-Americans, 48 (2.0%) with race listed as "other," and 277 (11.3%) patients with race listed as "unknown." Baseline characteristics by diagnosis are compared in Table 2.

Primary Results

Of the 2,461 patients who met inclusion criteria, we analyzed a total of 2,136 patients: 1,850 (75.2%) cases of back pain, 238 (9.7%) cases of migraine, and 373 (15.2%) cases of LBF. Patients (n=325) with other or unknown race were excluded from analysis (13%) (Table 2).

There was no statistically significant difference between the proportion of African-Americans and Caucasians who received some form of analgesia for any of the three diagnoses. Of patients who received analgesia and were diagnosed with a migraine or LBF, there was no statistically significant race-based difference in the likelihood of receiving an opiate. However, among patients who were diagnosed with back pain and received analgesia, African-Americans were less likely to receive an opiate than Caucasians (Table 3a and Table 3b): 50% versus 72%, $p<0.001$.

Secondary Results

Between 2007 and 2011, the 1,850 patients presenting with back pain were seen by 30 attending physicians (Table 4). The number of patients seen by each physician varied greatly from 1 to 226. To understand if the race-based disparity in opiate administration for back pain reflected department-wide prescribing practices or whether this finding stemmed from one or two outlying physicians, we conducted an analysis of analgesia administration using 17 out of 30 physicians who saw more than 25 patients with back pain. Together, these

Table 2. Baseline characteristics of study population by diagnosis, 2007-2011, N=2,461.

	Caucasian	African-American	p-value*	Other race	p-value*	Unknown race	p-value*	Total
Back pain								
N	469	1099		32		250		1850
Age, median	40	40	0.43	47	0.59	42	<0.01	41
Male (%)	277 (59%)	514 (47%)	<0.01	18 (56%)	0.75	138(55%)	0.31	947 (51%)
Acuity**	3.2	3.5	<0.01	3.6	<0.01	3.5	<0.01	3.4
Time in ED (h)	2.2	3.4	0.13	3.6	0.32	3.1	0.32	3.4
Migraine								
N	83	133		6		16		238
Age, median	34	36	0.72	36	0.45	31	0.17	34
Male (%)	20 (24%)	24 (18%)	0.31	1 (17%)	0.56	3 (19%)	0.76	48 (20%)
Acuity**	2.8	3.0	0.03	3.2	0.28	3.3	<0.01	2.9
Time in ED (h)	5.0	4.6	0.39	5.3	0.70	3.1	0.02	4.6
Long bone fracture								
N	189	163		10		11		373
Age, median	50	36	<0.01	26	0.04	47	0.05	45
Male (%)	105 (56%)	102 (63%)	0.18	10 (100%)	0.01	7 (64%)	0.76	225 (60%)
Acuity**	2.5	2.7	0.06	2.9	0.47	3.1	0.08	2.7
Time in ED (h)	4.6	4.3	0.69	4.6	0.85	5.3	0.77	4.3

ED, emergency department
*****As compared to Caucasians (h)=hours.
**Range=1-4, 1=highest acuity. Acuity listed is the mean.

Table 3a. Percent of patients receiving any analgesia by diagnosis and race.

	Back pain			Migraine			Long bone fracture		
Analgesia	n	% Analgesia	p-value	n	% Analgesia	p-value	n	% Analgesia	p-value
Caucasian	469	86%	0.81	83	73%	0.09	189	90%	0.17
African-American	1099	86%		133	83%		163	94%	
Total	1568			216			352		

Table 3b. Percent of patients receiving opiate by diagnosis and race.

	Back pain			Migraine			Long bone fracture		
Opiate	n	% Opiate	p-value	n	% Opiate	p-value	n	% Opiate	p-value
Caucasian	403	72%	<0.001	61	62%	0.11	170	98%	0.49
African-American	949	50%		111	49%		154	97%	
Total	1352			172			324		

17 physicians saw 95% of the 1,850 patients (Table 5). The difference in opiate administration to African-Americans and Caucasians for each physician ranged from -9% to 50% (mean = 21%, standard deviation = 14%). Two physicians were statistical outliers, as defined as falling greater than 2.5 standard deviations from the mean—one prescribing more frequently to African-Americans, the other more frequently to Caucasians. Only one physician administered opiates more frequently to African-Americans; the other 16 physicians administered opiates more frequently to Caucasians.

Since univariate analysis showed that gender congruence was not a significant predictor of opiate administration it was removed from further development of the logistic regression model. Among patients presenting

Table 4. Attending physician characteristics (n=30).

Race	n	%
Caucasian	25	83%
African-American	2	7%
Other	3	10%
Gender		
Male	20	67%
Female	10	33%
Emergency medicine trained		
Yes	19	63%
No	11	37%
Total	30	

with back pain who received some form of analgesia, the final multivariate model estimated the odds ratio that a Caucasian patient would receive an opiate to be 2.41 (95% CI [1.67,3.46]), as compared to an African-American patient. This model controlled for acuity, age, physician gender, race congruence, and physician training in EM. This model revealed that higher acuity, older age, physician training in EM, and male physicians were positively associated with opiate administration (Table 6). Given the cohort design and 43.5% prevalence of non-opiate use, the odds ratio was converted to a risk ratio of 1.49 per calculation procedures described by Zhang and Yu (1998).[18]

DISCUSSION

Racial and ethnic differences in pain management have been noted in many medical care settings (emergency departments, primary care offices), and for various types of pain (postoperative, nonmalignant, chronic, and cancer pain).[4] The complex factors that mediate this disparity through the range of clinical settings have not clearly been elucidated, but research suggests that patient, provider, systemic, and cultural issues directly and interactively are involved.[3,4,19] Other factors contributing to these disparities may include lack of education and quality improvement projects on pain management, and general reluctance to use or prescribe opiates.[16,20] Our current study reflects the sentiments of Tait et al.[3] that racial/ethnic disparities have proved difficult to change, despite the national focus on oligoanalgesia and decades of research on healthcare disparities.

In fact, we found similar results to a study of the National

Table 5. Treating practices of physicians who had seen 25 or more patients with back pain.

Physician	% Volume of patients with back pain**	Percentage of patients with back pain administered opiates		% Difference between African-American and Caucasian*
		African-American	Caucasian	
1	2	59	50	-9
2	7	79	81	1
3	6	46	50	4
4	4	60	67	6
5	2	56	67	11
6	7	35	48	13
7	4	37	53	16
8	10	63	80	17
9	7	26	48	22
10	5	58	80	23
11	8	58	84	26
12	8	49	76	27
13	5	55	85	30
14	8	39	74	35
15	4	39	75	36
16	5	45	81	37
17	2	50	100	50
Mean ± SD		50±13	71±16	21±14
Median		50	75	22

*Numbers may not sum to 100% due to rounding.
**5% of patients were seen by 13 physicians who saw fewer than 25 study patients each with back pain. These patients were not included in this analysis.

Table 6. Univariate and multiple logistic regression analysis of opiate administration to patients with back pain who received analgesia.

	Univariate analysis n=1352		Multivariable model n=1262	
Characteristic	OR	95% CI	OR	95% CI
Patient				
Race (Caucasian)	2.55	(1.97, 3.27)*	2.41	(1.67, 3.46)*
Sex (female)	0.84	(0.67, 1.04)		
Age	1.03	(1.02, 1.03)*	1.03	(1.02, 1.04)*
Acuity[$]	0.41	(0.33, 0.50)*	0.49	(0.40, 0.60)*
Physician				
Sex (female)	0.78	(0.55, 0.94)*	0.72	(0.55, 0.93)*
Same race as patient	1.70	(1.32, 2.18)*	0.94	(0.65,1.35)
Same gender as patient	0.94	(0.76, 1.17)		
Trained in emergency medicine[%]	1.53	(1.19, 1.97)*	1.45	(1.09, 1.93)*

*Statistically significant p<0.05.
[$]n=1264.
[%]n=1350.

Hospital Ambulatory Medical Care Survey (NHAMCS) from 15 years ago. African-Americans (AA) and Caucasians received some form of analgesia at similar rates across all diagnoses (back pain, migraine, LBF).[6] However, AA were less likely to receive opiates for back pain and migraine conditions, compared to Caucasians. Mills et al.[21] studied a cohort of patients with undifferentiated abdominal pain and back pain (based on chief complaints) and found that white patients were 10% more likely to receive opiates than non-whites. Pletcher et al.[5] (using NHAMCS 1993-2005) also found that overall analgesia administration (opiates and non-opioids) did not differ between non-whites and whites, but that opiates for various painful conditions, including back pain, were prescribed more frequently to whites (48% whites vs. 36% non-whites), even after controlling for covariates. They also noted that the differential in opiate prescribing by race/ethnicity did not decrease over time.[5] Thus, while the disparity in any analgesia administration has decreased over time, our study suggests that a disparity in the type of analgesia may still exist. As noted by Tamayo-Sarver,[6] the difference in opiate administration is noted in those with diagnoses that may have limited objective findings because the decision to administer an opiate "requires more trust of the patient by the physician." This observation can account for the fact that opiate use for LBF was consistently higher than the other two diagnoses, irrespective of race. Objective findings in LBF include radiographic evidence of fracture, visible deformity, or broken skin/bone visible on physical examination. In contrast, migraines and back pain commonly have limited objective findings on physical examination and are more subjective sources of pain. Studies also suggest that minority race/ethnicity was associated with lower rates of opiate prescriptions for discharged patients.[14,22]

Patient-physician communication and assessment of pain by the provider are important factors in the treatment of pain. Numerous studies have related that physicians underestimate pain more in racial/ethnic minorities, especially for patients reporting high pain severity.[4,19] Patient factors such as decreased satisfaction with patient-physician communication among African-American patients, and the decreased assertiveness shown by minority patients during interactions with physicians can hinder a patient's ability to express the nature of an ailment or the severity of a pain.[14,23] While race concordance may enhance pain communication[3] or patient satisfaction,[24] in our study, it did not translate into a higher chance of receiving opiates for back pain when other variables were accounted for. Heins et al.[1] did not note any racial concordance on clinically significant pain intensity reduction in the ED. They found non-white physicians were more likely to achieve pain reduction than white physicians despite lower opiate administration, possibly due to other characteristics of the clinical encounter unrelated to the medication treatment.[1]

Implicit bias that relies on unconscious racial stereotypes may influence pain management decisions such as assessment and credibility of pain, as well as possible misuse of opiate prescriptions.[3,19,25-27] Even the most well-intentioned individuals, such as emergency physicians who provide the "safety net" of healthcare, can lean towards unconscious stereotypes when fatigued or required to make quick decisions with little information (i.e. in cases of clinical uncertainty and the fast-paced environment of the ED).[28] A clinical vignette study on chronic low back pain suggests that prescribing practices vary, not only by physician gender, but by cognitive load in which greater load may enhance the implicit biases one may have.[27] Under high cognitive load, male physicians were more likely to prescribe opioids to white male patients. Under low cognitive load, male physicians were more likely to prescribe opioids for black male patients, implying the male

physicians were able to correct for their inherent bias when there was more time and resources to do so. Surprisingly and inexplicably, the pattern for female physicians was reversed.[27] Safdar et al.[16] found gender congruence in the administration of opiates in the ED, which may be partially explained by experimental studies that have found men report higher pain tolerance and lower pain intensity when reported to a female.[16,19] We found no such association between gender congruence and opiate administration in our patient population. The wide range of results on patient and provider characteristics in regards to analgesia administration and pain reduction makes regional and institutional data acquisition important in identifying practice patterns. This is especially true since many educational programs addressing racial disparities in healthcare focus on patient factors instead of provider factors (i.e. lack of trust).[29] Indeed, much of ED literature on factors associated with racial healthcare disparities focus on improving access to care, as opposed to any physician factors, especially since this can be difficult and sensitive to examine.[24]

Regarding approaches to improve pain management in the ED, clinical education shows promise.[14,30] Heins et al.[14] found that EM-trained physicians, similar to our study, and EM physicians practicing for fewer than three years—i.e. physicians with more recent EM education—were more likely to administer opioids in the ED and ensure adequate analgesia. However, those experienced EM physicians were more likely to prescribe opioids at discharge.

Looking forward, the question remains on the best ways to mitigate racial disparities in the ED for pain management, and ED healthcare in a broader context. Programs that may help include empathy training, communicating about expectations of pain relief in the ED, and cross-cultural training.[3,26] There is a dearth of evidence, however, that cross-cultural training actually reduces racial/ethnic healthcare disparities.[28,29] Awareness of and learning about implicit bias and how it operates in clinical settings is needed in undergraduate, graduate, and postgraduate programs to improve racial disparities.[26,28] Richardson et al.[31] suggests quality improvement programs such as periodic retrospective review of ED physician data on points of known disparate care so that physicians can be more cognizant of any implicit bias. In addition, a multidisciplinary approach using techniques from social and psychological science research could help to inform clinical educators and practicing physicians on the nuances of stereotypes and ways to overcome implicit bias.

LIMITATIONS

Potential limitations include those associated with retrospective chart reviews and the single-institution study design that limits the generalizability of the results. Self-identification of race, perception of others' race, and race relations differ regionally; accordingly, it is impossible to say whether the findings of the present study reflect only regional patterns, or if they are applicable to other areas of the country. Eleven percent of the study population had no recorded race documented in the medical chart (and 2% with "other" race) were excluded from analysis. It is unknown whether race, as recorded in the chart, was self-identified or assumed. Ethnicity (i.e. Hispanic white versus non-Hispanic white) was not elucidated from race although other studies have shown that ethnic minorities are also less likely to receive opiates.[3,4,6] In actuality race itself is not necessarily homogenous and cultural differences within the group may confound differences (African patients and African-American lumped into one group).[32]

Another limitation involves the use of diagnostic codes, as opposed to chief complaints, as inclusion criteria. Many conditions can cause back pain and the exact etiology cannot always be elucidated within one ED visit. Thus a diagnostic code of unspecified back pain may in fact be sciatica, nephrolithiasis, or an epidural abscess (that was not diagnosed in the ED), and be misclassified, although it is doubtful that there would be a differential by race. Along similar lines, selection bias may explain why there was no race-based disparity in opiate administration for migraines. It is plausible that only patients with a previous documented diagnosis of migraine or migraine recorded in their past medical history received this code. Thus, the complaint of pain may have been considered to be more objective evidence (compared to complaints of headaches of unclear etiology) due to their history.

Finally, the retrospective review of medical records allows only a limited understanding of clinical decision-making. Factors that are not always captured in patients' charts may have had a bearing on the decision to administer analgesia; these include nonverbal communication, verbal communication (asking to receive or not receive opiates), socioeconomic status, and education level. Other factors that may have impacted reception of opiates include mode of arrival, duration of pain, intoxication, and pain score. Pain scores can be extremely subjective with wide variability between patients and may not be able to discriminate between those who want pain medication and those who do not.[33,34] Analgesia was defined as in Table 1 with notable exclusions of muscle relaxers and neuroactive agents that can also be administered for pain relief. Similarly, sumatriptan, caffeine, or anti-nausea medications such as prochlorperazine may have been used to relieve the pain of a migraine headache, but these drugs were also not considered analgesics.

The use of opiates for back pain and migraine conditions in this ED may seem high at 49% and 43%, especially in light of guidelines calling to limit opiate use for these conditions. The American Academy of Neurology guidelines from 2000 recommend opiate use only as a rescue medication after first-line therapy has failed, and the 2008 American College of Emergency Physicians clinical policy

on headache makes no mention of opiate use.[35] However, using NHACMS data from 2002 to 2006, Friedman et al.[36] note that of medications administered or prescribed for low back pain, opiates were the most frequently used at 61.7% (compared to non-steroidal medications at 49.6%). Mazer-Amirshahi et al.[35,37] note an overall increase in the ED administration and prescription of opiates in pain-related ED visits (including headache) from 2001 to 2010 with the Midwest region having a greater proportional increase and showing a greater increase in narcotic use than others. While it is unclear what is driving this trend, the authors' theories include patient preferences, drug shortages, and patient satisfaction experiences.

Furthermore, this study was performed at a teaching hospital, where both residents and physicians were involved with care of the patient. Either member of the team could give analgesia; however, the physician level factors were attributed to the primary attending responsible for the patient.

CONCLUSION

No race-based disparity in overall analgesia administration was noted for all three conditions: LBF, migraine, and back pain at this Midwestern institution. However, we observed a race-based disparity in the likelihood of receiving opiate analgesia for back pain in this ED with Caucasians 1.5 times more likely than African-Americans to receive opiate analgesia. The etiology of this is likely multifactorial, but understanding physician and patient characteristics of institutions may help to decrease the disparity by raising awareness of practice patterns and can provide the basis for quality improvement projects. Additionally, this study provides an approach for identifying department-wide race-based disparities, allowing institutions to determine if steps addressing potential bias should be focused on a department as a whole or on specific members. More interdisciplinary research is needed to address ways in which racial disparities related to pain management in the ED can be mitigated.

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Opioid Education and Nasal Naloxone Rescue Kits in the Emergency Department

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Introduction: Emergency departments (EDs) may be high-yield venues to address opioid deaths with education on both overdose prevention and appropriate actions in a witnessed overdose. In addition, the ED has the potential to equip patients with nasal naloxone kits as part of this effort. We evaluated the feasibility of an ED-based overdose prevention program and described the overdose risk knowledge, opioid use, overdoses, and overdose responses among participants who received overdose education and naloxone rescue kits (OEN) and participants who received overdose education only (OE).

Methods: Program participants were surveyed by telephone after their ED visit about their substance use, overdose risk knowledge, history of witnessed and personal overdoses, and actions in a witnessed overdose including use of naloxone.

Results: A total of 415 ED patients received OE or OEN between January 1, 2011 and February 28, 2012. Among those, 51 (12%) completed the survey; 37 (73%) of those received a naloxone kit, and 14 (27%) received OE only. Past 30-day opioid use was reported by 35% OEN and 36% OE, and an overdose was reported by 19% OEN and 29% OE. Among 53% (27/51) of participants who witnessed another individual experiencing an overdose, 95% OEN and 88% OE stayed with victim, 74% OEN and 38% OE called 911, 26% OEN and 25% OE performed rescue breathing, and 32% OEN (n=6) used a naloxone kit to reverse the overdose. We did not detect statistically significant differences between OEN and OE-only groups in opioid use, overdose or response to a witnessed overdose.

Conclusion: This is the first study to demonstrate the feasibility of ED-based opioid overdose prevention education and naloxone distribution to trained laypersons, patients and their social network. The program reached a high-risk population that commonly witnessed overdoses and that called for help and used naloxone, when available, to rescue people. While the study was retrospective with a low response rate, it provides preliminary data for larger, prospective studies of ED-based overdose prevention programs. [West J Emerg Med. 2015;16(3):381–384.]

INTRODUCTION

In the United States, deaths from prescription opioid overdose increased from 4,041 in 1999 to 16,651 in 2010.[1] In 2011, an estimated 420,040 emergency department (ED) visits were prescription opioid-related and 258,482 were heroin-related.[2] The Office of National Drug Control Policy recognizes a "window of opportunity to intervene by calling 911, giving rescue breathing and by the administration of naloxone by a trained lay person."[3] Overdose education and naloxone distribution (OEN) programs educate those at risk for opioid overdose or those likely to witness an overdose to prevent, recognize and respond. As of 2010, OEN programs had been implemented in 188 communities nationwide to address this epidemic. Traditionally these programs were located in needle syringe programs. Over 53,032 individuals were trained in OEN from 1996 through 2010, resulting in 10,171 overdoses reversed with naloxone.[4] Previous studies have found implementation of OEN programs is associated with reduced opioid overdose death rates,[5-9] and is cost-effective among heroin users.[10] Through 2014, 25 U.S. states and the District of Columbia have amended their laws to allow physicians to prescribe and dispense the drug and to allow the lay public to administer naloxone without legal consequence.[11] Given the frequency of opioid-related visits, the ED may be a high-yield venue for overdose prevention interventions. To date, no published studies have described an ED-based OEN program that includes naloxone distribution.

Our objectives were to evaluate the feasibility of an ED-based overdose prevention and intervention program, and describe the overdose risk knowledge, opioid use, overdose, and overdose response actions among ED patients who received overdose education only (OE) or OEN in this observational study.

METHODS

Study Design

We conducted a survey of OE and OEN patients who had been seen in our ED between January 1, 2011 and February 28, 2012. Trained research assistants (RAs) interviewed participants by telephone between March 1, 2012 and October 31, 2012. Data entry, abstraction and analysis were performed by data analysts. The local institutional review board approved this study.

Study Setting and Population

This study was conducted at an academic, urban, Level I trauma center with racially and ethnically diverse patients. All patients who spoke English and were seen by our ED-based licensed alcohol and drug counselors (LADC) for OE or OEN were eligible for inclusion.

Study Protocol

Initially started in 1993 with funding from the Substance Abuse Mental Health Services Administration, Project ASSERT (PA) has been funded by the hospital since 1997, with a staff of LADCs that collaborates with ED providers to offer substance-abuse screening, brief intervention and referrals to substance use disorder treatment.[12] In 2009, PA implemented an overdose education program in accordance with the Massachusetts Department of Public Health (MDPH) overdose prevention pilot program for patients at risk for opioid overdose.[5] The LADCs dispense free nasal naloxone rescue kits to at-risk ED patients under a standing order from the MDPH medical director. OEN takes approximately five minutes, and while the kits cost $55 for two atomized 2mg naloxone vials, they are currently state funded.

Receipt of a naloxone kit was not randomized but was primarily dependent on trained staff availability and patient preference during the ED visit. OE and OEN patients seen by PA were educated about overdose risks and how to recognize and respond to a witnessed overdose by calling 911, delivering rescue breaths, and staying with the person until EMS arrives. A list of ED patients seen by PA who received OE or OEN was generated from ED electronic records and their phone numbers were extracted from the billing database. RAs contacted subjects from this list, obtained informed consent, and administered the survey. RAs attempted to make contact up to 10 times before excluding the subject. We excluded participants with disconnected or inaccurate phone numbers.

Data collection and Measurements

Survey questions included: demographics, overdose education and naloxone history, personal overdose history, witnessed overdose history, past 30-day substance use, and overdose risk knowledge retention (Appendix 1).

Data Analysis

We present descriptive data from our study and comparisons between OE and OEN groups among those patients who responded to the survey. We defined opioid use as any self-reported opioid use in the past 30 days. Opioid overdose was defined as any self-reported overdose since the ED index visit. To assess participants' overdose response behavior we asked participants about the following: 1) calling 911; 2) rescue breathing; 3) administering naloxone; and 4) staying with the victim. We used chi-square tests (Fisher's exact when appropriate) to compare these groups. All analyses were conducted in SAS v. 9.3.

RESULTS

There were 415 patients seen by PA during the study period; 359 received OE only and 56 received OEN. Among the 415, 12% (51/415) completed surveys; 4.6% (19/415) were reached but did not complete surveys; 38% (156/415) had wrong or disconnected phone numbers; 35% (147/415) were not reached after 10 attempts; 10% (40/415) had no phone number; 0.5% (2/415) were reported as deceased from an overdose. The median time between ED index visit and survey completion was 12 months for OE only (range: 8-17 months), and 11 months for OEN (range: 5-19 months).

Among the 51 patients who completed the survey, 73% (37/51) had received naloxone (Figure). Among these, 76%

Demographic Characteristics					
	Total Eligible (n=415)	**Total Surveyed (n=51)**	**OEN (n=37)**	**OE Only (n=14)**	**OEN vs OE (p-value)**
Mean Age (SD)	36 (10.6)	43 (11.1)	42 (12.2)	45 (7.8)	0.50
Male (n)	73% (301)	59% (30)	54% (20)	71% (10)	0.35
Race/ethnicity					
White (n)	62% (258)	55% (28)	51% (19)	64% (9)	0.05
Hispanic (n)	18% (74)	20% (10)	27% (10)	0	
Black/AA (n)	19% (77)	24% (12)	22% (8)	29% (4)	
Other (n)	1% (6)	2% (1)	0	7% (1)	
Overdose education knowledge, *opioid use*, *overdose outcomes*					
	Total Surveyed (n=51)	**OEN (n=37)**	**OE Only (n=14)**	**OEN vs OE (p-value)**	
Retention of knowledge					
Mixing substances	73% (37)	65% (24)	93% (13)	0.08	
Periods of abstinence	31% (16)	41% (15)	7% (1)	0.04	
Using alone	22% (11)	24% (9)	14% (2)	0.70	
Chronic medical conditions	4% (2)	3% (1)	7% (1)	0.48	
Any illicit opioid use, 30 days	35% (18)	35% (13)	36% (5)	0.97	
Non-fatal overdose	22% (11)	19% (7)	29% (4)	0.47	
Witnessed an overdose	53% (27)	51% (19)	57% (8)	0.71	
Overdose responses among those participants who witnessed an overdose					
	Witnessed OD (n=27)	**OEN (n=19)**	**OE Only (n=8)**	**OEN vs OE (p-value)**	
Called 911	63% (17)	74% (14)	38% (3)	0.10	
Rescue breathing	26% (7)	26% (5)	25% (2)	1.0	
Administered nasal naloxone	22% (6)	32% (6)	0		
Stayed with the victim	93% (25)	95% (18)	88% (7)	0.51	

Figure. Opioid education and nasal naloxone rescue kits in the emergency department.
AA, African American; *OEN,* overdose education and nasal naloxone rescue kit*; OE,* overdose education only*; OD,* overdose

(28/37) of respondents received a kit from the ED, and 24% (9/37) received their kit elsewhere, such as a detox facility. Past 30-day opioid use was reported by 35% of those surveyed and 22% self-reported surviving an overdose. Among the 27 participants who witnessed an overdose, 63% called 911, 22% performed rescue breathing, 22% used a naloxone kit to reverse the overdose, and 93% stayed with victim. We detected no significant differences in behavior in a witnessed overdose between the OEN and OE-only groups. In the OEN group, 16% (6/37) reported using their kit to successfully reverse a witnessed overdose, one person reported their kit was used by someone else to rescue an overdose victim, and 54% (20/37) still had their kits in their possession.

DISCUSSION

This brief report describes the implementation of an opioid harm reduction public health intervention in the ED setting. The participants represent a high-risk population; between their ED visit and study interview, more than one fifth reported a non-fatal overdose, over half witnessed an overdose and there were two overdose deaths reported. In this small sample, we did not detect statistically significant differences between OE-only and OEN behavior in a witnessed overdose, reported opioid use or overdose rates. Almost one third (6/19) of the OEN group who witnessed an overdose used naloxone to rescue someone and more than half of the OEN group still had a naloxone rescue kit.

The ED provides a promising opportunity for risk-reduction measures for opioid overdose, including naloxone rescue kits. Although no significant differences were detected in overdose response behaviors, the group with naloxone rescue kits did have higher rates of calling 911, administering naloxone and staying with the victim until help arrived. While a dedicated substance use service, such as PA, is not available in most EDs, ED providers, including social workers, can offer OE or OEN in the ED without

PA. There are useful tools for setting up an OE or OEN program,[13] including a prescription for naloxone with OE information, which can be found at prescribetoprevent.org (Appendix 2). An increasing number of outpatient pharmacies stock nasal naloxone. Thus, ED providers can work with their hospital outpatient pharmacy to stock kits. In September 2013, as a result of this pilot project, the hospital adopted a policy to make OEN accessible to all high-risk ED patients prior to discharge, not only through PA, but also through the inpatient and outpatient pharmacies.

LIMITATIONS

Our follow-up interview enrollment was low as we were limited to hospital billing data for participant phone numbers and many numbers were incorrect or no longer in service. However, we were able to reach 50% of the OEN group. Patients were exposed to OE in the ED, but they may also have received OE at other venues. The decision to provide a nasal naloxone kit was not randomized, and therefore the sampling was subject to selection bias and may not be generalizable. Because this study was a survey, responses to questions may have been subject to social desirability and recall bias. The chart abstractors were not blinded to the study hypothesis. As we did not survey patients without exposure to overdose education, we do not have a non-OE control group. To pursue these initial findings further, larger prospective studies are warranted as OEN programs are implemented in EDs.

CONCLUSION

The ED provides a promising opportunity for opioid overdose harm reduction measures and naloxone rescue kit distribution to laypersons and bystanders encountered during an ED visit. This is the first description and evaluation of an ED-based nasal naloxone rescue kit program. The program reached a high-risk population that commonly witnessed overdoses, called for help and used naloxone to rescue people, when available. This study provides useful information for planning larger studies and programs to further evaluate implementation, benefits and harms of OEN in EDs.

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Epinephrine for Anaphylaxis: Underutilized and Unavailable

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INTRODUCTION

Anaphylaxis is a rapidly progressing, potentially life threatening allergic reaction that has been increasing in prevalence, most commonly triggered by foods, medications, and insect stings. Allergies in children are increasingly more common. Unfortunately, anaphylactic reactions are under-recognized, due to overlooked or under-appreciated symptoms, and therefore under-treated with epinephrine.[1] For several years, epinephrine has been established as the drug of choice for anaphylaxis.[2] Even a few minutes delay in the recognition and treatment of anaphylaxis can lead to hypoxia or death. Therefore, healthcare professionals and laypeople alike should be able to recognize the signs and symptoms of anaphylaxis and have accessible resources to initiate treatment.

Broadened awareness of the need for emergent anaphylactic treatment with readily available epinephrine auto-injectors, analogous to the common awareness and use of publicly housed automated external defibrillators (AEDs) in cardiac arrest, may decrease the morbidity and mortality of this rapidly progressing disorder. In 2006, Lieberman et al. reviewed articles since 1968 regarding epidemiological studies of anaphylaxis, finding approximately 50-2,000 episodes per 100,000 people with the largest incidence among children and adolescents;[3] mortality rates approximate 0.65 to 2%.[4] Boyce et al. found anaphylaxis accounted for 1 to 70 per 100,000 hospitalizations or emergency department visits.[5] In 2014, Ma et al. demonstrated the annual number of hospitalizations related to anaphylaxis increased from 5,700 to 7,700 from 1999 to 2009, and from 2006 to 2009 anaphylaxis related emergency department visits and hospitalizations increased from 25,000 to 30,000 annually.[6] The most recent figures, published in 2014, estimate the prevalence of anaphylaxis in the general population to be at least 1.6%, although probably higher.[7] While literature strongly suggests the need for available epinephrine in schools to treat anaphylaxis,[8] often triggered by foods, it seems reasonable and logical to have epinephrine auto-injectors available in populated public areas, similar to those where AEDs are available, for the life-saving treatment of anaphylactic reactions triggered by any allergen.

TREATMENT AND CONSEQUENCES OF DELAYED TREATMENT

Anaphylaxis is a clinical diagnosis with symptoms that occur along a continuum. Symptoms may be as mild as itching of the eyes, nose, or skin although urticaria and tongue swelling manifest most commonly. Symptoms may progress rapidly to cardiovascular or respiratory collapse.[2] According to The 2013 World Allergy Organization (WAO) Anaphylaxis Guidelines, clinical criteria for diagnosing anaphylaxis include any one of the following three: 1. Acute onset of an illness (minutes to several hours) with involvement of the skin, mucosal tissue, or both (e.g. generalized hives, pruritus or flushing, swollen lips-tongue-uvula) with either respiratory compromise and/or reduced blood pressure or associated symptoms of end-organ dysfunction; 2. Two or more of the following that occur rapidly after exposure to a likely allergen for that patient over minutes to several hours: a. Involvement of the skin/mucosal tissue, b. Respiratory compromise, c. Reduced blood pressure or associated symptoms, or d. Persistent gastrointestinal symptoms (e.g., crampy abdominal pain, vomiting); or 3. Reduced blood pressure after exposure to known allergen for that patient.[9] According to the WAO 2013 Update, anaphylaxis in children is most often triggered by foods that cause respiratory symptoms, while anaphylaxis in the elderly manifests with cardiovascular symptoms, most often triggered by medications or insect stings.[3]

Intramuscular (IM) epinephrine has been well established as the first line treatment for anaphylactic reactions and should be administered immediately upon clinical suspicion. Epinephrine should be given at 0.01mg/kg, up to 0.5mg IM, typically in the lateral thigh. A repeat dose can be administered in five minutes if rapid improvement is not seen. Commercially available auto-injectors are dosed at 0.3mg for adults and 0.15mg for children.

There are no absolute contraindications for epinephrine

administration to treat anaphylaxis, although the National Electronic Injury Surveillance System, which reviewed 2,333 visits for anaphylaxis during 2002, found that only 19% of patients who needed epinephrine received the medication appropriately.[11] It is known that an inadequate dose increases the risk of a biphasic reaction,[15] while delayed or lack of treatment can lead to hypoxia and or death.

ADJUNCT THERAPIES

The necessity of prompt epinephrine administration cannot be stressed enough. While therapies exist to alleviate mild symptoms of allergies, let it be clear that epinephrine is the primary treatment for anaphylaxis given that no other pharmacotherapy will treat the vasodilation and bronchoconstriction characteristics of the illness. Unfortunately, antihistamine use is the most common reason providers report for not using epinephrine, leaving patients at increased risk for life threatening sequelae.[16] Literature supports that antihistamines have no effect on anaphylaxis. Antihistamine administration is optional and use should used for the symptomatic relief of pruritus and rash, understanding that this is over a mean time of 101 minutes. Also note that administration of an antihistamine may mask the cutaneous symptoms of anaphylaxis, potentially delaying treatment with epinephrine. Despite this, healthcare professionals often inappropriately rely on diphenhydramine for anaphylactic reactions. There is no evidence for the use of corticosteroids in the acute treatment of anaphylaxis. Steroids take 4-6 hours to reach maximum effectiveness, however they may be beneficial in preventing biphasic reactions when symptoms return 6-10 hours later.

EPINEPHRINE AUTO-INJECTOR AVAILABILITY

Most community spaces, such as schools, parks, pools, and event venues do not have patient non-specific epinephrine auto-injectors available on site. Of those locations with the drug device stocked, it may be difficult or impractical to locate and the employees or staff are often unskilled in their use. In 2008, Ben-Shosham et al. demonstrated that 48% of children prescribed an epinephrine auto injector did not have the device available at school and of those with the medication on site, 78% of the auto-injectors were kept in the office of the nurse or another administrator.[12] Additionally, many students with food allergies do not routinely carry epinephrine. All fifty states allow epinephrine to be carried in emergency vehicles, but only seventeen states require that epinephrine be carried by all levels of emergency medical system (EMS) providers.[14] Since many patients who have been prescribed an epinephrine auto-injector do not regularly carry one and not all basic life support ambulances carry epinephrine, because of legislation issues or cost, it is essential that life-saving epinephrine auto-injectors be readily available in community spaces and public venues.

CURRENT PRACTICES AND NEED FOR CHANGE

Current practice revolves around the physician or licensed provider prescribing the epinephrine auto-injector and educating the patient and family on the administration, storage and use. The WAO 2013 Guidelines report that patients and their caregivers are less likely to carry their epinephrine auto-injectors and competency in their use decreases over time.[10] Ercan et al. surveyed 237 teachers and found only 10% were familiar with an epinephrine auto-injector and 4% were aware of proper administration.[13]

A study in the United Kingdom revealed the onset of anaphylaxis leading to cardiopulmonary arrest caused by food reactions averaged 25-30 minutes, 10-15 minutes for insect stings, and 10-20 minutes for drugs consumed out-of-hospital.[2] Many healthcare professionals incorrectly treat anaphylactic reactions by administering epinephrine though alternate routes or by administering second line therapies first. In a study of 103 patients experiencing allergic reactions or anaphylaxis, 12 patients received intramuscular epinephrine before the arrival of EMS, 15 patients received epinephrine by EMS providers: 4 patients received intravenous epinephrine, and 11 patients received epinephrine subcutaneously.[17] Given that 55% or more of people receiving epinephrine out-of-hospital had no prior severe allergies or anaphylaxis,[8] it is reasonable to propose a model for publicly available epinephrine auto-injectors in populated community locations.

The American Heart Association has established a "chain of survival" for cardiac arrest that includes the following: 1. immediate recognition of cardiac arrest and activation of the emergency response system; 2. early cardiopulmonary resuscitation; 3. rapid defibrillation; 4. effective advanced life support; and 5. integrated post-cardiac arrest care.[18] Iwami et al. studied public AED use in Japan and found railway stations to be the most common site for shock deliveries, likely related to population concentration. In the US, sports facilities, airports, and amusement areas are the most common places where AEDs are used.[18,19] As literature supports, anaphylaxis is most commonly induced by exposure to food, medications, or stings. Therefore it seems only reasonable to have auto-injectors available in the same community areas as those where AEDs are stocked. Since 13-65% of anaphylaxis cases are thought to be food related,[5] patient non-specific epinephrine auto-injectors ought to also be available and accessible in schools, cafeterias, malls, and places where food is served. The 2014 study by Murakami et al. found that increasing publicly available AEDs decreased the average time from collapse to defibrillation to five minutes.[19] Similar patterns would likely be seen if epinephrine auto-injectors were readily available in public locations.

Reasonably, concerns regarding cost, safety, and education will arise. While this proposal is not recommending any one brand of auto-injector, Mylan Specialty L.P., the distributor and marketer of EpiPen and EpiPen Jr. Auto-Injectors, created the EpiPen4Schools program where eligible

schools can receive up to four auto-injectors and purchase discounted auto-injectors, two per package, for $112.[20] Muck et al., in their retrospective cohort study, reviewed data over a six year period on patients reported to six poison control centers after accidental epinephrine auto-injector injections. 365 cases were reported; most cases were treated supportively under observation, 29 required mild vasodilatory therapy, and all were discharged home.[21]

CONCLUSION

The literature widely supports that prompt administration of intramuscular epinephrine is essential in the treatment of anaphylaxis. Anaphylactic reactions are becoming increasingly common and can progress to cardiopulmonary arrest within minutes. It is essential that patient non-specific epinephrine auto-injectors be available in public locations including schools, parks, pools, airports, public venues, and shopping malls. Increasing the availability of epinephrine necessitates the need for education of healthcare professionals, first responders, and the general public on recognizing classic anaphylactic symptoms and how to properly initiate treatment with an available pre-dosed epinephrine auto-injector.

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Reassessing After-Hour Arrival Patterns and Outcomes in ST-Elevation Myocardial Infarction

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Introduction: Differences in after-hours capability or performance of ST-elevation myocardial infarction (STEMI) centers has the potential to impact outcomes of patients presenting outside of regular hours.

Methods: Using a prospective observational study, we analyzed all 1,247 non-transfer STEMI patients treated in 15 percutaneous coronary intervention (PCI) facilities in Dallas, Texas, during a 24-month period (2010-2012). Controlling for confounding factors through a variety of statistical techniques, we explored differences in door-to-balloon (D2B) and in-hospital mortality for those presenting on weekends vs. weekdays and business vs. after hours.

Results: Patients who arrived at the hospital on weekends had larger D2B times compared to weekdays (75 vs. 65 minutes; KW=48.9; p<0.001). Patients who arrived after-hours had median D2B times >16 minutes longer than those who arrived during business hours and a higher likelihood of mortality (OR 2.23, CI [1.15-4.32], p<0.05).

Conclusion: Weekends and after-hour PCI coverage is still associated with adverse D2B outcomes and in-hospital mortality, even in major urban settings. Disparities remain in after-hour STEMI treatment. [West J Emerg Med. 2015;16(3):388–394.]

INTRODUCTION

Myocardial Infarction and Timeliness of Response

Coronary heart disease is the leading cause of death and healthcare cost in the U.S.[1] The median lifetime mortality rate is 159.2 for every 100,000 citizens nationally. Among those with heart disease, acute myocardial infarction (MI) is a leading contributor to mortality. The national MI prevalence rate is currently 3.7%, resulting in more than 385,000 annual deaths and costing $108.9 billion dollars in the U.S. each year.[1-3]

Time to treatment for patients with ST-elevation myocardial infarction (STEMI) is critical, as it impacts both myocardial salvage and survival.[4,5] Door-to-balloon time (D2B) is a key component of time to treatment and a core quality measure for the Joint Commission.[6] The American College of Cardiology Foundation/American

Heart Association/American College of Cardiology (ACCF/AHA) guidelines recommend a D2B time of no more than 90 minutes from first medical contact to reperfusion.[7] A recent study reports that from 2005-2010, substantial progress was achieved in national D2B times, with median national D2B times reduced from 96 to 64 minutes.[8] In particular, when emergency medical services (EMS) activates the cardiac catheterization lab, D2B times can be reduced.[9]

Our analysis seeks to evaluate the impact of arrival times of STEMI patients at PCI-capable hospitals on D2B time and mortality. We specifically compare D2B times between patients who arrived at the hospital during usual business hours and patients who arrived after usual business hours (5pm - 8am). Similarly, we compare D2B times between patients who arrived on weekends and holidays and patients who arrived during working days. Our hypothesis is that patients who arrived after business hours or on weekends will have longer D2B times and higher mortality rates than those who arrived during usual business hours and on weekdays.

Variation in Quality of Care Across Time of Day and Day of Week

Availability and readiness of healthcare resources, particularly human resources, vary during time of day and day of week. Several studies have investigated the differences in outcome on weekends compared to weekdays and after hours compared to business hours. Some studies have found that there is no difference in outcome based on time of day or week. Miro et al.[10] and Arabi et al.[11] found no differences in the effectiveness and quality of care at emergency departments (ED) or intensive care units between weekdays and weekends. Other studies have found that day of admission does have an impact on outcome of care, where mortality was found to be higher on weekends.[12-14] One study with a small sample size of STEMI patients found that patients who arrived at the hospital on weekends or at night had a D2B of >90 minutes while those who arrived during weekday hours had a D2B of <90 minutes.[15] Two recently published studies found significant relationships between after-hour presentation, D2B and mortality.[16,17] However, many of the studies were not conducted in the U.S., and many studies were of only fair quality, both suggesting more research is needed to examine the relationship between after-hour presentation and mortality. In addition, conflicting research has shown that short-term clinical outcomes for PCI patients were similar, despite longer D2B times in patients receiving after-hour PCI.[18] Circadian variation has also been shown to impact both frequency of MI onset and infarct size.[19] Similarly, myocardial infarct size and left ventricular function after STEMI have been shown to have a circadian dependence on the time of day onset of ischemia.[20] It is quite possible that circadian variation plays a role in patient presentation and treatment times as well.

Our analysis seeks to evaluate the impact of arrival times of STEMI patients at PCI-capable hospitals on D2B time and mortality. We specifically compare D2B times between patients who arrived at the hospital during usual business hours and patients who arrived after usual business hours (5pm - 8am). Similarly, we compare D2B times between patients who arrived on weekends and holidays and patients who arrived during working days. Our hypothesis was that patients who arrived after business hours or on weekends would have longer D2B times and higher mortality rates than those who arrived during usual business hours and on weekdays.

METHODS AND DATA

Data Source

Data for this study were collected as part of a project sponsored by the American Heart Association and the W. W. Caruth, Jr. Foundation and the Communities Foundation of Texas to develop a regionally integrated system of care for MI patients in Dallas County, Texas. All of the Dallas County PCI-capable hospitals participated in the collection of the National Cardiovascular Data Registry (NCDR) dataset. NCDR ACTION Registry Get With The Guidelines (GWTG) data were the basis for the hospital component for response time calculations. We collected emergency medical services (EMS) data directly from each EMS agency's patient care record systems on a quarterly basis. De-identified pre-hospital data were linked to the hospital data using a unique key that joined the data drawn from the EMS incident run number provided by the hospital, which allowed for comparison of time intervals and outcomes. We stored and managed the combined data in a relational database with automated script procedures for suspected matching patient records, importing source files, and validating data within established criteria thresholds. Institutional review board (IRB) approval was obtained and informed consent for limited data set sharing was provided by all participating facilities.

Dallas County is the ninth most populous county in the U.S. Dallas has a very high number of PCI-capable hospitals (15) serving a city population of 1.3 million spanning over 908 square miles, representing a PCI density of 11 hospitals per million capita. This ratio is nearly one-third higher than the median for large urban market.[21] Data included in this study represent all eligible and complete, non-transfer STEMI patients who presented at the ED and received PCI treatment in Dallas County between October 1, 2010 and September 31, 2012. The age-adjusted mortality rate in Texas caused by AMI is higher than the national average ([52.6 ± 1.0] vs. [41.4 ± 0.2] cases per 100,000, respectively; 95% CI).[22,23]

Statistical Analysis

This study aims to assess the impact of STEMI patients' arrival times at the PCI-capable hospital on the treatment time as measured by the D2B time and in-hospital all-cause mortality rates. First, we initially grouped patient encounters based on patient characteristics (e.g., age, sex, race), clinical condition upon arrival (cardiac arrest, shock, heart failure – as

defined as physician documentation or report of any of the following clinical symptoms of heart failure, or cocaine use at first medical contact), and patient outcomes (length of stay, mortality rate, D2B). Variable definitions can be found in the National Cardiovascular Data Registry (NCDR) dataset. We had four groups (weekend vs. weekday; business hours vs. after hours). The holiday schedule used was obtained from the State of Texas Auditor's Office.[24]

To compare the D2B times between the different patients groups we initially used the Kruskal–Wallis one-way analysis of variance by ranks, since normality test showed that the dependent variables (D2B and mortality) were not normally distributed. D2B was transformed using the logarithm function to reduce its skewness. For D2B, we used a generalized linear model (GLM) to evaluate the relationships between arrival time variables and treatment time variables, controlling for the patient characteristics, clinical conditions, and arrival mode (EMS arrival vs. walk-in). For mortality, since the data were binary, we used logistic regression with many of the same variables. We used STATA 13 to conduct the statistical analysis.

RESULTS

For the 1,247 cases included in the analysis: 26% were female, 18% were of Hispanic origin (can be black or white Hispanic, thus some patients checked two ethnicities), 74% were white, and 18% were black. Median age was 59 years. Table 1 shows the demographic characteristics of the patients included in the study, broken down by category. Median D2B for total patients during the study period was 68 minutes, and 77.4% of the patients (n=965) achieved a D2B of less than 90 minutes.

Of the 1,247 STEMI patients in the study, 372 (29.8%) arrived at the hospital on weekends or holidays. Figure 1 describes the distribution of patients and median D2B by day of week. The characteristics of patients who arrived at the facility on weekends or holidays were similar to those of patients who arrived on non-holidays weekdays. When looking at the differences in the D2B times, there was a statistically significant difference (KW=48.9, $p<0.001$) in the D2B time between patients who arrived at the hospital on weekends or holidays compared to those who arrived on non-holiday weekdays. The median D2B for those who arrived at the hospital on weekends or holidays was 75 minutes compared to 65 minutes for those who arrived on non-holiday weekdays (and 75 vs. 59 for after-hours vs. business). D2B times ranged from 12 minutes to 1,152 minutes. Seventy-two percent of patients who arrived on weekends or holidays achieved a D2B time of <90 minutes, compared to 79.5% for those who arrived on weekdays. Figure 1 shows the distribution and median D2B of the number of STEMI patients across the seven days of the week. Comparing the D2B times across the seven days of week yielded statistically significant results (KW=44.5; df=6; $p<0.001$). D2B times were highest on Saturday and Sunday (77 minutes and 73 minutes respectively) compared to the rest of the days of the week (ranging from 63-69 minutes). Mortality rates were relatively similar in both groups (4.3% vs. 5.2%, and not statistically significant).

To further explore the differences between groups, we applied the generalized linear regression. We used D2B times as the dependent variable, and binary categorical variables for weekend/holiday, business hours, gender, EMS transport,

Table 1. Characteristics of STEMI patients by day/time category.

Variable	Weekend/holiday	Weekday	Business hours	Off hours	Total
STEMI patients (n)	372 (30%)	875 (70%)	611 (49%)	636 (51%)	1,247
White	262 (70.4%)	662 (75.7%)	446 (73.6%)	478 (77.8%)	924 (74.1%)
Black	78 (21.0%)	152 (17.4%)	116 (18.5%)	114 (16.2%)	230 (18.4%)
Hispanic	58 (15.6%)	161 (18.4%)	109 (18.5%)	110 (18.3%)	219 (17.6%)
Female	99 (27%)	224 (26%)	155 (25.7%)	168 (25.5%)	323(26%)
Median age	59 (±12.16)	59 (±12.24)	59 (±12.40)	58 (±12.00)	59 (±12.2)
Cardiac arrest at FMC	26 (7.0%)	58 (6.6%)	41 (6.7%)	43 (6.8%)	84 (6.7%)
Heart failure at FMC	46 (12.4%)	101 (11.5%)	67 (10.9%)	80 (12.6%)	147 (11.8%)
Patient in shock at FMC	32 (8.6%)	77 (8.8%)	49 (8.0%)	60 (9.4%)	109 (8.7 %)
EMS transport	194 (52.2%)	432(49.4%)	298 (48.7%)	328 (51.6%)	626 (50.2%)
CCL activated by EMS	59 (15.9%)	124 (14.2%)	94 (15.4%)	89 (14.0%)	183 (14.7 %)
Adjusted length of stay (days)	2.3 (±5.0)	2.2 (±4.3)	2.4 (±5.1)	2.2 (±3.9)	2.2 (±4.5)
D2B (minutes)	75*	65*	59*	75*	68*
D2B<90 minutes	268 (72.0%)	696 (79.5%)	507 (83%)	464 (73%)	965 (77.4%)
In-hospital mortality	4.3%	5.2%	3.6%*	6.3%*	4.97%*

STEMI, ST-elevation myocardial infarction; *D2B*, door-to-balloon; *FMC*, first medical contact; *CCL*, cardiac catheterization lab; *EMS*, emergency medical services

* Statistically significant differences, $p<0.001$.

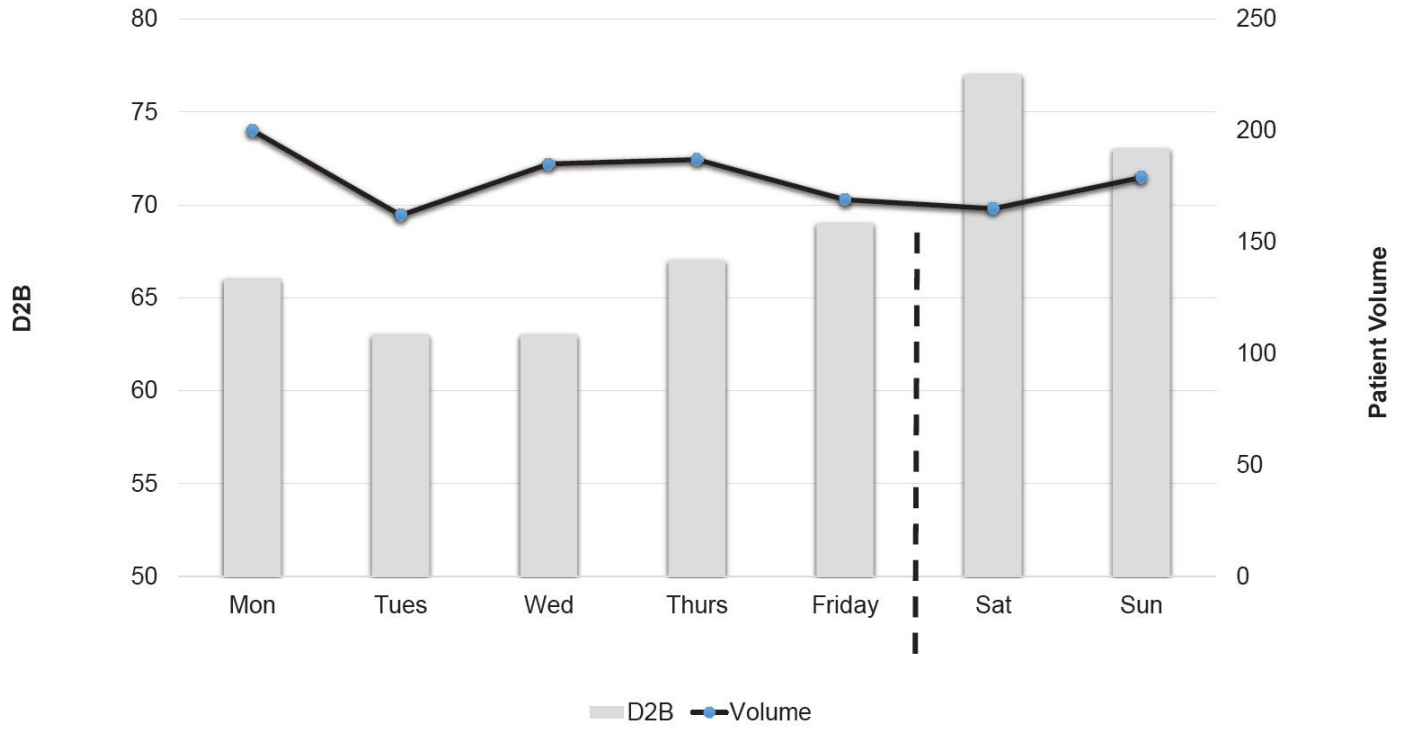

Figure 1. Volumes and median D2B for STEMI patients by day of week.
STEMI, ST-elevation myocardial infarction; *D2B*, door-to-balloon

and cardiac catheterization activation by EMS from the field. We controlled for confounding factors by using the presence of cardiac arrest, shock, and heart failure at first medical contact. Patient age was a continuous variable to control for confounding age-related differences.

The regression results confirm that four of these primary variables were statistically significant in the final model: 1) arriving on weekends or holidays (=0.186, p<0.001) and 2) arriving during after-hours (=0.253, p<0.001); 3) transport by EMS vs. patient own vehicle (=-0.150, p<0.001) and 4) cath lab activation by EMS (=-0.302, p<0.001 respectively). The presence of shock and heart failure in patients presentation at first medical contact were both associated with statistically significantly increased D2B time (=0.142, p<0.001 and =0.106, p<0.001 respectively). All other confounding variables were not associated with statistically significant differences in D2B times.

Eighty-three percent of patients who arrived at the hospital during business hours achieved a D2B time of <90 minutes, compared to only 73% for those who arrived after hours. Figure 2 shows the distribution and median D2B times across the time of day. Median D2B times were lower for the period 8am - 5pm compared to the period 5pm - 8am.

Mortality rates were also significantly different in the logistic regression for those patients arriving during after hours (OR 2.23, p<0.05, CI [1.15-4.32]) but not for those who arrived during weekends. The model had a pseudo R^2=0.36, and a log-likelihood of -158.6, representing a good fit in the model. Confounding control factors for patient age, and presence of shock and cardiac arrest, were significant in the final model as well. Table 2 presents the results of the logistic regression.

DISCUSSION

We analyzed all 1,247 non-transfer patient cases who were treated for STEMI in Dallas County between October 1, 2010, and September 31, 2012. Our analysis found differences in the D2B times and in-hospital mortality rates based on the day of week and time of day that patients arrived at the hospital. First, patients who arrived on weekends or holidays had a median D2B time 10 minutes longer than those who arrived on non-holiday weekdays (75 and 65 minutes respectively). Also, more patients achieved a D2B timeof <90 minutes on non-holiday weekdays than on weekends or holidays. Second, patients who arrived 8am - 5pm had a median D2B time that was 16 minutes shorter than for those who arrived 5pm - 8am. The 2.23 OR for mortality for patients presenting after hours vs. during business hours is relatively high, compared to the 16-minute difference in median D2B times (75 minutes vs. 59 minutes). This appears to be a disproportionately elevated mortality rate. This also contrasts significantly with the 1.06 OR for mortality for after-hour STEMI presentations in the systematic review and meta-analysis by Sorita et al.,[16] which demonstrated a similar D2B time delay (14.8 minutes) for after-hour SETMI presentations. However, there were several outlier

cases that may explain the mortality discrepancy in this study.

It is interesting to note, as an example, that median D2B at 5am was 85 minutes while 9am was only 56 minutes. As seen in Figure 2, significant treatment time differences exist based on arrival times. Similarly, more patients achieved a D2B of <90 minutes during business hours than after hours (86% and 73% respectively). In-hospital mortality rates were also significantly higher in the after hours than during business hours, with a 1.9 greater odds of dying after hours. Previous studies have shown mixed results regarding the impact of arrival or admission times on the quality of in-hospital care.[16,18] The findings of this analysis, however, are consistent with results from Bell and Redelmeier,[13] Wichmann et al.,[14] Mohammed et al.[12] and Takakuwa et al.[15]

Transport by EMS and field activation of the catheterization lab had a significant relation with D2B, but not with in-hospital mortality. Especially when trying to reduce D2B after hours, the mode of arrival and use of field-based activation of the cardiac catheterization lab appears essential. Results suggest that differences in D2B times and mortality can be influenced by in-hospital operational strategies, such as resource readiness and mobilization protocols. For example, the availability of an attending cardiologist, an emergency medicine physician, nurses, and technicians are well-established factors that affect D2B times.[25] This availability of key care team members is different across time of day and day of week. Additional investigation of the differences of staffing levels across time will shed more light on why D2B times are different across time.

LIMITATIONS

This study is one of the larger urban studies of treatment times and arrival patterns. However, it is not without limitations. It is an observational study, not a randomized clinical trial. Although we found a relationship between outcomes and afterhours care, we cannot associate cause

Table 2. In-hospital mortality based on patient arrival on weekends or holidays vs. on non-holiday weekdays.

Mortality	Odds ratio	Standard error	p-value	[95% CI]	
After hours arrival	2.23	0.75	0.017	1.15	4.32
Weekend arrival	0.75	0.28	0.46	0.36	1.59
EMS transport	1.13	0.38	0.70	0.58	2.22
Cath lab activate	0.30	0.18	0.049	0.091	0.99
Age	1.05	0.01	0.000	1.024	1.079
Gender	1.33	0.47	0.41	0.66	2.68
CA_FMC	6.55	2.76	0.000	2.87	14.96
HF_FMC	1.77	0.70	0.15	0.81	3.88
Shock_FMC	15.86	5.89	0.000	7.66	32.86
Cocaine use	1.88	2.20	0.59	0.18	18.70

n=1,247; Psuedo R^2=0.36, log-likelihood=-158.6

EMS, emergency medical services; *FMC*, first medical contact; *CA_FMC*, cardiac arrest at first medical contact; *HF*, heart failure at first medical contact

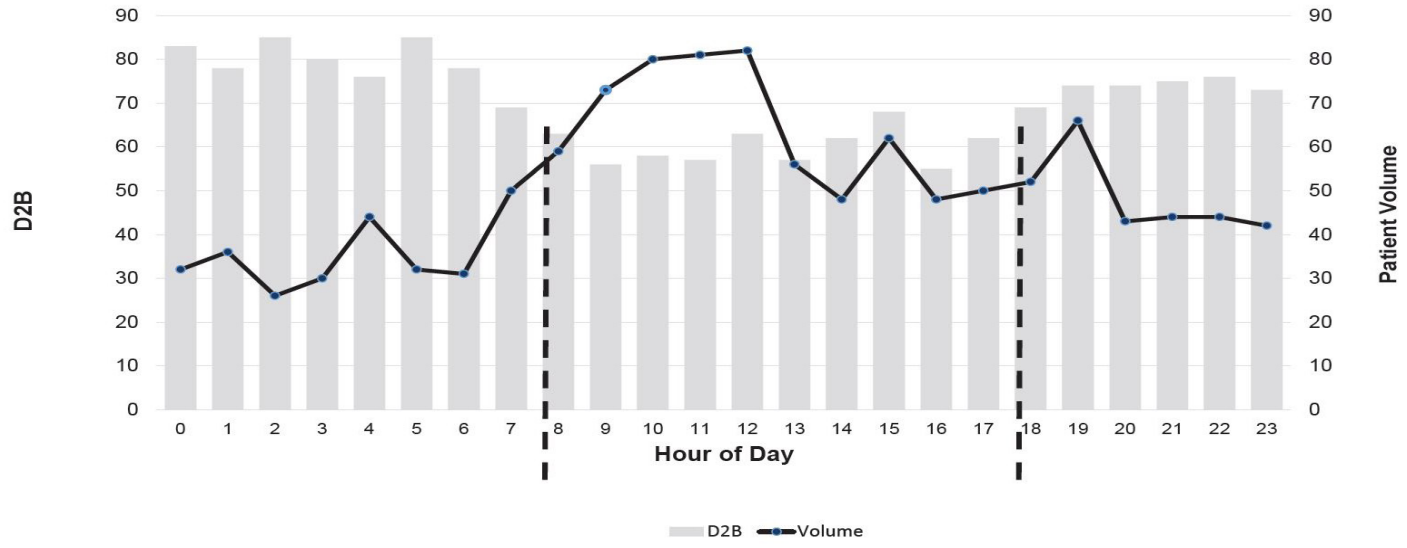

Figure 2. Distribution of STEMI patients by time of day.
STEMI, ST-elevation myocardial infarction; *D2B*, door-to-balloon

and effect. Additionally, although we controlled for multiple factors, we did not examine the hospital or CCL-specific factors that led to this longer treatment time. Although many previous studies have found associations between availability of certain care team members and D2B times, neither previous research nor our study measured the differences of staffing level across time of day or day of week in relation to differences in D2B times. Assessing and quantifying the impact of factors that differ across time on the D2B times will allow for identification of strategies to streamline STEMI treatment processes and reduce variability of D2B times across time of day and day of week.

Finally, these data were collected as part of a program to develop a regionally integrated system of care for patients suffering from acute coronary syndrome. The focus of the program is on reducing mortality and treatment times. This observer effect (or Hawthorne effect) could artificially produce short-term changes in treatment times during the measurement period. In addition, we were not able to measure mortality beyond the in-hospital stay, or control for holidays.

CONCLUSION

This study found that despite advances in urban STEMI care, disparities remain in after-hours treatment. The arrival time of MI patients at PCI-capable hospitals has an impact on treatment times as measured by D2B. Further investigation of how in-hospital variation affects treatment times will help hospitals streamline care processes across the day and week and reduce associated D2B time variability. Additionally, pre-hospital care was found to significantly improve D2B treatment times, and is especially necessary during after-hours and off-days. This will ultimately help increase the number of patients who receive treatment within the recommended 60-90 minute treatment window.

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Variability in the Initial Costs of Care and One-Year Outcomes of Observation Services

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Introduction: The use of observation units (OUs) following emergency departments (ED) visits as a model of care has increased exponentially in the last decade. About one-third of U.S. hospitals now have OUs within their facilities. While their use is associated with lower costs and comparable level of care compared to inpatient units, there is a wide variation in OUs characteristics and operational procedures. The objective of this research was to explore the variability in the initial costs of care of placing patients with non-specific chest pain in observation units (OUs) and the one-year outcomes.

Methods: The author retrospectively investigated medical insurance claims of 22,962 privately insured patients (2009-2011) admitted to 41 OUs. Outcomes included the one-year chest pain/ cardiovascular related costs and primary and secondary outcomes. Primary outcomes included myocardial infarction, congestive heart failure, stroke or cardiac arrest, while secondary outcomes included revascularization procedures, ED revisits for angina pectoris or chest pain and hospitalization due to cardiovascular diseases. The author aggregated the adjusted costs and prevalence rates of outcomes for patients over OUs, and computed the weighted coefficients of variation (WCV) to compare variations across OUs.

Results: There was minimal variability in the initial costs of care (WCV=2.2%), while the author noticed greater variability in the outcomes. Greater variability were associated with the adjusted cardiovascular-related costs of medical services (WCV=17.6%) followed by the adjusted prevalence odds ratio of patients experiencing primary outcomes (WCV=16.3%) and secondary outcomes (WCV=10%).

Conclusion: Higher variability in the outcomes suggests the need for more standardization of the observation services for chest pain patients. [West J Emerg Med. 2015;16(3):395–400.]

INTRODUCTION

The use of observation units (OUs) following emergency department (ED) visits as a model of care has increased exponentially in the last decade.[1,2] It is estimated that one-third of U.S. hospitals have OUs within their facilities.[3] While their use is associated with lower costs and comparable level of care compared to inpatient units,[4–6,19] there is a wide variation in OUs characteristics and operational procedures.[7,8] Ross and colleagues have listed four major models of OUs in U.S. hospitals.[8] The differences that characterize these models lie within whether they are protocol driven and/or on whether care is provided at dedicated units.[8] While two-thirds of hospitals do not have dedicated OUs to observe patients, these hospitals provide observation services to patients in unstructured units that may include any bed within their facilities.[2,9] The majority of hospitals that have dedicated OUs lack protocols or disease-specific guidelines.[8] Protocol-driven OUs were demonstrated to have lower length of stay and better outcomes compared to other models.[8] Given the variability in the structure, model and operations of OUs in the U.S., the objective of this study was to explore the variability in the input (initial costs of care) and outputs (one-year outcomes) across OUs.

Analysis was limited to patients admitted to OUs due to non-specific chest pain as it is the most cited reason for ED visits among adult population in the U.S.[10–12] and also to limit variability in costs and outcomes imposed by the prognostic characteristics of different diseases.

METHODS

Study Design and Data Sources

This was a retrospective cohort study that included patients who had observation services between January 2009 and December 2011 following ED visits for non-specific chest pain (ICD9 = 786.5, 786.50 and 786.59). The author extracted data from BlueCross BlueShield of Texas (BCBS-TX) with preferred provider organization (PPO) and PPO+ plans only. Patients in other plans were excluded due to contractual agreements with the providers or for lacking complete claims of their enrollees. Observation services were defined, per Medicare Claims Processing Manual,[13] as using a combination of a revenue code (0762, 0760) and Healthcare Common Procedure Coding System classification (HCPCS) code of G0378 (observation service per hour) and G0379 (referral to observation). The author performed costs, outcomes and risk adjustments at the patient's level and aggregated the averages at the OU's level.

Sampling

Patients who were between 18 and 63 years of age and had one year of continuous insurance enrollment prior to and after the ED visit were included in the study. Claims filed in the year prior to the ED visit were used to identify patients' comorbidities and calculate their risk scores. Outcomes of OUs admission were identified using the claims incurred in the year following the ED visit. Patients were then linked to OUs using the servicing provider identification number (SPID) associated with observation services (G0378 and G0379) on facility claims. Patients who had more than one SPID were excluded. Patients who were subsequently admitted to inpatient units were also excluded. To secure enough representations of patients within each OU, OUs that had less than 30 patients in the final sample were excluded from further analysis.

Cost of Care

The study took the payer's perspective in defining costs, which represented the allowed amount paid by the insurer to providers for the rendered services. The initial costs of care included all the medical and professional services incurred between the ED admission and OU discharge dates. All costs were adjusted for inflation to 2012 equivalent cost using the medical inflation factor published by the Bureau of Labor Statistics.

Outcomes

The author evaluated the effectiveness of OUs using a composite of primary and secondary outcomes that was previously used.[5,6] The primary outcomes included the first occurrence of myocardial infarction, congestive heart failure, stroke, and cardiac arrest. Secondary outcomes included subsequent one-year use of an ED for nonspecific chest pain or angina pectoris, hospitalization due to circulatory disorders, or revascularization procedures specifically percutaneous transluminal coronary angioplasty (PTCA), and coronary artery bypass graft (CABG). The prevalence rates of primary and secondary outcomes across OUs were calculated. Outcomes also included the inpatient, outpatient, and professional costs related to chest pain or cardiovascular diseases incurred in one year following initial OU discharge.

Clinical Risk Adjustment

Costs and outcomes of OUs discharge are contingent on the clinical condition of the admitted patients and their level of risk. To mitigate potential confounding and bias effect, the author used two methods to account for the different case-mix of patients across OUs. In the first method, patients' risk scores were calculated using the Adjusted Clinical Group (ACG) software. Scores created by the ACG software represents the burden of illness on patients and using them as a measure of patients comorbidities have been validated and used for similar purposes in many studies.[13-16] The average risk score for the sample population is calibrated to one and patients whose scores are greater than one are at higher risk of incurring more medical care next year. Data required for risk score calculation include patients' age, gender, up to 10 diagnoses per claim, revenue codes, place of treatment, and total cost of claims filed one year prior to the ED visits. Second, comorbidities that could confound the results of the analysis were identified and adjusted for. This included cardiovascular-related disorders, cardiac procedures, and other conditions that are highly associated with ED visits for chest pain (Table). Diagnoses at discharge and ambulance services use for transport to the ED were used as proxies of urgency of patients' condition during their ED visits. Details on the codes used to identify comorbidities are provided in the supplementary appendix (Appendix). The author included both the risk scores and patients' comorbidities in the statistical models.

ANALYSIS

The mean, median, and frequencies were used to summarize continuous and categorical variables (Table). Differences in patients' baseline demographics and clinical characteristics across OUs were tested using multivariate analysis of variance (MANOVA) for continuous variables and the randomization test of independence for categorical variables with Monte Carlo simulation with 100,000 replications. The author calculated the unadjusted prevalence rates of primary and secondary outcomes in each OU by dividing the number of patients who experienced outcomes over the total number of patients at each OU. The adjusted

Table. Baseline characteristics of the population sample using mean, median, and frequencies to summarize continuous and categorical variables.

	Patients' characteristics (mean, standard deviation, median, frequencies)	p-value[§]
Age (mean ± STD)	49.8 ± 8.3	<0.001
Gender (male)*	41% (1542)	0.023
Risk score (median)	0.42	<0.001
Chronic rheumatic heart disease (n)	0.8% (30)	<0.001
Hypertensive disease	53.6% (2027)	0.137
Ischemic heart disease	13.7% (520)	0.525
Diseases of pulmonary circulation	1.2% (44)	0.540
Other forms of heart disease[†]	16.9% (639)	0.790
Cerebrovascular disease	4.3% (164)	0.484
Diseases of arteries, arterioles, and capillaries	3.4% (128)	0.337
Diseases of veins and lymphatics, and other diseases of circulatory system	7.3% (278)	0.027
Diabetes mellitus	17.4% (657)	0.002
Dyslipidemia	46.6% (1764)	<0.001
Diseases of the digestive system	41% (1553)	0.773
Mental disorders	32.4% (1227)	0.006
Diseases of the respiratory system	54.7% (2070)	0.002
Coronary artery bypass grafting	0.5% (18)	0.577
Percutaneous transluminal coronary angioplasty	2.8% (106)	0.110
Used ambulance to reach emergency department	13.7% (517)	<0.001
Diagnosis at discharge: ill-defined	98.4% (3726)	0.602
Diagnosis at discharge: circulatory	0.7% (26)	0.431
Diagnosis at discharge: others	0.9% (33)	0.034

[§] P-value indicates whether patients' baseline demographics and clinical characteristics across OUs are similar or dissimilar.
[†] Other heart diseases include pericarditis, endocarditis, cardiomyopathy, conduction disorders, dysrhythmia, heart failure and complications of heart diseases.
* Percentages above are the proportion of identified comorbidities over the total number of patient visits in each group.
** Numbers in parentheses are the numbers of patients with the corresponding condition.

prevalence rates of primary and secondary outcomes (prevalence odds ratios) were calculated using two logit models that incorporated patients' age, gender, comorbidities, and risk scores. The averages of the estimated prevalence odds ratios were then computed for each OU.

The author computed the unadjusted median costs of initial care at OU and the one year costs of chest pain and cardiovascular diseases for each OU by summing the total costs for each patient and then taking the median cost for each OU. Both costs were then adjusted for patients' age, gender, comorbidities, and risk scores using quantile regressions at the patients' level. The averages of the predicted costs were then aggregated over OUs.

The variability in the unadjusted and adjusted prevalence of outcomes and costs were examined using the coefficients of variation, which is calculated by dividing the standard deviation by the mean. An increase in the coefficient represents an increase in the variability across OUs. The coefficient of variation is a standard statistical test that is used to compare the variability of factors with different measurement units. Coefficients of variation were then weighted using the number of patients seen at each OU to account for the unbalanced distribution of patients clustered within OUs (range: [30–254). The author conducted the study using SAS 9.3[16] for data management, and Stata13.1[17] for statistical analysis.

RESULTS

Population Sample

Figure 1 depicts the methodology that was employed to extract the final study sample. In total, there were 152,856 patient visits to the ED for which the primary complaint was non-specific chest pain. The author excluded 103,719 and 8,735 patient visits for not meeting the continuous enrollment and age criteria respectively. Another 4,440 patients were excluded for having prior ED visits related

to chest pain. Patients who were directly discharged home (n=27,519), admitted to inpatient units (n=2,587), had both inpatient and observation admissions (n=69), or experienced cardiac outcomes during their visits (n=825) were excluded. Finally, patients who had missing SPID (n=853) associated with observation services codes or had duplicated OU SPID (n=5) were excluded. This concluded a sample of 4,104 patients who were nested within 195 OUs. Finally, the author excluded OUs with less than 30 patients from further analysis. Thus, the final sample included 2,963 patients nested in 41 OUs. The median number of patients per OU was 56 (range: 30 to 242 patients).

Patients Baseline Characteristics

Demographic, risk scores, and patients characteristics for the sample population is depicted in the Table. The average age of the sample was 49.8 years old with a majority of females (59%). Patients nested across different OUs had statistically significant differences in their age, gender, risk scores, and clinical comorbidities in chronic rheumatic heart diseases, diseases of veins, lymphatics and other diseases of circulatory systems, diabetes mellitus, dyslipidemia, mental disorders, and ambulance use.

Outcomes

Within one year of their discharge from OUs, 126 (4.3%) patients experienced a total of 159 primary outcomes, and 302 (10.2%) experienced a total of 434 secondary outcomes. The proportion of patients who experienced primary outcomes included 0.88% (n=26) for MI, 1.55% (n=46) for CHF, 2.13% (n=63) stroke and 0.81% (n=24) cardiac arrest. In contrast, 2.06% (n=61) had revascularization procedures, 7.15% (n=212) went to the ED again within a year for a total of 271 unique visits and 2.8% (n=83) had 101 hospitalization events related to chest pain and cardiovascular related diseases. The unadjusted median cost of an ED episode across all OUs was $5,328 ($5^{th}$ percentile=$3,016, 95^{th} percentile=$10,113), and after adjusting for patients' differences the median cost went down to $4,838 ($4,646; $6,516). In contrast, the one-year median cost of cardiovascular-related medical services was $238 ($3; $1,694) compared to an unadjusted median costs of $271 ($0; $11,366).

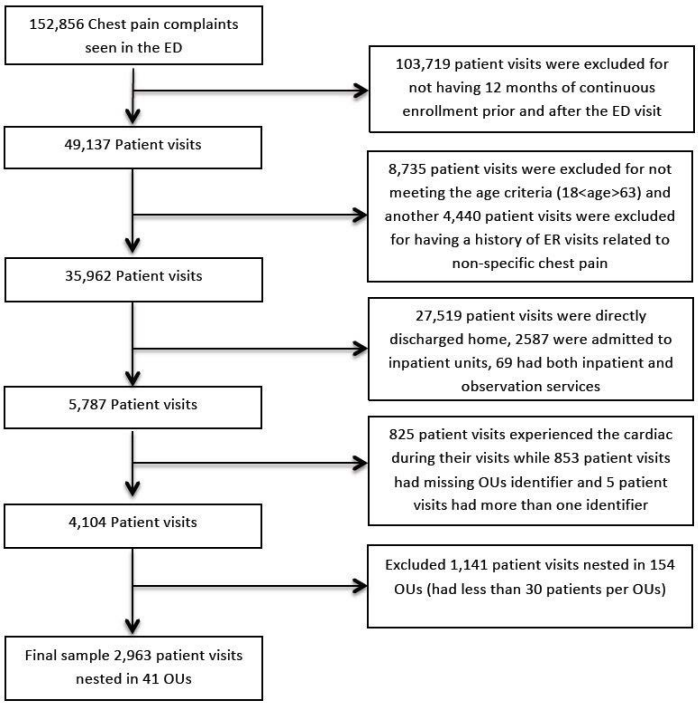

Figure 1. Methodology used to extract the final study sample. *ED*, emergency department; *ER*, emergency room; *OU*, observation units

Coefficients of Variation

The weighted coefficients of variation (WCV), as illustrated in Figure 2, demonstrated high variability in the unadjusted costs of initial care and all outcomes. The adjusted weighted coefficients of variation, however, exhibited less variability. A minimal variation (WCV=2.2%) was observed in the initial costs of care while higher variability were observed in the outcomes even after adjustment. The most pronounced variability were associated with the adjusted chest pain/cardiovascular related costs of medical services (WCV=17.6%) followed by the adjusted OR of patients experiencing primary outcomes (WCV=16.3%) and secondary outcomes (WCV=10.0%). Variability in the outcomes was relatively low even though it was higher when compared to the variability of the initial costs of care.

DISCUSSION

In perfect situations, we expect variability in the inputs to relatively match the variability in the outputs. In this study, input represented the initial costs incurred during patients' visits to the ED and subsequent admission to OUs. Outputs, on the other hand, were the outcomes that occurred one year after OU admission. The results of this study demonstrate that the variability in the input, after adjusting for patients' baseline differences across OUs was rather minimal (WCV=2.2%), while the variability in outputs (outcomes) were relatively higher compared to the variability of input (WCV from 10.0%-17.6%). The little variability observed in the initial costs of care is not surprising giving the fact it is governed by payment policies and contractual agreements for the rendered services between the insurer and the different OUs. In contrast, the variability in the outcomes even after adjusting for baseline differences were 7.4, 4.6, and 8 times greater for the primary outcomes, secondary outcomes, and the one-year chest pain/cardiovascular-related costs. Having little variability in the initial costs of care across all OUs does not necessarily imply that all OUs allocate costs in the same manner. Rather, OUs will have different protocols or approaches and allocate services differently. This may imply that the insurer is doing well in reducing variability toward paying for medical services for this specific condition, as

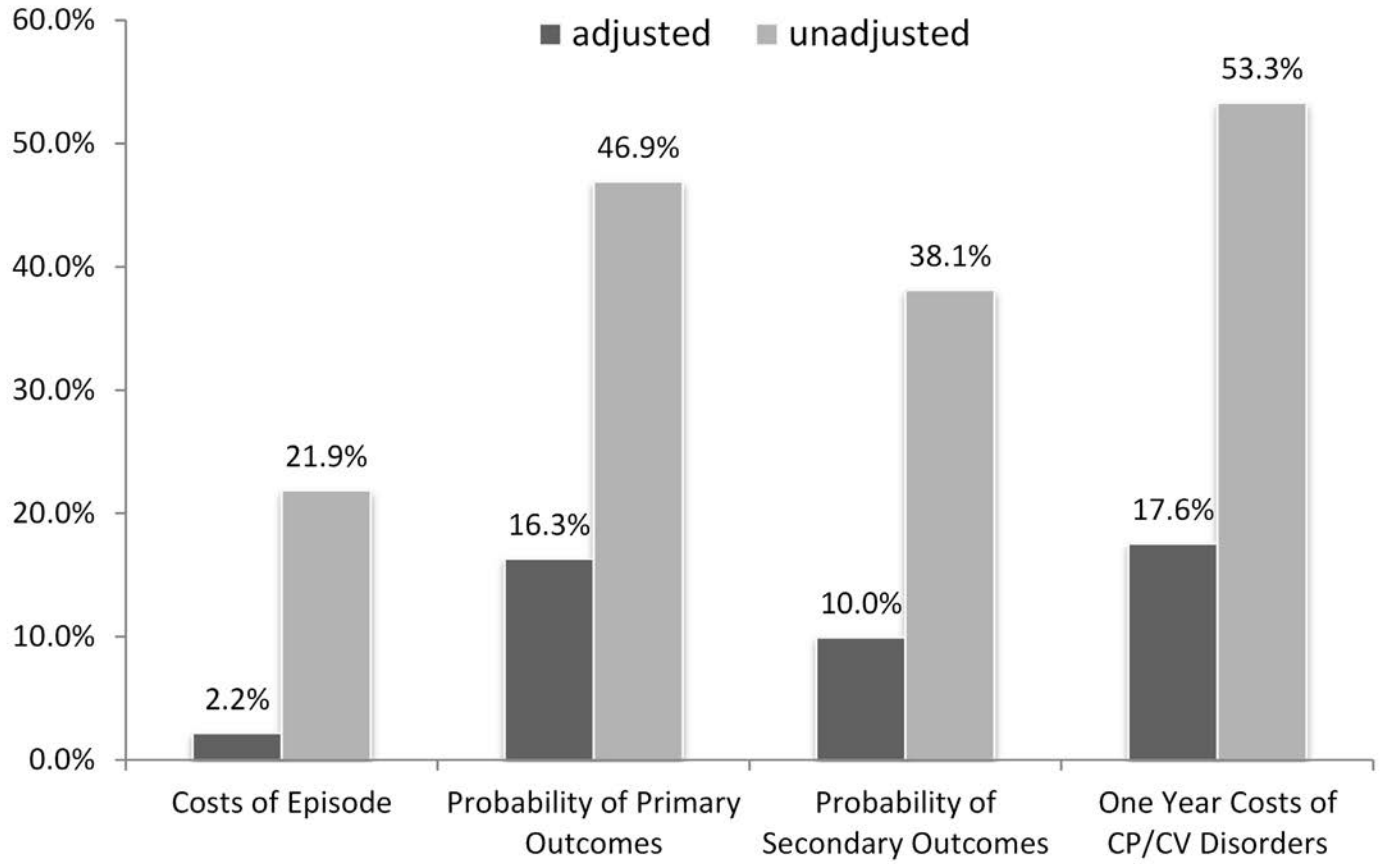

Figure 2. Weighted coefficients of variation demonstrating high variability in the unadjusted costs of initial care and all outcomes. *CP*, chest pain; *CV*, cardiovascular

they are supposed to do. However, the greater variability in the outcomes, compared to the initial costs of care, might be reflecting the differences in OU models and the variation in the implemented procedures and protocols to manage patients with chest pain within these OUs. According to Ross and colleagues, the majority of OUs lack standardized protocols leaving the provided care at the discretion of the treating physicians.[8] With that, variations in the employed approaches to treat patients are more likely to yield variant outcomes. Even if care was provided in protocol-driven OUs, the variation between different OUs protocols will more likely yield different outcomes as well. In contrast, protocol-driven OUs have operational guidelines that delineate the inclusion/exclusion criteria, the required staffing and disease-specific guidelines with more focus on quality measurements to ensure better and consistent outcomes.[8]

Even though variations in the outcomes were relatively low, the findings of this study indicate that there is still an opportunity for more savings if payment policies have incorporated outcomes measures as part of the payment schemes. Ross and colleagues proposed establishing different payment schemes that will reimburse OUs according to the model of care.[8]

If payment revision is to be established, then it might be more relevant to base these revisions on quality measures. The results of this study also signify the need to examine the source of variation in the implemented approaches across OUs to investigate best practices in managing patients with non-specific chest pain.

LIMITATIONS

This study has several potential limitations. First, there might be other underlying factors that drove the variability in outcomes, which were not adjusted for in the logit and quantile models. Nevertheless, factors included in both models reduced the variability of the initial cost of care from 21.9% to only 2.2%. Thus, these models, holding all variables constant, should produce relatively similar variability in the outcomes assuming the absence of other confounders that selectively affect the outcomes but not the clinical condition of patients at the time of OUs admission. Second, market-related factors and regional differences might contribute to the variability of costs and outcomes. While geographic variations across OUs might exist, the purpose of this study was to explore the degree and not the source of variation in costs and outcomes. Third, in calculating the initial costs of care, some claims for services rendered outside the ED/OU are included. The included claims, however, are small as 98.6% of evaluation and management costs, using

the Berenson-Eggers Type of Service (BETOS) classification system,[18] were incurred due to ED visits and consultation while the rest were due to specialists and office-based visits. Finally, the analysis was limited to patients placed in OUs following ED visits due to chest pain only. Thus, the results are not generalizable to OUs stays attributed to other disease conditions. Further studies are needed to examine whether the trends observed in this study hold using broader population.

CONCLUSION

Variability in the initial costs of care across the different OUs was minimal while greater variability in the outcomes was detected. The results of the study support the need for standardizing observation services for chest pain patients.

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Physician Documentation of Sepsis Syndrome Is Associated with More Aggressive Treatment

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Introduction: Timely recognition and treatment of sepsis improves survival. The objective is to examine the association between recognition of sepsis and timeliness of treatments.

Methods: We identified a retrospective cohort of emergency department (ED) patients with positive blood cultures from May 2007 to January 2009, and reviewed vital signs, imaging, laboratory data, and physician/nursing charts. Patients who met systemic inflammatory response syndrome (SIRS) criteria and had evidence of infection available to the treating clinician at the time of the encounter were classified as having sepsis. Patients were dichotomized as RECOGNIZED if sepsis was explicitly articulated in the patient record or if a sepsis order set was launched, or as UNRECOGNIZED if neither of these two criteria were met. We used median regression to compare time to antibiotic administration and total volume of fluid resuscitation between groups, controlling for age, sex, and sepsis severity.

Results: SIRS criteria were present in 228/315 (72.4%) cases. Our record review identified sepsis syndromes in 214 (67.9%) cases of which 118 (55.1%) had sepsis, 64 (29.9%) had severe sepsis, and 32 (15.0%) had septic shock. The treating team contemplated sepsis (RECOGNIZED) in 123 (57.6%) patients. Compared to the UNRECOGNIZED group, the RECOGNIZED group had a higher use of antibiotics in the ED (91.9 vs.75.8%, p=0.002), more patients aged 60 years or older (56.9 vs. 33.0%, p=0.001), and more severe cases (septic shock: 18.7 vs. 9.9%, severe sepsis: 39.0 vs.17.6%, sepsis: 42.3 vs.72.5%; p<0.001). The median time to antibiotic (minutes) was lower in the RECOGNIZED (142) versus UNRECOGNIZED (229) group, with an adjusted median difference of -74 minutes (95% CI [-128 to -19]). The median total volume of fluid resuscitation (mL) was higher in the RECOGNIZED (1,600 mL) compared to the UNRECOGNIZED (1,000 mL) group. However, the adjusted median difference was not statistically significant: 262 mL (95% CI [-171 to 694 mL]).

Conclusion: Patients whose emergency physicians articulated sepsis syndrome in their documentation or who launched the sepsis order set received antibiotics sooner and received more total volume of fluid. Age <60 and absence of fever are factors associated with lack of recognition of sepsis cases. [West J Emerg Med. 2015;16(3):401–407.]

INTRODUCTION

The early identification of sepsis leads to timely initiation of antibiotics and fluid resuscitation.[1,2] Administration of empiric, broad-spectrum antibiotic therapy is recommended within the first hour of recognition of severe sepsis or septic shock because it has been shown to decrease sepsis-related mortality.[3] Indeed, each hour of delay in the administration of antibiotic therapy is associated with an increased mortality rate.[4,5] However, despite the focus on improving care for sepsis patients, key questions remain unanswered. Does consideration of the sepsis syndrome – as distinct from localized infection or other diagnoses such as dehydration - have an independent effect on subsequent interventions and therapies delivered? After working diligently on a sepsis-screening tool, Moore stated, "early recognition of sepsis was a major obstacle to protocol implementation…. [and we hypothesize that] aggressive screening for sepsis would improve early recognition…and decrease sepsis-related mortality."[6] This may be particularly relevant in emergency department (ED) patients who present with a relatively complicated clinical picture, have impediments to diagnosis, such as altered mental status, have sepsis without fever, have undifferentiated shock or compensated shock.

In this study, we tested the hypothesis that consideration and documentation of sepsis syndromes by the emergency physician reduces the time to antibiotic administration and affects the amount of fluid resuscitation delivered to patients with sepsis.

METHODS

We conducted the study using patient data from a large, urban academic ED with an annual volume of approximately 70,000 patients. Greater than 4,000 blood cultures are ordered annually from the ED with an 8.5% positive rate. We identified a retrospective cohort of patients who presented to the ED and had bacteria cultivated from blood cultures (i.e., blood cultures were "positive") that were drawn during their ED visit over a 20-month period using a pathology database.

We used patient vital signs and initial laboratory studies to identify which of these patients met systemic inflammatory response syndrome (SIRS) criteria.[7] Patients who met SIRS criteria and had clinical, laboratory, or radiographic evidence of infection available to the treating clinician at the time of the encounter were classified as having sepsis. We classified patients who were septic and who experienced an episode of hypotension, or other signs of organ dysfunction as having severe sepsis.[8] Patients who were hypotensive on initial presentation and remained hypotensive after an initial fluid bolus were classified as having septic shock. We used the 2004 Sepsis guidelines in this classification system given that some of the patients included in the analysis were pre-2008.[3,8]

We reviewed handwritten and electronic physician and nursing charts for consideration of a sepsis syndrome. Patient sepsis was considered RECOGNIZED if there was documentation of consideration of sepsis, severe sepsis, or septic shock in the attending or resident differential diagnosis, in the documentation of the ED course, in the final diagnosis, or by initiation of the sepsis resuscitation bundle electronic order set. The remaining patients were classified as UNRECOGNIZED (Figure 1). Because lactate is an independent predictor of mortality in infected and non-infected admitted elderly patients[9] and is often ordered for patients where the treating clinician doesn't suspect sepsis, it was not used to determine if a patient was considered as RECOGNIZED or UNRECOGNIZED.

To assess the inter-rater agreement for categorizing a patient as either RECOGNIZED or UNRECOGNIZED from medical record reviews, a second group of evaluators reviewed a randomly selected subset of 103 of the charts. The kappa statistic was used to assess inter-rater agreement and agreement was considered adequate if the lower limit of the 95% confidence interval was above 0.61, the threshold for "substantial" agreement.[10]

Summary statistics for continuous data are presented as medians and IQRs and proportions are presented as percentages with 95% CIs using the Pearson-Clopper "exact" method. We used Fisher's exact test to compare proportions and median regression to compare continuous variables. *A priori*, α was set at ≤ 0.05. To test our hypotheses, we used multivariable median regression to calculate medians and absolute median differences, along with 95% CIs, for volume of fluid administration and time to antibiotic between RECOGNIZED and UNRECOGNIZED groups. We controlled for patient age, sex, and sepsis severity. Covariates were included in the final model if either they were significantly associated with the outcome variable ($p \leq 0.05$) or

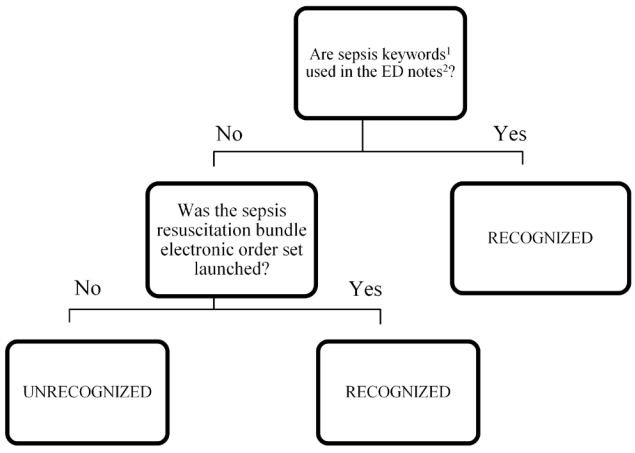

Figure 1. Algorithm for retrospective identification of sepsis recognition by emergency physicians.
ED, emergency department
[1]Sepsis keywords include systemic inflammatory response syndrome (SIRS), sepsis, severe sepsis, septic shock, septicemia, and septic.
[2]ED notes include attending's or resident's differential diagnosis, medical decision-making, ED course notes, or clinical impression.

if they were judged a significant confounder of the relationship between being RECOGNIZED/UNRECOGNIZED and the outcome variable. We considered covariates significant confounders if their inclusion changed the regression coefficient (median difference) for the RECOGNIZED/UNRECOGNIZED variable by greater than 10%. Median differences were considered statistically significant if the 95% CI did not contain 0. We performed all analyses using Stata (v.12.1, Stata Corp., College Station, Texas). Approval for the study was obtained from University of Arizona Institutional Review Board.

RESULTS

Table 1 shows population characteristics and demographics. A total of 315 positive blood cultures were identified between May 2007 and January 2009. SIRS criteria were present in 228/315 cases (72.4%, 95% CI [67.1 - 77.2]). Our chart review identified sepsis syndromes in 214/315 cases (67.9%, 95% CI [62.5 - 73.1]). Of the 214 septic patients, 118 (37.5%, 95% CI [32.1 - 43.1]) had sepsis, 64 (20.3%, 95% CI [16.0 - 25.2]) had severe sepsis, and 32 (10.2%, 95% CI [7.1 - 14.0]) had septic shock. The treating team recognized sepsis in 123/214 (57.5%, 95% CI [50.6 - 64.2]) patients.

Table 2 shows the comparison of characteristics of the RECOGNIZED vs. UNRECOGNIZED group. Antibiotic use, age, distribution of sepsis, and fluid administration differed significantly between the RECOGNIZED and UNRECOGNIZED group. Patients in the RECOGNIZED group tended to be older, had greater sepsis severity, more fluid administered, higher proportion of antibiotic administration, and shorter time to antibiotic administration than those in the UNRECOGNIZED group.

Figure 2 shows both the crude and adjusted medians and differences, along with 95% CIs, comparing the RECOGNIZED and UNRECOGNIZED groups for time to antibiotic administration in the ED and total volume of intravenous fluid administered. The median time (minutes) to antibiotic administration from triage time was significantly lower in the RECOGNIZED versus the UNRECOGNIZED group (142 versus 229; crude difference: -87 (95% CI [-139

Table 1. Demographics and characteristics of study population of patients who had bacteria cultivated from blood cultures.

Characteristic	N	Percent (95% CI)
Total	315	100
Age – years, median (IQR)	315	55 (38 – 71)
Patients 60+ years old	139	44.1 (38.6 – 49.8)
Male sex	181	57.5 (51.8 – 63.0)
ED disposition	315	
Admitted	242	76.8 (71.8 – 81.4)
Discharged	39	12.4 (9.0 – 16.5)
Transferred	30	9.5 (6.5 – 13.3)
Left AMA	3	1.0 (0.2 – 2.8)
Died	1	0.3 (0.01 – 1.8)
Met SIRS criteria	228	72.4 (67.1 – 77.2)
Met sepsis criteria	214	67.9 (62.5 – 73.1)
Presence of fever (>38°C)	101	32.1 (26.9 – 37.5)
Sepsis severity	214	100
Sepsis	118	55.1 (48.2 – 61.9)
Severe sepsis	64	29.9 (23.9 – 36.5)
Septic shock	32	15.0 (10.5 – 20.4)
Sepsis recognized (RECOGNIZED)	123/214	57.6 (50.7 – 64.2)
Received antibiotic in ED – all patients	227	70.5 (65.2 – 75.4)
Time – antibiotic – minutes, median (IQR)	227	176 (107 – 320)
Received antibiotic in ED – septic patients	182/214	85.1 (79.6 – 89.5)
Time – antibiotic – minutes, median (IQR)	182	160 (100 – 310)
Received IV fluid – all patients	259	82.2 (77.5 – 86.3)
Volume of IV Fluid – mL, median (IQR)	253	1,000 (250 – 2000)
Received IV fluid – Septic patients	193/214	90.2 (85.4 – 93.4)
Volume of IV fluid – mL, median (IQR)	188	1,050 (500 – 2000)

ED, emergency department; *AMA*, against medical advice; SIRS, systemic inflammatory response system; *IV*, intravenous

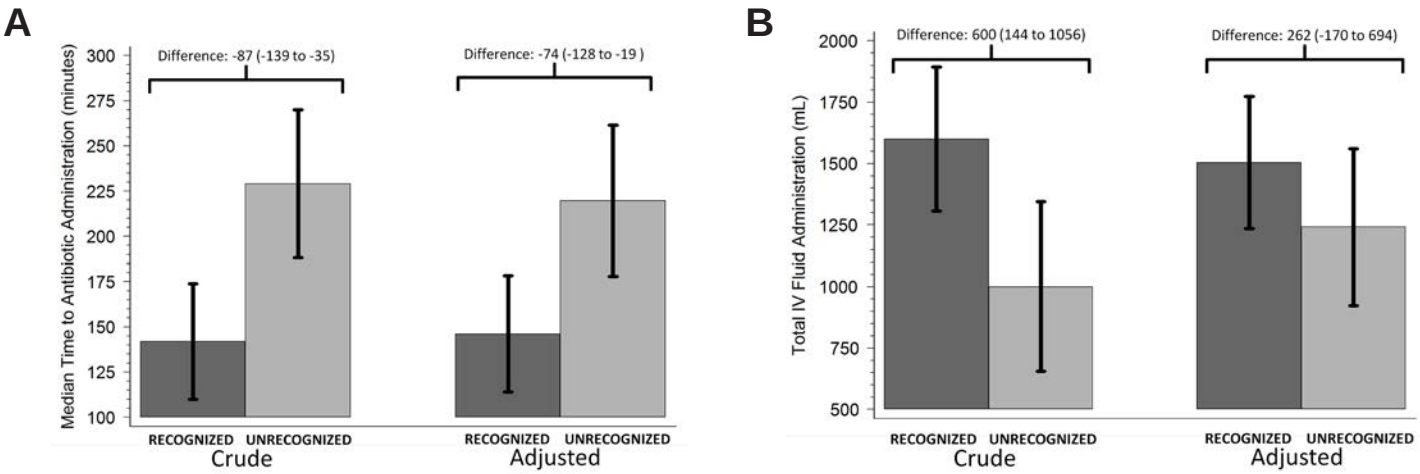

Figure 2. *A*, Comparison of crude and adjusted medians and differences between RECOGNIZED (dark gray) and UNRECOGNIZED (light gray) groups for time to antibiotic administration and *B*, total intravenous (IV) fluid administration in the emergency department. Bars indicate 95% CIs for medians. Median differences (95% CIs) are reported above each comparison. We calculated medians and median differences, along with 95% CIs, using median regression. Adjusted values were calculated using multivariable analyses adjusting for patient age, sex, and sepsis severity (septic, severe sepsis, or septic shock).

- -35]). In the adjusted analysis (controlling for patient age, sex, and sepsis severity), time to antibiotic administration remained significantly lower in the RECOGNIZED group (median difference = -74 minutes, 95% CI [-128 - -19]). Patient sex (p=0.57), age (p=0.30), and sepsis severity (p=0.3) were not significantly associated with time to antibiotic but were significant confounders for the relationship between RECOGNIZED/UNRECOGNIZED and time to antibiotic administration.

The total median volume of fluid resuscitation (mL) was significantly greater in the RECOGNIZED compared to the UNRECOGNIZED group (1600 vs. 1000; crude median difference: 600, 95% CI [283 - 1,197]; Figure 2). However, after controlling for patient age, sex, and sepsis severity, total fluid administration did not differ statistically between the two groups (median difference: -262 mL, 95% CI [-171 - 694]). Sex (p=0.81) and age (p=0.073) were not significantly related to total fluid volume but were significant confounders. Sepsis severity, however, was significantly related to total fluid administered (p<0.001), with patients with severe sepsis getting a median of 1,632 mL (95% CI [1037 - 2,227]) of additional fluid compared to those with sepsis.

Overall agreement was 89.3% for independent reviewers classifying patients as RECOGNIZED vs. UNRECOGNIZED and the inter-rater reliability (kappa statistic) was 0.78 (95% CI [0.66 - 0.90]), indicating substantial agreement.[10]

DISCUSSION

Even with aggressive therapy, sepsis is a condition that is associated with high mortality. Without the consideration of sepsis syndrome in the differential diagnosis, or with late consideration of this disease process, antibiotic administration and fluid resuscitation may be delayed. Without fever at triage presentation, this syndrome is even easier to overlook. In our study, septic patients in the RECOGNIZED group had a fever 47.2% of the time compared to only 30.8% of the time in the UNRECOGNIZED group (p=0.017).

To improve survival from sepsis, it must be promptly recognized and then expeditiously and aggressively treated.[1] The difference between Rivers' original goal-directed intervention and control groups was not in the types of treatments administered, but merely in the speed with which each group using the same tools achieved therapeutic endpoints.[1] Multiple other studies demonstrate improved outcomes with identification and aggressive treatment of septic patients.[11-14]

There were several reasons for selection of the ED cohort of patients with positive blood cultures. First, bacteremia offered a consistent and reliable means of identifying patients who were truly infected with a bacterial illness that had a high likely progression to severe sepsis and septic shock. Second, antibiotic time and fluid administration volume totals are reliably recorded in nursing documentation in the ED.

We found that over 42% of patients who met sepsis criteria in our retrospective analysis did not have sepsis syndromes explicitly articulated as part of the ED record by the treating physicians, nor did they have the sepsis bundle initiated. We also found that for the 58% of patients where sepsis was overtly considered by the treating team, there was a significant decrease in time to delivery of antibiotic therapy. This difference persisted even after controlling for age, sex, and severity of sepsis. Time to antibiotic administration has been repeatedly demonstrated to have a significant impact on mortality.[4] This effect is even more pronounced for patients with severe sepsis than those with septic shock.[5] Patients with severe sepsis are generally less overtly ill than patients with septic shock when they present to the ED; therefore, the urgency of treatment for this group may be underappreciated.

Table 2. Characteristics of patients with sepsis by RECOGNIZED vs. UNRECOGNIZED status.

Characteristics	RECOGNIZED n=123	UNRECOGNIZED n=91	p-value
Age – years, median (IQR)	63 (58-68)	51 (45-57)	0.003
Patients 60+ years old, No. (%)	70 (56.9)	30 (33.0)	0.001
Male sex, No. (%)	66 (53.7)	56 (61.5)	0.27
ED disposition, No. (%)			0.33
Admitted	108 (87.8)	73 (80.2)	
Discharged	5 (4.1)	6 (6.6)	
Transferred	10(8.1)	11 (12.1)	
Died	0 (0)	1 (1.1)	
Presence of fever, No. (%)	58 (47.2)	28 (30.8)	0.017
Sepsis severity, No. (%)			<0.001
Sepsis	52 (42.3)	52 (72.5)	
Severe sepsis	48 (39.0)	48 (17.6)	
Septic shock	23 (18.7)	23 (9.9)	
Received sntibiotic in ED, No. (%)	113 (91.9)	69 (75.8)	0.002
Time to antibiotic – minutes, median (IQR)	142 (90-260)	229 (130-352)	0.002
Received IV Fluid, No. (%)	121 (98.4)	88 (96.7)	0.65
Volume of IV Fluid – mL, median (IQR)	1,600 (920-3000)	1,000 (355-2000)	<0.001

ED, emergency department; *IV*, intravenous

Although the median total intravenous fluid administration did not differ significantly between the two groups in the adjusted analysis, there was still a trend toward higher volumes in the RECOGNIZED group. This may have been a reaction by the treating team to worsening symptoms over time. However, time to antibiotic treatment, while lower in the RECOGNIZED group, was not significantly related to sepsis severity and thus may have reflected proactive treatment by the treating team after consideration of sepsis.

We demonstrate that sepsis syndromes were explicitly identified in our cohort only 58% of the time. While a retrospective design precludes our ability to determine whether this is solely a documentation issue, an explicit failure to recognize sepsis as the cause of the patient's illness, or a combination of the two, it is clear that for those individuals who were identified as potentially septic, the course of their treatment was altered by that diagnostic impression. There were only eight cases identified in which the sole evidence of recognition of sepsis syndrome was launching the sepsis resuscitation bundle. However, given the labor-intensive nature of the bundle, we conclude that the clinician "recognized" sepsis prior to bundle initiation.

The UNRECOGNIZED group had less sick patients (i.e. a lower proportion of severe sepsis or septic shock compared to the RECOGNIZED group) and tended to be younger. This may contribute to the lower rates of recognition in this group. Patients with shock and those who fall on the sicker end of the illness spectrum are almost certainly easier to recognize. However, our study population was composed entirely of bacteremic patients who were classified as having sepsis by objective, well-recognized clinical parameters. In other words, patients categorized as UNRECOGNIZED were still very sick and required prompt treatment for sepsis. All septic patients require early antibiotic administration and many also frequently require fluid resuscitation to prevent progression to severe sepsis and shock. It is therefore important to recognize patients along the entire clinical spectrum from early sepsis to septic shock in order to optimize their care in the ED and maximize their chances for survival. However, even after controlling for sepsis severity, those in the RECOGNIZED group still had a shorter time to antibiotic administration. This suggested to the authors that it was the consideration by the treating physicians that resulted in shorter time to antibiotic administration and not simply because this group tended to be sicker on average.

Additionally complicating the clinical picture is the fact that blood cultures may be slow to yield a causative organism, and may have limited sensitivity for organisms that do not grow well in blood culture media.[15] In fact, up to 20-50% of bloodstream infections may not be identified by routine blood culture methods.[16] Identification of false positive blood cultures more often relies on the epidemiologic data obtained

from blood cultures from a given laboratory rather than the clinical context of a given patient. For example, while *S. epidermidis* may be a common skin contaminant, it may also be the result of a skin infection with hematologic spread. The three most commonly identified organisms in this pathology database were *S. aureus, E. coli, and S. viridans.*

Difficulty with the identification of sepsis persists in our clinical environment despite a Surviving Sepsis Campaign (SSC) committee at our hospital, a SSC bundle electronic order set, and multiple emergency physician "champions" of sepsis. In the era of electronic medical records, perhaps a computer-integrated sepsis ID tool could help identify those patients previously UNRECOGNIZED and prompt physicians to consider the diagnosis.

Recent trials such as ProCESS[2] and ARISE[17] have invigorated the discussion about optimal sepsis care. However, the difference of opinion between Rivers and subsequent investigators has not been over the importance of prompt antibiotic administration and fluid resuscitation, but rather on the method used to determine resuscitative endpoints.

LIMITATIONS

We recognize that there are several important limitations to this study. It is a single-center study performed in an urban academic setting and not powered to detect significant differences in survival between the RECOGNIZED and UNRECOGNIZED groups. However, the only death in the ED was in the UNRECOGNIZED group. Because of the setting it may not be generalizable to suburban or rural venues.

This was a retrospective chart review and follow-up telephone calls to assess survival beyond hospital discharge were not feasible. Survival to discharge was not our main outcome, as we knew we would not have enough power for analysis of survival.

There are well-known limitations to the process of extracting data from handwritten charts. There can be conflicting data in documentation between which interventions are ordered and which appear to have been completed by the nursing staff. Additionally, sepsis may have been considered by the treating team, but not documented by name and the SSC bundle may not have been initiated because of contraindications for individual patients. There is also the possibility of bias in our sample selection. Both false positive and false negative cultures are potential confounders in this study. Only patients who had blood cultures obtained that subsequently were positive were captured, thereby excluding septic patients with false negative blood cultures. There may have been unrecognized septic patients who did not have cultures obtained or whose cultures were negative, who were not included in this study.

Illness severity scores (Acute Physiology and Chronic Health Evaluation, Sequential Organ Failure Assessment, Simplified Acute Physiology Score) were not calculated, as much of this information is not available to the ED physician. Calculations of these scores require data based on the first 24 hours of hospital admission. This makes it difficult to determine the meaning of such scores during the initial ED encounter.

Additionally, this study used a pathology database of positive blood cultures from eight years ago that is no longer maintained. There have been great advances and education in sepsis care over the last decade, which may also limit this study. Hopefully clinicians today are better equipped to identify patients with sepsis syndrome earlier in their treatment course.

CONCLUSION

Lack of documentation of sepsis in the physician chart was associated with increased time to antibiotic delivery and a smaller total volume of fluid administration in patients that were bacteremic and had clinical signs of sepsis syndrome. Increasing early recognition and documentation of sepsis may improve clinical outcomes by shortening the time to antibiotic treatment and increasing fluid administration. Age <60 and absence of fever are factors associated with lack of recognition of sepsis cases.

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Association of Insurance Status with Health Outcomes Following Traumatic Injury: Statewide Multicenter Analysis

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Introduction: Recognizing disparities in definitive care for traumatic injuries created by insurance status may help reduce the higher risk of trauma-related mortality in this population. Our objective was to understand the relationship between patients' insurance status and trauma outcomes.

Methods: We collected data on all patients involved in traumatic injury from eight Level I and 15 Level IV trauma centers, and four non-designated hospitals through Arizona State Trauma Registry between January 1, 2008 and December 31, 2011. Of 109,497 records queried, we excluded 29,062 (26.5%) due to missing data on primary payer, sex, race, zip code of residence, injury severity score (ISS), and alcohol or drug use. Of the 80,435 cases analyzed, 13.3% were self-pay, 38.8% were Medicaid, 13% were Medicare, and 35% were private insurance. We evaluated the association between survival and insurance status (private insurance, Medicare, Medicaid, and self-pay) using multiple logistic regression analyses after adjusting for race/ethnicity (White, Black/African American, Hispanic, and American Indian/Alaska Native), age, gender, income, ISS and injury type (penetrating or blunt).

Results: The self-pay group was more likely to suffer from penetrating trauma (18.2%) than the privately insured group (6.0%), p<0.0001. There were more non-White (53%) self-pay patients compared to the private insurance group (28.3%), p<0.0001. Additionally, the self-pay group had significantly higher mortality (4.3%) as compared to private insurance (1.9%), p<0.0001.
A simple logistic regression revealed higher mortality for self-pay patients (crude OR= 2.32, 95% CI [2.07-2.67]) as well as Medicare patients (crude OR= 2.35, 95% CI [2.54-3.24]) as compared to private insurance. After adjusting for confounding, a multiple logistic regression revealed that mortality was highest for self-pay patients as compared to private insurance (adjusted OR= 2.76, 95% CI [2.30-3.32]).

Conclusion: These results demonstrate that after controlling for confounding variables, self-pay patients had a significantly higher risk of mortality following a traumatic injury as compared to any other insurance-type groups. Further research is warranted to understand this finding and possibly decrease the mortality rate in this population. [West J Emerg Med. 2015;16(3):408-413.]

INTRODUCTION

Multiple studies have shown insurance to be associated with health outcomes, including chronic diseases and medical complications.[1,2] This has been extended to include outcomes of different traumatic injury subsets.[3] Numerous investigations have examined the combined effect of race and insurance status on traumatic injury outcomes; however, some evidence suggests that insurance status alone may be a reliable predictor of mortality. While the general presupposition is that uninsured patients tend to be given the same level of intensive care services as insured patients, uninsured patients have exhibited higher odds of in-hospital mortality after both blunt and penetrating injuries as compared to insured patients with the same type of injury.[4-7] Some evidence has shown similar associations between insurance status and mortality rates following traumatic injury among the pediatric population.[8,9] Salim et al.[10] found insured trauma patients tend to be older, female, more likely to have blunt traumatic injuries, and tend to have a higher injury severity when compared to uninsured patients.

There is some conflicting evidence as to whether insurance status is associated with mortality outcomes by injury type: blunt or penetrating. In one study where patients from a single hospital's trauma registry were analyzed, Taghavi et al.[11] found no difference in mortality between insured and uninsured patients with penetrating injuries. Conversely, in another study using National Trauma Data Bank (NTDB) data, when injury trauma type was restricted to blunt injury only, uninsured patients were found to have a significantly higher mortality compared to insured patients.[12] Greene et al.[4] found an association between insurance status and mortality rates, and hypothesized that the findings may be due to the fact that the uninsured patients were more likely to be involved in penetrating trauma; which is often a more lethal mechanism of injury.

The conflicting evidence persists when examining insurance status and different mechanisms of traumatic injury. Insurance status was not determined to be associated with mortality when a study by Rhee et al.[13] restricted its sample solely to motor vehicle-related trauma patients. Clariadge et al.[14] used data from a single hospital's trauma registry where only penetrating injuries were analyzed, and reported no association with mortality when the cohort was limited to patients with spinal cord injuries. Perhaps lack of any significant association in these studies could be due to the fact that the study was limited to a single Level I trauma center and the results may have been due to their selective focus on a single regional facility. Schoenfeld et al.[15] used national data and found both race/ethnicity and insurance status to be associated with higher mortality in spinal trauma patients.

According to U.S. Census Bureau[16] statistics for 2006 through 2011, Arizona has consistently ranked above the national rate for uninsured adults under age 65. Statewide, 22.6 percent of all adults under age 65 have no health insurance coverage. Eight out of fifteen counties in Arizona have a higher percentage of adults under age 65 who do not have health insurance coverage compared to the state overall.[17] Several studies that have examined the relationship between insurance status and trauma injury outcome have used data from either NTDB or a single hospital, neither of which is necessarily representative of the state/regional relationship between trauma injury and insurance status. Given the variation in access to care by region in Arizona the current study examines whether insurance status is associated with outcomes in blunt and penetrating trauma using state level trauma registry data. The inclusion of all ages, injury mechanisms, and trauma types in our study provides a more comprehensive picture of association between insurance status and mortality.

METHODS

Data and Sample

Our study involved a retrospective analysis of the Arizona State Trauma Registry (ASTR) data. Over the years, ASTR has received data from 23 designated trauma centers and four non-designated healthcare institutions - eight Level I trauma centers, and fifteen Level IV trauma centers. This manuscript was deemed exempt from human subjects review by the local board, as it is public health surveillance and does not publish any personally identifiable information.

The ASTR was queried to identify patients who had sustained blunt or penetrating trauma in 2008-2011.We excluded from the analysis cases with missing data on primary payer, sex, race, zip code of residence, injury severity score (ISS), and alcohol or drug use. Patients of Asian/Pacific Islander or "Other" race were excluded from the analysis due to their small sample size. Out of the 109,497 records queried, 80,435 (73.5%) met the inclusion criteria. The ASTR contains information on patient demographics, pre-hospital treatment, emergency department care, complications, ISS, hospital outcomes, charges, and complications.

Measures

Overall mortality due to blunt and/or penetrating trauma was the primary outcome of interest. Other secondary outcomes included in-hospital mortality (i.e. excluded 'dead on arrival'), total hospital length of stay (LOS), intensive care unit (ICU) LOS, discharge to rehabilitation centers (Skilled Nursing Facility, Long Term Care Facility, or Other Rehabilitation Facility), and mortality by mechanism of injury. The independent variable of interest in this study was payer status. We categorized patients based on their insurance status as follows: self-pay (patient designated as self-pay), Arizona Health Care Cost Containment System (AHCCCS i.e. State Medicaid), Medicare, and Private (includes Blue Cross/Blue Shield, no fault auto insurance, worker's compensation, or other commercial plan).We classified external cause of injury codes (E-codes) into mutually exclusive categories of causes

and intents of injury in accordance with the Centers for Disease Control and Prevention (CDC).[18] Based on our sample size, mechanism of injury was classified into five categories, as opposed to using all 18 CDC recommended categories. These included (1) cut-pierce (injuries resulting from an incision, slash, perforation, or puncture by a pointed or sharp instrument, weapon, or object.); (2) falls; (3) firearm; (4) motor vehicle trauma (MVT); and (5) all other mechanisms. Intents of injury included the following four categories: unintentional, self-inflicted, assault, and undetermined/other.

Patient demographic variables included age, sex, race, ethnicity and median household income. We derived median household income data from the patient's zip code of residence using 2011 Nielsen Claritas dataset that uses American Community Survey small area estimates. We also included known confounders and predictors for injury-related mortality, such as ISS, trauma type (blunt or penetrating) and drug and/or alcohol use (defined as any indication of use, including self-report, suspected use, or tested positive in hospital). ISS was categorized into four groups due to its nonlinear relationship with mortality: low (1-8), moderate (9-15), somewhat severe (16-24), and severe (25+).

Analytic Procedures

We used bivariate and multivariate methods to compare risks for mortality at $\alpha = 0.05$. Mantel-Haenszel Chi-Square tests and logistic regression analyses were conducted using SAS v9.2 (SAS Institute, Inc., Cary, NC). We used ANOVA with Bonferroni correction to compare continuous variables across groups. Logistic regression analyses with adjusted odds ratios (OR) and 95% confidence intervals (95% CIs) were calculated for each of the independent variables.

RESULTS

Insured patients accounted for 86.7% of the study population: 31,177 (38.8%) were Medicaid, 28,143 (35.0%) were private insurance and 10,418 (13.0%) were Medicare. The uninsured self-pay patients accounted for 13.3% (n=10,697) of the population. Most of the patients (89.0%) had blunt trauma. The population was predominantly male (65.2%), with a mean age of 36.6 years (standard deviation=22.6 years). Most of the patients were White (57.6%), followed by Hispanics (29.4%), American Indian/Alaska Native (8.3%), and Black/African American (4.7%).

Table 1 illustrates the general characteristics of the population by payer. The average patient age was 30.4 years for self-pay, 27.8 years for Medicaid, 72.0 years for Medicare, and 35.6 years for those with private insurance. Self-pay patients were more likely to be males (75.7%), Hispanic (40.3%), and less severely injured (ISS 0-8, 70.6%) as compared to the other insurance groups. More self-pay patients suffered from penetrating trauma (18.2%), and used drugs and/or alcohol (42.3%) as compared to other insurance groups.

Table 2 provides differences in survival status, discharge to rehabilitation, and LOS by payer. There was a significant difference in overall mortality and in-hospital mortality among the four groups, with Medicare patients having the highest mortality, followed by self-pay patients. The rate of discharge to rehabilitation also differed significantly among the four groups, with self-pay patients having the lowest rate of being discharged to a rehabilitation facility (1.49%). Self-pay patients had a significantly shorter overall LOS in the hospital after admission (median 1 day, IQR 0-2) as compared to the patients with private insurance (median 1 day, IQR 0-3, $p<0.0001$). Further, following a traumatic injury, self-pay patients remained in the intensive care unit (ICU) for a significantly shorter length of time (median 1 day, IQR 1-3) as compared to the patients with private insurance (median 2 days, IQR 1-4, $p<0.0001$).

Table 3 provides unadjusted and adjusted odds ratios for insurance status as associated with overall mortality, in-hospital mortality and rehabilitation rates. In the unadjusted model, both self-pay (OR=2.3, 95% CI [2.1-2.7]) and Medicare patients (OR=2.9, 95% CI [2.5-3.2]) had significantly higher odds of overall mortality as compared to patients with private insurance. It is evident that, even after adjusting for known predictors as well as demographic confounders (age, gender, race/ethnicity, ISS, trauma type, drug/alcohol use, and income), insurance status was still significantly associated with trauma related mortality. In the adjusted model, self-pay patients were approximately three times (i.e. OR=2.76, 95% CI [2.3-3.32]) more likely to die in a trauma-related incident compared to privately insured patients. Medicaid (OR=1.26, 95% CI [1.08-1.47]) as well as Medicare patients (OR=1.41, 95% CI [1.17-1.71]) also had higher mortality compared to privately insured patients. Appendix A compares multiple models, which add the covariates in a stepwise manner so as to assess the effect of these variables on relationship between mortality and insurance status. The first model is unadjusted, assessing only at insurance status and mortality. Model II removes insurance status and is an unadjusted assessment of the demographic covariates. Model III adjusts for overall LOS, ISS, trauma type, and substance use without adjusting for demographic covariates. Model IV (full adjusted model) keeps the previous covariates in the model, and adds age, sex, race/ethnicity, and median household income.

After excluding death on arrival to the emergency department (ED) from the analysis, similar results were found for in-hospital mortality. The self-pay (adjusted OR=2.16, 95% CI [1.74-2.67]), Medicare (adjusted OR=1.57, 95% CI [1.28-1.93]), and Medicaid (adjusted OR=1.26, 95% CI [1.06-1.49]) patients had significantly higher in-hospital mortality as compared to the privately insured patients. Of those patients who survived to discharge, self-pay patients were least likely to be discharged to a rehabilitation facility as compared to other insurance groups. The adjusted model revealed that

Table 1. Characteristics of the population in the Arizona State Trauma Registry during 2008-2011 by payer.

Variables	Self-pay (n=10,697)	AHCCCS (n=31,177)	Medicare (n=10,418)	Private (n=28,143)	χ^2 (p-value)
Age of the patient (±SD) in years	30.4 (14.5)	27.8 (17.3)	72 (14.9)	35.6 (20.1)	p<0.001
Male (%)	8,100 (75.7)	21,042 (67.5)	5,367 (51.5)	17,921 (63.7)	p<0.001
Non-Hispanic White (%)	5,029 (47.0)	12,676 (40.7)	8,428 (81.0)	20,175 (71.7)	-
Hispanic (%)	4,306 (40.3)	11,875 (38.1)	1,304 (12.5)	6,167 (21.9)	p<0.001
American Indian/Alaskan Native (%)	687 (6.4)	4,598 (14.8)	417 (4.0)	962 (3.4)	-
African American/Black (%)	675 (6.3)	2,028 (6.5)	269 (2.6)	839 (3.0)	-
Income <=$34,000 (%)	2,912 (27.22)	10,521 (33.75)	2,039 (19.57)	3,704 (13.16)	-
Income >$34,000 <= $45,000 (%)	3,185 (29.77)	10,084 (32.34)	3,351 (32.17)	7,752 (27.55)	p<0.001
Income >$45,000 <= $55,000 (%)	2,483 (23.21)	6,275 (20.13)	2,643 (25.37)	6,593 (23.43)	-
Income >$55,000 (%)	2,117 (19.79)	4,297 (13.78)	2,385 (22.89)	10,094 (35.87)	-
Injury severity score (ISS) <=8 (%)	7,547 (70.6)	19,959 (64.0)	4,618 (44.3)	17,645 (62.7)	-
ISS 9-15 (%)	1,972 (18.4)	6,764 (21.7)	3,332 (32.0)	6,448 (22.9)	p<0.001
ISS 16-24 (%)	624 (5.8)	2,650 (8.5)	1,632 (15.7)	2,513 (8.9)	-
ISS 25-75 (%)	554 (5.2)	1,804 (5.8)	836 (8.0)	1,537 (5.5)	-
Penetrating trauma (%)	1,948 (18.2)	4,726 (15.2)	465 (4.5)	1,692 (6.0)	p<0.001
Drug and alcohol use (%)	4,598 (42.3)	11,947 (38.3)	1,557 (15.0)	5,632 (20.0)	p<0.001
Median total length of stay (IQR) in days	1.0 (0, 2)	1.0 (0, 3)	3.0 (1, 6)	1.0 (0, 3)	-

AHCCCS, Arizona Health Care Cost Containment System; *ISS,* injury severity score

Table 2. Survival status and length of stay in the Arizona State Trauma Registry during 2008-2011 by payer.

	Payer status			
Outcome variables	Self-pay	AHCCCS	Medicare	Private insurance
Survival status†				
Overall mortality***	456 (4.26)	635 (2.04)	537 (5.15)	524 (1.86)
In-hospital mortality***	250 (2.38)	478 (1.54)	468 (4.52)	379 (1.35)
Discharge to rehabilitation facility ***	153 (1.49)	2,231 (7.30)	3,459 (35.01)	2,351 (8.51)
Length of stay‡				
Total length of stay in days median (IQR)	1 (0,2)***	1 (0,3)***	3 (1,6)***	1 (0,3) (Reference)
Intensive care unit length of stay (IQR)	1 (1,3)***	2 (1,4)***	2 (1,5)***	2 (1,4) (Reference)

AHCCCS, Arizona Health Care Cost Containment System
***p<0.0001
†Mantel-Haenszel Chi-square tests
‡ANOVA with Bonferroni correction test p<0.0167

self-pay patients had the significantly lower odds of being discharged to a rehabilitation facility than privately insured patients (OR=0.16, 95% CI [0.13-0.19]).

We further analyzed the adjusted model based on mechanism (Table 4) and intent of injury (Table 5) sub-groups. Self-pay patients had significantly higher fall-related mortality (OR=2.06, 95% CI [1.17-3.61]), firearm-related mortality (OR=2.72, 95% CI [1.59-4.64]), MVT-related mortality (OR=3.11, 95% CI [2.34-4.14]) and mortality related to all other mechanisms of injury (OR=2.59, 95% CI [1.62-4.15]), with the exception of cut-pierce. Further, self-pay status was significantly associated with mortality related to unintentional injuries (OR=3.19, 95% CI [2.57-3.96]) and mortality related to assaults (OR=2.76, 95% CI [2.3-3.32]).

DISCUSSION

The higher odds of trauma-related mortality for self-pay patients may be related to a variety of factors. One possible explanation is care coordination in the trauma system, which is exacerbated by shorter LOS for this group. We know that LOS is proportional to costs and for a successful definitive care plan, it is important that the patient remains in the care of the trauma team to prevent further deterioration post-trauma and optimize conditions for recovery. However, in the case of self-pay patients, perhaps the high costs associated with post-injury care are prohibitive, thereby reducing the LOS

and increasing the risk for mortality. A potential confounder for the increased odds of mortality may be due to pre-existing comorbidities in this group.[19,20] Another factor that is perhaps attributable is potential differences in management of care (i.e. less use of procedural interventions).[19] Interestingly, while alcohol and/or drug use have been reported to be risk factors for increased in-hospital complications and in-hospital mortality,[20,21] we consistently found these to have a protective effect. Perhaps residual confounding and interaction with mechanism of injury may explain this effect; however, assessing these effects are beyond the scope of this paper.

Table 3. Self-pay as associated with mortality in Arizona State Trauma Registry during 2008-2011.

	Unadjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Overall mortality rate		
Private (reference)	1.00	1.00
Medicaid	1.10 (0.98, 1.23)	1.26 (1.08, 1.47)
Medicare	2.90 (2.54, 3.24)	1.41 (1.17, 1.71)
Self-pay	2.35 (2.07, 2.67)	2.76 (2.30, 3.32)
In-hospital mortality rate (excluding death on arrival)		
Private (reference)	1.00	1.00
Medicaid	1.14 (1.00, 1.31)	1.26 (1.06, 1.49)
Medicare	3.45 (3.01, 3.96)	1.57 (1.28, 1.93)
Self-pay	1.80 (1.51, 2.09)	2.16 (1.74, 2.67)
Rehabilitation rate (excluding all deaths)		
Private (reference)	1.00	1.00
Medicaid	0.85 (0.80, 0.90)	0.92 (0.84, 0.99)
Medicare	5.79 (5.46, 6.14)	1.68 (1.54, 1.82)
Self-pay	0.16 (0.14, 0.19)	0.16 (0.13, 0.19)

Another finding of the analysis was an increased mortality in Medicare patients, which may be attributable to advanced age and underlying comorbid factors. However, controlling for these potential comorbid conditions is again beyond the scope of this paper, due to the lack of robust documentation in this field of the registry.

This topic will change dramatically with the implementation of the Affordable Care Act. However, it will take a few years to see the full effects on the healthcare system, and it will be interesting to see the effects of the variety of coverage options that are available under the new law on trauma-related mortality.

LIMITATIONS

Despite the strong evidence of our findings, the study is limited in that the data are cross-sectional and no measures to account for pre-existing comorbidities were available. Additionally, a quarter of the study population was excluded due to missing values within the variables of interest. The state trauma system was still in the process of growing at the time this study was performed, and further research on this subject could be beneficial once the designation of new trauma centers slows down. Future research studies can examine the extent to which payer status has effect modification on LOS, injury severity,

Table 4. Self-pay as associated with mortality by mechanism of injury in Arizona State Trauma Registry during 2008-2011.

Payer status	Cut-pierce	Falls	Firearm	Motor vehicle trauma	All other mechanisms
Private insurance (reference)	1.0	1.0	1.0	1.0	1.0
Self-pay	1.65 (0.54-5.05)	2.06 (1.17-3.61)*	2.72 (1.59-4.64)***	3.11 (2.34-4.14)***	2.59 (1.62-4.15)***
AHCCCS	0.89 (0.32-2.48)	1.28 (0.87-1.86)	1.1 (0.67-1.81)	1.51 (1.19-1.91)***	1.29 (0.87-1.89)
Medicare	0.61 (0.11-3.46)	1.32 (0.96-1.83)	1.28 (0.53-3.11)	1.82 (1.34-2.49)***	3 (1.74-5.18)***

AHCCCS, Arizona Health Care Cost Containment System
***p <0.001
Estimates are odd ratios with CI in parentheses and all models are adjusted for covariates included in full model unless otherwise noted.

Table 5. Self-pay as associated with mortality by intent of injury in Arizona State Trauma Registry during 2008-2011.

Payer status	Unintentional	Self-inflicted	Assault	Undetermined/other
Private insurance (reference)	1.0	1.0	1.0	1.0
Self-pay	3.19 (2.57-3.96)***	0.63 (0.24-1.66)	2.07 (1.22-3.5)**	1.98 (0.75-5.22)
AHCCCS	1.39 (1.16-1.66)***	0.4 (0.18-0.89)*	0.9 (0.55-1.48)	1.55 (0.72-3.35)
Medicare	1.46 (1.19-1.79)***	0.63 (0.19-2.07)	2.21 (1.01-4.88)*	0.54 (0.22-1.29)

AHCCCS, Arizona Health Care Cost Containment System
***p<0.001, **p<0.01, *p<0.05
Estimates are odd ratios with CI in parentheses and all models are adjusted for covariates included in full model unless otherwise noted.

drug and alcohol, as well as race and/or ethnicity to explain trauma-related mortality. Our findings nonetheless draw attention to disparities that exist in definitive care for traumatic injuries among self-pay patients as compared to other insurance groups.

CONCLUSION

The results of this study indicate that insurance status is associated with trauma-related mortality for the majority of the mechanisms and intents of injuries studied. The odds of mortality for self-pay patients were twice that of patients with private insurance. Our study findings add to existing literature on trauma-related mortality and payer status by using a statewide trauma registry database, and are consistent with other studies that found that uninsured patients had elevated rates of mortality.[3-6,8-10,12,15] This information may aid in the development of targeted interventions aimed at reducing the high risk of trauma-related mortality in uninsured patients.

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Psychiatric and Medical Management of Marijuana Intoxication in the Emergency Department

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We use a case report to describe the acute psychiatric and medical management of marijuana intoxication in the emergency setting. A 34-year-old woman presented with erratic, disruptive behavior and psychotic symptoms after recreational ingestion of edible cannabis. She was also found to have mild hypokalemia and QT interval prolongation. Psychiatric management of cannabis psychosis involves symptomatic treatment and maintenance of safety during detoxification. Acute medical complications of marijuana use are primarily cardiovascular and respiratory in nature; electrolyte and electrocardiogram monitoring is indicated. This patient's psychosis, hypokalemia and prolonged QT_c interval resolved over two days with supportive treatment and minimal intervention in the emergency department. Patients with cannabis psychosis are at risk for further psychotic sequelae. Emergency providers may reduce this risk through appropriate diagnosis, acute treatment, and referral for outpatient care. [West J Emerg Med. 2015;16(3):414–417.]

INTRODUCTION

Already the most commonly used illicit drug in the United States, marijuana (or cannabis) is becoming more widely used and more potent with expanded legalization.[1-3] Legalization has also popularized "edible" forms of marijuana, including teas and food products. Although often portrayed as a harmless drug with potential therapeutic uses, marijuana has detrimental effects on brain development, psychiatric health (eg, psychosis, schizophrenia, depression and anxiety), lungs (eg, chronic bronchitis and lung cancer) and heart (eg, myocardial infarction and arrhythmias).[2] Public perception of these risks decreases with legalization, and no guidelines exist to help patients gauge the personal safety of use.[4,5] As emergency providers treat more patients with cannabis use disorders, they must educate patients about these chronic health risks and also manage the acute medical and psychiatric complications of marijuana intoxication.

To illustrate the management of acute complex marijuana intoxication and psychosis, we present a case of a woman requiring prolonged emergency department management after ingestion of edible tetrahydrocannabinol (THC), the active ingredient in marijuana.

CASE REPORT

A 34-year-old woman with no significant psychiatric history presented to the emergency department (ED) with erratic and disruptive behavior. She broke into a neighbor's home, requesting to "go to heaven." She feared people were stealing from her and that "something bad" was going to happen. She reported insomnia, racing thoughts, and euphoria for the past week.

Upon arrival to the ED, her vital signs were temperature of 36.4°C, heart rate of 96bpm, blood pressure 148/111mmHg, and respiratory rate of 11. She was difficult to redirect and her mental status revealed a thin, "nervous," well-groomed woman with a labile affect and pressured speech. The patient's thought process was loose and disorganized with thought blocking. She was paranoid, grandiose, hyper-religious, and endorsed auditory hallucinations. She denied suicidal or homicidal ideation. Her attention and memory were considered impaired though not formally tested.

The patient admitted to using cannabis lip balm and consuming edible cannabis chocolate bars daily over the past week, most recently the day of presentation. She could not quantify her consumption. She believed her paranoia and insomnia onset coincided with her THC ingestion last week. The patient denied other recent substance or alcohol use. She denied any falls or history of traumatic brain injuries. A friend of the patient confirmed this history. Her other medications included propranolol 20mg twice a day for hypertension and infrequent sumatriptan as needed for migraines. Family history of mental illness was unknown since the patient was adopted.

For this presentation of acute psychosis, emergency medical providers conducted a comprehensive work-up to exclude organic etiologies of psychosis or concurrent medical morbidity. A basic metabolic panel was significant for a potassium level of 3.2mg/dL (reference range: 3.5-5.0); her electrocardiogram (EKG) demonstrated a prolonged QT_c of 508ms, a pulse of 86, and no U waves or T wave changes. A 9-carboxy-THC level was over 500ng/mL; her urine toxicology screen was negative for cocaine, amphetamines, benzodiazepines, and opioids. A B12 level was elevated at 1186pg/mL. Her complete blood count and a noncontrast head computerized tomography (CT) study were unremarkable.

The patient refused supplemental potassium, and it was thought that her EKG findings did not warrant emergent, forcible repletion. She also removed her intravenous line while agitated. She was placed in two-point soft restraints for her safety. After consultation with psychiatry, the patient was deemed medically appropriate for transfer to the ED's psychiatric emergency service (PES) for further evaluation and treatment.

In the PES, the patient was hypersexual, hyperactive, and intrusive, entering other patients' rooms and touching them. As she could not be safely re-directed, physical restraints were again ordered for the patient's and others' safety. Risperidone 0.5mg PO q6hr and lorazepam 1mg PO q6hr were ordered as needed for management of psychosis and anxiety; the patient required one dose of each during her PES stay.

Twenty-four hours after presentation, her psychotic symptoms and anxiety persisted: she suggested that her food was poisoned and asked whether she was African-American (though she was Caucasian). The patient claimed to have forgotten her father's name, did not know where she was currently living, and was oriented only to person and place. She received her scheduled propranolol for hypertension and 40meq of oral potassium chloride (which she had earlier refused). Her consciousness and attention were intact.

Forty-eight hours after presentation, the patient's paranoia and hallucinations improved dramatically. The patient was able to reflect on the unreality of her paranoia and "odd thoughts" of being African-American. With improved insight, she confirmed heavy use of multiple edible THC products in addition to frequent coffee and energy drink consumption, which she had difficulty quantifying. The patient was diagnosed with cannabis-induced psychotic disorder and severe marijuana use disorder; she was instructed to follow up with outpatient mental health to ensure resolution of her psychosis and begin substance abuse treatment.

DISCUSSION

New-onset psychosis is a medical emergency with a broad differential.[6] Signs and symptoms concerning for a medical etiology of psychiatric symptoms include abnormal vital signs, altered consciousness, or lack of prior psychiatric history in a patient over 40 years old.[7] The acute onset of symptoms with marijuana use, high serum marijuana metabolite levels, and symptomatic resolution with detoxification suggest these symptoms were secondary to marijuana use.

Cannabis-induced psychotic disorder ("cannabis psychosis") is diagnosed when psychotic symptoms persist beyond acute intoxication and may require clinical management.[8] Psychiatric symptoms include paranoia, derealization, disorganized thinking, persecutory and grandiose delusions, hallucinations, and cognitive impairment. Patients pose a danger to others and themselves due to their altered sense of reality. Safe cannabis detoxification typically requires 24 hours, but sometimes longer for patients with unstable vital signs and persistent psychosis. Benzodiazepines are recommended for agitation related to stimulant intoxication – unless psychosis is present, in which case oral atypical antipsychotics are considered first-line.[9]

Cannabis blood levels reflect the extent and chronicity of marijuana use. A free THC level below 3ng/mL (µg/L) suggests occasional consumption (≤1 joint/week) while a concentration higher than 40ng/mL corresponds to heavy use (≥10 joints/month).[10] Levels above 10ng/mL impair motor function, leading two states with legal recreational marijuana to establish the legal limit for driving at 5ng/mL. In clinical practice, measuring an inactive metabolite of THC, 9-carboxy THC, is preferred due to the rapid decrease in free serum THC levels.[11] In a prior case report, oral cannabis-induced psychosis resolved within 24 hours after recorded serum THC levels below 20ng/mL, or 9-carboxy-THC levels below 50ng/mL; the authors suggested that oral administration may not achieve high serum THC levels.[12] Our patient's 9-carboxy-THC level over 500ng/mL demonstrates that oral administration can achieve high serum THC levels and suggests a dose-response relationship between serum metabolite levels and the severity of psychosis. Moreover, serum drug levels may anticipate a patient's clinical course.

The medical risks of acute cannabis use are primarily cardiovascular in nature. THC enhances sympathetic tone, thereby increasing heart rate and blood pressure.[13] Marijuana increases the risk of myocardial infarction within one hour of use, and cardiovascular events have been reported in otherwise healthy patients.[5,14,15] A Norwegian autopsy study suspected THC-induced arrhythmias (including ventricular tachycardia and fibrillation) as the culprit in six patients who

died suddenly.[15,16] Electrocardiograms should be obtained for patients with severe cannabis intoxication; telemetry monitoring may be considered for patients with known cardiac pathology.

Electrolyte abnormalities reported in marijuana users contribute to this cardiac pathology. Chronic marijuana users have lower serum sodium and potassium than non-users.[17] The heavy consumption of carbohydrates while intoxicated leads to an increase in serum insulin levels, driving potassium into cells and causing serum hypokalemia.[18] This hypokalemia can produce reentrant arrhythmias by decreasing conductivity and increasing the resting membrane potential, duration of the action potential, and duration of the refractory period.[19] EKG changes include the decrease in T-wave amplitude, presence of U waves and a prolonged QTc. This patient's very high THC metabolite level, prolonged QTc, and hypokalemia increased her risk for an arrhythmia. The hypokalemia observed in this case was likely related to acute intracellular potassium shifts superimposed on chronic hypokalemia.

Clinicians must manage other, non-vascular risks of acute marijuana use. Respiratory symptoms include shortness of breath, wheezing, and even respiratory failure when marijuana has been smoked "wet" with phenylcyclidine or embalming fluid.[20,21] Patients with pre-disposing genetic vulnerabilities may develop hypokalemic periodic paralysis.[18] And, marijuana use correlates with fatal motor vehicle collisions – clinicians should educate patients and ensure a safe transportation plan on discharge.[22]

Patients with toxic ingestion must be screened for co-ingestion. The persistence and intensity of the patient's symptoms warranted consideration of multiple involved substances. Co-ingestion may also be signaled by an abnormal osmolar or anion gap, positive urine toxicology screen, or QTc or QRS prolongation (Only QTc prolongation was present here).[23,24] However, in many cases, the presence of co-ingestion may only be detected once the patient is able to provide a reliable history. In this case, an elevated B12 level was found on work up of the patient's psychiatric symptoms and suspected to have been caused by energy drink consumption; only later did the patient confirm this suspicion. By its effects on mesolimbic dopamine activity, caffeine may precipitate psychosis, exacerbate chronic psychosis, or worsen affective lability and mood states.[25-28] This patient's high THC metabolite level and medical course are consistent with cannabis psychosis; however, we cannot exclude excessive caffeine use as a contributor to this presentation.

What is this patient's prognosis? Marijuana correlates with the onset of psychosis in patients with schizophrenia and perhaps bipolar disorder as well.[29-32] About half of patients with cannabis psychosis will later be diagnosed with a primary psychotic disorder.[8,33] This high rate may reflect high rates of marijuana use among patients with schizophrenia. Younger age, greater frequency of marijuana use, family history of psychosis, trauma history, and schizotypal personality correlate with higher risk of a later diagnosis of primary psychosis.[8] ED providers can mitigate the risk of psychopathology by addressing the patient's substance use disorder. Safe detoxification is a primary goal and was accomplished here; brief interventions like motivational interviewing and referral for treatment in the ED may reduce use on discharge.[34,35]

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Pediatric Urinary Retention and Constipation: Vaginal Agenesis with Hematometrocolpos

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An 11-year-old healthy female presented to the emergency department with three days of worsening suprapubic pain, urinary retention, and constipation. She was afebrile with normal vital signs. Her physical examination was notable for suprapubic distention and bulging pink vaginal tissue at the introitus. Bedside ultrasound suggested a distended bladder. Placement of a Foley catheter returned 550mL of urine with improvement of the patient's discomfort, but repeat ultrasound visualized a persistent hypoechoic mass adjacent to the newly decompressed bladder (Figure). The obstructive cause of her abdominal pain and urinary retention was revealed by magnetic resonance imaging (MRI) of the pelvis, which confirmed distal vaginal agenesis with uterine distention from hematometrocolpos (Figure). A Foley catheter was temporarily left in place, and after pediatric and gynecological consultation and operative intervention, she was later free of obstructive symptoms after surgical correction of her vaginal agenesis and hematometrocolpos.

Müllerian duct abnormalities, such as imperforate hymen, transverse vaginal septum, and vaginal agenesis, may be associated with abdominal pain or other symptoms of pelvic outlet obstruction, hematocolpos, and amenorrhea in the early adolescent years.[1-4] While the prevalence of congenital uterine anomalies is estimated at 6.7%, Müllerian agenesis with lack of vaginal or uterine development is thought to only occur in one out of every 4,000-10,000 females.[1,2] These errors in development are strongly associated with a number of other congenital anomalies including urinary tract abnormalities such as renal agenesis in an estimated 18-40% of patients, particularly when a hymen is

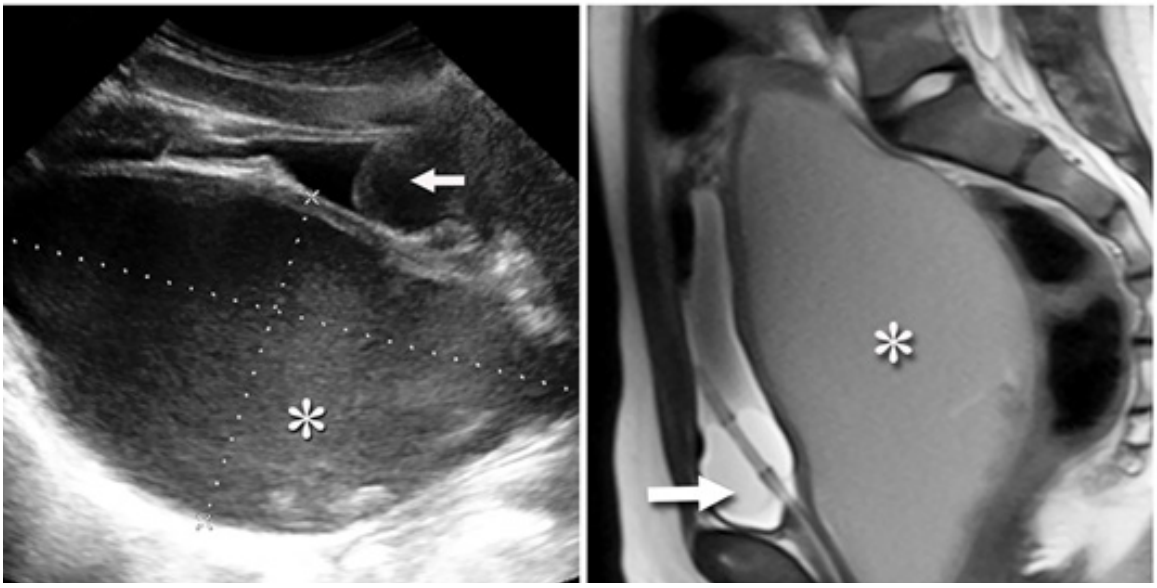

Figure. Long axis transabdominal sonographic view (left) of the patient's abdomen revealing intrauterine low-level echogenic material (asterisk) communicating with the vaginal vault and a Foley catheter within a decompressed bladder (arrow). Sagittal magnetic resonance image (right) demonstrating fluid-filled distention (asterisk) of the patient's uterus and vagina to the level of the introitus and a Foley catheter within the decompressed bladder (arrow).

absent.[3-5] Visualization of vaginal-appearing tissue on physical examination instead of bulging bluish tissue more indicative of an imperforate hymen may suggest vaginal agenesis, but both ultrasound and MRI are recommended to adequately characterize pelvic and neighboring anatomy.[6]

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Rectus Sheath Hematoma: An Unfortunate Consequence of Novel Anticoagulants

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INTRODUCTION

A 76-year-old male presented to the emergency department complaining of intense abdominal pain. He reported one week earlier an upper respiratory illness with violent coughing spells. Past medical history included recent percutaneous coronary intervention for a myocardial infarction 6 months prior where he received three drug-eluting stents and was subsequently discharged home on Prasugrel (Effient) and Aspirin.

Physical exam revealed a large tender right lower quadrant mass with areas of ecchymosis appreciated over the supra-pubic and right lower abdominal region. Abdomen was otherwise soft and non-distended. Basic laboratory tests were noted to be within normal limits. A computed tomography (CT) of the abdomen and pelvis was performed and revealed a 12cm rectus sheath hematoma in the right lower quadrant (Figures 1 and 2).

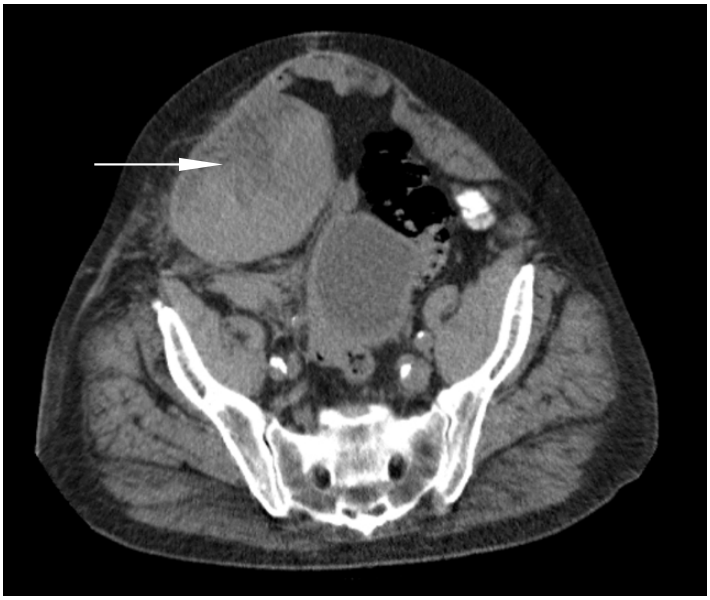

Figure 1. Axial view computed tomographic scan revealing hematoma within the rectus sheath (arrow).

DIAGNOSIS

Rectus sheath hematomas (RSH) are often misdiagnosed and overlooked as a cause of acute abdominal pain. It has been estimated that RSH account for 1.5-2% of unexplained abdominal pain in hospitalized patients,[1] but with the widespread use of newer agent anticoagulants this number is likely on the rise.

RSH result from the accumulation of blood in the rectus sheath, secondary to disruption of the blood vessels that course through it. The most common inciting factors

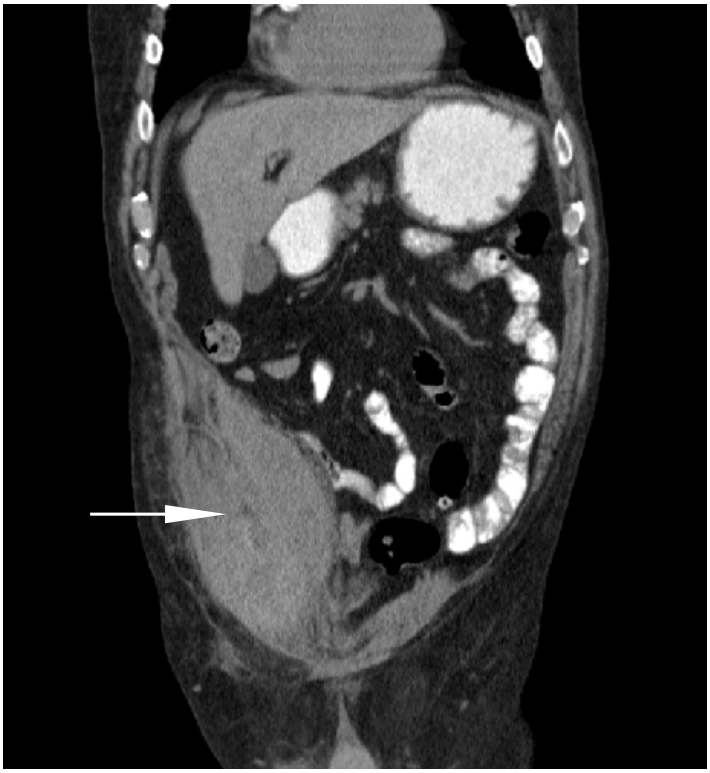

Figure 2. Coronal view computed tomographic scan revealing hematoma within the rectus sheath (arrow).

are direct trauma, strenuous straining (e.g. coughing, exercise, vomiting), and anticoagulants.[2] Large hematomas are more likely to occur in patients who have disruption of one of the epigastric arteries in combination with anticoagulant use.

The mortality rates associated with RSH can be as high 25% for those patients on anticoagulation drugs[3] and is due to a delay in diagnosis as symptoms are often non-specific. Not all patients will have a visible hematoma on physical exam at time of presentation, often leading to further delays in diagnosis. The diagnostic modality of choice is CT of the abdomen and pelvis, which is believed to be 100% sensitive[4] for RSH.

Management of RSH is dependent on the grade of hematoma that encompasses the size, degree of anti-coagulation, and the patient's hemodynamic status. Low-grade RSH can usually be managed with conservative treatment. Higher-grade hematomas require more aggressive treatment including blood products, reversal of anticoagulation, and in certain cases surgical evacuation.[2,5]

Our patient was treated conservatively with Desmopressin and was discharged without additional complications.

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Unusual Placement of a Central Venous Catheter: Left Pericardiophrenic Vein

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A 62-year-old man presented to the emergency department with hypotension and diarrhea secondary to Clostridium difficile infection. Due to poor peripheral access, a left internal jugular vein triple lumen central venous catheter (CVC) was inserted for fluid resuscitation. The CVC was placed under real-time ultrasound guidance, which revealed normal anatomy, with no resistance during placement. Good blood return was noted in all three ports. Follow-up chest radiograph showed an abnormal course of the CVC (Figure 1). Despite the abnormal course, blood gas analysis and pressure transduction via the CVC were consistent with venous placement. Chest computed tomography without contrast revealed placement of the CVC in the left pericardiophrenic vein (Figure 2).

Left paramediastinal central line position can be extravascular with direct placement in the mediastinum or pleural space, arterial with extension into the descending thoracic aorta, or venous. Differential diagnosis of venous left paramediastinal CVC position includes left-

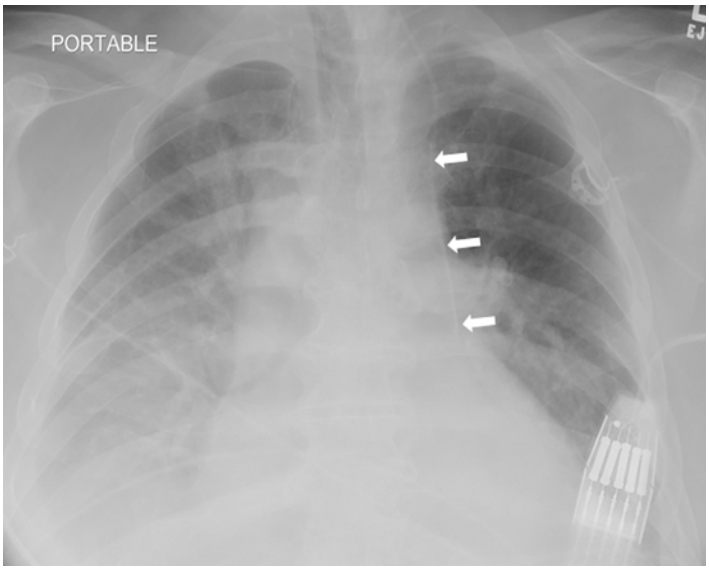

Figure 1. Chest radiograph shows left paramediastinal position of the central venous catheter (arrows) inserted via left internal jugular vein.

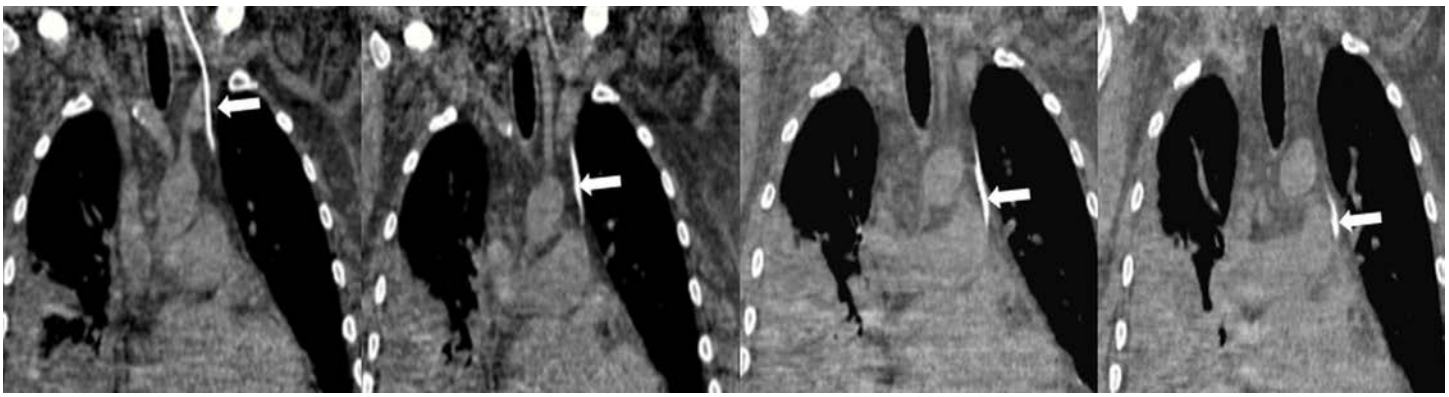

Figure 2. Chest computed tomography without contrast (coronal sections) shows the course of the CVC (arrows) descending via the left internal jugular vein, crossing the left brachiocephalic vein, and then descending through the left pericardiophrenic vein.
CVC, central venous catheter

sided superior vena cava, left internal mammary vein, left superior intercostal vein and left pericardiophrenic vein.[1] The left pericardiophrenic vein accompanies the left pericardiophrenic artery and the left phrenic nerve along the left pericardium before joining the floor of the left brachiocephalic vein opposite to the entrance of left internal jugular vein. Misplaced catheter tip can migrate into the pericardial space resulting in cardiac tamponade due to fluid administration into the pericardium.[2] The use of central venous catheters should be postponed, if possible, until a chest radiograph has documented correct placement.

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Vaginal Bulge

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PATIENT PRESENTATION

A 61-year-old female presented to the emergency department complaining of constipation and vaginal bulge with valsalva 89 days after a robotic-assisted hysterectomy. The patient had intercourse three days prior to presentation and experienced postcoital abdominal discomfort with vaginal bleeding. She denied any other trauma. She had no other complaints and denies fevers, chills, nausea, vomiting, abdominal distension, or constipation. Physical exam revealed exposed bowel protruding through the vaginal cavity.

Figure. Intestinal tissue erythematous, edematous, non-necrotic and visibly peristalsing on exam.

DISCUSSION

This patient had an impressive amount of evisceration through the dehisced vaginal cuff (Figure). Vaginal cuff dehiscence is a rare but emergent complication of gynecologic operations. A full thickness dehiscence can be complicated by prolapse of intra-abdominal organs. When this occurs, evisceration of the distal ileum is most common and can include the appendix as in this case.[2]

Multiple large retrospective studies have demonstrated an increased incidence of dehiscence with laparoscopic hysterectomies (0.64-5.42%) as compared to vaginal hysterectomies (0.13-1.68%).[2,3] This increased risk is likely due to suture knot strength and reduced surgical field visualization.[1,2] Nonsurgical risk factors for dehiscence include post-operative infection, post-menopausal status, exposure to pelvic radiation, corticosteroid use, penetrative vaginal trauma, previous history of vaginal surgery, and coitus prior to full healing of the cuff.[1] Dehiscence after hysterectomy is most common in the first three months but has been reported as late as five years.[2,4]

Vaginal eviscerations are gynecologic emergencies requiring exploratory laparotomy for repair. Prolapsed structures should be irrigated with warm normal saline and wrapped in a moist towel. If delay is anticipated, management includes reduction of prolapsed organs followed by vaginal packing. Because bowel wall edema, peritonitis, and sepsis may result from vaginal dehiscence, these patients should be treated with antibiotics.[4] In this case the patient was immediately taken to the operating room and recovered without complication.

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Rare Radiological Pattern of Diffuse Esophageal Spasm

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A 42-year-old man with history of esophageal strictures and esophageal dilation presented to the emergency department with 12 hours of dysphagia and non-bloody emesis. His symptoms started upon waking and included sharp retrosternal pain during each attempt at swallowing. Dysphagia occurred with both solids and liquid. He denied difficulty initiating swallowing, pain with eating the previous night, halitosis and hematemesis. His vitals and 12-lead electrocardiogram were normal. Despite several attempts at esophageal relaxation using standard methods, he continued having symptoms. At this point an esophagram was obtained (Figure).

The esophagram shows a dilated proximal esophagus and grossly abnormal mid-esophagus with abrupt cutoff of ingested barium contrast. The differential diagnosis of these findings is broad and includes Chagas disease, malignancy and obstruction. An esophagealduodenoscopy was ordered; however, the patient's symptoms abruptly resolved without additional intervention.

This case illustrates an uncommon radiological finding in likely diffuse esophageal spasm (DES). The classic radiographic pattern, resulting from strong muscular contractions, resulting in near-complete lumen obliteration is not present, and there is no evidence for the classic fluoroscopic appearance of a "corkscrew" or "rosary bead" esophagus.[1] The small contractions of the proximal esophagus in this case do not obliterate most of the lumen. This image supports several studies showing that barium studies in DES are usually not characterized by a corkscrew appearance.[1-4] These studies illustrate that radiography alone is insufficient to diagnose DES. However, since DES occurs intermittently, it is a difficult diagnosis to make as esophagram and manometry cannot be performed together.[3] Although our patient had a classic presentation, he did not have the classic radiographic finding. This image further illustrates the non-specific information provided by a barium swallow and importance of history and physical exam in the diagnosis of diffuse esophageal spasm.

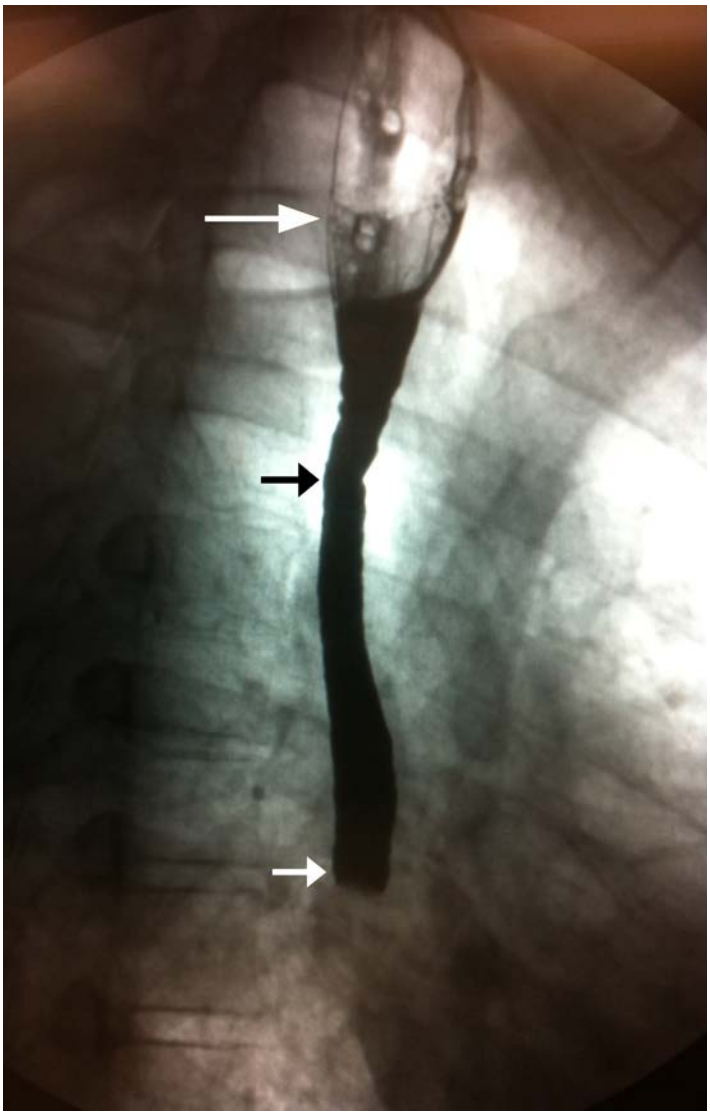

Figure. Barium esophagram. Grossly abnormal esophagram with dilated proximal esophagus (white arrow), abnormal appearance of middle one-third (short black arrow) and abrupt cutoff of ingested barium contrast material (short white arrow).

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Horner's Syndrome after Superficial Cervical Plexus Block

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Ultrasound-guided nerve blocks are becoming more essential for the management of acute pain in the emergency department (ED). With increased block frequency comes unexpected complications that require prompt recognition and treatment. The superficial cervical plexus block (SCPB) has been recently described as a method for ED management of clavicle fracture pain. Horner's syndrome (HS) is a rare and self-limiting complication of regional anesthesia in neck region such as brachial and cervical plexus blocks. Herein we describe the first reported case of a HS after an ultrasound-guided SCPB performed in the ED and discuss the complex anatomy of the neck that contributes to the occurrence of this complication. [West J Emerg Med. 2015;16(3):428–431.]

CASE REPORT

A 20-year-old male presented to the emergency department (ED) with right shoulder pain and deformity after falling from his bicycle. Exam was notable for swelling and tenderness overlying the right clavicle with a comminuted mildly displaced clavicular fracture confirmed by plain radiography. The patient complained of severe pain unrelieved by initial parenteral opioids. For improved pain management, an ultrasound-guided superficial cervical plexus block (SCPB) was performed.[1,2]

Ultrasound-guided SCPB

The patient was placed on continuous cardiac monitoring. Placement of a high frequency linear transducer (13-6 MHz, SonoSite™ M-Turbo, Bothell, WA) was approximated by palpation of the superior pole of the thyroid cartilage (C4 level), and visual approximation of the midpoint of the sternocleidomastoid muscle (SCM), from mastoid to the clavicle.

The superficial cervical plexus was identified as the hyper echoic fascia posterior to the SCM and superficial to the levator scapula muscle (LSM) (Figure 1). The area was prepped with chlorehexidine and a skin wheal of 1% lidocaine was injected. The patient was placed in left lateral decubitus with the ultrasound system contralateral to the provider (Figure 2). Using a 25g 1.5-inch standard hypodermic needle, with an in-plane posterior approach, 10mL of 0.5% bupivacaine was injected under the SCM in the fascial space between the SCM and LSM. Aspiration and real-time visualization of anechoic anesthetic was done to prevent intravenous injection (Figure 2).

Approximately 15 minutes after block placement, the patient had complete pain relief, reporting sensory deficit in the cape region of the shoulder, neck, and skin overlying the clavicle without changes in motor function of the arm. Forty-five minutes later, the patient complained of right-sided facial numbness and was noted to have ptosis, miosis, and conjunctival injection on the ipsilateral side of the block (Figure 3). There was no voice hoarseness, anhidrosis or enophthalmos. The patient was observed in the ED and symptoms resolved 1.5 hours after the block was placed.

DISCUSSION

Potential complications of a SCPB include Horner's Syndrome (HS), partial brachial plexus blocks, phrenic and recurrent laryngeal nerve blocks. We believe the HS described here developed as an inadvertent complication of deep spread of local anesthetic after superficial injection, involving the ipsilateral cervical sympathetic chain.[3] Several studies suggest that the deeper compartments of the neck, (containing the

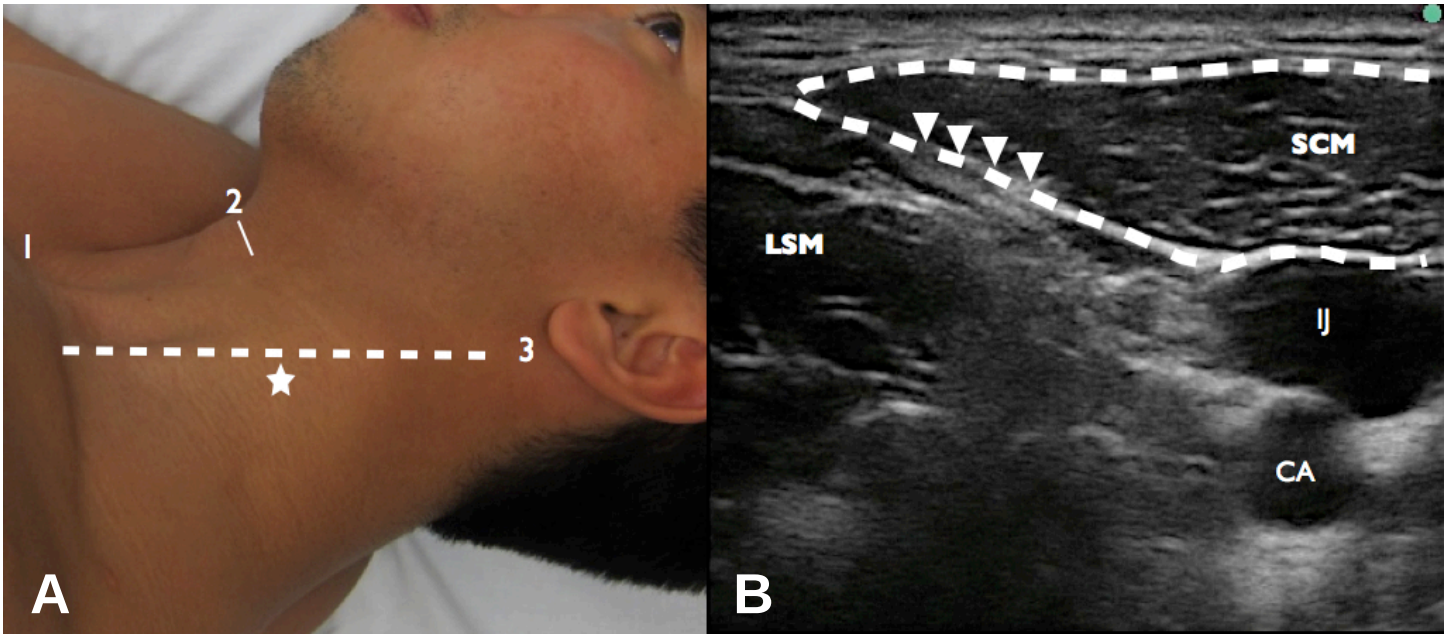

Figure 1. *A*, Key surface landmarks include the (1) sternal notch, (2) superior pole of the thyroid cartilage, (3) the mastoid process, and (dashed line) the posterolateral border of the sternocleidomastoid muscle (SCM). The injection site is marked (star). *B*, Survey ultrasound scan showing the tapering posterolateral border of the sternocleidomastoid (SCM) outlined in red, the internal jugular vein (IJ), the carotid artery (CA), and the levator scapulae muscle (LSM). The superficial cervical plexus just deep to the muscle is marked (arrow heads).

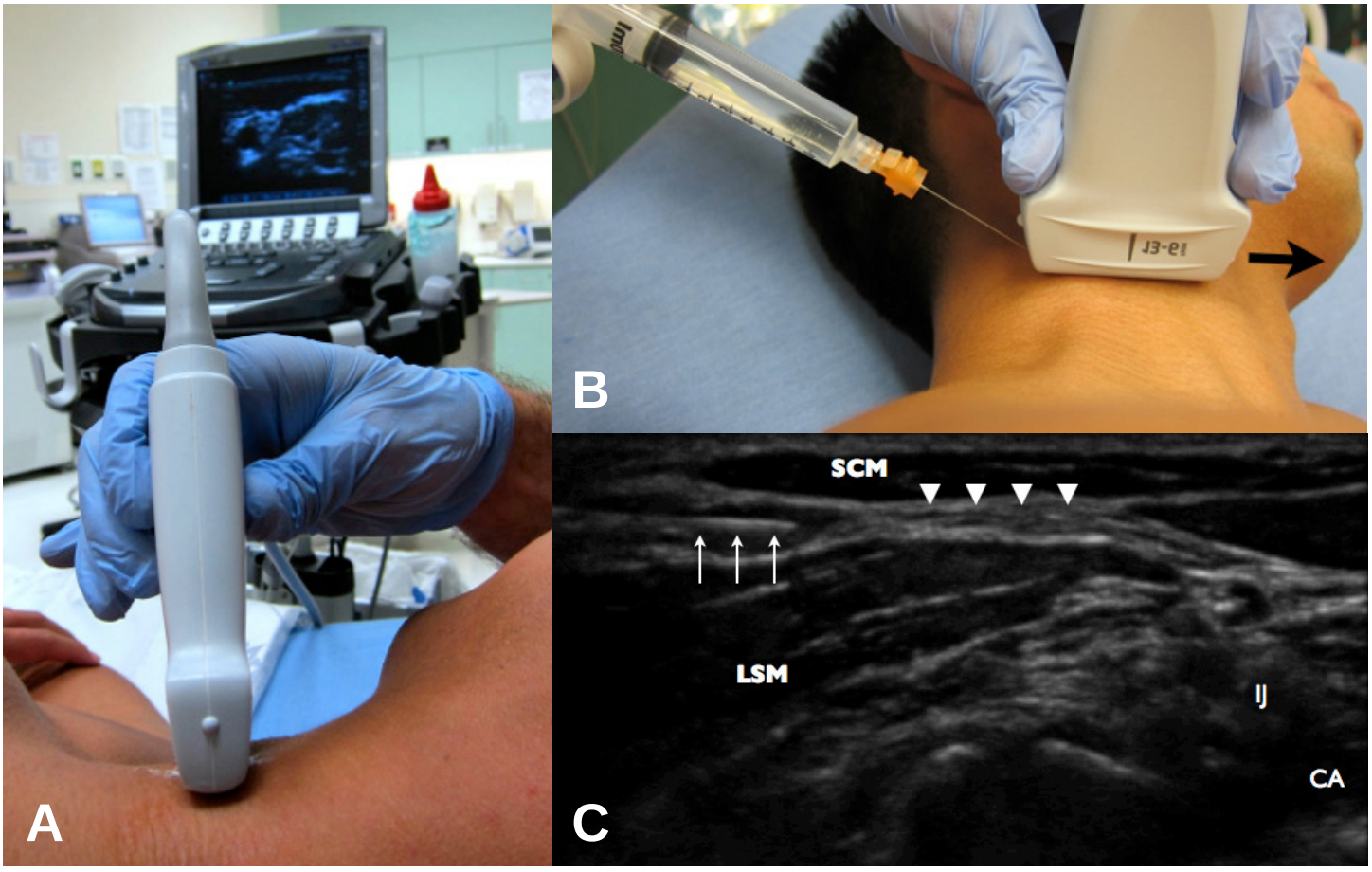

Figure 2. *A*, Probe positioning for the in-plane approach in the lateral decubitus position. *B*, Needle injection and proper orientation of probe marker during superficial cervical plexus block. The arrow delineates the probe marker orientation. *C*, Ultrasound image of needle injection within the superficial cervical plexus. The arrows mark the needle. The sternocleidomastoid muscle (SCM) noted on the top right, the levator scapulae muscle on top left (LSM), the carotid artery (CA) and internal jugular vein (IJ) on the bottom right, and the injection site marked (arrowheads).

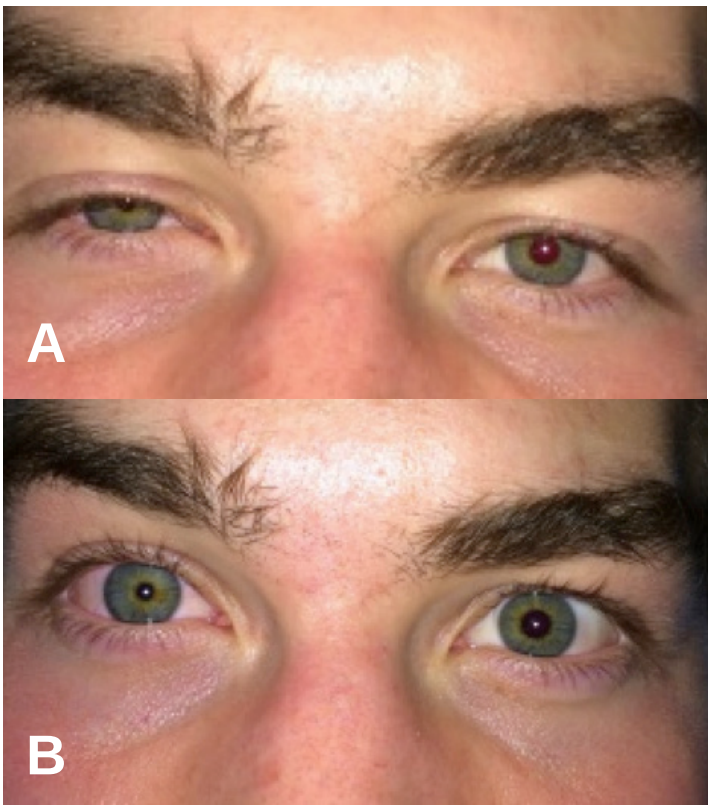

Figure 3. Horner's syndrome after block placement with *A*, ptosis and *B*, miosis.

cervical sympathetic chain), and superficial spaces are in communication with each another allowing for potential deep spread of a superficial injection.[4-6]

Nash et al.[7] reported that the investing layer of the deep cervical fascia in the anterior triangle of the neck is nearly non-existent, suggesting that fat and connective tissues surrounding neck neurovascular structures provide direct communication between the subcutaneous tissue and the prevertebral layer beneath the deep cervical fascia. Pandit et al.[4] further demonstrated that dye injected above the prevertebral layer of the deep cervical fascia penetrates through pores where the nerves pierce the fascia, ending in the deep cervical space. While the precise anatomy has not been completely elucidated, current data supports the concept that the deeper neck compartments potentially communicate directly with the subcutaneous tissue, which explains why in our case the patient experienced a ipsilateral HS after a SCPB. We hypothesize that adhering to three simple precautions can reduce the incidence of HS. More than 5mLs of local anesthetic volume is unnecessary, and placing larger volumes may promote deeper spread of local anesthetic via the anatomic pathways described above. Needle placement at the superior pole of the thyroid (C4 level) should be ensured and not approximated, as was done in this case. Finally, proper depth of injection should be ensured. Needle-tip placement should be maintained just underneath the SCM belly; insertion past the superficial investing fascia may promote the anesthetic to spread into the deep cervical fascial plane potentially involving the phrenic nerve, brachial plexus, and the stellate ganglion.[5]

Finally, it is important to be aware that if HS occurs after the SCPB, providers should consider it self-limiting, requiring only patient reassurance and observation versus urgent neuroimaging to evaluate for an acute stroke.

CONCLUSION

The SCPB is strategy for ED pain management of clavicle fractures. However, emergency clinicians should be aware that similar complications expected of a deep cervical plexus block could occur with the SCPB, such as HS. To minimize risk of complications of the SCPB, in addition to standard precautions for ultrasound-guided nerve blocks, several precautions should be taken. Clinicians should be aware of the anatomy of the superficial cervical plexus and be familiar with the landmarks, ensuring to stay at the level of C4; the injection should be shallow, just under the SCM belly; and appropriate anesthetic volumes (2-5mL) should be used. The development of HS after SCPB can be frightening to patients and the physician should reassure the patient that it is self-limited and not a sign of intracranial pathology or permanent damage.

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Video. Needle injection within the superficial cervical plexus.

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Emergent Presentation of Decompensated Mitral Valve Prolapse and Atrial Septal Defect

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Mitral valve prolapse is not commonly on the list of differential diagnosis when a patient presents in the emergency department (ED) in severe distress, presenting with non-specific features such as abdominal pain, tachycardia and dyspnea. A healthy 55-year-old man without significant past medical history arrived in the ED with a unique presentation of a primary mitral valve prolapse with an atrial septal defect uncommon in cardiology literature. Early recognition of mitral valve prolapse in high-risk patients for severe mitral regurgitation or patients with underlying cardiovascular abnormalities such as an atrial septal defect is crucial to prevent morbid outcomes such as sudden cardiac death. [West J Emerg Med. 2015;16(3):432–434.]

CASE REPORT

A 55-year-old man presented to the emergency department (ED) with abdominal discomfort and shortness of breath in obvious visible distress. He had a two-week history of abdominal discomfort. He had no other significant past medical history. He was seen at a walk-in clinic earlier on the same day due to chest discomfort, and was unable to speak in full sentences. He was sent to the ED by the general practitioner due to increasing shortness of breath. His social history was significant for 3-4 glasses of wine a night on weekdays, and more on weekends. He did not have a family history of heart disease.

On examination, his heart rate was 180 beats/min, systolic blood pressure was 80mmHg, respiratory rate was 30 breaths/min, temperature was 36.4°C, and oxygen saturation was 78% on room air. Upon auscultation, his S1 and S2 were normal and S3 and S4 were absent. He had a systolic murmur of grade 3/6 at the apex. Initial electrocardiogram (EKG) showed the patient in rapid atrial fibrillation with a ventricular response rate of 168 beats per minute. Some nonspecific ST and T wave abnormalities were found. Chest radiography showed markedly increased cardiothoracic ratio and clear lung fields. On laboratory workup, he was jaundiced with total bilirubin of 42umol/L, and a troponin level of 101ng/L. He was seen by cardiology and given an initial diagnosis of cardiomyopathy potentially alcohol induced. It was difficult to determine the primary reason for his presentation: possibilities of pulmonary embolism, ruptured chordae with mitral regurgitation (MR), and cardiomyopathy were considered. Plan of action was to electrically cardiovert if his condition deteriorated.

In the ED he was administered dopamine intravenously (IV) (5mcg/kg), which was subsequently increased to 7.5mcg/kg as his systolic blood pressure was difficult to maintain. He was also administered metoprolol 5mg IV and digoxin 0.5mg IV for rate control.

A transthoracic echocardiogram was performed, which revealed a normal left ventricular cavity size with estimated ejection fraction of 50-55%. The posterior mitral leaflet was determined to be flail with a ruptured mitral valve chordae, and there was severe MR.

The patient was admitted to the coronary care unit with an oxygen saturation in the 80s and extreme shortness of breath, diaphoresis and cyanosis of the extremities. Continuous positive airway pressure (CPAP) therapy was administered; however, he became increasingly anxious and dyspneic. A transesophageal echocardiogram revealed severe mitral regurgitation with P2 prolapse secondary to ruptured cords. Left ventricle function was poor at an ejection fraction of 30%, and the right ventricle was almost akinetic. He was subsequently intubated and evaluated in the catherization lab where upon selective coronary angiography, left and dominant right coronary arteries were determined to be normal. An intraaortic balloon pump was placed for surgery and he was

transferred to the operating room on an emergent basis due to critical decompensation to undergo a mitral valve repair with a P2 resection and a 34mm annuloplasty ring.

Direct visualization of the mitral valve showed a posterior leaflet prolapse secondary to ruptured cords, which took up about one third of the posterior leaflet. There was an atrial septal defect (ASD) noted with some right to left shunting. The right atrium was large and pressurized. The posterior leaflet was resected and a 34 mm annuloplasty ring was put in place. The atrial septal defect was closed through the left atrium.

The patient tolerated the surgery well and returned to cardiovascular intensive care unit in good condition. He was found to be in atrial fibrillation post-op, which was rate controlled with nadolol. He was also started on warfarin for his atrial fibrillation. Upon discharge, he was given amiodarone to be tapered off and discontinued in the subsequent couple of weeks. Follow up at the outpatient cardiovascular clinic was unremarkable. He had no complaints or complications from the surgery and no further follow up was arranged.

Post-surgical pathology of the posterior leaflet revealed myxomatous mitral valve disease, with diffuse rubbery thickening.

INTRODUCTION

Mitral valve prolapse (MVP) is a very common valvular abnormality that is likely to be an incidental finding on auscultation in the ED as it is often asymptomatic in patients.[1] Patients with non-specific clinical features such as dyspnea, tachycardia and abdominal pain would have a wide differential diagnosis. It is crucial to identify individuals at increased risk for MVP or those with accompanying cardiac abnormalities such as an ASD to prevent serious complications such as severe MR and sudden cardiac death (SCD). Although secondary MVP has been associated in patients with ASD, our patient presented with a unique presentation of a primary MVP with an ASD in a severely decompensated state.[1] This case report offers a different perspective of a patient in acute, severe distress with a primary MVP with an ASD infrequently reported in cardiology literature.

DISCUSSION

MVP is a multifactorial valvular abnormality that can be caused by histological abnormalities or valvular tissue, geometric disparities between the left ventricle and mitral valve or various connective tissue disorders such as Marfan syndrome and Ehlers-Danlos syndrome.[1] This diagnosis is typically detected by auscultation with systolic clicks or mid to late systolic murmur, as most patients with MVP are asymptomatic.[2] As such, patients are unlikely to present to the ED with problems specific to MVP unless they develop serious complications such as severe MR or SCD.[1]

Myxomatous degeneration of the mitral valve is the most common pathophysiological basis for MVP, producing characteristic histologic changes also known as primary or classic MVP.[1] However, secondary or non-classic MVP can occur in those with histologically normal valves, and is associated in 50-80% of patients with unrepaired secundum ASD.[1] The underlying mechanism between classic and non-classic MVP differ: in the classic MVP, there is characteristic myxomatous degeneration of the valve with leaflet thickening and redundancy that appears to be due to a dysregulation of the components of the extracellular matrix.[1] Comparatively, non-classic MVP can be attributed to imbalance of geometric features between the mitral valve and the left ventricle that govern the mechanical function of the mitral valve:,such as LV size, mitral annular dimensions, and the leaflet size.[3]

Regardless of the underlying mechanism, patients with MVP typically present with atypical chest pain, dyspnea, palpitations, syncope and anxiety, as well as lower blood pressure and non-specific T-wave abnormalities on EKG.[4] Some of the clinical features of mitral regurgitation secondary to mitral valve prolapse include various clinical manifestations such as sudden onset dyspnea, fever, cough and chest pain.[5] Often these presentations are non-specific and can be mistaken for other common emergency conditions such as pulmonary embolism, acute coronary syndrome or exacerbation of chronic obstructive pulmonary disease. Initial misdiagnosis of acute flail mitral valve causing severe mitral regurgitation is not infrequent and can result in morbid outcomes.[5] It is therefore crucial to raise awareness of this clinical entity and to better identify mitral valve prolapse in those with atypical symptoms. This is especially true in patients who are high risk for severe MR such as presence of thickened leaflets, posterior leaflet prolapse and increased left ventricular dimensions, and those patients with other cardiovascular abnormalities such as ASD.[1] Clinical course of MR and MVP are altered by the presence of ASD. Some patients with severe MR may not manifest typical symptoms of MR because the ASD may unload the left atrium making prompt diagnosis a challenge.[6] Interestingly, in our patient, his long-standing ASD caused reverse shunting due to higher pressure in the right atrium than in the left atrium, resulting in partially deoxygenated blood pumping out of the ventricles. This, in combination with the flail mitral valve resulting in poor cardiac output, led in his severely decompensated state.

Management of this presentation in the ED setting involves stabilizing the patient in preparation for surgery. Intravenous vasodilators such as nitro may be given to reduce the MR by reducing the systemic vascular resistance and improving the mitral valve competence. This is, however, limited in a hypotensive patient with cardiogenic shock.[7] Intraaortic balloon pump may be used as a temporary measure to reduce systemic resistance thus improving cardiac output, without a reduction in mean arterial pressure.[7] Management involves use of oxygen or ventilatory support to improve hypoxemia. Cardiogenic shock requires fluid restriction although with poor right ventricular function, fluid administration may be required to increase preload.[8] Treatment with inotropes will increase contractility of the heart and increase cardiac output, while decreasing afterload.[8]

In this case, we observed a patient with a myxomatous degeneration of the mitral valve with MR secondary to MVP. He also has an ASD, which is a risk factor of MVP independent of the myxomatous histological nature of the mitral valve. This led to his acute, distressed initial presentation that was not characteristic of that of a mitral valve prolapse. Early recognition of MVP in high-risk patients for severe MR or patients with underlying cardiovascular abnormalities is crucial to prevent morbid outcomes.

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Anaphylaxis Due to Head Injury

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Both anaphylaxis and head injury are often seen in the emergency department, but they are rarely seen in combination. We present a case of a 30-year-old woman who presented with anaphylaxis with urticaria and angioedema following a minor head injury. The patient responded well to intramuscular epinephrine without further complications or airway compromise. Prior case reports have reported angioedema from hereditary angioedema during dental procedures and maxillofacial surgery, but there have not been any cases of first-time angioedema or anaphylaxis due to head injury. [West J Emerg Med. 2015;16(3):435–437.]

INTRODUCTION

Anaphylaxis with angioedema is a serious and potentially life-threatening emergency. There are many potential triggers for anaphylaxis. Head trauma has not been previously reported as a trigger for an acute allergic reaction with angioedema. We present a case report of a young woman with mild traumatic head injury who subsequently developed urticaria and angioedema.

CASE PRESENTATION

A 30-year-old Caucasian female presented to the emergency department (ED) after being hit in the head by a baseball sustaining a laceration to her right lateral forehead. She did not lose consciousness and was driving herself home from a baseball game when she began to develop urticaria, tongue swelling and difficulty breathing. She stopped at a local fire station where her rapidly worsening symptoms were treated with 0.3mg of intramuscular (IM) epinephrine before transport to our ED approximately 30 miles from the fire station.

At the time of her arrival, her urticaria had subsided, but her tongue swelling persisted such that she had difficulty speaking and some discomfort with swallowing but was tolerating her own secretions without difficulty. She denied vomiting or present shortness of breath, but she did initially feel short of breath prior to epinephrine administration. She complained of a headache but no neck pain since the trauma, and she was not confused.

Her physical exam revealed a patient who was appropriately alert and oriented with a Glasgow Coma Score (GCS) of 15 and completely intact neurologic exam. She had a 4cm laceration over the right side of her forehead with minimal bleeding after being bandaged at the local fire station but no other deformity. She was tachycardic with a pulse of 110 beats per minute with a blood pressure of 118/76mmHg. Her respiratory rate was 22 breaths per minute with oxygen saturation of 98% on room air and no active stridor or wheezing noted. Her skin exam revealed several minor urticarial lesions on her anterior neck and trunk but no other lesions.

She reported no history significant past medical or surgical history and denied any allergies or history of allergic reactions. There was no family history of hereditary angioedema, and the patient was not taking any prescribed or over the counter medications. She stated that she had not been stung or bitten, and had ingested no new foods prior to or after being hit by the baseball.

In the ED she received methylprednisolone 125mg intravenous (IV), diphenhydramine 25mg IV, famotidine 20mg IV and one liter of normal saline. A non-contrast computed tomography (CT) of the head was negative for fracture or intracranial hemorrhage. Her forehead laceration was subsequently repaired without difficulty.

After a period of observation in the ED, her tongue swelling had not improved. Because she had persistent tongue swelling and lived more than one hour from the hospital, she was admitted to the hospital for airway observation. She was discharged 18 hours later with improvement in her swelling and no recurrent allergic symptoms.

DISCUSSION

This presentation represents the first reported case of

anaphylaxis occurring as a possible result of blunt head trauma. In attempting to explain the combination of this patient's presenting symptoms, we considered the possibility that she may have had some unrecognized allergen exposure leading to her anaphylaxis. However, she denied any new exposures either before or after, and she was not taking any medications that could have contributed to a delayed allergic reaction. The alternative explanation remains that the head injury was the proximate cause of her subsequent anaphylaxis, and this combination of these symptoms has not been previously presented in the medical literature.

When patients present to the ED with head trauma, the physician's primary concern is to evaluate for possible intracranial hemorrhage. In managing these patients one typically tries to avoid potentially increasing the intracranial pressure (ICP) until it is apparent that there is not any intracranial hemorrhage. The conundrum for the management of this patient, in particular by the emergency medical services (EMS) providers, was whether or not a patient with head trauma and a possible intracranial hemorrhage should receive epinephrine to treat her angioedema, which could elevate her mean arterial pressure (MAP) and thus potentially increase her ICP.

The thought process of the emergency medical technician (EMT) was that he should manage her airway first, and he decided to administer an appropriate IM dose of epinephrine that helped to ameliorate, but not resolve, her allergic symptoms. Clearly, the EMT made the correct treatment choice to manage the anaphylaxis first as the patient's head injury was not severe enough to cause any neurologic deficit or subsequent intracranial hemorrhage. However, had the injury been severe enough to create a space-occupying lesion, the use of epinephrine could certainly contribute to a rise in ICP and potentially worsen the neurologic outcome. Using epinephrine to mitigate an airway and oxygenation emergency would have to be weighed against the possible risk of increasing ICP.

Anaphylaxis due to trauma alone has not been reported in the literature based on our review. Research in rats has suggested that injury to the blood brain barrier in head trauma may possibly contribute to cerebral edema and angioedema because of changes in expression of aquaporin-4 (AQP4), but this has only been studied in rats and little is known about the correlation of angioedema that occurs in rats with traumatic brain injury.[1]

Hereditary Angioedema (HAE) has been reported in several older case reports to be triggered during maxillofacial or dental surgery. There are case reports of acute HAE occurring for the first time during oral surgery for an acute mandibular fracture.[2,3] There are multiple potential triggers for HAE, including many types of physical and psychological trauma.[4,5] However, most of these events have been reported in patients with known HAE. Our patient had no personal or family history of HAE, and her symptoms began with urticaria which is more likely to be present in anaphylactic reaction than HAE which usually is more likely to be swelling that is nonpitting, not raised, and not pruritic as our patient's symptoms were.[4,5]

This patient had a mixed presentation of allergic symptoms that could potentially be attributed to anaphylaxis or HAE. Type 1 allergic reactions are the common cause of anaphylaxis. They are due to IgE mediated mast cell degranulation that causes pruritus, flushing, urticaria, and anaphylaxis within minutes to hours of exposure.[4,6] Our patient could also have had exercise-induced anaphylaxis that can occur from direct or non-immune related mast cell activation up to 4-6hours after exposure and exercise.[4] HAE symptoms differ in that urticaria is rare, while there may be nonpitting and nontender perioribital, lip, or tongue swelling.[5] We contend that our patient had an allergic anaphylactic reaction because she had mucosal and skin findings within hours of "exposure," but there are no prior reports of trauma triggering anaphylaxis. Trauma, however, is noted in reviews of HAE as a potential trigger, but we could not find any case reports to support this contention. While this could be the case for our patient, her symptoms were more indicative of anaphylaxis, and there was no personal or family history of HAE.

We referred our patient to an allergist for further testing, but she did not go to that appointment. She did follow up with her primary physician within the following week for suture removal and did not report recurrence of her symptoms.

In summary, this was an unusual case of minor head trauma leading to a first-time incidence of anaphylaxis with angioedema. The head injury may have been the triggering mechanism for her allergic reaction, and was managed successfully with one dose of IM epinephrine, diphenhydramine, steroids, and observation. Although HAE symptoms have been reported with head, neck and dental surgery previously, the combination of head injury leading to angioedema has not previously been reported.

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Morel-Lavallee Lesion Initially Diagnosed as Quadriceps Contusion: Ultrasound, MRI, and Importance of Early Intervention

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Morel-Lavallee lesions (MLL) are rare, closed degloving injuries caused by trauma that delivers a shearing force to the soft tissue most commonly of the hip. If not treated in the acute and subacute setting these lesions are often complicated by re- accumulation of fluid, infection, or chronic pain. We present a unique case of a recurrent, massive medial knee/thigh MLL in which proper treatment was delayed due to initial diagnosis of a quadriceps contusion. We describe the ultrasound and magnetic resonance imaging findings of this patient and based on a review of recent literature propose that the initial management should have included early drainage/debridement, which likely could have prevented recurrence and significantly shortened the clinical course. [West J Emerg Med. 2015;16(3):438–441.]

INTRODUCTION

Morel-Lavallee lesions (MLL) are rare injuries that occur due to a traumatic shearing force or crush injury acting on the skin surface that causes a separation of the skin and subcutaneous tissue from the underlying fascia. This mechanism of the injury is referred to as internal degloving. The traditional and most common location of these injuries is the lateral hip/greater trochanter. Other frequent areas include the pelvis, thigh, and knee.[1] The separation of the subcutaneous tissue from the fascia in MLLs causes a disruption of the lymphatics and blood vessels in the affected region. This precipitates the accumulation of fluid in this newly formed potential space. Subsequently, the formation of a hematomas or seromas occur.[2] The inflammatory reaction that ensues if these injuries are not treated in the acute phase can organize granulation tissue into a fibrous capsule.[1,3] This capsule impedes the absorption of the fluid and is thought to be the cause of recurrent fluid collection even after drainage,[3] MLLs are often not diagnosed initially. Kottmeir et al. reported that they are missed up to 44% of the time.[4] Early detection and treatment of MLLs is vital to circumvent complications such as re-accumulation of fluid, infection-related morbidity, and chronic pain.[5,6] Recent studies advocate for early treatment via drainage and possible debridement of acute and subacute lesions.[2,7,8]

We present a patient with a massive MLL of the medial thigh that was initially diagnosed as a quadriceps contusion, which caused delayed treatment. We discuss the pertinent ultrasound and magnetic resonance imaging (MRI) findings as well as address the importance of early identification and proper management of these lesions.

CASE

The patient was a 22-year-old active duty male in the Navy who presented to the emergency department (ED) with a massively swollen, bruised, and painful right thigh/knee after falling down the stairs onto his knee 11 days prior. Before seeking treatment at the ED he saw his primary care provider and was treated with decadron and toradol injections. He was also given oral nonsteroidal anti-inflammatory drug (NSAIDS), muscle relaxants, an ACE wrap, and crutches. The patient denied fever and chills. His medical history was significant only for hypertension. On physical exam he had a large fluctuant fluid collection along the medial aspect of his right thigh as well as diffuse ecchymosis of the leg centered over the knee. There was

no joint line tenderness and no ligamentous laxity of the knee joint. He had full range of movement at the knee, and he was neurovascularly intact distally. All compartments of the leg were soft. Plain films of right knee, femur, tib/fib, were significant for soft tissue swelling and no osseous abnormality. Bedside ultrasound in the ED showed approximately 500mL of subcutaneous, anechoic fluid near the vastus medialis. He was diagnosed with a quadriceps contusion and managed with NSAIDs, compressive dressing, knee immobilizer, and follow up with orthopedics.

The patient presented again to the ED approximately three weeks later with worsening pain and swelling of the right thigh and knee. Ultrasound demonstrated a fluid collection measuring 26cm cranio-caudid x 6.2cm AP x 13.8cm transverse (Figure 1). The lesion was percutaneously drained and 1900mL of serosanguineous fluid was expressed. Compressive dressing and knee immobilizer were placed and follow up in one week was recommended.

One week later the patient had re-accumulation of the fluid and the decision for surgical irrigation and debridement (I and D) with negative pressure wound dressing placement was made. A pre-operative MRI was obtained (Figure 2a-d). The patient eventually underwent one more surgical I and D with delayed primary closure, and at that time the fluid collection had completely resolved. This was more than a month and a half after his initial presentation to the ED.

DISCUSSION

This case is clinically significant for two primary reasons. First, the lesion was extremely large for its location. There are very few published accounts of massive MLLs occurring in the medial thigh/knee. To our knowledge our patient's lesion may in fact be the largest documented in this region, measuring at 26cm cranio-caudal, 6.2cm AP, and 13.8cm transverse and draining 1900cc. Multiple lesions of this magnitude have been described along the lateral thigh/greater trochanter, but after a thorough literature review only two other lesions that possibly were of similar magnitude in the

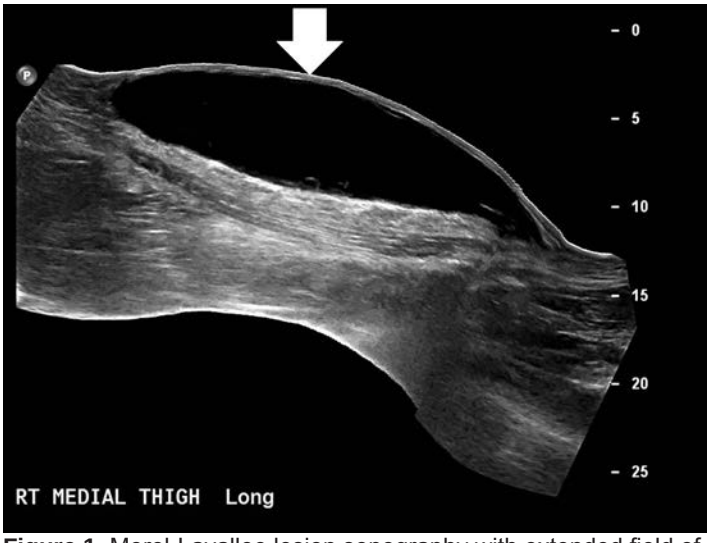

Figure 1. Morel-Lavallee lesion sonography with extended field of view along the long axis of the lesion shows fusiform shape and anechoic texture.

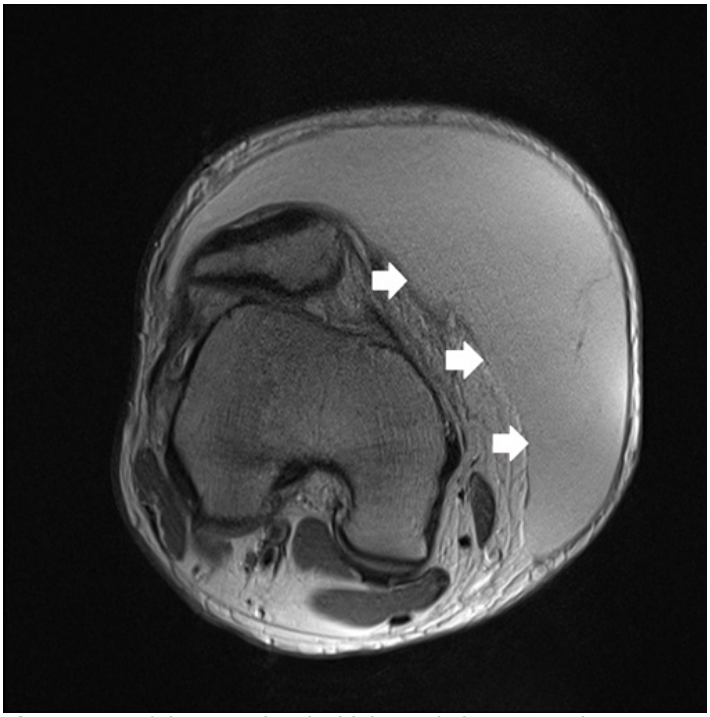

Figure 2a. Axial proton density high resolution magnetic resonance imaging shows T2 prolongation in the Morel-Lavallee lesion of the anteromedial right thigh soft tissues.

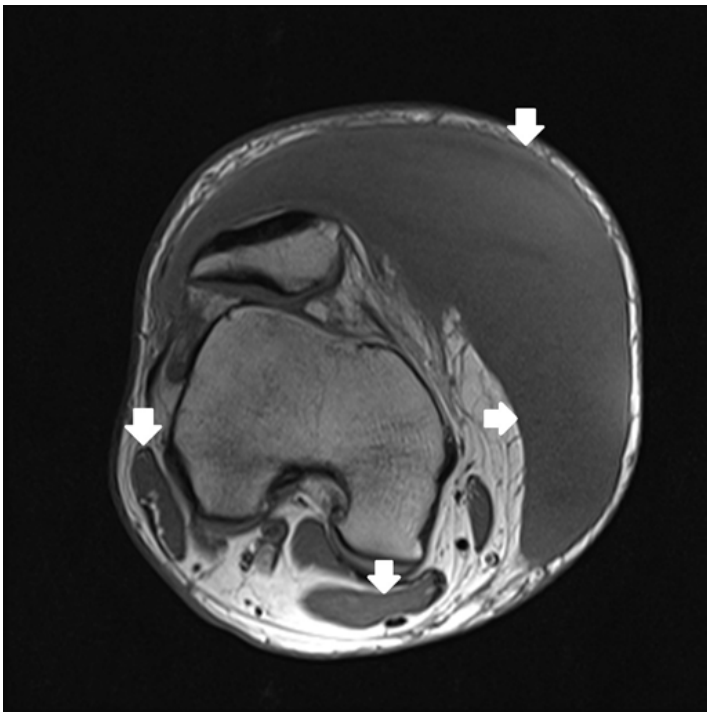

Figure 2b. Axial T1-weighted magnetic resonance imaging shows the lesion is isointense to muscle.

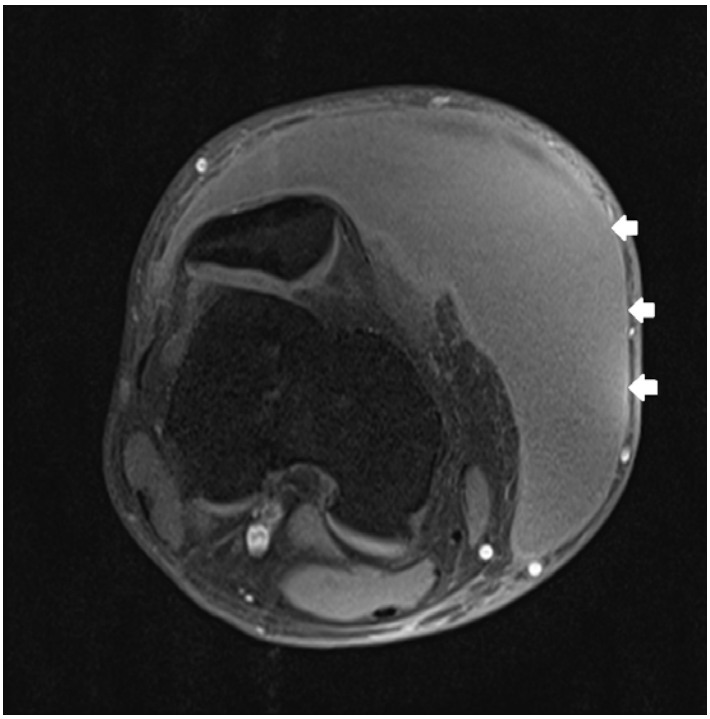

Figure 2c. Axial T-1 weighted magnetic resonance imaging with fat saturation shows a capsule of variable thickness (white arrows).

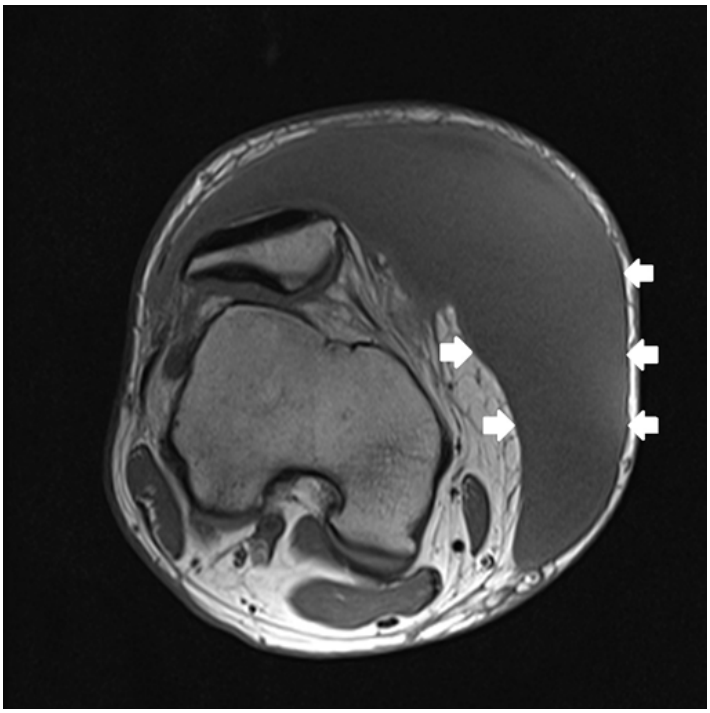

Figure 2d. Axial T1-weighted magnetic resonance imaging shows enhancement of the capsule.

medial thigh/knee were found. Jones et al. presented a large MLL in a 70-year-old women who had been hit by a car. Her lesion measured 30 x 15cm, but the article did not describe a fluid volume.[9] The other case is of a 26-year- old male who fell on his anteromedial knee during a soccer match. The case simply describes a medial thigh/knee MLL as massive, but does not make comment of measurements.[10] Most of the lesions caused by trauma to the knee are significantly smaller than the one described on our case. A 2007 study evaluated 27 cases of MLLs of the knee in the National Football Leauge. The largest suprapatellar and midthigh lesions in this study were up to 300mL in size. The mean amount of fluid that could be aspirated from an area of fluctuance in the knee or thigh was only 46mL with a range of 12-120mL.[11]

The second reason this case is clinically significant is that it demonstrates the importance of early identification and proper treatment of MLLs, which are very often not diagnosed initially.[4] Our patient's lesion was first thought to be a quadriceps contusion. Complications including recurrence, infection, and chronic pain arise when MLLs are not treated in the acute or subacute window. Although there was evidence present in the history, physical exam, and ultrasound to indicate a MLL, due to its rarity the diagnosis was not made at first. The history detailed a traumatic sheer injury to the soft tissue of the knee. The exam demonstrated diffuse ecchymosis and the hallmark finding of MLLs, a palpable, soft, fluctuant mass over the medial thigh and knee.[10,11] On ultrasound exam the fluid collection was compressible, anechoic and located subcutaneously. In a retrospective study of 21 MLLs of the hip and thigh all demonstrated hypoechoic or anechoic echogencity, were compressible and were located in between the deep subcutaneous fat and the fascia.[5]

Once a fluid collection has been identified as a MLL, research demonstrates that timely intervention via drainage with or without debridement is essential to avoid potential complications. In a 2013 retrospective study of 87 MLLs Nickerson et al. demonstrated that lesions with volumes exceeding 50mL on aspiration were especially prone to reoccur, even after percutaneous aspiration. Specifically, 83% of lesions that drained more than 50ml recurred. This study recommends that lesions with >50ml aspirated require operative drainage via incision and insertion of suction drain.[2] In a different study of 19 patients with MLLs the authors used operative percutaneous drainage, irrigation and debridement with drain placement to treat large lesions averaging 30x12cm. The study demonstrated prevention of recurrence in all patients treated, and recommended treatment within 3 days if possible.[12] A similar study used operative percutaneous drainage, debridement, catheter placement and suction of MLL's at a mean time of 11.9 days from time of injury to intervention. This method was also successful in preventing lesion recurrence in all patients.[13] Through earlier diagnosis and following the recommendations to operatively drain with or without debridement we propose that our patient may have avoided lesion recurrence and would have healed faster. Although MLLs are admittedly a rare diagnosis, a persistent subcutaneous fluid collection in the setting of trauma should raise clinical suspicion of an underlying MLL.

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Rapid Diagnosis of Nonconvulsive Status Epilepticus Using Reduced-Lead Electroencephalography

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Introduction: Electroencephalography (EEG) is indicated for diagnosing nonconvulsive status epilepticus (NCSE) in a patient who has altered level of consciousness after a motor seizure. A study in a neonatal population found 94% sensitivity and 78% specificity for detection of seizure using a single-lead device. This study aims to show that a reduced montage EEG would detect 90% of seizures detected on standard EEG.

Methods: A portable Brainmaster EEG device was available in the emergency department (ED) at all times. Patients presenting to the ED with altered mental status and known history of seizure or a witnessed seizure having a standard EEG were eligible for this study. The emergency physician obtained informed consent from the legally authorized representative (LAR), while an ED technician attached the electrodes to the patient, and a research associate attached the electrodes to the wiring routing to the portable EEG module. A board-certified epileptologist interpreted the tracings via the Internet. Simultaneously, the emergency physician ordered a standard 23-lead EEG, which would be interpreted by the neurologist on call to read EEGs. We compared the epileptologist's interpretation of the reduced montage EEG to the results of the 23-lead EEG, which was considered the gold standard for detecting seizures.

Results: Twelve of 12 patients or 100% had the same findings on reduced-montage EEG as standard EEG. One of 12 patients or 8% had nonconvulsive seizure activity.

Conclusion: The results are consistent with prior studies which have shown that 8-48% of patients who have had a motor seizure continue to have nonconvulsive seizure activity on EEG. This study suggests that a bedside reduced-montage EEG can be used to make the diagnosis of NCSE in the ED. Further study will be conducted to see if this technology can be applied to the inpatient neurological intensive care unit setting. [West J Emerg Med. 2015;16(3):442–446.]

INTRODUCTION

Patients having a seizure compose one million of all emergency department (ED) visits in the U.S.[1] Approximately 6% of these seizures are prolonged or recurrent without a return to baseline and are designated as status epilepticus (SE), as defined by 30 minutes of continuous seizure activity or a series of seizures without return to full consciousness between the seizures.[2-4] Further, 8-48% of these patients with SE will have nonconvulsive status epilepticus (NCSE) diagnosed by electroencephalography (EEG).[5,6] The mortality of NCSE can exceed 30% if the seizure lasts more than one hour.[7]

Approximately 2% of EDs in the U.S. have EEG technicians available to obtain tracings and neurophysiologists to interpret EEG 24 hours a day seven days a week, and studies have shown that it takes three hours on average to

obtain and interpret an EEG in the ED.[8,9] Because permanent brain damage may occur after only 30 minutes in NCSE it would be ideal to have a quicker means of determining if patients are in NCSE at ED presentation. Earlier recognition of NCSE may save lives and costs by diagnosing a previously unrecognized cause of a patient's altered mental status (AMS) and/or by avoiding overtreatment of presumed seizures.

Standard EEG in the U.S. requires active electrodes and a specially-trained EEG technician to obtain tracings. Therefore, there have been several attempts to conduct bedside EEGs with passive electrodes to decrease the time interval of arrival to interpretation by a general healthcare technician in the ED. One study researched the use of a helmet with EEG electrodes, but this approach was cumbersome.[10] BrainScopes, a company dedicated to EEG applied research, sponsored a study evaluating a device that supplied a red light/green light function to indicate based on a quantified electronic algorithm if a patient was exhibiting seizure activity. The removal of the human interpreter led to results doubted by neurophysiologists. While relying on algorithmic interpretations may be helpful in situations with untrained care takers, in the ED there are trained personnel able to interpret more complex diagnostic outputs that could prevent missed diagnoses and inappropriate overcalls. Therefore, there is still a need for the development of rapid bedside testing of patients with AMS for possible NCSE.

The objective of the study was to determine if it is possible to use a passive electrode reduced-lead EEG in the ED to determine if patients with AMS are experiencing nonconvulsive status epilepticus at ED presentation. The proposed model employed six leads, two frontal, two temporal, a ground, and a reference, designed to capture the areas where 80% of seizures originate.

METHODS

This study was a convenience sample of adult patients presenting to the ED with AMS. These patients were screened for eligibility in the study when research associates or the study PI were available. We included patients with a history of seizures or witnessed seizures, having a standard EEG ordered as part of their care in the ED for evaluation of persistent altered level of consciousness (ALOC) and who had a family member available to give pre-consent. Patients under the age of 18 were excluded, as well as patients who had no known history of seizures or witnessed seizures or persistent ALOC. A portable Brainmaster EEG device was available in the ED at all times for recording of the reduced-lead EEG. Immediately following pre-consent the research associate prepared the Brainmaster EEG and notified the ED technician to apply the electrodes. The electrode placement is shown in Figure 1. The Brainmaster EEG system provided the capabilities for a neurophysiologist to gain real-time remote Internet access to view and interpret the reduced-montage EEG tracings. Time was recorded from the completion of study consent to start of the Brainmaster EEG recording and then interpretation of the study neurophysiologist. Simultaneously, the emergency physician ordered a standard 23-lead EEG, which would be interpreted by the neurologist on call. We compared the neurophysiologist's interpretation of the reduced-montage EEG to the results of the 23-lead EEG, which was considered the gold standard for detecting seizures. Patients were post-consented following obtaining baseline mental status. We excluded any patients not willing to consent to the study at that time, and their data was not used. Following their ED visits, we reviewed patients'medical records to determine the results of the clinical 23-lead EEG. This study was reviewed and approved by the SUNY-Upstate Medical University Institutional Review Board.

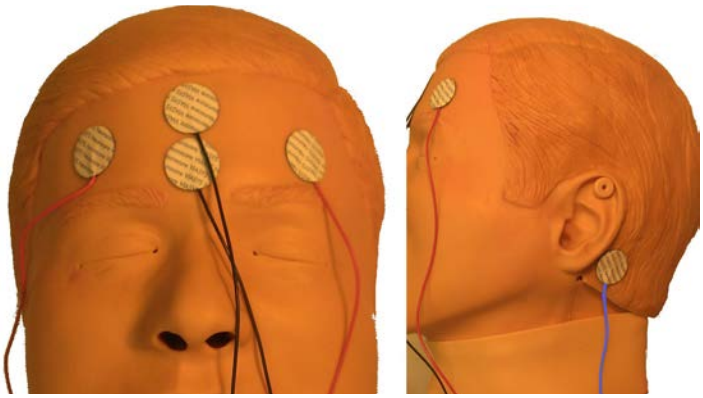

Figure 1. Electrode placement.

RESULTS

We enrolled 12 patients from February 10, 2010–July 19, 2011. The study patients were 50% male with a median age of 51.5 years (range 25–81 years). The time from study consent (surrogate for ordering an EEG) to beginning of the study EEG recording was a median of 10 minutes (range 5–40 min) (n=11) and median of 38 min (range 10–135 min) (n=8) until neurophysiologist interpretation. For all 12 patients, or 100% of the time, the research neurophysiologist's interpretation of the reduced-lead EEG and the clinical neurophysiologist interpretation of the standard EEG were the same for whether or not the patient was in NCSE. The demographics for the 12 included patients are shown in the Table. Only one of 12 patients or 8% was determined to have nonconvulsive seizure activity. The resulting tracings from the Brainmaster reduced-lead EEG for a patient determined to be in NCSE is shown in Figure 2.

DISCUSSION

The current approach to diagnosing NCSE in the ED setting is to obtain a standard EEG, which has been shown to take three hours on average nationwide. As permanent brain

Table. Demographics, medications, and comorbidities of study patients.

Age	Sex	Current medications	Comorbidities
80	F	Levetiracetam, levothyroxine,lisinopril, alendronate, aspirin, celecoxib, ranitidine	Seizure disorder, hypothyroidism, hypertension, transient ischemic attack, gastroesophageal reflux disease, migraine
44	F	Cyclobenzaprine	None
48	M	Aspirin, hydrocodone, duloxetine, propranolol, escitalopram, clonazepam, oxycodone, gabapentin	Bipolar disorder, depression, transient ischemic attack, posttraumatic stress disorder, nephrolithiasis
54	M	None	Anxiety, depression, opioid addiction, hypertension, alcohol dependence
49	M	Clonazepam, duloxetine, fentanyl, hydrochlorothiazide, lamotrigine	Hyperammonemia, depression, anxiety, bipolar disorder
62*	F	Levetiracetam, oxcarbazepine, phenytoin, glargine, atenolol, albuterol, Ipatropium bromide and albuterol, venlafaxine, pantoprazole	Encephalitis, chronic obstructive pulmonary disease, lymphoma, hypertension , type 2 diabetes mellitus
55	M	Allopurinol, aspirin, divalproex sodium, lisinopril, metoprolol, risperidone	None
81	F	Not documented	Not documented
33	M	Docusate, phenytoin, simvastatin, hydroxyzine, ezetimide, sertraline, olanzapine	Stroke
26	M	Carbamazepine, methotrexate	None
60	F	Ciprofloxacin, rasuvostatin, l-methylfolate, sumatriptan, clonazepam, levothyroxine	Depression, asthma, Hashimoto's thyroiditis, migraines, restless leg syndrome, hydronephrosis
25	F	None	None

*Patient with nonconvulsive status epilepticus.

damage in incompletely or inadequately diagnosed patients may occur after 30 minutes of uncontrolled seizures, it is imperative to develop modalities to bridge this gap. Bleck states that EEG is crucial in the diagnosis and classification of potential seizures in his review of continuous EEG monitoring in the ICU.[11] It is time for this technology to come to the ED.

The best justification for the use of reduced-lead EEG is found in a study of the neonatal population. While newborns have very different EEG tracings, they have fairly similar obstacles to obtaining and interpreting standard EEG as adult patients in an ED. Shellhaas and Clancy detected 94% of seizures with a single-lead EEG compared to the standard 10-lead neonatal EEG.[12] This study established the baseline expectation for our study. While this study represents only a small sample, our results were consistent with prior studies, which have shown that 8-48% of patients who have had a motor seizure continue to have nonconvulsive seizure activity on EEG.

Ultimately, emergency physicians could perhaps interpret the screening bedside reduced-lead EEG themselves to make clinical decisions in real time. We conducted a study on emergency medicine residents in our simulation lab to assess their comfort level with interpreting EEG in the case of a patient with NCSE. They averaged about a 2 on a scale of 1 to 5, with 5 being very comfortable with a past experience average of about one day during medical school. If we were to expand training, as we have with electrocardiogram interpretation, comfort levels and reliability would theoretically improve.

In the meantime, however, an epileptologist (a neurologist with fellowship training in epilepsy) is the most appropriate physician to interpret EEG tracings from either a standard 23-lead EEG or our reduced-lead EEG device. Several studies have looked into the use of standard EEG in the ED for evaluation of seizure, but none discuss the use of reduced-lead EEG. Three studies investigated the use of reduced-lead EEG in the ICU. Two of them reported on the sensitivity and specificity as compared to standard EEG. One found 68% sensitivity and 98% specificity for seizure detection using a four-channel device.[13] Another found 54% sensitivity and 100% specificity.[14] Another study showed that neurophysiologists had 70% sensitivity and 96% specificity for seizure detection when interpreting archived EEGs presented to them with reduced-lead montages.[15]

Although our study did not explicitly study the cost effectiveness of reduced lead EEG, we ought to acknowledge that the reduced-lead EEG device used in our study cost $2,500. The standard EEG device cost approximately 20 times that amount.

Our pilot study suggests that reduced-lead EEG may be quicker than standard EEG and may be sufficiently sensitive and specific to diagnose NCSE. While not intended to be as comprehensive as standard EEG, reduced-lead EEG may be useful as a screening tool in the acute care setting such as the ED. Even in a resource-poor facility, Internet access to these tracings may open the potential for neurology

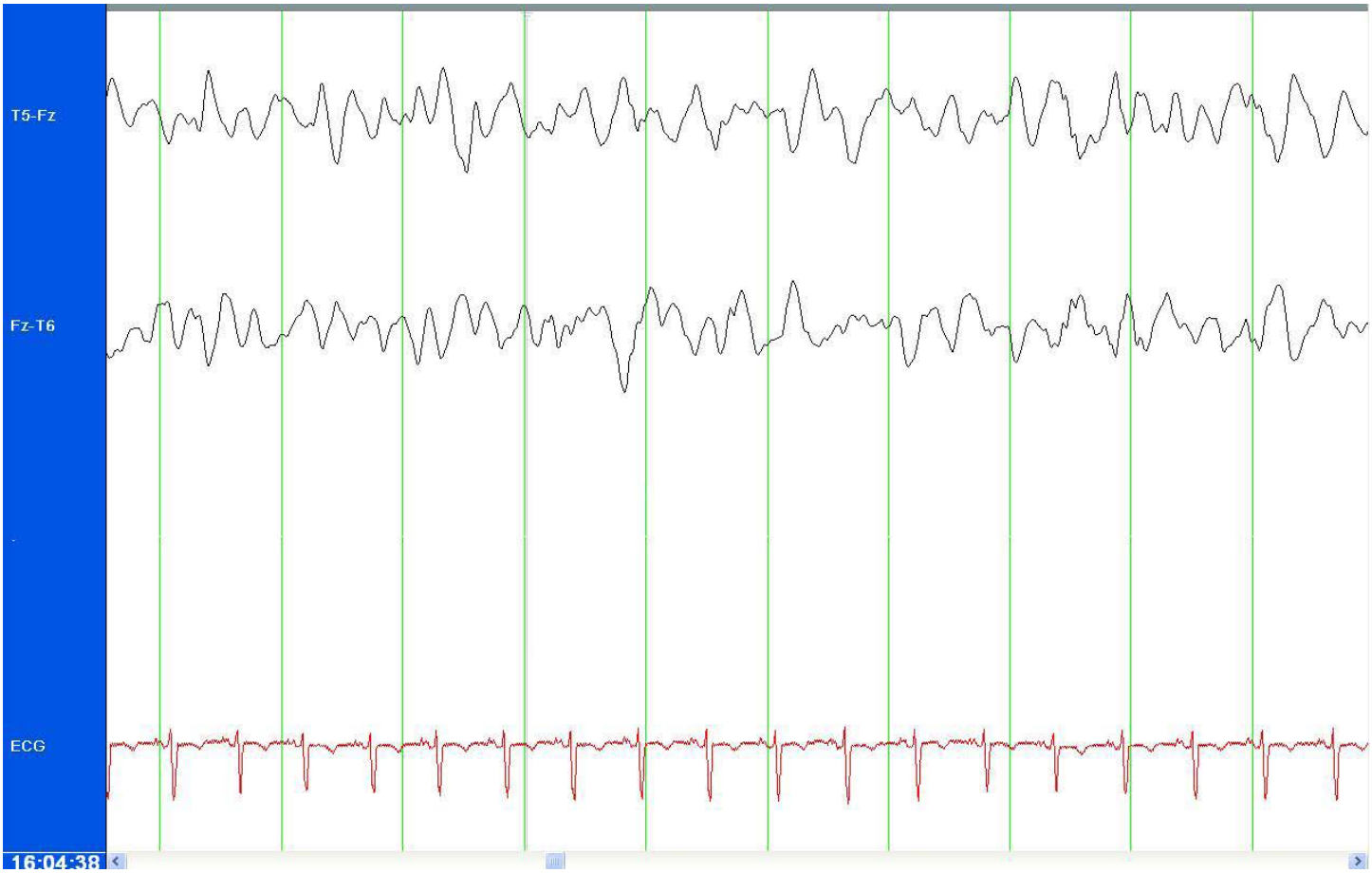

Figure 2. Tracings from Brainmaster reduced-lead electroencephalogram showing periodic lateralized epileptiform discharges.

telemedicine coverage to improve patient care.

LIMITATIONS

This study is limited by the size of the sample of patients. It had been intended to recruit 120 subjects to reach statistical significance of feasibility based on the prior neonatal study. It was difficult to enroll patients because standard EEG is performed infrequently in the ED. When EEG was ordered, it was often by the neurologists, who did not necessarily communicate this with the emergency physicians or research associates.

Real-time Internet access to the tracings was not always obtained, therefore not providing an assessable time frame for off-site neurophysiologist interpretation in some cases. Also, the variation from an n of 12 to an n of 8 was due to research associates' failure to capture time data. Standard EEG time date was not captured at the time of the study, and unfortunately because of a vendor change for the standard EEG data, this is not available retrospectively either.

The study equipment used required access to a wired Internet port and IP addresses, which proved more difficult to find throughout the ED than anticipated. For future studies if immediate Internet access and interpretation were necessary, a wireless Internet connection would be necessary.

CONCLUSION

This study suggests that the use of a bedside reduced-montage EEG as a screening tool may be feasible in the ED to make the diagnosis of nonconvulsive status epilepticus in patients with AMS on arrival.

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Bleb Point: Mimicker of Pneumothorax in Bullous Lung Disease

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In patients presenting with severe dyspnea, several diagnostic challenges arise in distinguishing the diagnosis of pneumothorax versus several other pulmonary etiologies like bullous lung disease, pneumonia, interstitial lung disease, and acute respiratory distress syndrome. Distinguishing between large pulmonary bullae and pneumothorax is of the utmost importance, as the acute management is very different. While multiple imaging modalities are available, plain radiographs may be inadequate to make the diagnosis and other advanced imaging may be difficult to obtain. Ultrasound has a very high specificity for pneumothorax. We present a case where a large pulmonary bleb mimics the lung point and therefore inaccurately suggests pneumothorax. [West J Emerg Med. 2015;16(3):447–449.]

INTRODUCTION

Bullous lung disease is a spectrum of disease with multiple causes, most commonly smoking.[1] These giant bullae develop and can progress to occupy much of the hemithorax and compress surrounding normal lung parenchyma.[2-4] A pneumothorax is a collection of air in the pleural space with subsequent lung collapse. Plain films will classically demonstrate a white linear density (pleura) outlining a distinct area of black pleural space where lung markings are absent.[5] Because of these similarities, it can be difficult to differentiate bullae from pneumothoraces.

Lung ultrasound is based on the interpretation of several artifacts. The first important sign to be checked is lung sliding. It is horizontal movement of the pleural line during active and passive inspiration. The two pleural layers are not distinct sonographically, thus the sliding is an indirect sign indicating the presence of the visceral pleura adhering to the parietal pleura. Lung sliding can be represented on M-Mode by a granular pattern below the pleural line, often described as "sea shore sign" or "sand on a beach." Presence of lung sliding rules out pneumothorax with 100% specificity.[6]

Absence of lung sliding can be a result of pneumothorax, massive atelectasis, main-stem intubation, pulmonary contusion, acute respiratory distress syndrome, and pleural adhesions.[6] Since absence of lung sliding alone may not be enough to diagnose pneumothorax, confirmation can be achieved by gradually moving the probe inferiorly on the chest wall, targeted at the detection of a point on the chest wall where a respiratory pattern (i.e., lung sliding) is visualized again and intermittently replaces the motionless pleura. This point is named the "lung point" and has been described as having 100% specificity for detection of pneumothorax.[7]

We present a case report of a patient with severe bullous lung disease in respiratory distress and sonographic findings suggestive of pneumothorax.

CASE REPORT

A 33-year-old male with severe chronic obstructive pulmonary disease and unexplained extensive bilateral bullous emphysema presented to the emergency department with a chief complaint of dyspnea. The patient was in moderate respiratory distress with vital signs upon presentation: blood pressure 130/84mmHg, pulse 99, respiratory rate 32, pulse oximetry 94% on 4L nasal cannula, temperature 37°C. That morning he developed markedly worsening dyspnea, despite supplemental home oxygen therapy. He also reported subjective fevers and cough. Physical exam demonstrated respiratory distress, with coarse upper breath sounds and diminished breath sounds at the bases bilaterally. He was placed on high-flow nasal cannula due to worsening respiratory distress. Portable chest

radiograph demonstrated large bullous emphysema on the right lung with complete obliteration of normal lung and possible pneumothorax. The patient was unable to lie flat for computed tomography (CT), so bedside ultrasound (Figure 1 and Video) was subsequently performed using a high frequency linear transducer, demonstrating normal lung sliding at the left apex. No lung sliding was noted at the right apex and lung point was also noted. Differential diagnoses included pneumothorax, worsening bullous emphysema, and pneumonia.

The patient rapidly improved with oxygen, nebulized albuterol and ipratropium, intravenous methylprednisolone, and antibiotics, so tube thoracostomy was held. He became stable enough for CT (Figure 2), which demonstrated complete collapse of the right lung secondary to extensive progressive bullous emphysema with extensive bilateral bullae and bronchiectasis. There were air-fluid levels at the right lung base concerning for superinfection vs. secretions. No pneumothorax was appreciated. The patient was admitted to the respiratory stepdown unit, where steroids and antibiotics were continued, and the patient was subsequently transferred to a specialty tertiary hospital for lung transplant.

DISCUSSION

Distinguishing pneumothorax from bullous emphysema is a difficult but important distinction in management of the severely dyspneic patient. Patients with bullous emphysema, especially large bullae are at higher risk for pneumothorax.[5] Thus, risk factors and often clinical exam are less than helpful. Frequently chest radiograph is unable to differentiate bullous emphysema from pneumothorax, but chest CT, the gold standard, is often difficult for patients to tolerate. A physician may also feel that the patient is not stable enough to go to radiology for a CT. This creates a dilemma as to what diagnostic test will aid in the accurate assessment of these acutely ill patients.

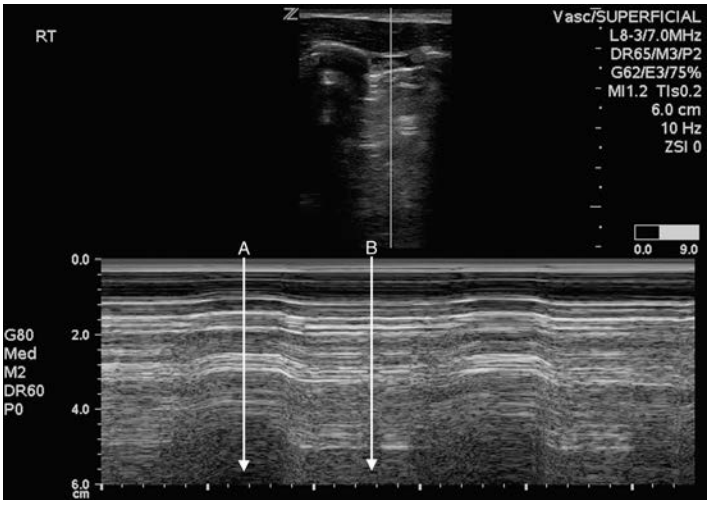

Figure 1. M-mode ultrasound of the right lung, demonstrating bleb point.
A. No lung sliding (barcode sign).
B. Lung sliding (seashore sign).

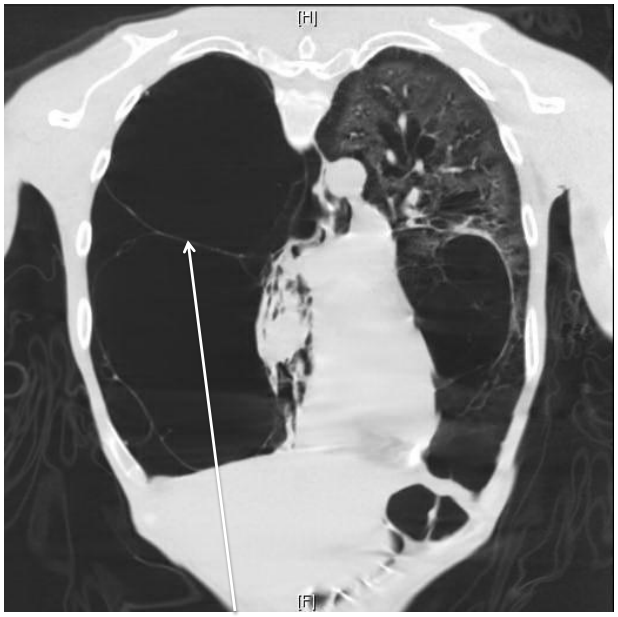

Figure 2. Coronal chest computed tomography demonstrating extensive bullous lung disease and no pneumothorax (arrow).

Lung ultrasound has been proven to be valuable in assessing pneumothorax in the unstable patient, especially compared to portable chest radiograph.[8,9] While there has been some argument about the sonographic appearance of bullous emphysema, anecdotal reports and case series have determined that ultrasound is still able to differentiate bullous emphysema from pneumothoraces.[10,11] Presence of lung sliding effectively rules out pneumothorax despite concomitant lung disease while presence of a lung point was previously thought to effectively rule in pneumothorax.

However, none of those cases involved discovery of a bleb mimicking a lung point, or "bleb point." We postulate that because of the severity of bullous emphysema that the amount of healthy lung tissue was minimal and that the visceral pleura was so thin at the junction of parietal pleura that M-Mode ultrasound was unable to detect any sliding. Further study is required to examine the utility of these findings in larger populations.

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Video**.** Ultrasound demonstrating normal lung sliding in right apex and bleb point.

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Diagnosis of a Strangulated Laparoscopic Incisional Hernia with Point-of-Care Ultrasonography

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The use of point-of-care ultrasound for the diagnosis of bowel obstructions and hernias is becoming increasingly common in the emergency department (ED). Using a relatively rare case of an incisional port hernia, we demonstrate the ultrasound findings of a strangulated hernia causing a partial small bowel obstruction. A 46-year-old female presented four days following a laparoscopic surgery complaining of abdominal pain, nausea and lack of bowel movements. There was a palpable mass in the left lower quadrant under the 12mm trocar port incision. ED point-of-care ultrasound revealed herniated akinetic loops of bowel through her laparoscopy incision. This is the first case report to describe the use of point-of-care ultrasound for the diagnosis of a strangulated incisional port hernia at the bedside. [West J Emerg Med. 2015;16(3):450–452.]

INTRODUCTION

Incisional hernias are a well described surgical complication and a common emergency department (ED) presentation. Despite the predominance of laparoscopic surgery, port hernias remain a rare complication with an incidence as low as 0.14% to 6%.[1,2] They are most commonly associated with trocars with a diameter greater than 10 mm.[1,2] Any hernia, including a port hernia, may become incarcerated or strangulated, resulting in bowel necrosis and small bowel obstruction (SBO) and necessitating urgent surgical intervention.

The role of point-of-care ultrasonography (POCUS) in the ED management of abdominal pain, including hernias and small bowel obstruction is growing. Multiple studies have demonstrated sensitivities of 93.9-97.7% and specificities of 81.4 -92.7% for the diagnosis of SBO using POCUS in the ED setting.[3-5] There are also several case reports in the literature describing the examination of an abdominal hernia with POCUS, including describing ultrasound-guided ED hernia reduction.[6-8] However, we could find no published reports on the use of POCUS for diagnosing strangulated hernias. Here we describe the findings of POCUS in this case of a rare strangulated incisional port hernia and its potential application for the ED diagnosis of all strangulated abdominal hernias.

CASE REPORT

A 46-year-old woman presented to the ED with left lower quadrant pain associated with nausea and anorexia worsening over the last 48 hours. The pain was constant and progressive and worsened with movement. Four days earlier the patient had undergone a laparoscopic Burch colposuspension for stress incontinence and pelvic organ prolapse. The surgical notes were unremarkable and her post-operative course was uncomplicated. She was discharged home on post-operative day one.

On arrival, she was tachycardic at 110 beats per minute and normotensive at 117/75. She was afebrile, had a normal respiratory rate, but was quite pale and had considerable difficulty transferring from the chair to the examination table. Her abdomen was generally soft, but a firm, focally tender mass was noted in the left lower quadrant. It was unclear based on the physical examination whether this mass was a seroma, hematoma, or hernia. The patient reported she was passing gas but not stool.

On bedside ultrasonography by the emergency physician, dilated fluid-filled loops of bowel were visible in the mass, herniating through a 12mm port site directly under the skin (Figure and Video). Free fluid was noted between the loops of bowel within the hernia sac. The bowel within the mass

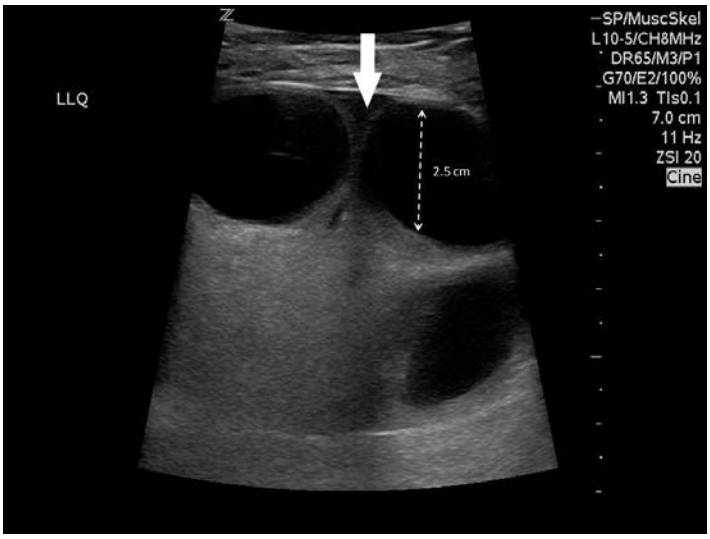

Figure. Dilated fluid-filled loops of bowel visible within a herniating mass. Fluid is seen between bowel loops (arrow).

was entirely akinetic; however, flow could be identified using colour Doppler.

Based on these results, the general surgery team was called and the decision was made to take the patient to the operating room. An interval computed tomography (CT) confirmed a small bowel obstruction due to a laparoscopic port hernia with signs of early ischemic changes secondary to strangulation of small bowel. The patient underwent an urgent laparotomy that identified purple, yet still viable, strangulated small bowel loop without full thickness necrosis. The bowel was reduced and no bowel resection was necessary.

DISCUSSION

Laparoscopic port incisional hernias are uncommon, and can be difficult to distinguish from benign fluid collections such as post-operative hematomas or seromas. While most hernias are easily palpable on exam, some cases of Spigelian hernias may not be palpable and ultrasonography has been an established tool in their diagnosis.[8] In this case, POCUS allowed us to quickly differentiate between a benign postoperative fluid collection and a strangulated hernia.

To examine for a hernia using POCUS, a high-frequency linear transducer is placed over the region of swelling or pain. For evaluation of deeper hernias, a low-frequency curvilinear transducer should be used. The region should be evaluated systematically in two orthogonal planes. On ultrasound, hernias appear as loops of bowel trapped within an echogenic sac protruding through a defect in the abdominal wall.

POCUS can be used to examine for signs of bowel obstruction and strangulation within the hernia sac. A study comparing abdominal radiographs to POCUS for bowel obstruction found that abdominal radiographs had a sensitivity of 46.2% and a specificity of 66.7% when diagnostic, but were non-diagnostic 36% of the time. POCUS on the other hand was found to be 91% sensitive and 84% specific, with no non-diagnostic scans.[3] Using POCUS, small bowel obstruction should be suspected when there are dilated fluid-filled loops of bowel (>25mm), to-and-fro movement of bowel contents, and free fluid between the loops of bowel. The main findings of strangulation on POCUS include an edematous bowel wall (wall thickness >3mm) with echogenic fat, loss of peristalsis and fluid within the hernia sac.[9] Late presenting strangulation can have reduced or absent colour flow on colour Doppler and may require bowel resection.[9-11] It is important to note that since absent colour Doppler flow is a late finding of bowel strangulation, Doppler ultrasound is not a sensitive modality for the diagnosis of bowel strangulation. As venous and lymphatic vessel walls are thin, they are readily compressible, resulting in a loss of venous flow significantly earlier than loss of arterial flow.[10] Detecting venous flow on ultrasound is difficult and is rarely attempted at the bedside.

CONCLUSION

Point-of-care ultrasound has been shown to be an effective tool for the diagnosis of bowel obstruction and hernias. In this case, timely access to emergency POCUS allowed us to quickly identify a strangulated incisional port hernia. Presence of Doppler flow does not rule out strangulation, while absence of Doppler flow is a late finding. Further studies are needed to evaluate the accuracy of POCUS findings for strangulated hernias.

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Video. A narrated recording of a POCUS scan of a strangulated incisional hernia. Note the dilated akinetic loops of bowel, free fluid between the bowel loops and edematous bowel wall.

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Rapid Extrication versus the Kendrick Extrication Device (KED): Comparison of Techniques Used After Motor Vehicle Collisions

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Introduction: The goal of this study was to compare application of the Kendrick Extrication Device (KED) versus rapid extrication (RE) by emergency medical service personnel. Our primary endpoints were movement of head, time to extrication and patient comfort by a visual analogue scale.

Methods: We used 23 subjects in two scenarios for this study. The emergency medical services (EMS) providers were composed of one basic emergency medical technician (EMT), one advanced EMT. Each subject underwent two scenarios, one using RE and the other using extrication involving a commercial KED.

Results: Time was significantly shorter using rapid extraction for all patients. Angles of head turning were all significantly larger when using RE. Weight marginally modified the effect of KED versus RE on the "angle to right after patient moved to backboard (p= 0.029) and on subjective movement on patient questionnaire (p=0.011). No statistical differences were noted on patient discomfort or pain.

Conclusion: This is a small experiment that showed decreased patient neck movement using a KED versus RE but resulted in increased patient movement in obese patients. Further studies are needed to determine if the KED improves any meaningful patient outcomes in the era of increased evidence-based medicine in emergency medical services. [West J Emerg Med. 2015;16(3):453–458.]

INTRODUCTION

A common complaint after traumatic injuries is neck or back pain.[1] The primary concern of the pre-hospital provider in handling and transporting a patient with a potential spinal cord injury is prevention of further neurologic injury. This concern is legitimate as spinal cord injuries have the potential to occur after transit or during early management at the scene.[2]

It is estimated that 3% to 25% of spinal cord injuries occur after the initial traumatic insult, either during transit or early in the course of management.[3-8] As many as 20% of spinal column injuries involve multiple non-continuous vertebral levels; therefore, the entire spinal cord is potentially at risk.[9-11]

Two common methods of immobilization in the pre-hospital setting include the Kendrick Extrication Device (KED) and rapid extrication (RE). The Kendrick Extrication Device (shown in Figure 1 with a yellow arrow) is used in the pre-hospital environment to stabilize patients complaining of neck or back pain after car collisions. The KED is a low-flexibility device that is secured to the patient's torso, legs and head to prevent movement. It consists of three straps across the torso, an additional strap for the groin, and another strap that rides over the forehead. The back of the device is composed of several long blocks of hard, inflexible material with cloth in between to allow for flexibility related to the patient's back.

RE is a method of moving a patient from the sitting to a supine position through a series of coordinated movements. Rapid extrication is indicated when the scene is unsafe, a patient is unstable, or a critical patient is blocked by another less critical patient. The standard longboard or backboard (shown in Figure 1, the large yellow device) is a device approximately six or seven feet in length that is hard and inflexible. The patient is secured to it using three or more straps and with two large foam blocks adjacent to the head referred to as cervical immobilization devices. RE involves immobilizing the patient on a longboard without the application of the KED.

For both devices, a c-collar (shown in Figure 1 with a green arrow) is applied while in-line stabilization is held. After application of the collar in a motor vehicle, the patient is either secured to a KED and removed or removed and secured to a longboard. The KED is most often used in motor vehicle crashes (MVCs) and other trauma involving back injuries such as falls.

The application of the KED may require significant movement of the patient in order to apply the device, causing further pain and possible further aggravation of the potential back/spinal injury. Furthermore, it places both the crew and the patient at risk due to operating under dangerous on-scene conditions for prolonged periods of time, such as on a highway with high speed traffic or in severe weather conditions.[12,13] The FERNO KED manual states that, "The KED is designed for use by a minimum of two trained operators. Additional help may be preferred or needed."[14] This places an additional burden on the emergency medical services (EMS) crew to request additional trained personnel if necessary, which can be both time consuming and resource extensive.

There have been very few studies done on the KED. Graziano et al. determined, through radiographic imaging, that the KED was superior in reducing motion in all directions; however, that was compared to an older device no longer in use.[15] Howell et al. determined, through radiographic imaging, that the KED superiorly limited rotational motion of the cervical spine but was similar in other planes to other immobilization techniques.[16] Another study has found that the KED is an excellent device to use for the immobilization of pediatric patients, an off- label use.[17] These studies evaluated movement of the cervical spine after application of the device, but not during the application process.

The goal of this study was to compare movement of the head, time to extrication and patient comfort for application of the KED versus RE by pre-hospital healthcare workers.

METHODS

We used 23 subjects in 46 trials for this study. Subjects were included if they were over 21 and were able to give verbal consent to participate. We also excluded subjects if they were experiencing any pain prior to the beginning of the study.

Each rescue trial consisted of the participant and two EMS personnel. Both trials involved extricating the participant from a vehicle in a situation similar to a MVC by two EMS providers. The EMS providers were composed of one emergency medical technician (EMT), one paramedic. This was done to demonstrate consistency between each trial. All subjects underwent both scenarios.

Trial A involved a c-collar being applied, followed by the application of the KED, and extrication onto a longboard and ambulance stretcher. Trial B involved RE technique – a c-collarwas applied and the participant extricated on to a longboard without a KED applied. The only difference between trial A and B was the use of the KED prior to extrication from the vehicle. The trial was time of arrival of EMS providers until the time the participant was correctly positioned on the ambulance stretcher, as determined by the researchers. We did not include securing the patients to the backboard. This would increase the time required to finish each trial but would not provide any additional information.

The angle of cervical spine movement was measured using a protractor placed on the bridge of the nose and a pen used to denote the plane of reference (a sagittal line). Subjects were asked to turn their head to the right and the left as far as tolerable. Angle measurement of movements was made at the following points in the KED group: after the KED has been applied and after the patient has been correctly positioned on the backboard. For the backboard-only group, the measurement of movement was made after c-collar application and after they had been correctly positioned on the backboard. The angle of measurement is axial movement, which was defined as asking the patient to turn their head to the left or right. Lateral rotation, which was not measured, is defined as moving the head laterally while maintaining the eyes forward. All trial scenarios were done with the seat in a standardized position of 19.75 inches from the tip of the steering wheel, and 120 degrees of steering wheel angulation. Seat belts were not worn during the scenarios.

We developed surveys to assess many variables associated with this study. The surveys were distributed to the participants after they have been extricated from the car and placed onto the stretcher.

The participant surveys measured level of pain, level of discomfort, perceived amount of movement, and perception of amount of time taken to remove from car. These were asked at different stages: during application of KED or c-collar, and then extrication and positioning on the backboard (Figure 1). We measured these variables using a visual analog scale consisting of a 100mm horizontal line drawn with the two extremes of the variables at both ends. Participants were shown the line and the scale of 0–100 and asked to tell us what value they would like to ascribe to the specific question. This study was conducted in one of our EMS building garages using a 1995 Jeep Cherokee, which was fully functional and not damaged. Of the two person

crew used in this study, one was an EMT instructor with 20 years of experience working approximately 40-50 hours per week who also worked for Robert Wood Johnson EMS as a paramedic (Figure 2). The other study participant was a volunteer EMT from a local volunteer first aid squad who also had over 10 years of experience.

This study received institutional review board approval at our institution, which has a subcontract with our hospital.

We conducted statistical analysis using SAS 9.1 TS level 1M0, XP_PRO platform (SAS Institute Inc., Cary, NC, USA) and MINITAB 15 (MINITAB Inc., State College, PA, USA).

We calculated summary statistics, including means, standard deviations and percentiles for times of extraction and degree of head turning for both conditions, extraction using KED versus RE.

Paired t-tests were used to examine basic differences in time and degree of head turning between these two techniques. We ran regression models to examine whether age, sex, height or weight modified the effect of the type of extraction. These regression models included the difference in outcome between KED and RE as the response variable and age, sex, height or weight as covariates. We repeated these analyses to summarize information about pain, comfort level and amount of movement experienced during the techniques.

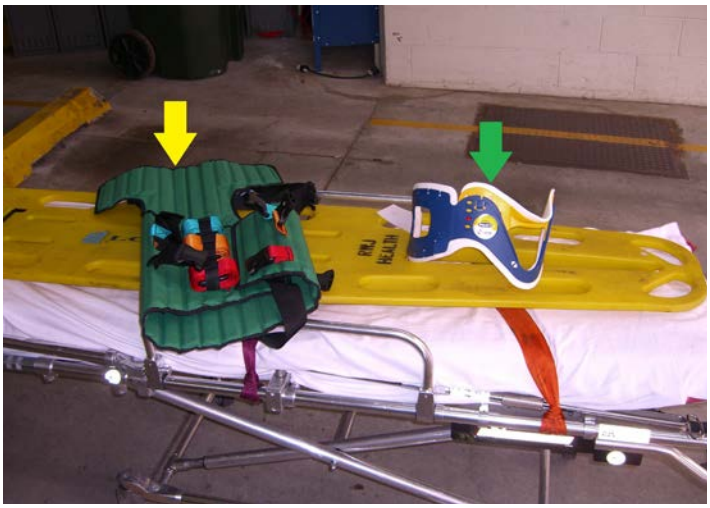

Figure 1. Application of Kendrick Extrication Device (yellow arrow) or cervical collar (green arrow).

Figure 2. Vehicle used for study.

RESULTS

Table 1 provides summary statistics of the outcome variables, as well as p-values for detecting differences between outcomes under the two techniques.

Time was significantly different (shorter) using RE. In fact, there was no overlap in the times required by KED and RE (minimum KED time was greater than the maximum RE time). However, the angles of head turning were all significantly larger when using RE.

Weight marginally modified the effect of KED versus RE on the "angle to left after patient moved to backboard" (Table 2). Weight also significantly modified the subjective question about movement as heavier patients were associated with increased movement. There was a slight trend for patients in the heaviest weight category to experience either almost as much movement or more movement using KED than RE.

DISCUSSION

Standards of care in the prehospital setting must be constantly reevaluated. Evidence-based care needs to be sought as many interventions in the pre-hospital environment have never been researched and have been based on anecdote.

The KED has been thought to improve spinal immobilization in patients complaining of traumatic induced neck or back pain. It has never been studied in live patients.

In our limited experiment, we found that extrication times are significantly shorter using RE versus KED. This is an important finding, as extrication of a patient from a vehicle is a time-consuming matter and may place the patient and the providers in danger due to environmental situations.

There was a notable difference in head turning with RE versus KED. This is not unexpected, as the KED does immobilize the head as securely as possible to the stretcher and backboard. Unexpectedly, a positive association with increasing weight and greater movement of the head to the left on RE versus KED was found in our study. This is likely due to the design of the devices, as neither device was designed for obese patients. There was no strong evidence for this finding due to a somewhat limited sample.

Subjects perceived a trend towards greater discomfort on the 100mm VAS with the KED versus RE. The heavier patient also perceived statistically significant more movement than less heavy patients on the KED. Both patients did perceive movement with the application of either device. The KED is supposed to be used on patients with neck and back pain after trauma. If the application of the device is causing greater movement of the patient, then the utility of this device should

Table 1. Summary statistics for outcome variables using the KED versus RE on 23 subjects, as well as p-value for detecting a difference based on a paired t-test.

Variable	Technique	Mean (SD)	Minimum	Median	Maximum	Paired t-test p-value
Time (minutes)	KED	6.63 (1.29)	5.13	6.35	9.43	<0.0001
	RE	0.74 (0.26)	0.25	0.43	1.25	-
Angle to right after c-collar (RE)/KED applied (degrees)	KED	16.9 (9.0)	2	15	35	0.0028
	RE	24.1 (9.1)	10	25	45	-
Angle to left after c-Collar (RE)/KED applied (degrees)	KED	15.6 (9.2)	2	15	40	0.033
	RE	20.3 (9.1)	7	20	45	-
Angle to right after patient moved to backboard	KED	20.6 (11.5)	3	20	45	0.0025
	RE	30.8 (13.0)	15	30	70	-
Angle to left after patient moved to backboard	KED	21.6 (12.7)	3	20	50	0.045
	RE	26.9 (13.8)	3.0	25.0	55.0	-
Pain	KED	4.1 (8.0)	0	0	25.0	0.82
	RE	3.6 (10.0)	0	0	40.0	-
Discomfort	KED	25.7 (25.5)	0	20.0	70.0	0.11
	RE	16.5 (21.7)	0	10.0	75.0	-
Movement	KED	19.9 (26.4)	0	10.0	100.0	0.041
	RE	32.3 (31.8)	0	20.0	95.0	-

KED, Kendrick Extrication Device; *RE*, rapid extrication

Table 2. P-values of regression analysis testing significant effects of age, weight, sex, and height as modifiers of the effect of using KED versus RE.

	Modifying effect of			
Variable	Age	Weight	Sex	Height
Time	0.74	0.67	0.97	0.72
Angle to right after c-collar (RE)/KED applied	0.77	0.39	0.75	0.71
Angle to left after c-collar (RE)/KED applied	0.26	0.26	0.44	0.96
Angle to right after patient moved to backboard	0.23	0.029	0.38	0.16
Angle to left after patient moved to backboard	0.079	0.16	0.63	0.26
Pain	0.90	0.40	0.41	0.71
Discomfort	0.63	0.92	0.17	0.47
Movement	0.11	0.011	0.36	0.56

KED, Kendrick extrication device; *RE*, rapid extrication

be called into question.

The KED can add considerable cost to an emergency medical service provider. FERNO charges $100 per device.[18] This can become a considerable financial burden for EMS divisions. Also, parts must be replaced when destroyed. Sometimes, hospitals will cut the straps off instead of

disconnecting the device properly. An EMS supplier website lists the replacement cost at $13.50 to replace all five straps.[18] The KED is listed as a critical supply according to ambulance standards checklist and therefore must be carried on every ambulance.[19] This can become a considerable financial burden for EMS agencies.

While this study provides limited data that the KED decreases ability of the patient to move their neck after application of the device, further studies are needed to determine if the device actually changes patient outcomes. In an era of increasing use of evidence-based care, all interventions that we commonly do based on anecdote need to be called into question. The National Association of EMS Physicians released a position paper last year on the use of longboards, as there is momentum to move away from longboards due to evidence that they can cause skin necrosis, worsen patient outcomes and have not been proven effective.[20]

LIMITATIONS

There are several important limitations in our study. This was a single institution study where two EMS providers participated in each trial. Various EMS providers could have greater ability to use the KED or RE subsequently producing different results.

It is possible that different vehicles and angles of measurement could produce various results. We only measured axial movement and did not attempt to measure flexion, extension or lateral rotation. Axial movement was defined as asking the patient to turn their head to the left or right. Lateral rotation, which was not measured, is defined as moving the head laterally while maintaining the eyes forward.. This provides only limited information about total movement of the head during extrication. It should be noted that this was a controlled scientific experiment which is significantly different to performing the skill in the field with its more unpredictable variables. This was a controlled setting inside a garage with no risk for adverse weather or for suffering personal injury from vehicles on the road, which are frequently encountered when rendering pre-hospital care. Furthermore the vehicle was not damaged, which is not representative of most vehicular extrications. We also elected not to measure movement of the thoracic spine during our study. Measuring movement of the thorax would have been difficult to do using our study method.

Also, an expanded number of participants would enable more data to be collected and more significant analyses of the variables in the study.

CONCLUSION

Based on our findings, we recommend that the utility of the KED needs to be further studied and compared to the rapid extrication technique. This study provides limited evidence for the use of the KED in patients who meet its indications that it can decrease their ability to laterally rotate their neck. It provokes concern with regard to using the device when prolonged scene time is a concern for provider or patient safety. KED's beneficial effects are still largely unproven. Finally, there are additional concerns regarding the possible increased risk of movement of the spine in obese patients.

Further research should be conducted to determine whether the KED has a positive effect on patient outcomes and has any role in patient care.

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Self-Reported Provider Safety in an Urban Emergency Medical System

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Introduction: Emergency Medical Service (EMS) personnel often respond to dangerous scenes and encounter hostile individuals without police support. No recent data describes the frequency of physical or verbal assaults or which providers have increased fear for their safety. This information may help to guide interventions to improve safety. Our objective was to describe self-reported abuse and perceptions of safety and to determine if there are differences between gender, shift, and years of experience in a busy two-tiered, third service urban EMS system.

Methods: This was a secondary analysis of an anonymous, cross-sectional work safety survey of EMS providers. This survey included demographics, years of experience, history of verbal and physical assault, safety behavior following an assault and perceptions of safety. Descriptive statistics were generated.

Results: Eighty-nine percent (196/ 221) of EMS providers completed the survey. Most were male (72%) and between the ages of 25 and 50 years (66%). The majority of providers had worked in this service for more than five years (54%), and many for more than ten years (37%). Verbal assaults were reported by 88% (172/196, 95% CI [82.4%-91.6%]). Although 80% (156/196, 95% CI [73.4%-84.6%]) reported physical assaults, only 40% (62/156, 95% CI [32.4%-47.6%]) sought medical care and 49% (76/156, 95% CI [41%-56.6%]) reported the assault to police. The proportion of those who sought medical care and reported the assault to the police was not the same across years of experience ($p<0.0001$). Fear for personal safety was reported by 68% (134/196, 95% CI [61.6%-74.5%]). There was no statistical difference in assault by gender; however, females feared more for their safety compared to men (38/50, 76% v 96/142, 68%, $p=0.02$). The proportion of those who have ever been physically assaulted was not the same across shift worked ($p=0.01$).

Conclusion: The majority of EMS providers surveyed reported an assault and certain groups had a higher rate of assault. Most assaults were not reported to the police and medical care was infrequently sought following an event. The majority of providers reported feeling fear for their personal safety. Further research into enhancing safety mechanisms is needed. [West J Emerg Med. 2015;16(3):459–464.]

INTRODUCTION

In recent years, work-place safety has come into the spotlight as an important topic that needs to be addressed, especially in healthcare.[1-4] While workplace violence permeates all fields of work, healthcare providers are at increased risk for violent events.[2-4] Emergency medical professionals may be particularly vulnerable to such violence. In an online survey among emergency medicine (EM) residents and physicians 78% of respondents reported at least one act of workplace violence in the previous 12 months and 21% reported more than one type of violent act.[5] While the most common type of violence was verbal threats (75%), physical assaults represented 21% of violent acts. Unlike other EM providers, much of an emergency medical services (EMS) provider's work occurs out of the hospital, in patients' homes, public spaces and on the streets. In the hospital, greater public safety measures have been established in many areas, including increased security officers, less after-hours access to facilities, improved surveillance, employee safety training, and in some hospitals even metal detectors at key entrances.[3,6] Additionally, methods which may be employed to subdue hostile or aggressive patients in the emergency department (ED) or inpatient hospital settings are essentially unavailable to paramedics and emergency medical technicians (EMTs). In the ED, patients may be physically restrained by multiple security officers if deemed necessary; however, EMS providers are often outnumbered by patients and bystanders on the scene. The need for police back-up may not be apparent during the initial call-taking leading to a delay in the arrival of these services. EMS providers may also be unable to chemically restrain patients with sedative agents, which physicians administer if necessary for patient or provider safety. The fact that hostile or out-of-control patients may have a significant underlying medical illness that is contributing to their behavior, such as hypoglycemia, metabolic disorders, infections, or head injuries also complicates the issue.

The public calls upon EMS providers to respond to a variety of emergency situations in many different environments. Although dispatchers attempt to supply the responders with an accurate account of the incident, information relayed by patients, families, and other parties is often insufficient or inaccurate. Attempts are made to dispatch law enforcement officers or other back-up services if appropriate, but often times the two ambulance providers may be the only emergency services at a scene.[7] In addition, emergency calls that do not initially appear to involve violence may escalate with patients, family members, or bystanders becoming aggressive or hostile. Other than training in management of aggressive behavior and scene safety, EMS providers may have few other tools to protect themselves or their patients.

Violence toward EMS providers was recognized in 1993 when Tintinalli published the results of a survey distributed to registrants of the National Association of EMS Physicians (NAEMSP) national conference.[8] That study demonstrated that while many prehospital providers reported injuries due to violent patients, few systems had protocols for managing violent patients or formal training for recognizing and responding to violent encounters.[8] Two years later 90% of EMS personnel in a fire-based system reported a history of violence directed toward them while at work, and abuse and violence was ranked as the top job stressor.[9] In 1998 Corbett and Grange published that 61% of EMS providers in a Southern California system reported assaults while at work, with 25% reporting injuries from the assault.[10] In the same system, Grange and Corbett reported violence aimed at prehospital care providers in 4.5% of patient encounters.[11] An urban fire-based EMS system reviewed all injuries reported over a two-year period in 2002 and found that only 4% were the result of assaults.[12] However, this study by design did not include physical assaults that did not result in injuries or were not formally reported or any verbal assaults.

Studies of international ambulance services reveal similar results. A survey of prehospital providers in Paris, France, found that 88% of respondents had been victims of a verbal threat and 41% a physical threat, yet only 9% reported formal training in managing violence.[13] Eighty-three percent of Swedish paramedics surveyed responded that they were threatened or subject to violence, and 67% stated that they were subject to physical violence.[14] A recent survey performed in Australia reports 87.5% of paramedics responding had experienced at least one form of violence associated with the work place in the past year.[15]

With the known risks involved in providing prehospital emergency care, changes such as improved training in personal safety and management of aggressive behavior, as well as systems for reporting violence and abuse, may have improved EMTs' and paramedics' perceptions of safety and exposure to violence in the U.S. This study attempts to quantify self-reported abuse among paramedics and EMTs in an urban EMS system, safety behaviors following assaults, and perceptions of safety among EMS providers. It also describes differences in reports of abuse and perceptions of safety among different groups of providers, such as gender, years of experience with the service, and shift worked. Knowledge of the frequency of assaults and factors associated with perceptions of safety may help to guide interventions to improve provider safety.

METHODS

Study Design

This study was a cross-sectional, anonymous survey on various safety measures among EMS personnel (EMTs and paramedics) in a two-tiered, urban EMS system. The portion of the survey reported here includes history of physical and verbal assaults, as well as perceptions of safety in the prehospital setting. A convenience sampling of participants completed surveys during required EMS clinical education

sessions. This study was deemed exempt from the local institutional review board.

Characteristics of the Sample Population

The survey was distributed to field-level providers of a two-tiered, urban EMS system in New England. This is a third service system that responds to greater than 100,000 responses per year, making it a busy, urban environment.

Eligibility: Inclusion and Exclusion Criteria

All full-time active field providers who attended the required training sessions were asked to participate. These providers are Advanced Life Support (ALS) and Basic Life Support (BLS) providers who respond in a transport vehicle. Each employee was allowed to complete only one survey. Non-clinical providers, such as managers and administrators, and new employees (<90 days) were not included in the study population.

Procedure

We conducted this study over a three-month period of time. This anonymous, self-administered survey was distributed during required training sessions held twice weekly during each of the three shifts. The intent was to allow participation by as many and as varied a group of providers as possible.

Survey Instrument

We designed the survey to assess self-reported abuse and perceptions of safety in prehospital providers. Analysis of other sections has been published previously.[16] The survey included the following sections: demographics (age, gender, and professional designation), years of experience, shift worked, history of verbal and physical assaults, incidents reported to police, incidents in which medical care was obtained, and perceptions of fear for personal safety. We measured providers' perceptions of fear for personal safety using a Likert scale. The survey was previously tested among a group of senior EMS leadership and EMS emergency physicians. The primary outcome was the occurrence of verbal and physical assaults.

Data Analysis

We generated descriptive, univariate statistics for all demographic variables and for the primary outcomes to determine proportion of self-reported physical and verbal abuse. We used chi-square test (Fisher's exact when appropriate) to compare history of injury and perceptions of safety to gender, shift worked, and years of experience. Statistical significance was determined at the α=0.05 level. We conducted all analyses using SAS 9.3 (SAS Institute, Cary NC).

RESULTS

A total of 196/220 (89%) EMS providers completed the survey. Of those respondents, 142/196 were male (72%): 37% (72/196) reported working the day shift, 30% (59/196) the evening shift, and 23% (46/196) the night shift. Most providers were between the ages of 25 and 50 years (129/196; 66%). The majority of providers had worked in this service for more than five years (105/196; 54%), and many for more than 10 years (72/196; 37%). The time with the service ranged from one to 38 years. Of all respondents, 68% (134/196, 95% CI [61.6%-71.5%]) reported that they had feared for their safety while at work (Table). Eighty-eight percent reported that they had been verbally abused or threatened (172/196, 95% CI [82.4%-91.6%]), and 80% reported that they had been physically assaulted while at work (156/196, 95% CI [73.4%-84.6%]). Overall, 40% reported that they went to the hospital post-physical assault (62/156, 95% CI [32.4%-47.6%]), and 49% (76/156, 95% CI [41%-56.6%]) replied that they reported the assault to the police.

When separated based on years of experience, providers with two or more years of experience were more likely to have been victims of physical assault (Figure 1). Eighty-six percent (62/72) of providers with greater than 10 years experience reported a history of physical assault, compared to 82% (27/33) with 6-10 years of experience, 77% (33/43) with 2-5 years of experience, and only 62% (18/29) with less than two years of experience (p=0.03).

Only 21% of providers with less than 11 years of experience sought medical care (16/78) post-assault compared to 60% of providers with 11 or greater years of experience (37/62) (p<0.0001). (Table). In addition, only 29% of providers with less than 11 years of experience reported assaults to the police (23/78) as opposed to 74% of providers with 11 or greater years of experience (46/62) (p<0.0001). Providers with greater number of years of experience were also more likely to have feared for their safety while at work; 69% (50/72) for greater than 10 years experience, 82% (27/33) for 6-10 years experience, 67% (29/43) for 2-5 years of

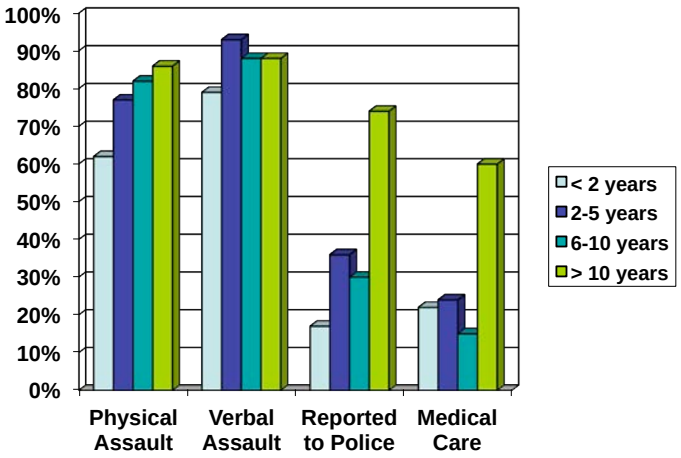

Figure 1. Percentage of assaults and safety behaviors by years of experience.

Table. Emergency medical services provider responses to survey on work environment safety by provider characteristics.

Respondent characteristics	History of physical assault	History of verbal assault	Assault reported to the police	Hospital visit after assault	Report fearing for safety while at work
All respondents (n=196)	156	172	76	62	134
Gender: male (n=142)	116	127	57	45	96
Gender: female (n=50)	38	43	19	16	38
Years at service: <2 (n=29)	18	23	3	4	15
Years at service: 2-5 (n=43)	33	40	12	8	29
Years at service: 6-10 (n=33)	27	29	8	4	27
Years at service: >10 (n=72)	62	63	46	37	50
Shift worked: day (n=72)	50	61	23	21	48
Shift worked: evening (n=59)	48	51	24	14	37
Shift Worked: night (n=46)	41	42	20	15	37

experience, and 52% (15/29) for providers with less than two years of experience (p=0.05).

When comparing responses by gender, 76% of females reported having feared for their safety at work (38/50) compared to 68% of males (96/142) (p=0.025) (Table). However, there was no statistical difference in reported rates of verbal abuse or physical assault by gender. There was also no difference between males and females in terms of seeking medical care at the hospital post-assault or in reporting assaults to the police.

Responses were also compared by shift worked, and showed that fewer assaults occurred during day shift compared to both evening and night shifts (Figure 2). Only 69% (50/72) of day-shift workers reported an assault compared to 81% of evening-shift workers (48/59) and 89% of night-shift workers (41/46) (p=0.013). Rates of reporting assaults or seeking medical care were not significantly different based on shift worked.

Providers were asked to rate how safe they felt at work compared to one year prior. Sixty percent reported feeling equally safe compared to the year prior; 14% reported feeling "somewhat unsafe;" 4% reported feeling "not very safe at all;" 8% replied that they feel "somewhat safer;" and only 4% reported feeling "much safer."

DISCUSSION

Violence toward prehospital providers has been described previously but recent data on the prevalence of assaults and safety behaviors is lacking.[10-15] This study found that more than two-thirds of professionals in EMS in an urban system have feared for their safety while at work, and that upwards of three-quarters of providers have been assaulted. Unfortunately, with such high frequency of violence, providers may have come to view threats and violence as "part of the job." Providers may not report assaults to authorities or seek medical care unless the safety environment of each organization stresses a policy of not tolerating acts of abuse. EMS workers are responsible for delivering quality medical care to an entire community, and personal safety should be a high priority. Based on this survey, rates of assault toward EMS providers remain unacceptably high.

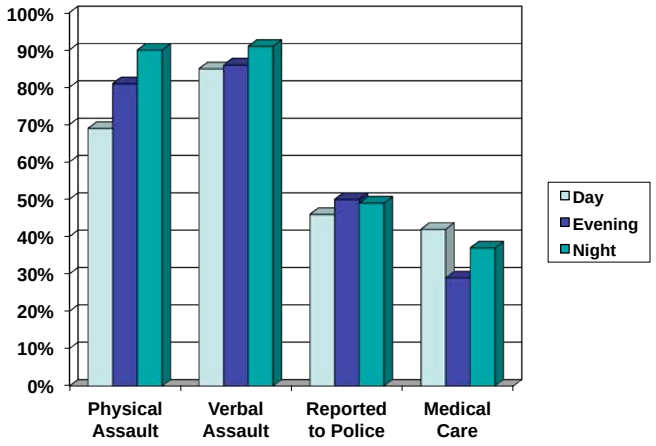

Figure 2. Percentage of assaults and safety behaviors by shift worked.

The data from this survey demonstrate that certain groups of employees within the EMS system have a real or perceived increased risk to their safety. Evening and night workers experience increased assaults compared to day shift workers. This finding is consistent with data from another study which showed that the hours of midnight to 6:00 AM were associated with an increase in assaults on EMS providers.[17] Female employees fear more for their personal safety than males. While this survey found no statistically significant difference in the rates of assault based on gender, previous data has shown that of the EMS providers who died by homicide, the majority were female.[18] In addition, employees with less than 10 years of experience may be less likely to report assaults or seek appropriate medical care following an assault. These groups may benefit from the implementation of additional safety measures. While no evidence currently exists as to the best interventions to mitigate the risks of assault in this setting, additional back-up support services, alterations in dispatch procedures, different or more extensive safety gear or training, and improved reporting systems and follow up after violent calls should be explored.

In addition to physical injuries or psychological stress sustained during an assault, an increased sense of fear of assault among EMS providers may have further consequences. Providers may change their attitudes toward patients and families or may be more hesitant to intervene in certain circumstances. Patient care may be affected if providers become impaired by their lack of sense of personal safety.[19] Over time EMTs and paramedics may experience decreased job satisfaction, which may shorten their careers in pre-hospital medicine. Further studies would be needed to evaluate the long-term impact of assaults toward this group of medical professionals.

LIMITATIONS

Overall, the survey had an excellent response rate. However, there are other limitations to the study. Firstly, the data collection all depended on providers' recollection of past events, which may lead to a bias either in terms of forgetting assaults that occurred or exaggerating the events that transpired. Secondly, the data were self-reported responses, which is susceptible to over- or under-reporting based on the perceived social desirability of the answers. It was not possible to corroborate data with police or hospital records, or with EMS patient care reports. Thirdly, the survey relied on respondents' subjective perceptions of assault and safety, which may vary greatly among providers. No standard definition for physical or verbal assault was suggested in the survey. While the lack of a standard definition does introduce a possible limitation, it remains important that each provider defined assault according to his or her own sense of personal safety. It is important to identify how providers perceived the encounter as opposed to evaluating events that met a standard definition. Further studies that gather data in real time, after each ambulance call, may help to eliminate some of these limitations. Lastly, this study gathered data from one full-time paid, urban EMS organization, which dedicates training to management of aggressive behavior. Significant variability exists in EMS organizations and results may not necessarily be generalizable to other services.

CONCLUSION

EMS providers have made a decision to dedicate their time in the service of their community. The personal safety of these emergency providers should be a high priority. This study found that a substantial proportion of providers had feared for their safety at work, with a high prevalence of verbal assaults and physical abuse being reported. Although training in managing aggressive behavior is presented, most providers do not report feeling an increased sense of personal safety. There are certain groups of providers who have an increased real or perceived risk of violence, namely evening and night shift workers and female providers. Further strategies aimed at reducing the risk of violent events may be needed to increase feelings of safety among providers, and specific groups may need to be targeted for additional risk prevention. Additional resources should be allocated to decrease the risk of violence toward pre-hospital providers and potential consequences of these violent acts.

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Knowledge and Beliefs of EMS Providers toward Lights and Siren Transportation

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Introduction: The use of warning lights and siren (WLS) increases the risk of ambulance collisions. Multiple studies have failed to demonstrate a clinical benefit to the patients. We sought to investigate the degree to which providers understand the data and incorporate it into their practice.

Methods: The authors distributed an anonymous survey to prehospital providers under their medical direction at staff and quality assurance meetings. The surveys asked the providers' degree of agreement with four statements: transport with lights and siren shortens transport times; transport with lights and siren improves patient outcome; transport with lights and siren increases the risk of collision during transport; and transport with lights and siren reduces the utilization of "mutual aid" service. We compared responses between providers who had been in prior ambulance collisions and those who had not.

Results: Few responses reached statistical significance, but respondents tended towards agreement that WLS use shortens transport times, that it does not improve outcomes, and that it increases the risk of collision. Despite the overall agreement with the published literature, respondents report >80% of transports are conducted using WLS.

Conclusion: The data demonstrate the surveyed providers are aware of the risk posed by WLS to themselves, their patients, and the public. Nevertheless, their practice in the absence of rigid protocols suggests they disregard this knowledge. Despite a large number of prior ambulance collisions among the surveyed group, a high number of transports are conducted using WLS. [West J Emerg Med. 2015;16(3):465–471.]

INTRODUCTION

Ambulance collisions represent a risk for the emergency medical services (EMS) providers who operate on the front lines of our healthcare system.[1-9] EMS personnel in the United States have more than twice the annual occupational fatality rate of the general public.[2] Many of these fatalities occur during the operation of ambulances.[2,9] Operation of the ambulance with warning lights and siren (WLS) is associated with an increased rate of collisions.[3,4,6,8] These collisions cause a loss of both life and resources. Further, there is a demonstrated increase in the risk of personal injury and death in collisions that occur under WLS operation.[4,6,8] Research has shown that time saved in using WLS for patient transports ranges from less than one minute to almost four minutes.[10-14] Research evaluating the clinical benefit of use of WLS has shown a small benefit of decreased field times in penetrating trauma,[15] but the remainder of the literature examined is negative.[16-19] The National Association of EMS

Physicians (NAEMSP) has issued a position statement calling for limitation of the use of WLS to "emergency situations only."[20] Because there is no clear definition of an emergency situation, practices vary tremendously from service to service.

Literature has suggested that field providers are aware of the increased risk borne in operating with WLS.[21] The authors' personal observations of practice in our region reveal that many services continue to routinely use WLS for the transport phase of 911 calls. It is also unclear why providers do not incorporate the knowledge of increased risk and minimal benefit into their practice. We designed this study to evaluate the field level providers' awareness of the potential problem. Based on our observations of the practice of providers in our region, it is our hypothesis that field providers do not understand the risk associated with WLS and that they believe it improves outcomes and system performance. We further hypothesized that those providers who had experienced ambulance collisions personally would have a greater understanding of the risk, the marginal time benefit, and the lack of proven clinical benefit.

METHODS

Participants

We distributed the survey at staff and quality assurance meetings. Participants represented a diverse sample of prehospital providers under the medical direction of EMS physicians from the authors' group. The participants included practicing field emergency medical technicians (EMTs) and paramedics from fire-based EMS, hospital-based EMS, and private companies providing both emergency response and transfer services. The providers surveyed represented a geographical distribution including suburban and urban environments. The services surveyed had annual 911 call volumes ranging from 1,100 to over 30,000. Because many providers work for multiple services across the above domains, it was impractical to stratify responses by type of employment. At the time that this survey was conducted, there existed no generalized protocol towards the use of lights and siren. Individual services generally left the decision regarding their use to the individual provider.

Study Design

The local institutional review board waived full review for this observational, anonymous survey-based study of both Advanced Life Support (ALS) and Basic Life Support (BLS) providers. The demographics weobtained included age, gender, level of certification (ALS or BLS), number of years in service, and number of accidents. The respondents were also asked for an estimate of the percentage of their own transports that were conducted using WLS. This estimate was not stratified by transfer or emergency response role.

We surveyed participants using a 10-point scale, assessing the degree to which the provider agrees with the following statements (1 equals "Not at all", 4-5 equals "Unsure", 10 equals "Strongly Agree"):

1. Transport with lights and siren shortens transport times.
2. Transport with lights and siren improves patient outcome.
3. Transport with lights and siren increases the risk of collision during transport.
4. Transport with lights and siren reduces the utilization of "mutual aid" service.

Statistical Analyses

We performed overall comparisons of the distribution of responses using the Kolmogorov–Smirnov test. The comparison of median response frequencies were done using the Mann-Whitney U test. Analyses were done with SPSS, version 21 (Armonk, NY). We prepared histograms of total response by category using Microsoft Excel version 14.0. Trendlines were applied and displayed with R^2 values to aid in visual interpretation of trends.

RESULTS

The response rate was 100% for the 108 surveys distributed. All 108 surveys returned contained responses to the primary survey questions. Because some surveys were incomplete in the areas of demographics and background information, we performed analysis based on the data available for each individual response. Specifically, four surveys did not include the respondents' age, two did not include the extent of their experience, and one survey did not include gender. Table 1 shows the overall characteristics of respondents. The mean age was 35 and the mean total experience level was 13 years. Figure 1 shows the distribution of total years of experience of respondents. Respondents' estimation of the percentage of their transports conducted using WLS revealed that approximately 82% of transports were conducted in this manner. ALS providers estimated 89% WLS transports vs. 61% for BLS providers ($p<0.001$).

Respondents reported 147 collisions (Table 2). One provider reported 12 collisions. Respondents reported a cumulative total of 1,380 years of experience yielding a rate of 0.1 collisions per EMS year of service, or onecollision for every 10 providers each year. Forty percent of these collisions were reported as occurring during WLS operation. Figure 2 shows the responses of providers separated by whether they had previously experienced and ambulance collision. Figure 3 provides histograms of the total responses to each statement.

Statement 1: Transport with lights and siren shortens transport times.

Table 1. Characteristics of emergency medical services responders to a survey on the use of lights and siren.

Characteristic	Mean (95% CI)
Age (years)	35 (33-37)
Minimum age	21
Maximum age	67
Gender, *n* (%)	
Total surveys completing this response	107
Female	24 (22)
Male	83 (78)
Experience (years)	
Total (*n*=106)	13 (11-15)
ALS providers (*n*=79)	
Total experience	14 (13-16)
ALS experience	9 (8-11)
BLS providers (*n*=27)	
Total experience	9 (5-13)
Estimated % WLS transports	
All providers	82 (77-87)
ALS providers	89 (84-94)
BLS providers	61 (50-73
Collisions, *n*, (%)	
Providers involved in collisions	59 (55)
Providers involved in >1 collision	34 (32)

ALS, advanced life support; *BLS*, basic life support *WLS*, warning lights and sirens

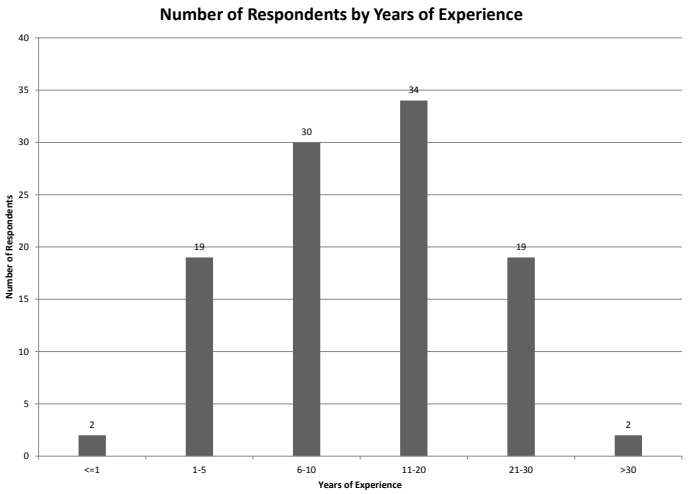


Figure 1. Experience of respondents in years.

Table 2. Collisions reported by emergency medical service providers.

	N
Total collisions reported	147
Median collisions per provider, *n* (range)	1 (0-12)
Providers involved in collisions, *n* (%)	59 (55)
Providers involved in >1 collision, *n* (%)	34 (32)
Collisions using WLS, *n* (%)	59 (40)
Collisions per year of service in EMS	0.1

WLS, warning lights and sirens; *EMS*, emergency medical services

We found a difference in the distribution of answers from those involved in an accident, compared to those not involved in an accident, which approaches but does not achieve significance (p=0.110).

Comparing median responses did not yield a significant difference (p=0.162), which can be confirmed visually for almost all categories of responses.

Statement 2. Transport with lights and siren improves patient outcome.

We did not find a significant difference between overall answers from those involved in an accident, compared to those not involved in an accident (p=0.861).

Comparing median responses did not yield a significant difference (p=0.982), which can be confirmed visually for almost all categories of responses.

Statement 3. Transport with lights and siren increases the risk of collision during transport.

We did not find a significant difference between overall answers from those involved in an accident, compared to those not involved in an accident (p=0.952).

Again, comparing median responses did not yield a significant difference (p=0.846), which can be confirmed visually for all categories of responses.

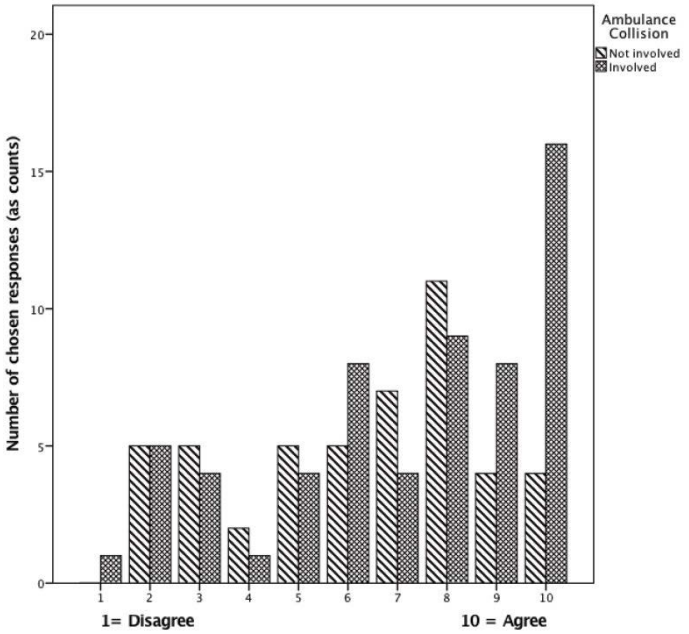
Statement 4. Transport with lights and siren reduces the utilization of "mutual aid" service.

We found a significant difference between overall answers from those involved in an accident, compared to those not involved in an accident (p=0.007). Comparing median responses yielded a significant difference (p=0.003), which can be confirmed visually for the most extreme categories of agreement responses.

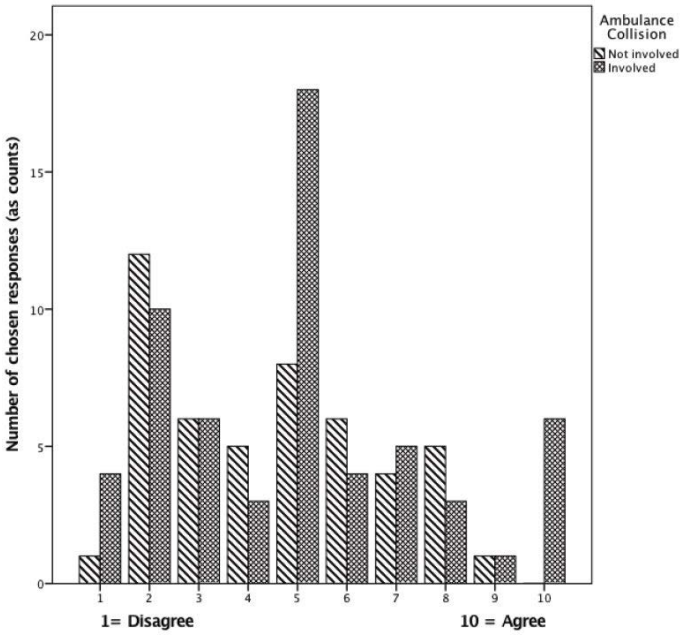
Individual respondents' estimated percentage of transports with WLS was compared to their responses into the survey questions in Figure 4. Scatter plots with R^2 values show a lack of correlation between the response and the percentage of WLS transports for any of the survey questions.

DISCUSSION

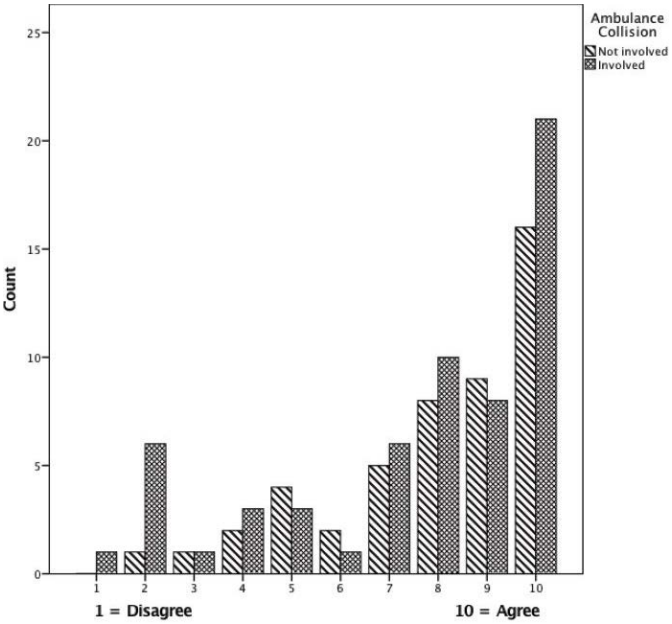
Among surveyed EMS providers, a knowledge of the lack of clear benefit and the increased risk of WLS use is not associated with a reduction in the use of WLS by the surveyed



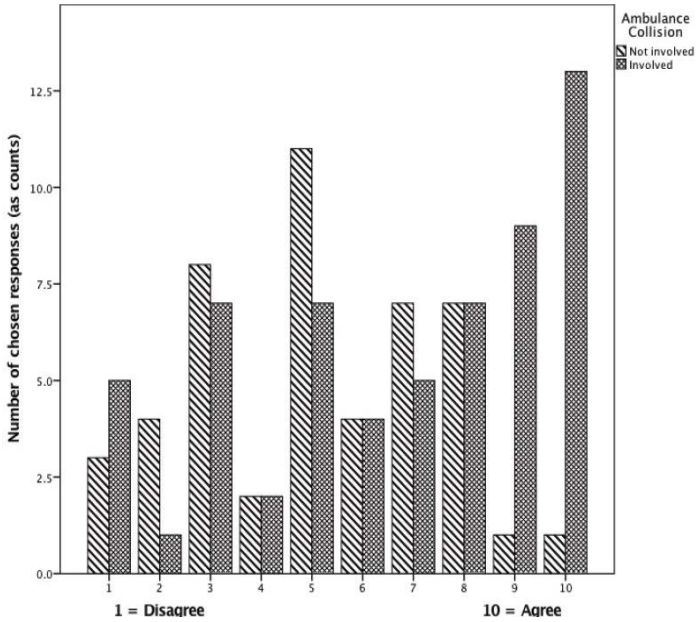
a) **Statement 1**: Transport with lights and siren shortens transport time.



b) **Statement 2**: Transport with lights and siren improves patient outcome.



c) **Statement 3**: Transport with lights and siren increases the risk of collision during transport.



d) **Statement 4**: Transport with lights and siren reduces the utilization of "mutual aid" service.

Figure 2. Distribution of responses from emergency medical services providers separated by whether they had experienced a prior ambulance collision.

providers. Despite a trend toward agreement with the concept that WLS increased the risk of collisions, greater than 80% of transports in our surveyed group were transported using WLS. The fact that a provider had a prior ambulance collision did not significantly influence the providers' belief in the risk of using WLS. Few prior works have addressed the knowledge base and beliefs of prehospital providers toward the published data on risks associated with WLS. One recent paper demonstrated providers' concern for these risks and their concern that too many protocols required WLS response.[21] This study, conducted in another state, suggests that there is a developing concern for the risks associated with this practice and that the practice patterns revealed in this survey may be a regional cultural phenomenon.

Considerable evidence consistently reported over the years has associated the use of WLS with an increased risk of collision, injury and fatality.[2-8] The responses suggest that the providers surveyed are aware of this risk. Despite this, survey respondents estimated that more than 80% of transports were conducted using WLS. At the time of the survey, the region in which the surveyed providers practice had no specific protocols regarding the use of WLS. The

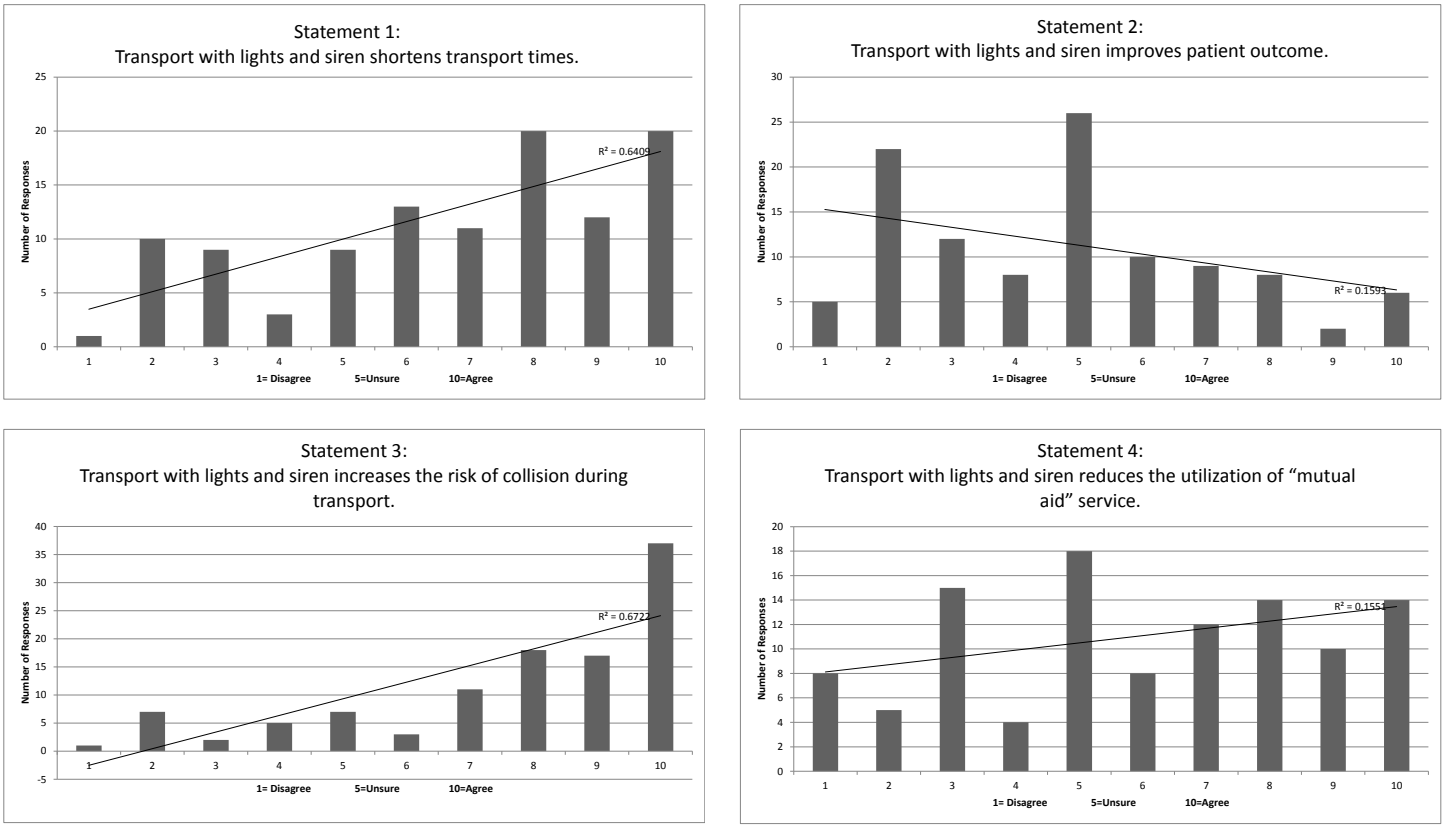


Figure 3. Distribution of total responses from emergency medical services (EMS) providers.

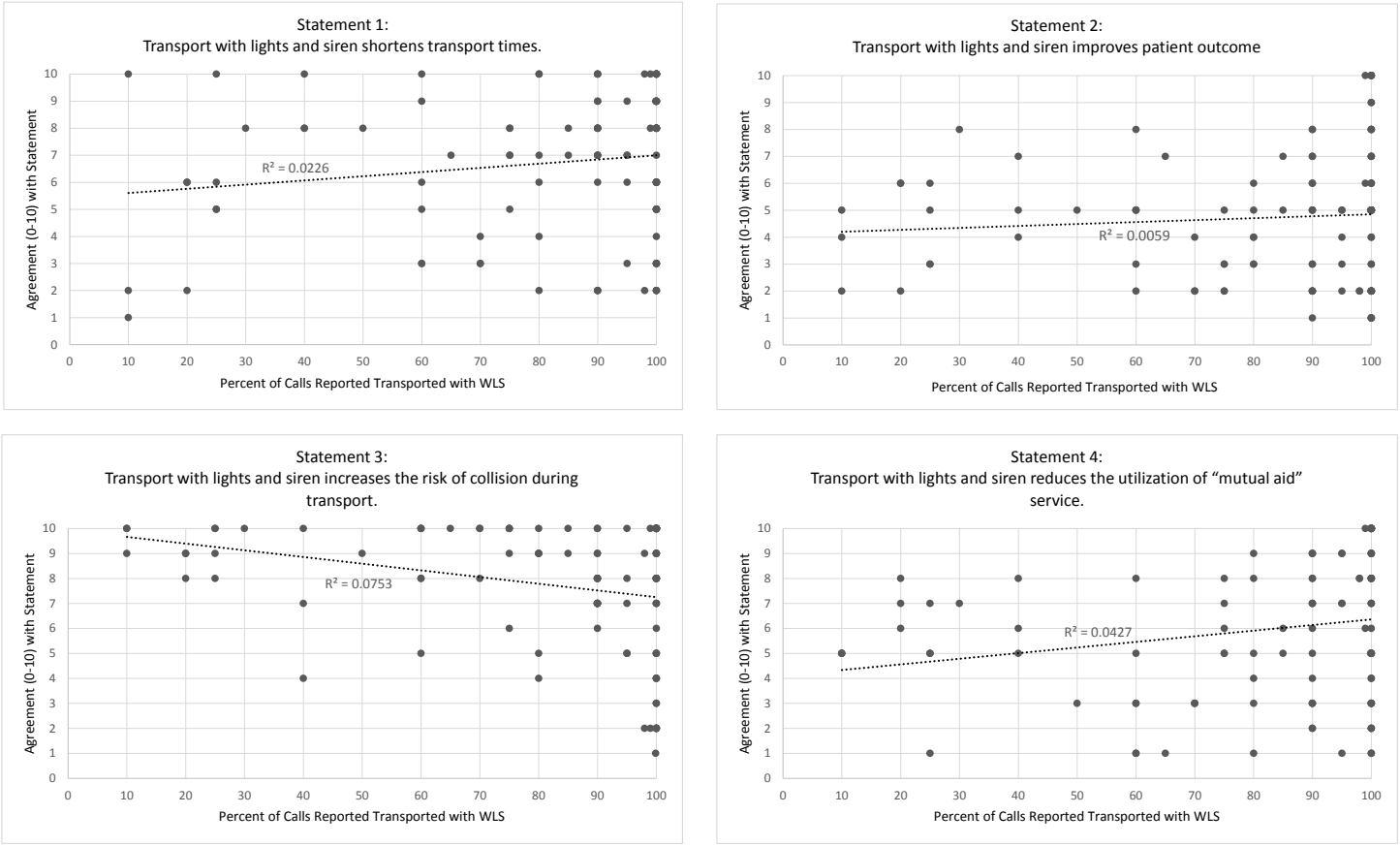


Figure 4. Comparison of statement responses with providers' reported warning lights and siren (WLS) use.

decision is left to the provider. Many local services routinely use WLS for all transports.

ALS providers were more likely to use WLS for transport than were BLS providers. This may relate to a sampling bias. ALS providers represented 75% of respondents. There was no stratification of the responses by role in the EMS system. BLS providers are more likely to work on non-emergency transfer ambulances, though one of the services involved in the survey provides BLS 911 service to a small city. ALS providers may fill either the 911 or the transfer role, but some bias may be introduced in that the patients transported by ALS crews are more likely to be critical and require more interventions, increasing the likelihood that WLS would be used.

A surprisingly high number of providers surveyed had been involved in ambulance collisions in the past. Previously experiencing an ambulance collision had some influence on responses to the statements on the survey. Only the extreme ranges of responses demonstrated statistical significance.

A visual inspection of the data displayed in Figure 3b suggests that the surveyed providers lack a strong consensus as to whether WLS use improves patient outcomes, though a trend toward disagreement is noted. Published data is mixed on this point. Some papers suggest an increase in mortality for trauma associated with increased out-of-hospital time.[15,22] Other research points to a lack of benefit for trauma[16,17] and other conditions.[19,23,24] As more diagnoses are managed with scrutiny of associated time metrics (eg. ST-elevation myocardial infarction and acute stroke), a sense of time pressure may be felt by the providers, which may be a contribution to the responses.

A visual analysis of the data displayed in Figure 3a reveals a tendency toward agreement with the concept that WLS use shortens transport times. The published literature agrees with this response, reflecting a small but consistent shortening of transport times under WLS conditions.[10-14]

EMS providers must practice within the boundaries set by state law and treatment protocols. Occasionally state laws address the safety risk of lights and siren in general terms. For example; Massachusetts General Law does not specifically address the use of WLS on ambulances, but addresses the rights of ambulances to violate traffic regulations, which implies the use of WLS. This right is limited in MGL Chapter 89; 7B to use "in an emergency," only with the application of due regard for the safety of the patient and the public.[25]

Some states have adopted regulations and protocols for the limitation of transportation with WLS. The Commonwealth of Pennsylvania, for example, instituted regulations and statewide treatment protocols which limited the use of WLS to medically necessary situations.[26] The Commonwealth of Pennsylvania further codifies the specific operation of emergency vehicles, imposing an increase in regulation and promoting the safe operation of emergency vehicles.[27] There remains, however, no national consensus on how to address the use of WLS during transport.

Massachusetts Motor Vehicle Regulations are broad in their permission of use of WLS for ambulances, limiting the criteria to "in an emergency" without further specification.[25] In an addition to the protocols that was not present at the time the survey was conducted, Massachusetts Statewide Treatment Protocols address the use of WLS in a single sentence in the Routine Care Protocol:

> *Use of lights and sirens should be justified by the need for immediate medical intervention that is beyond the capabilities of the ambulance crew using available supplies and equipment.*[28]

The lack of more specific regulation may contribute a sense of freedom to use WLS at will. When discussing the rate of WLS use with providers, providers commonly argue that the emergency is determined by the fact that 911 was called or by the patient's perception of emergency. Anecdotally, the authors have found that a common explanation from local providers for use of WLS for otherwise minor complaints is the need to return the ambulance to service and thereby reduce the need for a mutual aid service to cover calls. The evidence that the time saved in these transports is an average of 3-4 minutes vacates this argument.

Survey responses to statement 4 differed significantly between those who had previously experienced an ambulance collision and those who had not. This raises questions as to whether having been involved in a collision begins to affect the belief in the need for WLS in order to satisfy service needs as opposed to patient-centered needs.

LIMITATIONS

This is a limited data set representing a small fraction of prehospital providers. The data collected are not stratified by EMS system role, which may introduce bias in the amount of WLS used. The data span the areas of urban and suburban, but exclude true rural areas. We collected data from hospital-based, fire-based, and private EMS services, but did not include volunteer services. Finally, the size of the dataset and the scales used on the survey prevented a robust statistical analysis of the results, limiting some outcomes to inferences based on visual analysis.

CONCLUSION

The data demonstrate the surveyed providers are aware of the risk posed by WLS to themselves, their patients, and the public. Nevertheless, their practice in the absence of rigid protocols suggests they disregard this knowledge. Despite a large number of prior ambulance collisions among the surveyed group, a high number of transports are conducted using WLS.

Further education needs to be conducted among providers to increase their knowledge of the published data. More focused research into providers' motivations for use of WLS in the face of evidence of risk and questionable benefit may help guide education efforts in the future. Protocol and regulatory changes

should be implemented to limit the use of WLS to those few patients who are most likely to derive a benefit.

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Using EMS Dispatch to Trigger STEMI Alerts Decreases Door-to-Balloon Times

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Introduction: We sought to determine the potential reduction in door-to-balloon time (DTB) by allowing paramedics to perform prehospital ST-Elevation Myocardial Infarction (STEMI) notification using brief communications via emergency medical services (EMS) 9-1-1 dispatchers as soon as they saw a STEMI on 12-lead electrocardiogram (EKG). Our hypothesis was that earlier cardiac catheterization lab (CCL) activation would improve overall DTB and avoid delays arising from on-scene issues or the time required to deliver a full report.

Methods: The study setting was a single suburban community teaching hospital, which is a regional percutaneous coronary intervention (PCI) center with more than 120,000 Emergency Department (ED) visits/year and is serviced by a single tiered-response, advanced life support (ALS) paramedic-level agency. STEMI notifications from July 2009 to July 2012 occurred by either standard direct EMS-to-physician notification or by immediate 9-1-1 dispatch notification. In the 9-1-1 dispatcher-aided notification method, paramedics were asked to provide a brief one-sentence report using their lapel microphones upon immediate realization of a diagnostic EKG (usually within 1-2 minutes of patient contact). This report to the 9-1-1 dispatcher included the patient's sex, age, and cardiologist (if known). The dispatcher then called the emergency department attending and informed them that a STEMI was being transported and that CCL activation was needed. We used retrospective chart review of a consecutive sample of patients from an existing STEMI registry to determine whether there was a statistically significant difference in DTB between the groups.

Results: Eight hundred fifty-six total STEMI alert patients arrived by EMS during the study. We excluded 730 notifications due to events such as cardiac arrest, arrhythmia, death, resolution of EKG changes and/or symptoms, cardiologist decision not to perform PCI, arrival as a transfer after prior stabilization at a referring facility or arriving by an EMS agency other than New Castle County EMS (NCC*EMS). Sixty-four (64) sequential patients from each group comprised the study sample. The average DTB (SD) for the standard communication method was 57.6 minutes (17.9), while that for dispatcher-aided communication was 46.1 minutes (12.8), (mean difference 57.6-46.1 minutes=11.5 minutes with a 95% CI [6.06,16.94]) p=0.0001. In the dispatcher-aided group, 92% of patients (59/64) met standards of ≤60 minute DTB time. Only 64% (41/64) met this goal in the standard communication group (p=0.0001).

Conclusion: Brief, early notification of STEMI by paramedics through 9-1-1 dispatchers achieves earlier CCL activation in a hospital system already using EMS-directed CCL activation. This practice significantly decreased DTB and yielded a higher percentage of patients meeting the DTB≤60 minutes quality metric. [West J Emerg Med. 2015;16(3):472–480.]

INTRODUCTION

Cardiac catheterization is the preferred treatment for patients suspected of having an ST-segment elevation myocardial infarction (STEMI). The epidemiology of acute coronary syndrome (ACS) and STEMI is staggering. With 1,680,000 estimated ACS discharges yearly and >500,000 estimated STEMI events in the United States yearly the impact of improving treatment of this disease cannot be overstated.[1] At the time of data collection for this publication, the Ameruican College of Cardiology (ACC) guideline considered a "door to balloon" (DTB) of less than 90 minutes the treatment goal.[1] Although the guideline is nearly a decade old, compliance remains difficult for many hospital systems.[2] Our hospital system strives for a DTB metric of less than or equal to 60 minutes. A recent review by Camp-Rogers concluded that of eight approaches associated with reduced DTB, only two, including emergency medical services (EMS) activation of the cardiac catheterization lab (CCL), had sufficient evidence to support causality.[3] This review found 18 studies examining EMS CCL activation, all associated with decreased DTB. The different methods of EMS CCL activation including wireless transmission from the paramedic monitor, cell phone transmission, and activation of the CCL with complete bypass of the emergency department (ED). They were all associated with decreased DTB. Bradley et al. reports a 15.8 minute decrease on average from their 2005 review for all types of prehospital activation.[4] Concern about improper activation of the CCL is the major reason for incomplete adoption of EMS activation protocols, despite reported false positive rates below 10%.[3,5-8] This paper describes a cost-free method for further streamlining and implementing EMS activation of the CCL for STEMI patients in a system already using EMS activation.

Importance

The U.S. healthcare system currently struggles with providing efficacious care cost-effectively. The ACC/American Hearth Association guidelines at the time of data collection, now backed by Medicare and Medicaid performance standards, evaluate hospital systems' abilities to meet a 90-minute DTB standard with the risk of decreased reimbursement facing systems that consistently exceed this target. For hospital systems already using prehospital CCL activation, any cost-free modification that could decrease DTB times without sacrificing the quality of patient care should be evaluated and adopted whenever possible.

Goals of this Investigation

We recognized that our prehospital system has relatively short patient contact times (20-30 minutes) and transport times typically are less than 10 minutes. Notification during patient interventions or transport may not provide sufficient time to fully prepare and staff the CCL with an interventional cardiologist. We sought to maximize the notification time window. This would permit more of the process of CCL team arrival and preparation to occur parallel to EMS evaluation, treatment and transport, allowing seamless transfer from the ED to the CCL and a greater proportion of DTB ≤60 minutes (Figure 1).

We hypothesized that under the prehospital STEMI alert model, bypassing discussion and lengthy notification with hospital personnel, DTB would be decreased significantly by earlier CCL activation. This advance notice would allow for more of the CCL preparation including arrival of personnel and an interventional cardiologist to occur parallel to EMS packaging and transport of their patient. Our goal was to demonstrate that this single intervention could decrease DTB by an average of 10 minutes.

METHODS

Study Design

This was a retrospective chart review of an existing STEMI registry comprising a consecutive sample of patients presenting to the ED between July 2009 and December 2012. The existing STEMI registry was compiled by trained research nurses in an ongoing fashion. They were blinded to the hypothesis of any ongoing studies, and data collection was begun prior to the generation of the research hypothesis. The same research nurses also applied the predefined inclusion and exclusion criteria to cases as they occurred to create a separate databank of consecutive cases for inclusion. This study relied on only one additional data abstractor (primary author) and they were trained in data abstraction prior to abstraction. This additional data abstractor, while not blinded to the study hypothesis, further excluded patients whose data collected by the initial abstractors were incomplete. They did not have the ability to add any additional cases. We defined all variables prior to abstraction, and the research nurses used abstraction forms. There was no inter-observer reliability testing performed. However, ongoing review of research nursing performance monitoring occurs in an ongoing fashion within the institution.

The majority of patients in our catchment area are served by a single, tiered-response, advanced life support (ALS) agency, New Castle County Paramedics (NCC*EMS).This agency transports over 95% of the ALS patients arriving at our facility, while almost all basic life support (BLS) calls are transported by the regional fire department-based responders. NCC*EMS employed approximately 100 paramedics at the time of this study. All paramedics are nationally registered (NR-EMT-P) and undergo field training certification that lasts 8-24weeks (depending on prior experience) during which time they manage patients under the supervision of a field training officer (FTO). Beyond the NR-EMT-P level of electrocardiogram (EKG) training, 20% of the yearly in-service education is focused on STEMI recognition and mimics. Monthly quality assurance newsletters are distributed highlighting difficult EKGs. Individual cases of failed STEMI recognition are reviewed both formally with the medics involved and the medical director, as well as via distribution of the EKG with salient teaching points to the entire service. On

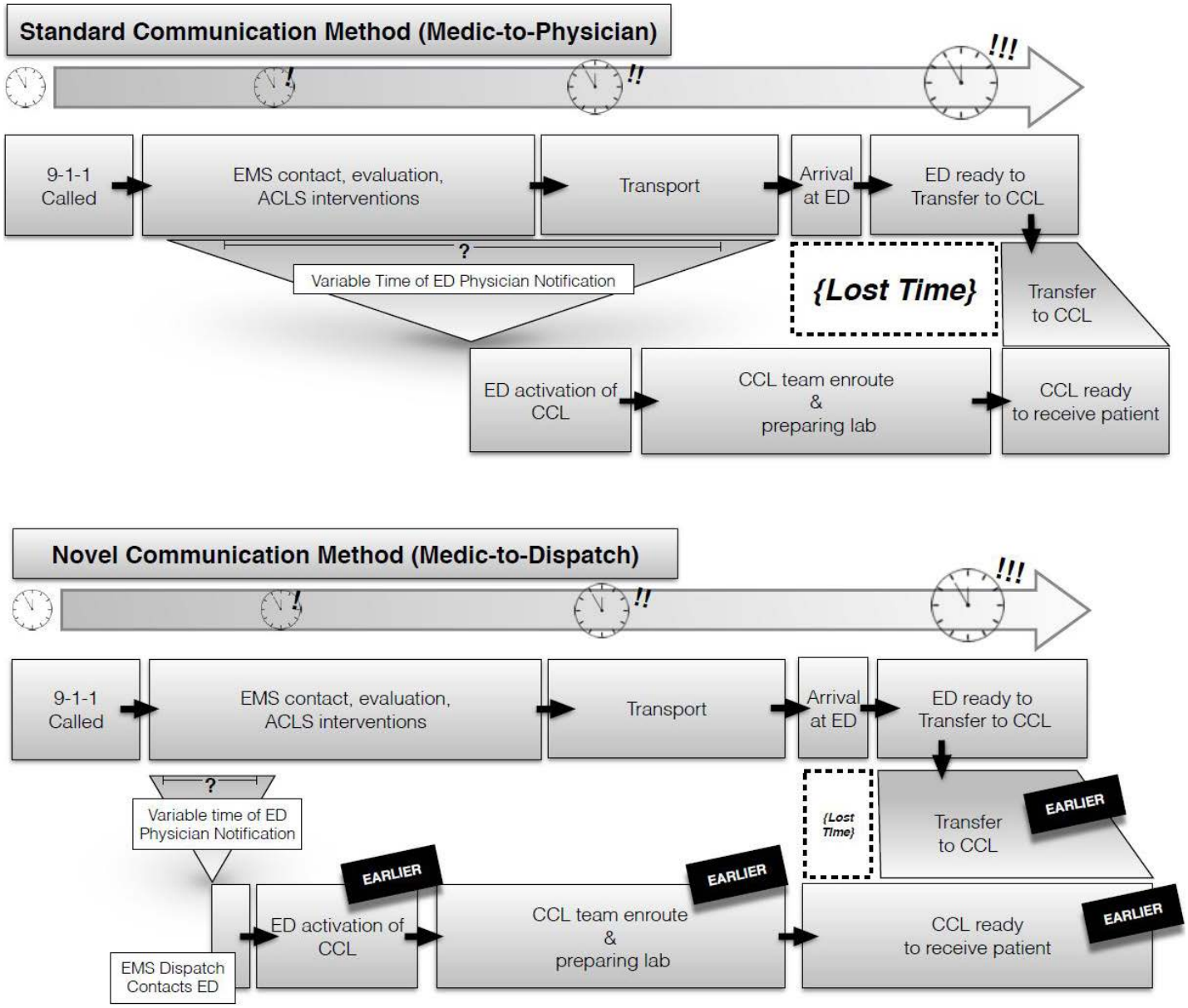

Figure 1. Comparison of standard and novel ST-elevation myocardial infarction notification methods.
EMS, emergency medical services; *ACLS,* advanced cardiac life support; *ED,* emergency department; *CCL,* cardiac catheterization lab

average, the system has 1-3 occurrences per year where medics fail to recognize a STEMI.

In our system, prior to June 2009 NCC*EMS contacted the ED and gave a full report to an ED attending. This included the patient's EKG findings, vital signs, and overall clinical picture as part of the standard pre-hospital radio notification (medic-to-physician approach). The notification proceeded from the ED attending to the clerical staff who would activate the CCL team. The paramedic's work environment often is chaotic and filled with barriers to completing even basic assessments. It was not uncommon for notification between medic and emergency physician to be delayed until the patient was moved to the controlled environment of the ambulance. Paramedic decision to implement intravenous (IV) access and treatment on scene may further delay a request for CCL activation. At the receiving facility, it is not uncommon for a busy emergency physician also to experience delays getting to the radio. Other reasons for delay varied but included the CCL team had not yet arrived, delay of cardiologist, or no available operating table in the CCL due to cases in progress.

In July 2009 our system worked cooperatively with NCC*EMS and began allowing notification of a STEMI to reach the emergency physician via NCC*EMS Dispatch. Instead of spending the time to give the entire report along with STEMI notification, NCC paramedics were instructed to give one sentence to their EMS dispatchers that consisted of the words "STEMI notification" or "Heart alert" with the patient's age and gender along with the name of the patient's cardiologist, if known. The paramedics communicated

STEMI status using a lapel microphone at the patient's side immediately after obtaining and interpreting a diagnostic EKG and prior to any further intervention. The NCC dispatchers then made a direct call on an existing, dedicated landline phone connection. This connection from paramedic through dispatch to the receiving facility took 60-90 seconds from start to finish allowing activation of the CCL in 1-2 minutes from the acquisition of the EKG. Emergency physicians were instructed that the dispatcher would have no other information, and that they should act on these requests for activation of the CCL (medic-to-dispatch approach).

NCC*EMS is a high performance ALS service accredited by the Commission on Accreditation of Ambulance Services (CAAS). NCC*EMS was an early adopter of prehospital 12-lead EKG. NCC paramedics are trained to perform 12-lead EKG early in the assessment of any patient who they suspect could be having acute coronary syndrome (ACS), including complaints of chest pain and other angina equivalents. NCC paramedics perform their own interpretation of the 12-lead EKG and request activation of the CCL on patients with appropriate presentation and EKG changes meeting STEMI criteria delineated by the ACC. The LifePak® monitors used by NCC*EMS also provide a computer interpretation that can help alert the paramedic to an abnormal EKG. The study intervention sought to capitalize on this early diagnosis by having paramedics immediately notify dispatch as soon as they obtained a diagnostic EKG.

Patients were assigned to a group for study analysis based on whether the CCL was activated via the new "medic-to-dispatch" approach or by a traditional medic-to-physician conversation. Our observational study capitalized on the ongoing use of the original medic-to-physician procedure parallel with use of the new medic-to-dispatch relay notification route to CCL activation beginning July 2009.

As the new procedure was made available and medics were trained to activate the CCL via EMS dispatch, some medics mistakenly continued to activate the CCL via the antiquated method. The original route of speaking to an emergency physician directly was left in place intentionally as the lines of communication between paramedic and physician needed to remain open for all other care direction. As paramedics continued to use the old notification pattern after July 1, these patients were captured as a control group for the group of patients for whom the medic-to-dispatch route of CCL notification occurred. All other aspects of patient care and progression through the hospital system remained the same between the two groups. Over the subsequent three years the number of patients for whom the medic-to-physician communication route was implemented decreased and the number of medic-to-dispatch patients increased. Per EMS administration there was no identifiable group of paramedics that routinely chose one route of communication over the other.

We selected the patients tagged for the chart review sequentially from this time period to overcome any bias that may have otherwise occurred from sampling at any particular time period during a period of nationally decreasing DTB. We also compared the two groups for demographic and pathologic co-morbid conditions (Table 1). There were no significant differences between groups.

The study protocol was reviewed and approved by the institutional review board. As this was a retrospective chart review, the institutional review board waived informed consent.

Setting

Christiana Hospital is a 913-bed, Level 1 trauma center, located in Newark, DE. It is the only hospital of its size with Level 1 designation and CCL capabilities between Baltimore and Philadelphia. The ED sees >120,000 patients per year. The prehospital care system consists of county-sponsored ALS transport, BLS- trained fire department response, and hospital-based critical care transport. Paramedics transport between 400 and 500 non-transfer STEMI/NSTEMI patients to Christiana on average per year.

Selection of Participants

We selected participant's charts for review for inclusion in the study if they presented to the ED at Christiana Hospital between July 2009 and December 2012 and were subsequently taken to percutaneous coronary intervention (PCI).

Inclusion Criteria

All included patients were prehospital STEMI alerted patients transported by EMS from the field and taken to CCL for PCI at Christiana Hospital between July 2009 and December 2012 directly from the ED. We selected the study group from a consecutive series of patients who arrived at our facility and were diagnosed with STEMI. Patients had to have arrived by NCC*EMS to be eligible for consideration. The patient had to have a STEMI on prehospital 12-lead EKG and CCL activation must be initiated by EMS report whether by standard radio contact or the medic-dispatch approach. STEMI diagnosis was not disputed and the patient moved to the CCL without delay for further diagnostic testing. All patients in the study group had angioplasty performed to allow evaluation of DTB time.

Exclusion Criteria

We excluded patients if they arrived by any EMS agency other than NCC*EMS. We did not enroll patients under age 18, patients who arrived as transfers from other facilities, patents whose STEMI occurred after ED arrival or who were already inpatients when their STEMI occurred. Other exclusion criteria included receiving thrombolytics prior to PCI or any documented clinical reason for delay in the decision to proceed with PC,I including possible confounding diagnoses requiring testing, cardiac arrest or arrhythmia requiring intervention, respiratory failure requiring intubation, balloon pump insertion, or delays in patient consent for religious, social, or other personal reasons. We also excluded patients enrolled in other clinical trials.

Table 1. Comparison of patient demographics by Notification Method, dispatcher-aided (new) vs. medic to physician (standard method), for ST-elevation myocardial infarction alerts.

Variable	New method	Standard method	p-value*
Age			
Mean (standard error)	61.0 (1.7)	64.4 (1.7)	0.16
Minimum (maximum)	30 (94)	34 (90)	
Sex (n%)			
Male	41 (64.1)	48 (75.0)	0.18
Female	23 (35.9)	16 (25.0)	
Race (n%)			
Asian	0 (0.0)	1 (1.6)	0.79
Black	5 (7.8)	3 (4.7)	
Hispanic	1 (1.6)	2 (3.1)	
Indian	-	1 (1.6)	
Unknown	1 (1.6)	-	
White	57 (89.1)	57 (89.1)	
Patients with coronary artery disease (n%)	16 (25.0)	16 (25.0)	1.0
Patients with congestive heart failure (n%)	1 (1.6)	4 (6.3)	0.36
Patients with atrial fibrillation (n%)	3 (4.7)	5 (7.8)	0.72
Patients with prior myocardial infarction (n%)	6 (9.4)	12 (18.8)	0.13
Patients with hypertension (n%)	37 (57.8)	38 (59.4)	0.86
Patients with diabetes (n%)	11 (17.2)	10 (15.6)	0.81
Patients with hyperlipidemia (n%)	25 (39.1)	31 (48.4)	0.28
Patients with prior stents (n%)	11 (17.2)	19 (29.7)	0.10
Prior catheter patients without stents (n%)	4 (6.3)	4 (6.3)	1.0

*P-values are calculated with a pooled t-test, chi-squared test or Fisher exact test when appropriate. New method=medic-to-dispatch, standard method=medic-to-physician.

Data Collection and Measurements

For the study time period we retrieved demographic information, including age, sex, ethnicity, presence of selected cardiac comorbidities such as hypertension, diabetes mellitus, hyperlipidemia, prior PCI, atrial fibrillation, congestive heart failure, or known coronary artery disease, on all patients included in the chart review (Table 1). The DTB time, the arrival-to-PCI time, the diagnostic EKG-to-dispatch notification time, and the time-to-ambulance-ready time all were recorded for both groups and the averages calculated for comparison with determination of confidence intervals and p-values. Initial power analysis suggested that a minimum of 64 charts from each group would be needed obtain statistical significance for an effect size of a 10-minute difference in DTB time between groups (80% power for a significance of 0.05).

Analytical Methods

We conducted hypothesis tests for differences between groups using Mann-Whitney tests for the differences in DTB time and using chi-square tests for the proportion of patients achieving DTB time of less than or equal to 60 minutes. Sub-analysis was also performed to control for a possible temporal bias, as DTBs generally decreased over the study period. We also performed linear regression on several covariates and created a multivariate model. False positive rates were not analyzed in this study as there is concurrent research in progress at our institution including the same time period; therefore, they were not included in our data set.

RESULTS

A total of 1,405 STEMI notifications occurred during the study period; 856 notifications arrived by EMS. We excluded 730 notifications due to confounding events such as cardiac arrest, arrhythmia, death prior to PCI, resolution of EKG changes and/or symptoms, cardiologist decision not to perform PCI, prior stabilization at a referring facility, or because the patient was not transported by the EMS agency involved in the study, NCC*EMS. Of the remaining patients, we performed analysis of 64 sequential patients in each group (Figure 2). The average DTB for the standard communication method was 57.6 minutes (SD 17.9). The 9-1-1 dispatcher-

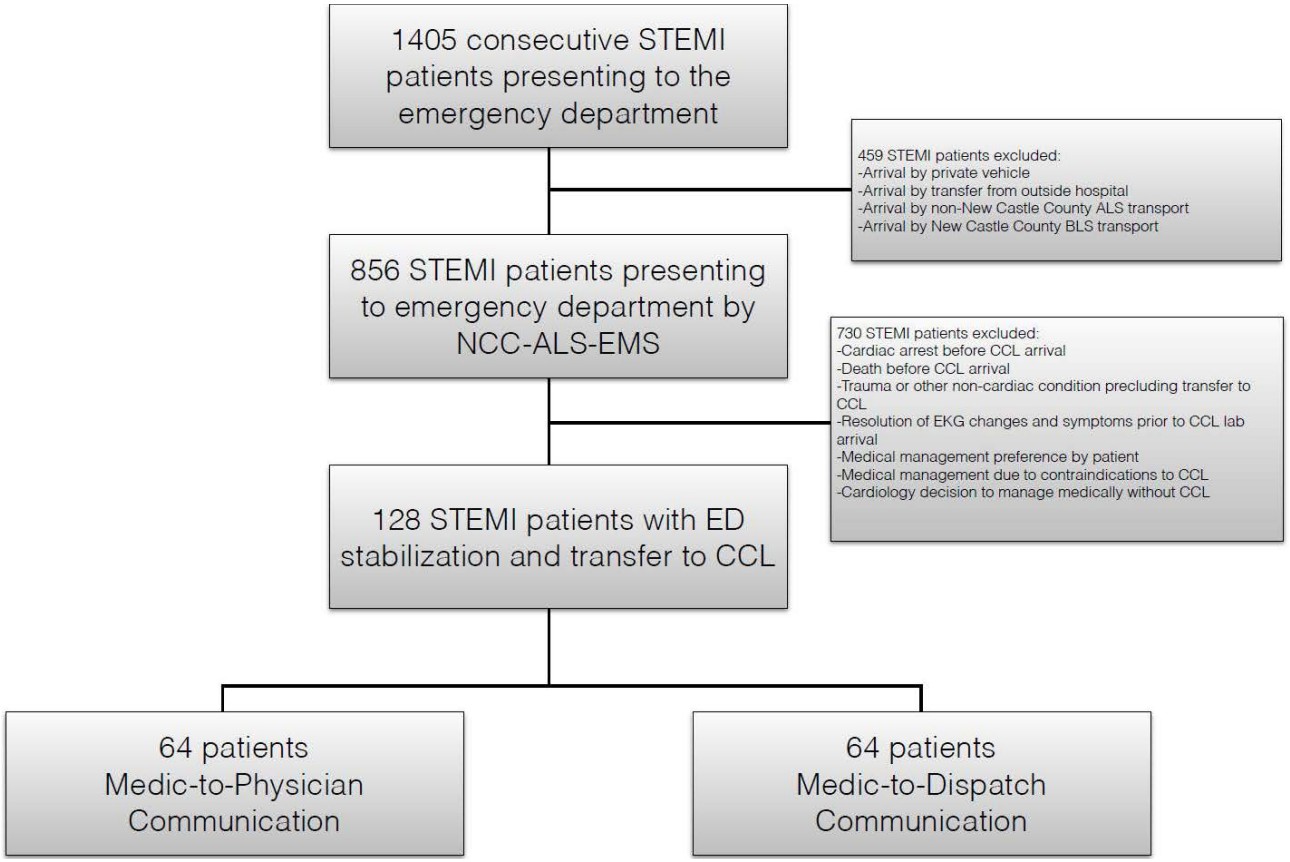

Figure 2. Enrollment flow chart with exclusions.
STEMI, ST-elevation myocardial infarction, *NCC-ALS-EMS,* New Castle County-advanced life support-emergency medical services, *ED,* emergency department; *CCL,* cardiac catheterization lab; *BLS*, basic life support; *EKG,* electrocardiogram

aided communication average DTB was 46.1 minutes (SD 12.8). The difference between the two groups was an average of 11.5 minutes (95% CI [6.06,16.94], p=0.0001). In the 9-1-1 dispatcher-aided group 92% (59/64) met the metric of ≤60 minute DTB. Only 64% (41/64) met this goal in the standard communication group (p=0.0001). This decrease in DTB was consistent with prior reports of decreased DTB through various methods of EMS CCL activation.[4]

To determine if the treatment analysis was instead capturing a temporal effect of an ever-improving system, we conducted a sub-analysis on the observations between July 2, 2010 and November 4, 2011. These dates represent the first new method observation (7/2/2010) and the last standard method observation (11/4/2011). Figure 3 shows a scatterplot of DTB times over the length of the study. The shaded area shows the observations included in the analysis. The average DTB (and standard deviation) time for the standard communication method was 55.1(18.2) minutes and the average time for the dispatcher-aided method was 46.1(13.3) minutes, with an average difference of 9.0 minutes. Mann-Whitney testing showed that this difference was significant (p=0.0159). When comparing the percent of patients with a DTB of less than or equal to 60 minutes, the standard method had 71% (37/52) while the new method had 91% (30/33). This was a significant difference (p=0.0298). This group consisted of 85 patients. This sub-analysis demonstrates that when a possible temporal effect is controlled for, the difference of the effectiveness of the two methods is maintained and is still significantly present.

The only significant predictors of DTB time, when looked at separately, were age, sex and congestive heart failure (CHF). We included these covariates in a linear regression model along with an interaction effect for treatment and sex. CHF was not significant in any multivariate models and was removed. The final multivariate model predicting DTB time from treatment, age, sex and a treatment* sex interaction showed that all predictors were significant and including these variables significantly improve the reduced models. In this model, the DTB difference (SE) is greater for females, 20.2 (4.8) minutes, than males, 7.4 (3.2) minutes. Figure 4 illustrates this difference and notably shows that age, regardless of sex, increased DTB time. Multivariate logistical modeling predicting patients with more than 60 minutes DTB time with controlling for covariates showed that there were no other significant predictors of the binary outcome other than the method of activation (p=0.0004) and patients with prior catheter without stents (p=0.0478). The dispatch-aided method reduced the relative likelihood of DTB being greater than 60

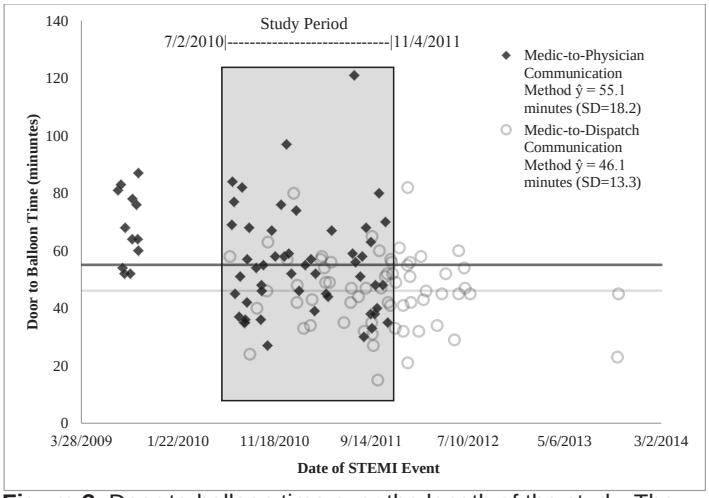

Figure 3. Door-to-balloon time over the length of the study. The shaded area reflects observations included in the analysis. *STEMI,* ST-elevation myocardial infarction

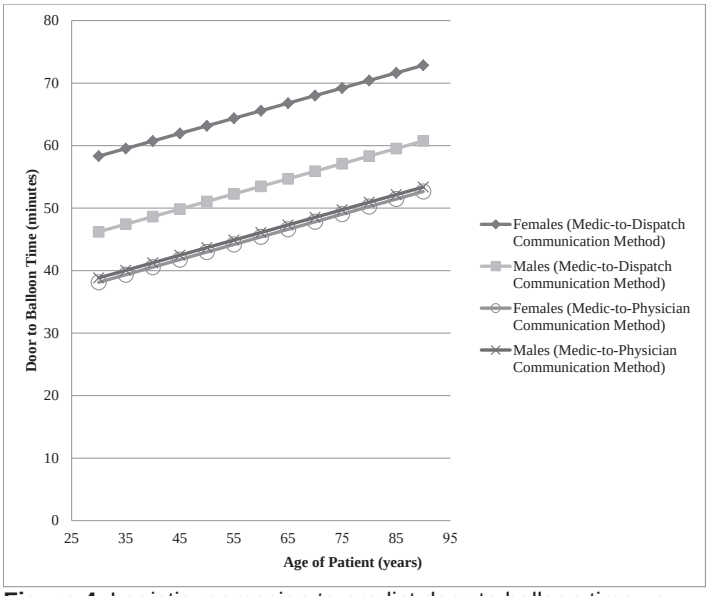

Figure 4. Logistic regression to predict door-to balloon time vs. age by sex and notification method.

minutes by 86% (95% CI [59%-95%]). Prior catheterization, while significant, may not be a reliable indicator of longer DTB time with a low count of observations (Table 1), which is reflected in its wide confidence interval (1% to 2,800% increase). In all these models the treatment effect remains significant ($p<0.001$), so even when we controlled for variables that correlated with DTB independently, there is still a prominent decrease in DTB associated with the dispatcher-aided notification method.

The new procedure used only existing equipment so no equipment training was needed or costs incurred. To change paramedic practice pattern, a memo from EMS leadership was distributed to all paramedics describing the reasoning and details of the new protocol. Following the initiation, frequent communications from the medical direction or command staff were circulated through EMS platoons as a reminder of the process. Reports had no reliability issues that are sometimes associated with new technology such as WiFi or cellular transmission of EKG. This notification was rapid enough that it avoided patient care interruption, allowing acceptance by paramedics. The communication was brief, simple and consistent, allowing it to be easily relayed and not being overly burdensome to dispatch staff. ED staff members were well informed of the limit of information that would come to them from the dispatcher and that as a third party, the dispatcher would not have anything other than the brief communication to report. Because our facility had an existing acceptance to activate the CCL based on paramedic report/request, there was a willingness to accept this earlier request and activate based on this brief communication.

DISCUSSION

DTB time reduction strategies are an important metric for STEMI-receiving facilities, and results presented here are consistent with the prior research included in the review by Camp-Rogers showing EMS to be a valuable tool to decrease DTB.[3] The nature of the benefit of early notification may be multi-factorial. Earlier notice initiates the process and seems to be the most important factor. The brief report prevents any risk of important information delivery being delayed or misinterpreted if included in the full body of the paramedic report. The brevity of the report also insures rapid initiation of the request, which could be delayed if the physician listened to the entire report before initiation of the STEMI alert request. It should not be overlooked that the EMS dispatcher is unable to provide any "discussion" with the physician as to the details of how the patient met criteria for CCL activation. This removed any time used in discussion between the receiving doctor and the paramedic.

Our hospital and the paramedic agency involved have worked cooperatively for many decades. Our ED physicians and cardiologists have a high level of confidence in NCC*EMS with a willingness to accept some false activations. False activations by EMS have been examined in the literature, although few definitive conclusions or recommendations have been drawn. Some of the frequently cited studies by Camp Rogers found a false activation rate by EMS of 8%, while Garvey reports a 6% false activation rate and Lee reports 8.3%.[3,5,6] There are similar false activation rates by emergency physicians reported in the literature. Youngquist reports 8.0%, Feldman reports a 93-95% accuracy for both emergency physicians and paramedics.[7,8] With similar numbers reported throughout the literature it will still remain up the collaborative efforts between cardiology and emergency medicine at each individual institution to agree on an acceptable false positive rate.[9,10] It is the belief of the authors that this tolerance of false positive activation is critical to allow an EMS-directed intervention, such as this one, to work to maximum benefit and achieve individual patient and

system-wide benefits. In our system, feedback from the ED and cardiology on both false activations as well as missed activation opportunities are brought to the EMS medical director at monthly meetings. The EMS medical director then meets with the paramedics individually to review the case. The system has also employed a "STEMI coordinator" who provides feedback to the paramedics, usually before the end of their shift. Paramedics are also refreshed on EKG interpretation as part of their yearly educational curriculum. These benefits of rapid EMS recognition, notification, and transport to appropriate destinations will become even more important as new metrics such as first medical contact to balloon time becomes the standard.

Based on education provided to NCC*EMS regarding the time benefits of using the dispatch notification process, the use of the new process is now a widely accepted clinical practice in our system. Future questions to be followed include monitoring for an increase in the false activation rate of our CCL and if these shorter DTB times continue with regular use of the new activation pattern. A potential positive with this approach is the possibility that our system will be able to more frequently use direct transport of the patient from EMS to the CCL with the ability to bypass the ED. Recent research has suggested this may be a viable approach to further decrease DTB by greater than 30 minutes.[10,11] A barrier to that implementation has been variability in the time for the CCL team to arrive and have the CCL ready for the patient. We hope that with regular advanced notification we will achieve consistent availability of the CCL team prior to patient arrival and that the use of direct EMS-to-CCL transportation may add to the improvements already seen with this intervention.

Our analysis also shows a direct correlation between DTB and both age and sex, with longer DTB being associated with both the elderly and women (Figure 4). The reasons for this were not obvious from the data but it might be hypothesized that the simple act of moving a more elderly patient to the hospital stretcher, recording medications, consenting for the procedure, assuring no contraindications to performing the procedure and gaining IV access may have increased their DTB. It may be that the elderly are a sicker population requiring more time for stabilization of STEMI-associated morbidity (intubation for respiratory failure, for example). Or it may simply be harder to pass the catheter wire though more atherosclerotic vessels.

The difference between genders is also unclear. It is known that women generally present for STEMI at an older age and therefore the sex may be an association and not a true causality of longer DTB.[12] However it is also known that women present later to the hospital for STEMI, likely due to atypical symptoms.[12] It may be that this later presentation may have selected for a sicker patient at presentation, again making the interventions necessary prior to CCL transport more difficult. It may be that atypical symptoms (a lack of pain) gave the receiving emergency physician or CCL cardiologist pause, or that women presented with more STEMIs at the time of night during which the CCL team had to be called into the hospital. These findings point to needs for future study

LIMITATIONS

We report results from a single, suburban, regional center with a high performance EMS agency transporting to a single receiving hospital, which requires consideration before any generalization of these results. The EMS agency has a long history of utilization and reliable interpretation of prehospital 12-lead EKGs. The combination of these factors made this process change more easily accepted at our institution than it may be in institutions where this historical working relationship is not in place.

During the data collection process, the specific emergency physician receiving the alert from either method was not recorded. Theoretically, if a specific physician or group of physicians decided to withhold or delay activation based on the method of notification this could induce bias and exaggerate the difference measured between the two methods. However, in the area of the ED that received the STEMI notification, there are anywhere from 5-7 different physicians working simultaneously and receiving the reports based on staffing needs. These physicians change every eight hours and are part of a group consisting of approximately 100 different physicians, which should provide a nice randomization.

It is also possible that a bias in patient randomization occurred as the paramedic's decision to use the dispatch-aided method or the standard communication method was not a controlled decision. It is theoretically possible that slower paramedics consistently chose to use the standard communication method, making the standard communication rate seem falsely high. We did not collect paramedic identification data in this study limiting our ability to report on this possible bias.

False activation of the CCL remains a concern for any system employing paramedic activation of the CCL. While this study did not evaluate false activation, it is theoretically possible that removing the physician's ability to discuss the case with the paramedic over the radio may increase the overall false activation rate. Anecdotal reports do not indicate this happened at our institution, but concurrent research is ongoing.

An additional limitation exists with respect to the methods of data abstraction. We did not perform interrater reliability testing as only one unblinded chart abstractor was used in addition to the blinded research nursing staff, and there was no oversight of this data abstractor.

CONCLUSION

Early notification of STEMI by a 9-1-1 dispatcher-aided method achieves earlier CCL activation compared to notification by standard, direct communication from paramedic to physician in a hospital system that already uses

EMS-directed CCL activation. This practice significantly decreased DTB by an average of 11.5 minutes per patient (95% CI [6.06,16.94]) and allowed a significantly higher percentage of patients (92% vs. 64%) to meet the DTB≤60 min metric. The intervention adds no cost or new technology, requires little training and requires only minimal changes to paramedic work processes.

We believe systems looking for additional ways to shorten DTB should consider this process.

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Understanding Why Patients Return to the Emergency Department after Mild Traumatic Brain Injury within 72 Hours

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Introduction: Although there are approximately 1.1 million case presentations of mild traumatic brain injury (mTBI) in the emergency department (ED) each year, little data is available to clinicians to identify patients who are at risk for poor outcomes, including 72-hour ED return after discharge. An understanding of patients at risk for ED return visits during the hyperacute phase following head injury would allow ED providers to develop clinical interventions that reduce its occurrence and improve outcomes.

Methods: This institutional review board-approved consecutive cohort study collected injury and outcome variables on adults with the purpose of identifying positive predictors for 72-hour ED return visits in mTBI patients.

Results: Of 2,787 mTBI patients, 145 (5%) returned unexpectedly to the ED within 72 hours of hospital discharge. Positive predictors for ED return visits included being male (p=0.0298), being black (p=0.0456), having a lower prehospital Glasgow Coma Score (p=0.0335), suffering the injury due to a motor vehicle collision (p=0.0065), or having a bleed on head computed tomography (CT) (p=0.0334). ED return visits were not significantly associated with age, fracture on head CT, or symptomology following head trauma. Patients with return visits most commonly reported post-concussion syndrome (43.1%), pain (18.7%), and recall for further clinical evaluation (14.6%) as the reason for return. Of the 124 patients who returned to the ED within 72 hours, one out of five were admitted to the hospital for further care, with five requiring intensive care unit stays and four undergoing neurosurgery.

Conclusion: Approximately 5% of adult patients who present to the ED for mTBI will return within 72 hours of discharge for further care. Clinicians should identify at-risk individuals during their initial visits and attempt to provide anticipatory guidance when possible. [West J Emerg Med. 2015;16(2):481–485.]

INTRODUCTION

Traumatic brain injury (TBI) occurs when an outside force, such as a blow to the head, alters brain function;[1]it remains a leading cause of injury-related death and disability in developed countries.[2] In the U.S. alone, TBI accounts for 1.4 million case presentations to the emergency department (ED) annually, with 80% of these cases categorized as mild TBI (mTBI).[3] Despite its high prevalence, optimal ED management strategies for patients presenting with mTBI remain controversial, and no standardized protocol has been introduced.[3] Additionally, clinicians make little effort to identify patients at high risk for poor outcomes, such as ED return visits, when designing a treatment plan. Identification of positive predictors for patients at risk of returning to the ED within 72 hours of discharge could lead to improved patient outcomes and conserve hospital resources.

The incidence of unplanned ED return after trauma is not insignificant. Previous estimates of trauma- related ED return visits range from 0.38% to 44%,[4,5] but incidence of unplanned ED return following mTBI has not been reported, even though one of the most common reasons for it is failure to improve after discharge.[6] More information is needed to understand the underlying causes of unplanned ED return visits in cases of mild mTBI so that clinicians may develop clinical interventions to reduce its occurrence. The goal of this project was to identify factors associated with 72-hour unplanned ED return visits in our mTBI population. A second goal was to investigate complaints upon return, course of treatment, and outcomes for those ED recidivists.

METHODS

This was an institutional review board-approved retrospective chart review of consecutive adult patients presenting to the ED with mTBI, defined as a Glasgow Coma Scale (GSC) of 13 or greater, during a 43-month period from January 1, 2008, to July 3, 2011. The study was conducted in the ED of a Level I trauma center in the southeastern U.S., which has a catchment area for trauma of over one million.

We performed data abstraction using *a priori* designed data abstraction forms, which paralleled the flow of the information in the health record. Possible answers to data capture were unambiguous, with numerical values defined for each answer. We built in drop-down menus, radio buttons, and range checks to further minimize data entry errors. Data entry personnel were trained on the REDCap (Research Electronic Data Capture) system, which is a secure, web-based application designed to support traditional case report form data capture, and they were blinded to the outcome of interest. We performed statistical analyses using JMP 10 for Macintosh.

Cohort identification was accomplished via identification of ICD-9 codes assigned to head injury, as previously reported by the authors[7]. We classified TBI severity using the Glasgow Coma Score, with GCS 13-15 considered as mild, GCS 9-12 as moderate, and a score less than 9 classified as severe. Post-injury symptomology collected included the occurrence and length of loss of consciousness (LOC), posttraumatic amnesia (PTA), seizure, vomiting, and an alteration of consciousness (AOC). An AOC was defined as being present if the patient reported any of the following: feeling dazed or confused, having difficulty thinking, or if the neurologic exam revealed a decreased mental status.

We also collected data for mechanism of injury, including a fall, motor vehicle collision (MVC), object striking the head, recreational activity, sports, and assault. For patients who returned to the ED within 72 hours of ED discharge, reason(s) for ED return, course of treatment, and outcome were also collected. Two patients had planned 72-hour ED return and were not considered for analysis.

RESULTS

Demographics of Mild TBI Cohort

The mTBI cohort consisted of 2,567 patients, of whom 35% were admitted to the hospital, with a median length of stay of two days (IQR 1-4, range 1-59). GCS scores were 13 (3%), 14 (11%), and 15 (86%). Men accounted for 57.5%. One hundred twenty-four (4.8%) returned to the ED unexpectedly within 72 hours of discharge.

Injury Characteristics of Mild TBI Cohort

Positive loss of consciousness at the time of head injury was reported in 47.8%. Almost one third (27.9%) experienced posttraumatic amnesia for events before and/or after head injury. Altered mental status was experienced by 28.0%. Six percent reported at least one episode of vomiting following head trauma, and 1.8% suffered from seizure after injury. A computed tomography (CT) was performed in 2,347 or 91.4% of the cohort. Of the 2,347 who had CTs, it was abnormal in 27.8% of the cases. Of those with an abnormal CT (n=652), 27.3% or 178 patients had skull or calvarial fracture, and 91.4% or 596 patients had intracranial hemorrhage.

Demographics of 72-Hour ED Return Cohort

The ED return visit cohort consisted of 124, with 83 being men. Men had a higher median age at 46, compared with 39 years for women. The racial composition was 68% white, 23% black, 6% Hispanic, and 3% other. Fall was the most commonly reported initial mechanism of injury (49%), followed by MVC (34%), and a strike to the head (29%). Seventy percent were transported by EMS, 6% by air and 64% by ground.

Determinants of Unplanned 72-Hour ED Return

A return ED visit was significantly more common in males (p=0.02), who accounted for 66.9% of this subpopulation. Additionally, patients with an intracranial bleed on head CT were significantly more likely to return to the ED within 72 hours of discharge (p=0.03); 74.5% with 72-hour ED return had intracranial bleed on head CT. Black patients were more likely to return to the ED (p=0.0456). Other predictors included mechanism of MVC (p=0.0065), and a lower prehospital GCS.

Among signs and symptoms related to traumatic brain injury, the only symptom that was significant was LOC > 30 min (p=0.0381), of which there were 29 (3%). In contrast, vomiting, seizure, alteration of consciousness and posttraumatic amnesia were not associated with increased risk of ED return visit. A finding of fracture on head CT was not predictive of a patient's likelihood to return to the ED, nor was the patient's age.

Reasons for ED Return

Patients most commonly returned to the ED for symptoms of post-concussion syndrome (46.0%), including headache, altered mental status, and vomiting. Twenty-three patients (18.7%) reported pain and 14.6% were recalled to the ED after discharge for further evaluation, while 9.76% returned for evaluation of a repeat head injury.

Treatment Course Upon Return to ED

Of the 124 patients who returned to the ED within 72 hours, head CTs were performed in 47 patients, with 17 requiring a hospital stay. Eighty percent of patients were discharged from the ED after treatment, but one out of five was admitted to the hospital for further care. Five of these patients had intensive care unit (ICU) stays (4%), and four (3.2%) required neurosurgery. No in-hospital mortality was reported. One patient left the ED without treatment.

DISCUSSION

Several studies have recently attempted to characterize factors associated with ED return visits following trauma. Caulfield et al.[5] found that the rate of ED return visits in men is higher than in women, a finding supported by others.[4-8] One study[9] reported a higher rate of ED return visit in association with young age and low socioeconomic status, since they are more likely to use the ED as a source of primary medical care.[10] Meanwhile, another study[11] found that patients who receive compassionate contact from clinicians are less likely to return to the ED for further care. No studies to the authors' knowledge, however, focus on the characterization of mTBI return visits.

A 72-hour ED return visit rate of 5% was demonstrated in this study for adult mTBI patients. Additionally, our data confirm that ED return following trauma is not always an unpredictable event, as we found a few descriptors associated with it. Compared to mTBI patients who presented once to the ED, the patients with repeat visits tended to be men, black, have suffered a MVC, and to have a bleed on head CT during the initial ED visit (Table 1). Intracranial bleed complicates initial evaluation of mild head injury since a small percentage of patients with intracranial hemorrhage remain neurologically stable during clinical evaluation but then deteriorate within 24 hours of injury.[12,13] We suspect that the significant rate of return ED visits associated with bleed on head CT is driven by two factors. First, neurological symptoms do not appear immediately with intracranial hemorrhage, so patients may be discharged before clinical assessment can identify anything of medical concern. Second, delayed neurological deterioration encourages individuals to seek further medical care. The best predictor of this progressive intracranial hemorrhage is the male sex,[14] which perhaps partly explains the male sex as a predictor for 72-hour ED return following mild TBI. Symptomology following head injury, such as loss of consciousness, was also related to risk of ED return visit (Table 1). With the exception of gender and race, the mTBI return visit cohort reflects the demographics of the surrounding population (Table 2).

Four complaints represented 86% of 72-hour ED return visits for the mTBI cohort (Table 3). Post-concussion syndrome was the most common complaint and was reported by nearly half of all patients with return ED visits. Post-concussion syndrome is a term given to describe a variety of physical, cognitive, emotional and sleep symptoms[14] (Table 4) that arise following head injury. These can be difficult to predict,[15] although one study suggested that headache and alteration of consciousness immediately following the head

Table 1. Determinants of unplanned 72-hour ED return for patients with mild traumatic brain injury.

	Unplanned return ED visit – yes (124 patients)	Unplanned return ED visit – no (2,443 patients)	p-value
Age	Mean= 45.9 SD= 22.5	Mean= 43.0 SD= 21.5	0.15
Gender – % male	66.9%	57.0%	0.02
Black race	22%	16%	0.04
Vomiting at time of head trauma	6.4%	6.0%	0.84
Seizure at time of head trauma	3.2%	1.7%	0.22
Loss of consciousness	43.5%	48.0%	0.93
Alteration of consciousness	24.2%	28.2%	0.48
Post traumatic amnesia	28.2%	27.9%	0.99
Fracture on head CT	18.2%	18.1%	0.99
Bleed on head CT	74.5%	60.0%	0.03

ED, emergency department; *CT*, computed tomography

Table 2. Demographic characteristics of 72-hour return cohort.

Demographic characteristics	n (%)
Race	
White	84 (67.7%)
Black	28 (22.6%)
Hispanic	8 (6.5%)
Native Hawaiian/Pacific Islander	1 (0.8%)
Native American	3 (2.4%)
Gender	
Men	83 (66.9%)
Women	41 (33.1%)
Median age	
Men	46 (IQR 25-57)
Women	39 (IQR 25-79)
Mechanism of injury	
Fall	71 (49%)
Object struck head	44 (29%)
Traffic accident	27 (34%)

Table 3. Most common reasons for 72-hour emergency department return.

Reason	Percentage of patients
Post-concussion syndrome	43.1%
Called back for further evaluation	14.6%
Pain	18.7%
Repeat head injury	9.8%

Table 4. Signs and symptoms associated with post-concussion syndrome.

Type of symptom following head injury	Signs and symptoms
Physical	Headache Nausea Vomiting Balance problems Dizziness Visual problems Fatigue Sensitivity to noise or light Numbness or tingling Feeling dazed or stunned
Cognitive	Feeling mentally "foggy" Feeling mentally slowed down Difficulty concentrating Difficulty remembering Forgetful of recent conversations Confused about recent events Answers questions slowly Repeats questions
Emotional	Irritability Sadness More emotional Nervousness
Sleep	Drowsiness Sleeping less than usual Sleeping more than usual Trouble falling asleep

injury, and consumption of alcohol prior to it, are predictive.[16] The second most commonly reported complaint upon ED return was pain, particularly of the back and limbs. Some patients were called back to the ED for further evaluation after receiving test results, while other patients suffered repeat head injuries that required medical attention.

These common complaints allowed us to identify potential areas for improvement to reduce the rate of ED return visits following mTBI. First, it is possible that patient education about post-concussion syndrome could be a successful and economical strategy to reduce ED return visits. If patients expect symptoms such as headache or vomiting after hospital discharge and understand that the majority of patients experience complete resolution of these symptoms within days of onset,[17] fewer individuals are likely to return to the ED for further evaluation, thus conserving hospital resources and mitigating mTBI's financial burden on the patient. Second, improved pain management is an opportunity to lower ED return visit rates. Assessment of a patient's pain prior to discharge could eliminate the immediate need to return for pain management. Third, mTBI patients should not be discharged until imaging studies have been reviewed. This would allow medical personnel to determine if further evaluation is needed while the patient is on site in order to eliminate patient recall to the ED. Fourth, mTBI patients are at heightened risk for head injury compared to the general population,[18,19] signifying that specific discharge instructions that limit return to normal activity could reduce a patient's risk of recurrent head injury and improve patient outcome.

By identifying at-risk patients for unplanned return visits and following the aforementioned guidelines, we could improve patient outcomes in cases of mTBI. Twenty percent of our return visit cohort was admitted to the hospital upon return to the ED, and these individuals represent two distinct groups: patients whose condition deteriorated after discharge and patients who initially required hospital admission but were overlooked. Identification of at-risk patients could reduce the overlooking of patients requiring hospital admission by encouraging close observation. Of the return visits admitted to the hospital, four patients required ICU says and five underwent neurosurgery (Table 5). This demonstrates that 72-hour ED return can be associated with life-threatening conditions and should not be ignored. Early intervention could improve patient outcomes and reduce the rate of ED return.

LIMITATIONS

First, this was a single-center study. It is possible that some patients returned to the ED of a surrounding hospital rather than to our study center; therefore, our study likely underestimates the true level of ED return visits following mTBI. Second, our study analyzed positive predictors for return visits within 72 hours of initial discharge. The determinants for ED return during the hyperacute phase after brain injury might not be associated with return visits beyond 72 hours after injury,

Table 5. Course of treatment for mild traumatic brain injury patients with ED return.

Course of treatment	n (%)
Left without treatment	1 (0.8%)
Discharged from ED	98 (79%)
Admitted to hospital	25 (20.2%)
Computed tomography	47 (37.9%)
ICU stay	5 (4.0%)
Neurosurgery	4 (3.2%)

ED, emergency department; *ICU*, intensive care unit

limiting the study's generalizability to beyond 72 hours. Future studies should attempt to identify predictors for less immediate ED return after mild TBI as well.

CONCLUSION

Approximately 5% of adult patients who present to the ED for mild TBI will return within 72 hours of discharge for further care. Predictors of return visits include being male being black, having a lower prehospital GCS score, suffering the injury due to a motor vehicle collision, or having intracranial hemorrhage on CT.

Clinicians should identify at-risk individuals during their initial visits and attempt to provide anticipatory guidance when possible.

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Comments on "Low-Cost Alternative External Rotation Shoulder Brace and Review of Treatment in Acute Shoulder Dislocations"

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Lacy K, Cooke C, Cooke P, et al. Low-cost alternative external rotation shoulder brace and review of treatment in acute shoulder dislocations. *West J Emerg Med*. 2015;16(1):114-120.

To the Editor:

We read the paper of Lacy et al. (2015) with interest.[1] The authors present a narrative review of the use of external rotation bracing in acute shoulder dislocations. One of the weaknesses of a narrative review is that it is more likely to be subject to reporting bias. In their review the authors focus on published studies that demonstrated successful outcomes. The first two originate from Itoi et al. whose 2003 randomized controlled trial popularized the concept of external rotation bracing in this patient group.[2,3] However, their good results have not been replicated in three subsequent randomized controlled trials.[4-6] The third study cited concluded that external rotation bracing was advantageous.[7] However, the major confounding factor in that study was that the internal rotation group had a younger mean age. As this is a well-established risk factor for re-dislocation the results of this study should be interpreted with caution.[8,9] Furthermore, a recent systematic review and meta-analysis also concluded that ER bracing is not advantageous.[10,11] We feel that the narrative review in this publication does not provide a balanced overview of the clinical studies available and we question the value of external rotation in the management of these patients.

Lacy et al. also describe the production of a low-cost external rotation brace that is more cost effective than those commercially available. The image of the sling provided demonstrates that this device produces only a small degree of external rotation. A recent systematic review demonstrated that reduction of the labrum is only achieved in 35% of cases when the arm is positioned in over 30 degrees of external rotation.[12] However, the clinical studies previously discussed[3-5,7] only achieved 10 to 20 degrees of rotation, and the illustration of the described technique in this paper suggests even less was achieved with this alternative brace. As a result, its effectiveness in achieving labral reduction and shoulder stability cannot be extrapolated from previous studies where a higher degree of rotation was obtained. An additional factor not addressed is the acceptability of the splint to patients. External rotation bracing is extremely inconvenient and poorly tolerated. Its prescription is associated with poor compliance, which may limit effectiveness.[3-5]

In closing we commend the authors on their innovative thinking and consider their design to be a cost-effective alternative to commercially available external rotation braces for posterior dislocations. However, the lack of any clear advantage to external rotation bracing for anterior shoulder dislocations in previous systematic reviews and meta-analysis should limit the subjection of patients to this poorly tolerated brace. The cheaper, more readily available internal rotation sling remains the standard treatment for these patients.

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In Reply:

We would like to thank the editors of the *Western Journal of Emergency Medicine* for the opportunity to reply to the letter to the editor by Jordan et al. regarding our paper "Low-Cost Alternative External Rotation Shoulder Brace and Review of Treatment in Acute Shoulder Dislocations."[1]

Jordan et al. comment in their letter to the editor,[2] "We feel that the narrative review in this publication does not provide a balanced overview of the clinical studies available and we question the value of external rotation in the management of these patients. They further state that, the paper is "likely to be subject to reporting bias.'' Jordan et al.[2] quote articles that question the value of external rotation bracing over internal rotation bracing for acute anterior dislocations.[3-7] Each one of these publications[3-7] is also referenced in our review[1] and are the reason we clearly state in our article that "Posterior dislocations are immobilized in external rotation or a 'gunslinger' position of neutral rotation, abduction, and slight flexion.[8] The position of immobilization for anterior shoulder dislocations is somewhat controversial," and we repeat that "larger randomized controlled trials, as well as meta-analyses comparing external and internal rotation immobilization for acute traumatic anterior shoulder dislocation, have not shown a statistically significant difference in regards to recurrence of dislocation.''[3-7]

Jordan et al.[2] further state that "a recent systematic review and meta-analysis also concluded that external rotation bracing for anterior shoulder dislocations is not advantageous."[6,7] Unfortunately they misquote Patterson et al.,[6] which states in its conclusion, "Bracing in external rotation may provide a clinically important benefit over traditional sling immobilization, but the difference in recurrence rates did not achieve significance with the numbers available."

Also in a commentary written by Bruce S. Miller on this article[8] in the same journal, Miller questions the discrepant findings in this emerging body of evidence for external rotation bracing in anterior shoulder dislocations and feels it certainly warrants further investigation but does not discount the work of Itoi et al.[3] as does our current letter to the editor.

Jordan et al.[2] state, "The image of the sling provided demonstrates that this device produces only a small degree of external rotation," and also state that "the clinical studies previously discussed[3-5,10,11] only achieved 10 to 20 degrees of rotation and the illustration of the described technique in this paper suggests even less was achieved with this alternative brace." Allow us to provide you with some better images (Figure) and mention that the degree of external rotation brace is adjustable depending on the amount of padding used in the bump. The placement of more padding anteriorly in the bump will create a greater degree of external rotation. The padding within the bump can also be compressed posteriorly to create a wedge shape, which aids in achieving additional external rotation.

Jordan et al. further comment that an additional factor not addressed is the acceptability of the splint to patients. "External rotation bracing is extremely inconvenient and poorly tolerated. Its prescription is associated with poor compliance which may limit its effectiveness."[3,4,11] Unfortunately the above statement is

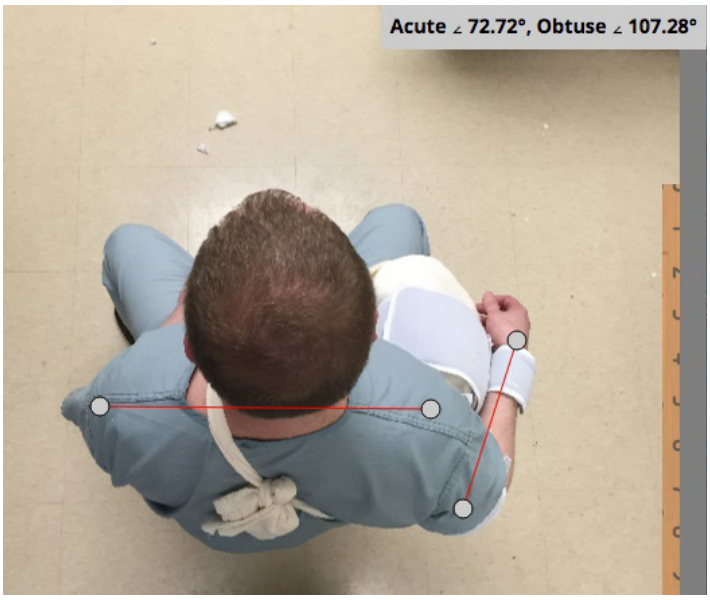

Figure. An overhead picture of the low-cost alternative external rotation shoulder brace demonstrating 18 degrees of external shoulder rotation. With additional padding in the bump anteriorly, greater external rotation can be achieved.

referenced by three randomized controlled trials that report the following compliance with bracing:

3) The external rotation brace was used in 27 patients, all but one of whom complied fully with the treatment. An internal rotation brace was used in 24 patients, all of whom complied with the treatment regime.[3]

4) The compliance rate with the immobilization was 47.4% (45 of 95) in the internal rotation group and 67.7% (63 of 93)) in the external rotation group.[4]

11) The compliance rate was 39 (53%) of 74 in the internal rotation group and 61 (72%) of 85 in the external rotation group (p=0.013).[11]

Our patients also seem to tolerate this soft padded brace pretty well.

In conclusion, we would like to reiterate that our low-cost brace is a good option for patients who would benefit from external rotation bracing of the shoulder or humerus. It can be adjusted to get up to 20 degrees of external rotation, and like other external rotation braces the compliance of use is very similar to internal rotation bracing. It is beneficial in posterior dislocations, certain humerus fractures, and for post-op care, and although the literature is controversial it may be an option for acute anterior shoulder dislocations. So we feel that our review is balanced not biased, represents the opinion of recent publications and feel that the letter to the editor misrepresents the literature as we have stated.

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Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The authors disclosed none.

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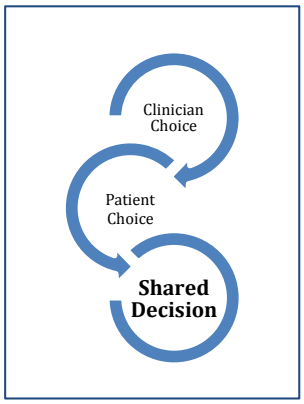

Call for Papers

2016 *Academic Emergency Medicine* Consensus Conference

Shared Decision Making in the Emergency Department: Development of a Policy-Relevant Patient-Centered Research Agenda

The 2016 *Academic Emergency Medicine* (*AEM*) consensus conference, "**Shared Decision Making in the Emergency Department: Development of a Policy-Relevant Patient-Centered Research Agenda,**" will be held on May 10, 2016, immediately preceding the SAEM Annual Meeting in New Orleans, LA. Original research papers on this topic, if accepted, will be published together with the conference proceedings in the December 2016 issue of *AEM*.

The consensus conference will convene major thought leaders and necessary stakeholders on shared decision making in acute care. Specifically, the conference will include patients, patient representatives from national advocacy organizations, emergency physicians, mid-level providers, emergency nurses, and researchers with expertise in shared decision making and patient-centered outcomes research, comparative effectiveness research, and health information technology. There will be clinicians across various disciplines such as emergency medicine, health services research, psychology, and quality improvement. Finally, the conference will include national policy makers, payer representatives, and other stakeholders with the expressed goal of developing a multidisciplinary, consensus-based, high-priority research agenda to improve and optimize shared decision making in the emergency department.

Consensus Objectives:

1. Critically examine the state of science on shared decision making in emergency medicine, and identify opportunities, limitations, and gaps in knowledge and methodology;
2. Develop a consensus statement that prioritizes opportunities for research in shared decision making that will result in practice changes, and identifies effective methodological approaches;
3. Identify and build collaborative research networks to study the use of shared decision making and patient-centered outcomes research in emergency medicine that will be competitive for federal funding.

Accepted manuscripts will present original, high-quality research in shared decision making in the ED, such as clinical decision rules, shared decision making, knowledge translation, comparative effectiveness research, and multidisciplinary collaboration. They may include work in clinical, translational, health systems, policy, or basic science research. Papers will be considered for publication in the December 2016 issue of *AEM* if received by April 17, 2016. All submissions will undergo peer review and publication cannot be guaranteed.

For queries, please contact the conference chair, Corita R. Grudzen, MD, MSHS (corita.grudzen@nyumc.org), or the co-chairs Christopher R. Carpenter, MD, MSc (carpenterc@wusm.wustl.edu) and Erik Hess, MD (Hess.Erik@mayo.edu). Information and updates will be regularly posted in *AEM* and the SAEM Newsletter, and on the journal and SAEM websites.

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