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Emergency Department Management of Suspected Calf-Vein Deep Venous Thrombosis: A Diagnostic Algorithm

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Introduction: Unilateral leg swelling with suspicion of deep venous thrombosis (DVT) is a common emergency department (ED) presentation. Proximal DVT (thrombus in the popliteal or femoral veins) can usually be diagnosed and treated at the initial ED encounter. When proximal DVT has been ruled out, isolated calf-vein deep venous thrombosis (IC-DVT) often remains a consideration. The current standard for the diagnosis of IC-DVT is whole-leg vascular duplex ultrasonography (WLUS), a test that is unavailable in many hospitals outside normal business hours. When WLUS is not available from the ED, recommendations for managing suspected IC-DVT vary. The objectives of the study is to use current evidence and recommendations to (1) propose a diagnostic algorithm for IC-DVT when definitive testing (WLUS) is unavailable; and (2) summarize the controversy surrounding IC-DVT treatment.

Discussion: The Figure combines D-dimer testing with serial CUS or a single deferred FLUS for the diagnosis of IC-DVT. Such an algorithm has the potential to safely direct the management of suspected IC-DVT when definitive testing is unavailable. Whether or not to treat diagnosed IC-DVT remains widely debated and awaiting further evidence.

Conclusion: When IC-DVT is not ruled out in the ED, the suggested algorithm, although not prospectively validated by a controlled study, offers an approach to diagnosis that is consistent with current data and recommendations. When IC-DVT is diagnosed, current references suggest that a decision between anticoagulation and continued follow-up outpatient testing can be based on shared decision-making. The risks of proximal progression and life-threatening embolization should be balanced against the generally more benign natural history of such thrombi, and an individual patient's risk factors for both thrombus propagation and complications of anticoagulation. [West J Emerg Med. 2016;17(4)384-390.]

INTRODUCTION

Clinical Scenario

Our interest in this topic was prompted by two emergency department (ED) visits by an 84-year-old man. Initially, he presented with right calf swelling 10 days after shoulder surgery. Bedside compression ultrasound (CUS) was negative for proximal deep venous thrombosis (DVT), and a D-dimer was elevated at 3.3µg/mL. Right calf DVT was strongly suspected and he was treated with therapeutic enoxaparin. Whole leg ultrasound (WLUS) 36 hours later diagnosed chronic DVT in the right gastrocnemius veins. Therapeutic enoxaparin was continued by his physicians. He returned to our ED six days after his initial visit with right shoulder pain and an 18cmx7cm chest wall hematoma with evidence of active bleeding. Inpatient management consisted of protamine reversal of his enoxaparin and transfusion of blood and platelets.

Background

In emergency patients, acute unilateral leg pain and/or swelling are common complaints, often prompting a search for DVT. Proximal DVT (with its risk for pulmonary embolism [PE]) is commonly ruled in or out during the initial ED encounter.[1,2] As in our patient, when proximal DVT is eliminated, isolated calf deep vein thrombosis (IC-

DVT) often remains in the differential diagnosis. Whole-leg duplex ultrasonography (WLUS), the current standard for an affirmative diagnosis of IC-DVT, is unavailable after-hours in many EDs.[3,4] The purpose of this article is to suggest an algorithm for the evaluation of patients with suspected IC-DVT when WLUS is unavailable. Treatment controversies surrounding this entity are described.

DISCUSSION

The Nature of the Problem

No one would deny the frequency and importance of DVT, which affects around one in 1,000 persons per year.[5] Emergency physicians appropriately have a high degree of concern for this condition. We look for it frequently, and DVT is found in 10-25% of patients in whom it is suspected.[6] We seek to diagnose proximal DVT to prevent PE and the postthrombotic syndrome. When proximal DVT is ruled out, distal thrombus must often still be considered. We pursue the diagnosis of IC-DVT out of concern for the progression of these distal thrombi to proximal DVT and PE. In community practice, isolated calf DVT was diagnosed in 11% of 1,495 patients in whom it was suspected.[7] When all patients undergo WLUS, IC-DVT is even more frequently found, representing about 50% of diagnosed DVTs.[8] The majority of distal thrombi are non-obstructive and asymptomatic and long-term outcomes are similar in patients diagnosed using either proximal or whole-leg imaging.[9,10]

IC-DVT: Risk of Thrombus Propagation, Mortality, and Pulmonary Embolism

All DVT is assumed to start in the calf veins.[11] Untreated, symptomatic IC-DVT progresses to involve the popliteal or femoral veins ≤16% of the time.[1,12-14] Such propagation has not been documented after two weeks.[13,15-17] Risk factors promoting propagation include a history of cancer, inpatient status, positive D-dimer, extensive thrombus or proximity to proximal veins, absence of reversible provoking factors for DVT, history of trauma and history of prior venous thromboembolism (VTE).[13]

Calf vein DVT, with or without treatment, has a mortality of ≤1%.[1] When the search for DVT begins after a diagnosis of PE is made, 7-11% of patients with suspected symptomatic PE will have IC-DVT.[18] If tested, 13% of patients with proven IC-DVT will have evidence of "silent" PE.[19] The controversy surrounding the significance of diagnosing and treating small or minimally symptomatic PEs is under active discussion, and is not covered here.[20, 21]

How Should the Diagnosis of Suspected IC-DVT Be Approached?

When available, WLUS rules out IC-DVT with a subsequent composite VTE complication rate of ≤1%.[5,8,10,22-24] In the absence of WLUS, commonly available diagnostic modalities are bedside (or radiology department) proximal compression ultrasonography, clinical probability assessments, and D-dimer testing.

The Role of D-dimer Testing, Pretest Clinical Probability, and Compression Ultrasonography

D-dimer and Clinical Probability: For both DVT in general, and isolated calf DVT specifically, the negative predictive value (NPV) of a D-dimer in low-risk patients (Wells score of zero or less) is≥99%.[6,25] The 2012 American College of Chest Physicians (ACCP) Clinical Practice Guidelines for Antithrombotic Therapy and Prevention of Thrombosis endorses a strategy for diagnosing DVT combining D-dimer testing with pretest probability assessment using the Wells score.[5] In patients with a negative D-dimer and a low pretest probability of first lower extremity DVT, Wells et al. 2003 and 2006 and the ACCP 2012 guidelines support no further testing.[5,6,26] With an elevated D-dimer, ACCP recommendations are for proximal compression ultrasound.

Compression Ultrasound (CUS): In the absence of WLUS, the presence of a positive D-dimer or a moderate or high clinical probability Wells score should be followed by compression ultrasonography in the ED to rule out proximal DVT. A positive CUS would identify the need for therapeutic anticoagulation. The significant numbers of emergency physicians trained in bedside CUS make that modality increasingly more accessible and often more available than radiology studies, particularly outside normal business hours. Multiple studies have demonstrated that proximal DVT can reliably be diagnosed or excluded in the ED with bedside proximal CUS with sensitivities of 95-99%.[27-30] Formal radiology CUS remains an option when available. The additional value of initially combining both CUS and a D-dimer has yet to be specifically studied. However, when both tests are done and negative, the combination effectively excludes any clinically significant DVT (≥99% NPV).[10,26,31-34] The combination has been recommended in patients with high clinical pretest probability.[5]

RECOMMENDATIONS

Diagnosis of IC-DVT in the Setting of Positive D-dimer and Negative CUS for Proximal DVT

When the D-dimer is positive and CUS is negative, WLUS is the definitive diagnostic test and the procedure of choice. When WLUS is not immediately available, the ACCP recommends two strategies presented in the Figure: either direct imaging of the calf veins with a short-term definitive whole-leg ultrasound, or a repeat proximal CUS in a week to assess for proximal progression.[5] The 1-week repeat CUS has been found to be both equivalent to a single WLUS in ruling out IC-DVT likely to progress, and safe (0-1.8% VTE at 3-6 months).[10,23,31-36]

For the many emergency patients for whom outpatient testing and follow up cannot be reliably arranged, the ability to rule out proximal propagation of suspected IC-DVT with

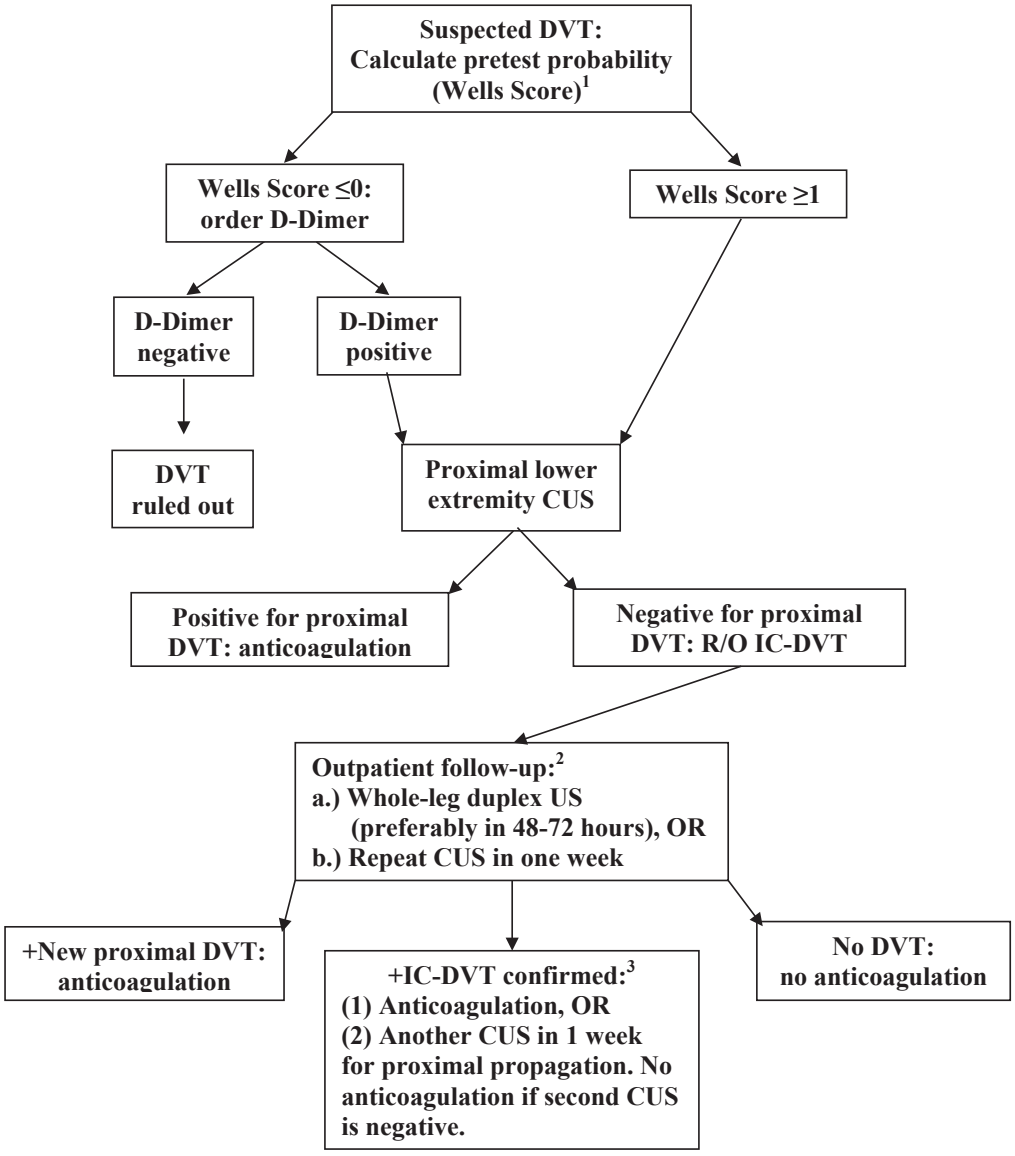

Figure. Proposed emergency department DVT evaluation algorithm when full-leg vascular duplex ultrasonography is unavailable. *ACCP,* American College of Chest Physicians; *CUS,* compression ultrasound; *DVT,* deep venous thrombosis; *IC-DVT,* isolated calf deep venous thrombosis; *R/O,* rule out; *US,* ultrasound.

1. The pretest probability of DVT is most frequently assessed with the clinical model developed by Wells, et al.[6] One point is added for each of the following positive findings: (i) active cancer (treatment ongoing or within the previous 6 months, or palliative); (ii) paralysis, paresis or recent plaster immobilization of the lower extremities; (iii) recently bedridden for 3 days or more, or major surgery within the previous 12 weeks requiring general or regional anesthesia; (iv) localized tenderness along the distribution of the deep venous system; (v) entire leg swelling; (vi) calf swelling at least 3 cm larger than that on the asymptomatic leg (measured 10 cm below the tibial tuberosity); (vii) pitting edema confined to the symptomatic leg; (viii) collateral superficial veins (nonvaricose); and (ix) previously documented DVT. Two points are subtracted from the total if an alternative diagnosis is at least as likely as DVT. Based on this checklist the clinical probability of DVT is assessed as low if the score is ≤0, moderate (a score of 1 or 2), or high (a score of ≥ 3). The ability of a negative D-dimer to rule out DVT at a given pretest clinical probability (Well's score) is dependent upon the sensitivity of the specific assay used. When a negative high-sensitivity D-dimer is combined with a low (≤0) or moderate (≤2) Well's score, the negative predictive value for DVT is 99%. This is reflected in the algorithm. Wells, et al. (2006) conclude that with moderate sensitivity D-dimer tests "the negative LRs are not sufficiently low to exclude DVT without ultrasound among patients with moderate and high pretest probability estimates" (Well's score ≥ 1). [6]

2. The practice of providing a bridge of empiric anticoagulation between imaging studies is not supported.[10, 23, 31-34, 36]

3. Per ACCP and others, the decision to anti-coagulate confirmed IC-DVT (versus conservative therapy) benefits from a thorough risk/benefit analysis and shared decision-making. Risk factors for extension of confirmed IC-DVT include positive D-dimer, severe symptoms, thrombosis that is extensive or close to the proximal veins, absence of reversible provoking factors for DVT, active cancer, a history of venus thromboembolism (VTE), and inpatient status. Those at higher risk for bleeding complications from anticoagulation may be better served by continued surveillance with compression ultrasonography alone (Kearon, et al.; Table 11).[13,14] The patient's primary provider and/or consultants should be involved in the decision-making whenever possible, with every effort to assure close follow up.

repeat ED bedside compression ultrasound, makes return to the ED for such testing an option.

Bridging Anticoagulation

When proximal DVT has been ruled out in the ED and suspected IC-DVT is being investigated with planned short-term deferred WLUS or repeat proximal CUS, the practice of providing a bridge of empiric anticoagulation between imaging studies is not supported.[4,10,23,31-34,36]

Treatment of Confirmed IC-DVT - Selective Anticoagulation is Controversial

We present an algorithm for the diagnosis of IC-DVT when definitive WLUS is not immediately available. Treatment for IC-DVT is controversial, and will only be briefly reviewed here.[1,9,14,36-40] Previous ACCP guidelines, current European guidelines and commonly used references (UpToDate) recommend treating IC-DVT with at least three months of anticoagulation.[41,42,43] The latest ACCP guidelines include a more selective approach.[13] The controversy is best exemplified by a survey of faculty physicians at a major U.S, medical center. Half of respondents would "routinely use anticoagulation to treat venous thrombosis below the knee" and half would not.[44] There is a near-universal call for large randomized trials to address the question. One such trial is underway (www.ClinicalTrials.gov).[45] In the absence of new and definitive data, and as suggested by the ACCP, recommendations to base treatment decisions on risk/benefit analysis and shared decision-making are becoming more common.[1,12,13]

The controversy over treatment largely derives from an increase in the frequency of diagnosis of IC-DVT, coupled with conclusions that distal DVT is less concerning than proximal. When WLUS is used instead of CUS, the reported prevalence of distal DVT rises to half of all lower extremity DVTs.[36] However, risk factors associated with distal DVTs are more commonly transient and reversible, and mortality and recurrence rates are less.[18, 46, 47] Those in favor of observation rather than treatment for IC-DVT note that untreated patients with negative proximal CUS (many of whom would likely have IC-DVT if looked for) demonstrate an acceptable outcome profile without treatment.[14,36] Treating them all exposes patients to unnecessary bleeding complications.[18,23,36,48] Our patient is an example.

Selective Treatment of Confirmed IC-DVT - Shared Decision-Making

The ACCP evidence-based clinical practice guidelines (currently in their 10th edition, spanning 30 years) provide a solid starting point for clinical decision-making.[5,13,49,50] The most recent edition offers two options for confirmed IC-DVT: (1) therapeutic anticoagulation or (2) weekly surveillance with compression ultrasonography for two weeks to monitor for proximal thrombus propagation.[13] They suggest that those with severe symptoms or with risk factors for proximal extension should receive anticoagulation. Patients at risk for anticoagulation-associated major bleeding (see Table 11, Kearon et al., 2016) may be better served by surveillance. For those at lower risk for both propagation and hemorrhage there may be room to consider a more selective approach using shared decision-making.[13,14,51] Discussions should be well documented and focus on the patient's valuation of, and ability to comply with, serial surveillance for clot propagation versus their tolerance for the risks of bleeding associated with prevention. Given the controversy over IC-DVT treatment, the patient's primary provider and/or consultants should be involved in the decision-making whenever possible, with every effort to assure close follow up. There is a lack of data comparing management strategies for IC-DVT in patients with varying levels of these conflicting risks.

Therapeutic Adjuncts

The role of compression stockings for comfort and for the prevention postthrombotic syndrome (PTS) has not been studied for IC-DVT. For proximal DVT, adverse events from stockings are rare and minor, but their value for preventing PTS is "in doubt."[52-54] No recommendations could be found for the role of aspirin in the treatment of IC-DVT.

LIMITATIONS

Data on the prevalence of DVT overall and the subset of IC-DVT vary significantly. While the number of reports is considerable, many are derived from small underpowered observational cohort studies, subsequently folded into meta-analyses. Explanations for variability include the size and heterogeneity of the patient population (inpatient, outpatient, community, post-surgical, trauma, presence or absence of symptoms), the reason for testing (suspected or confirmed PE, versus DVT), and the diagnostic imaging used. Most series did not image the entire leg.

The algorithm suggested is based on the latest evidence and practice guidelines. Like so much of the literature on this topic, it would benefit from prospective controlled evaluation.

Any strategy involving compliance with return visits (surveillance) loses some patients to follow up.[18,55] During the period covered by this discussion, D-dimer assays evolved and the Wells clinical prediction rules were modified.[6,26,56] Current recommendations are predicated on the use of high-sensitivity D-dimer assays.[5,57] Multiple such assays are in use.[58] Both the Wells criteria and D-dimer assays have greater sensitivity for proximal than isolated distal DVT.[25,59-61]

Leg pain and swelling are among the common ED complaints that trigger a search for serious conditions requiring urgent intervention. Yet<25% will have DVT. Even applying clinical decision rules and diagnostic tests with 99% sensitivity, physicians will see false negatives with serious consequences, as seen in multiple case reports available in the literature.[62-64] Clinical judgment, "high index of suspicion,"

patient education, comprehensive discharge instructions, and close follow up remain tools we need to routinely apply.

Muscular calf vein thrombosis: Roughly half of calf vein thromboses are isolated to the veins of the soleus and gastrocnemius muscles.[65] Although these are most often considered "deep" veins, thrombosis confined to the muscular veins has a "lower risk of extension than thrombosis that involves the axial (i.e., true deep; peroneal, tibial) veins."[13] Although subject to similar variability in opinion as DVT treatment in general, anticoagulation of calf muscle thrombosis is less commonly favored.[15,66,67]

CONCLUSION

Unilateral leg pain/swelling is a common ED complaint. The diagnosis of isolated calf vein DVT is particularly challenging when the definitive diagnostic study, whole-leg ultrasound, is unavailable. An ED diagnostic algorithm is presented for this situation, based on the most recent recommendations of the American College of Chest Physicians. It is important to remember that this algorithm is based on critical appraisal of the current literature and will require prospectively controlled studies before it can be recommended for widespread implementation. Treatment is controversial: universal versus selective anticoagulation. The risks of proximal progression and life-threatening embolization should be considered along with the generally more benign natural history of distal clots and an individual patient's risk factors for both clot propagation and the complications of therapy.

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Perception of the Risks of Ebola, Enterovirus-E68 and Influenza Among Emergency Department Patients

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Introduction: Emerging infectious diseases often create concern and fear among the public. Ebola virus disease (EVD) and enterovirus (EV-68) are uncommon viral illnesses compared to influenza. The objective of this study was to determine risk for these viral diseases and then determine how public perception of influenza severity and risk of infection relate to more publicized but less common emerging infectious diseases such as EVD and EV-68 among a sample of adults seeking care at an emergency department (ED) in the United States.

Methods: We included consenting adults who sought care in two different urban EDs in Seattle, WA in November 2014. Excluded were those who were not fluent in English, in police custody, had decreased level of consciousness, a psychiatric emergency, or required active resuscitation. Patients were approached to participate in an anonymous survey performed on a tablet computer. Information sought included demographics, medical comorbidities, risk factors for EVD and EV-68, and perceptions of disease likelihood, severity and worry for developing EVD, EV-68 or influenza along with subjective estimates of the number of people who have died of each virus over the year in the United States.

Results: A total of 262 (88.5% participation rate) patients participated in the survey. Overall, participants identified that they were more likely to get influenza compared to EVD ($p<0.001$) or EV-68 ($p<0.001$), but endorsed worry and concern about getting both EVD and EV-68 despite having little or no risk for these viral diseases. Nearly two-thirds (64%) of participants had at-least one risk factor for an influenza-related complication. Most participants (64%) believed they could get influenza in the next 12 months. Only 52% had received a seasonal influenza vaccine.

Conclusion: Perception of risk for EVD, EV-68 and influenza is discordant with actual risk as well as self-reported use of preventive care. Influenza is a serious public health problem and the ED is an important healthcare location to educate patients. [West J Emerg Med. 2016;17(4):391-395.]

INTRODUCTION

Ebola virus disease (EVD) and enterovirus (EV-68) are uncommon viral diseases in the United States (U.S.). An EVD outbreak in West Africa in 2014 was associated with four confirmed cases of EVD in the U.S. There was also an outbreak of EV-68 among patients with severe respiratory symptoms, resulting in over 1,000 confirmed cases in 49 states from August 2014, to January 2015. During this same time period, influenza activity increased across the country with high levels of outpatient illness and influenza-related hospitalizations especially in older adults.[1] There is concern for diversion of resources toward preparedness for emerging infectious diseases such as EVD and EV-68 in emergency departments (EDs) within the U.S. that are more likely to see patients with seasonal flu.

Influenza poses a serious threat to public health in the U.S.;

it causes over 2,000 deaths per year.[2] In August 2014, the Centers for Disease Control and Prevention (CDC) recommended that all adults without a contraindication get vaccinated for seasonal influenza.[3] The perception of influenza severity predicts vaccination uptake.[4] Influenza-like illness can account for significant ED volume during influenza season. However, perception of risk of EVD, EV-68 and influenza among patients in an ED setting remains unknown. We hypothesized that patient perception of risk of these viral illnesses would not correlate with actual individual risk. Furthermore, worry about EVD would not be correlated with risk for influenza-related complications or self-reported vaccination for influenza.

The overall objective of this brief report is to determine how public perception of influenza severity and risk of infection relate to more publicized but less common emerging infectious diseases such as EVD and EV-68. This study was conducted during the 2014-15 winter season and reflects patient opinion during the EVD outbreak.

METHODS

Setting and Study Population

This is a cross-sectional survey of a convenience sample of adult patients seeking care at the University of Washington Medical Center (UWMC) ED and Harborview Medical Center (HMC) ED; two diverse urban hospitals in Seattle, WA. Adult ED patients were approached to participate in a voluntary computer-assisted survey. Patients were ineligible if they had an abnormal mental status, were having a psychiatric emergency, were in police custody, or did not speak English. Data were collected during the day for three weeks in November 2014. This study was reviewed and considered exempt from human subject research by the University of Washington Institutional Review Board.

Study Protocol and Measurement

Participants completed a computer-survey on a tablet computer while waiting for medical care. The survey included questions regarding demographics, influenza vaccination status, medical comorbidities,[5] risk factors for EVD[6] and EV-68,[7] perceptions of disease likelihood, severity and worry for developing each viral illness along with estimates of the number of people who have died of each virus over the year in the U.S. Questions on perception of likelihood, severity and worry were adapted for influenza, EVD and EV-68 from published surveys addressing the same concept for the swine flu epidemic.[8,9] We collapsed a Likert scale for questions on perceived likelihood, severity and risk for each viral illness into two dichotomous categories consisting of 'not likely' vs 'likely,' 'not worried' vs 'worried,' and 'not a severe health issue' vs 'a severe health issue.' The survey was piloted for response process validity and content validity[10] among a sample of subject matter experts to ensure completeness, clarity of questions and answers and content. After piloting, changes were made prior to initiating data collection. Total time to complete the survey was approximately 15 minutes.

Table 1. Participant characteristics among patients seeking care in the ED.

	n (%)/M (SD)
Demographics	
Age	47 (17)
Male gender	143 (56)
Live in the United States	248 (98)
Education level:	
High school graduate or less	119 (47)
Undergraduate classes or completion	106 (42)
Graduate school or professional school	29 (11)
Health care worker	19 (7)
EVD	
Risk factor for EVD[a]	0 (0)
Contact with someone with known EVD	1 (0)
EV-68	
Risk factor for EV-68[b]	46 (18)
Contact with someone with known EV-68	2 (1)
Influenza	
Any Risk Factor for influenza-related complication[c]	165 (64)
Contact with someone with known influenza	26 (10)
Received seasonal influenza vaccine for 2014-2015 season	123 (48)

ED, emergency department; *EVD,* Ebola virus disease; *EV-68,* enterovirus

[a]Risk factor for EVD defined as travel to Sierra Leone, Guinea and Liberia in the 3 weeks prior to their ED visit.

[b]Risk factor for EV-68 defined as having pulmonary disease or asthma.

[c]Risk Factor for influenza-related complication as defined by the CDC5 include age ≥ 65, pregnancy, patients with chronic lung disease or asthma, neurologic disease, heart disease, blood disorders, endocrine disease, liver disease, metabolic disorder, those that are immunocompromised including those with HIV/AIDS or cancer, morbid obesity and persons younger than 19 years old receiving long-term aspirin therapy.

Data Analysis

Prior to recruitment, we determined a sample size of 263 participants was necessary to have a 90% power to detect a 10% difference among groups, estimating that 50% of the population would receive the influenza vaccine.[11] A two-tailed

alpha was set at 0.05. Descriptive statistics of demographics, vaccination status and risk for each viral illness based on CDC criteria[5-7] were estimated using Stata v.12 (StataCorp, College Station, TX). We calculated actual participant risk based on CDC criteria[5-7] and perceived likelihood, worry, and severity for each viral illness based on respondent's self-reported comorbidities. Continuous and categorical data were evaluated using paired t-tests or McNemar's test as appropriate.

RESULTS

We recruited 296 eligible patients, and 262 patients (88.5%) participated. Of these, 48% completed the survey at the UWMC ED and 52% completed the survey in the HMC ED. Participant demographics, vaccination status and risk factors for EVD,[6] EV-68,[7] and influenza[5] are listed in Table 1. Approximately half (53%, n=135) of the sample received the influenza vaccine for the 2013-2014 year, and 48% (n=123) received the influenza vaccine for the 2014-2015 year. A total of 74 participants who did not receive the 2014-2015 vaccine had at least one risk factor for influenza-related complications.[5]

Overall, participants recognized that they were more likely to get influenza than either EV-68 or EVD and were more worried about influenza than EV-68 or EVD (Table 2). Nearly one in five patients (n=45, 18%) thought there was some likelihood they could get EVD in the next 12 months, 71 (28%) were worried about getting EVD and nearly all of respondents (n=246, 96%) recognized EVD infection to be a serious health issue. Approximately one third (n=90, 35%) of respondents reported there was some likelihood to be infected with EV-68 in the next 12 months while 18% were at risk for EV-68.[7] Sixty-four percent of participants thought it was likely they that they get influenza in the next 12 months and 214 (84%) thought influenza infection would be a serious health issue. There was no difference in the number of participants worried about influenza among those who received the influenza vaccine compared to those who did not. Specifically, 43% of participants (n=53) who received the influenza vaccine were worried about influenza, compared to 53% of participants (n=69) who did not receive the influenza vaccine (p=0.13)

To understand participants' knowledge about public health risk in the U.S. for each virus, they were asked to estimate the number of deaths in the last year for each viral illness. Overall, 178 (70%) were able to correctly identify that less than five people had died from EVD in the U.S. In comparison, only 12% of the sample was able to correctly identify that more than 2,000 people in the U.S. died of influenza in the past 12 months. About one-third of the sample (n=91, 36%) reported that they did not know the number of decedents annually in the U.S. from influenza; 133 (52%) underestimated the annual number of deaths from influenza.

DISCUSSION

Overall, patients in the ED receiving care were worried about influenza, EV-68 and EVD. Nearly one in five participants thought there was some likelihood they would get EVD, and one in four were worried about getting EVD in the next year. There were no patients with risk factors for EVD.[6] Nearly two-thirds of participants had a risk factor for an influenza-related complication, and only 48% of the sample reported that they had received the influenza vaccine. These findings suggest that perception of viral illness risk is incongruent with risk of illness or use of preventive vaccination.

Emerging infectious diseases such as EVD and EV-68 within the U.S. are associated with a significant amount of time, planning, money and resources. As international travel becomes easier and the global population is more connected, concerns about emerging infectious diseases will become

Table 2. Participant risk and perception of EVD, EV-68 and influenza.

Variable %(n), 95% CI	EVD	EV-68	Influenza	EVD vs EV-68	EVD vs influenza	EV-68 vs influenza
Risk of infection based on CDC criteria[a,b,c]	0 (0) (0%-1%)	18% (46) (13%-23%)	64% (165) (58%-70%)	<0.001	<0.001	n/a*
Perceived likelihood of infection	18 (45%) (13%-22%)	35% (90) (29%-41%)	64% (163) (58%-70%)	<0.001	<0.001	<0.001
Worried about infection	28% (71) (22%-33%)	33% (85) (28%-39%)	48% (122) (42%-54%)	0.092	<0.001	<0.001
Perception of disease severity	96% (246) (94%-99%)	89% (228) (86%-93%)	84% (214) (80%-89%)	<0.001	<0.001	0.060

EVD, Ebola virus disease; *EV-68,* enterovirus; *CDC,* Centers for Disease Control and Prevention

*Not performed because risk for EV-68 risk factor[7] was part of the risk factor for influenza-related complication.[5]

[a]Risk factor for EVD defined as travel to Sierra Leone, Guinea and Liberia in the 3 weeks prior to their emergency department visit.

[b]Risk factor for EV-68 defined as having pulmonary disease or asthma.

[c]Risk Factor for influenza-related complication as defined by the CDC5 include age ≥65, pregnancy, patients with chronic lung disease or asthma, neurologic disease, heart disease, blood disorders, endocrine disease, liver disease, metabolic disorder, those that are immunocompromised including those with human immunodeficiency virus/acquired immunodeficiency syndrome or cancer, morbid obesity and persons younger than 19 years old receiving long-term aspirin therapy.

increasingly common. The ED will serve as the frontline for these outbreaks, and therefore discussing concerns with all patients is important. Media coverage of the EVD epidemic inflated public concern and likely increased health system costs,[12] diverting the public's attention away from the health risks associated with influenza and the need for prevention. The ED is an important place to address public health issues and preparedness for emerging infectious diseases such as EVD and EV-68. However, the public needs a more accurate understanding of their risk for these potentially fatal but extremely rare infections as people tend to overestimate actual risk from severe or novel diseases.[13] Emergency physicians are often frontline healthcare workers and can play an important role in providing accurate public health messages to patients based on their individual risk for disease. Importantly, EDs can deliver preventive measures and provide vaccines to eligible patients even if they are not there primarily for respiratory illness.[14-16] A recent survey of ED medical directors found that while most do not offer influenza vaccine screening or administration, nearly 75% of those surveyed are not opposed to offering such preventive services in the ED.[17] The majority (84%) of participants in our survey thought influenza infection would be a serious health problem.

LIMITATIONS

While this study provides novel information on the perception of viral illness risk among patients in the ED, it has some important limitations. First, we excluded non-English speaking patients, who have lower vaccination rates than their English-speaking counterparts.[18] Patient self-report was used for comorbidities and vaccination status. The survey was administered to a large sample over two sites and did not capture chief complaint or discharge diagnosis for the ED visit; it's possible that patients presenting for fever or respiratory illness could have a different perception of EV-68, EVD and influenza than patients presenting for other reasons. We did not ask about contraindications to influenza vaccine and thus did not capture those who had risk for influenza-related complications, but could not receive the vaccine. Additionally, this was a convenience sample of adult patients at two urban EDs, which could potentially limit the generalizability of the findings to other settings.

CONCLUSION

The ED is an important healthcare location where public perception of viral illness is discordant with actual risk. Emerging infectious diseases such as EVD and EV-68 cause concern and worry among patients in the ED that is disproportionate to the actual risk of getting infected. Influenza is a serious public health concern and the majority of patients in this study were appropriately concerned and worried about influenza, but only 48% of study participants had received the influenza vaccine. This suggests that emergency medicine providers should be counseling patients in the ED about influenza and other viral illnesses and offering preventive vaccination. Future work should consider the benefit of offering influenza vaccination to all adults without contraindications[3] from the ED as a way to improve vaccination rates and therefore decrease influenza-related complications.

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The Decline in Hydrocodone/Acetaminophen Prescriptions in Emergency Departments in the Veterans Health Administration Between 2009 to 2015

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Introduction: The purpose of the study was to measure national prescribing patterns for hydrocodone/acetaminophen among veterans seeking emergency medical care, and to see if patterns have changed since this medication became a Schedule II controlled substance.

Methods: We conducted a retrospective cohort study of emergency department (ED) visits within the Veterans Health Administration (VA) between January 2009 and June 2015. We looked at demographics, comorbidities, utilization measures, diagnoses, and prescriptions.

Results: During the study period, 1,709,545 individuals participated in 6,270,742 ED visits and received 471,221 prescriptions for hydrocodone/acetaminophen (7.5% of all visits). The most common diagnosis associated with a prescription was back pain. Prescriptions peaked at 80,776 in 2011 (8.7% of visits), and declined to 35,031 (5.6%) during the first half of 2015 (r=–0.99, p<0.001). The percentage of hydrocodone/acetaminophen prescriptions limited to 12 pills increased from 22% (13,949) in 2009 to 31% (11,026) in the first half of 2015. A prescription was more likely written for patients with a pain score≥7 (OR 3.199, CI [3.192–3.205]), a musculoskeletal (OR 1.622, CI [1.615–1.630]) or soft tissue (OR 1.656, CI [1.649–1.664]) diagnosis, and those below the first quartile for total ED visits (OR 1.282, CI [1.271–1.293]) and total outpatient ICD 9 codes (OR 1.843, CI [1.833–1.853]).

Conclusion: Hydrocodone/acetaminophen is the most frequently prescribed ED medication in the VA. The rate of prescribing has decreased since 2011, with the rate of decline remaining unchanged after it was classified as a Schedule II controlled substance. The proportion of prescriptions falling within designated guidelines has increased but is not at goal. [West J Emerg Med. 2016;17(4):396-403.]

INTRODUCTION

Background

In the late 1990s, there was a growing belief that physicians were under-treating pain.[1,2,3] Some investigators demonstrated that the risk of addiction was less than what had been perceived,[4] so national professional medical societies and the Joint Commission on Accreditation of Healthcare Organizations (JCAHO) began advocating aggressive pain control.[5,6,7] The Veterans Health Administration (VA) followed suit, launching the "Pain as the Fifth Vital Sign" campaign in 1998.[8,9] Since that time, the United States has seen a three-fold increase in the use of pain medications [10] and is the world's biggest consumer of prescription opioid pain medications. Roughly 260 million opioid prescriptions were written in 2012.[11] It is estimated that 2.1 million people in the U.S. are currently abusing prescription opioid pain medications [12] and that 23,000 unintentional deaths were attributable to them in 2013.[13]

Hydrocodone is a semisynthetic opioid medication, originally derived from codeine. It was developed in the

1920s and approved for use by the Food and Drug Administration in 1943. The combination of hydrocodone/acetaminophen was approved in 1983. Hydrocodone-containing products are now the most frequently prescribed opioids in the U.S., with the combination of hydrocodone/acetaminophen being the most popular.[14] The U.S. accounts for 99% of all hydrocodone prescriptions worldwide.[15]

Importance

In 2012, the Centers for Disease Control and Prevention linked the rise in prescription opioid use to an increase in drug overdoses and opioid abuse.[16-19] In response, many agencies and authors now advocate changes in opioid-prescribing habits,[12,20-22] especially in the ED.[23,24] This change imposes important challenges, since pain is the most common presenting complaint in the ED,[25-28] and a significant number of ED visits result in an opioid pain prescription.[29,30]

Many jurisdictions now advocate that emergency physicians limit opioid prescriptions to a three-day supply of a short-acting medication.[31,32] A recent cross-sectional study reported that ED patients received an average of 17 pills of short-acting pain medications per prescription.[31] Concerns about the rising use of hydrocodone specifically led the U.S. Drug Enforcement Agency to reclassify it as a Schedule II drug, effective October 6th, 2014.[33] The VA launched its own safety campaign on October 1st, 2014 (VA Opioid Safety Initiative), to teach providers and patients about appropriate opioid use.[34]

Goals of This Investigation

This observational study sought to measure national trends in prescribing patterns for hydrocodone/acetaminophen in VA EDs, and to determine if prescribers are following appropriate prescription guidelines. A secondary objective was to see if prescribing patterns have changed since this medication became a Schedule II controlled substance.

METHODS

Study Design and Setting

The VA is an integrated healthcare system encompassing more than 150 hospitals and 800 community-based outpatient clinics. In 2013, the system provided comprehensive care to 8.9 million veterans through 86 million outpatient visits and 700,000 hospital admissions.[35] A single electronic health record system is used across the VA system by more than 50,000 providers. It captures demographics, diagnostic codes, outpatient visits, hospital admissions, patient orders, vital signs, laboratory test results, inpatient and outpatient pharmacy data, clinical consults, immunizations, mental health screening, associated physicians, payment information, progress notes, radiology reports, procedure reports, images, and clinical narratives.

In this retrospective cohort study, we analyzed data across the entire VA population. Data for our study were obtained from the VA Informatics and Computing Infrastructure (VINCI), which maintains the national VA clinical repository and makes these data available to researchers within the VA system.[36] This study was supported with resources and facilities at the Baltimore VA Medical Center and the Veterans Affairs Informatics and Computing Infrastructure. Regulatory approval was obtained through the University of Maryland School of Medicine and the Baltimore VA Medical Center. Our research protocol included an informed-consent waiver.

Selection of Participants

We developed a study cohort using data from the national VA repository. Eligible participants included all veterans who received emergency medical care within the VA system in the 78-month period between January 1, 2009, and June 30, 2015. Patients were excluded from the study if their age, gender, location, or diagnosis was missing from their medical record (292,390 patients) or if they were born after 1996 (624 patients).

Methods and Measurements

For each participant, we collected information on demographics, comorbidities, the ED encounter, and utilization of medical services. Demographic measures were age, gender, and ethnicity.

Encounter measures were visit date, initial pain score, and diagnosis.The diagnoses for each encounter were organized into six categories by ICD-9 code as musculoskeletal, soft tissue, trauma, oncologic, psychiatric, or medical. The quantity and days of hydrocodone/acetaminophen prescribed were collected, and noted as to whether they followed the appropriate prescribing guidelines of no more than twelve pills and a three-day supply.

Utilization measures were the total number of ICD-9 codes from outpatient clinic visits, total number of ED visits, and total opioid medication doses prescribed to each patient between January 1, 2009, and July 15, 2015. The number of ED visits is commonly used, and provides an unbiased measure of how often a patient interacts with the medical system.[37] The number of outpatient ICD-9 codes provides a weighted measure of visits, as we would expect patients with multiple comorbidities to require frequent follow-up visits. Total doses of opioids provides a similar, unbiased estimate of the amount of pain medications a patient receives.

Comorbidity measures included 12 medical and mental health diagnoses, a dual diagnosis of a mental health issue and a substance abuse issue and Comorbidity-Polypharmacy Score (the sum of the pre-visit medications with the number of comorbid conditions).[38] The medical and mental health diagnoses were cardiovascular disease, type 2 diabetes, chronic kidney disease, chronic obstructive pulmonary disease, osteoarthritis, chronic pain, depression, post-traumatic stress disorder, bipolar disorder, schizophrenia, substance abuse, and alcohol

Table 1. Demographic and clinical characteristics of the ED cohort.

Characteristic	All ED visits	HD/A prescribed
Demographics		
Study sample, n (%)	6,270,742	471,221 (7.5%)
Male, n (%)	5,715,263 (91.1%)	426,785 (90.6%)
Age, median years (IQR)	58 (48-66)	54 (44-62)
Ethnicity, n (%)		
Caucasian	3,712,661 (59.2%)	293,393 (62.3%)
African	1,730,065 (27.6%)	125,530 (26.6%)
Hispanic	370,401 (5.9%)	18,898 (4.0%)
Asian	30,401 (0.5%)	2,287 (0.5%)
Other/unknown	426,915 (6.8%)	31,113 (6.6%)
Comorbid conditions, n (%)		
Cardiovascular disease	1,364,953 (21.8%)	83,081 (17.6%)
Type 2 diabetes	1,977,908 (31.5%)	132,843 (28.2%)
Chronic kidney disease	748,134 (11.9%)	42,786 (9.1%)
Chronic obstructive pulmonary disease	1,141,558 (18.2%)	70,427 (14.9%)
Osteoarthritis	1,752,200 (27.9%)	135,904 (28.8%)
Chronic pain	828,567 (13.2%)	74,694 (15.9%)
Depression	2,266,675 (36.1%)	183,372 (38.9%)
Post-traumatic stress disorder	1,277,666 (20.4%)	109,635 (23.3%)
Bipolar	1,323,827 (21.1%)	104,486 (22.2%)
Schizophrenia	317,835 (5.1%)	14,464 (3.1%)
Substance abuse	1,501,786 (23.9%)	120,275 (25.5%)
Alcohol abuse	1,365,015 (21.8%)	101,986 (21.6%)
Comorbidity indexes		
Comorbidity-polypharmacy index, median (IQR)	24 (14-37)	23 (14–35)
Charlson index, median (IQR)	1 (0-2)	1 (0–3)
Dual diagnosis, n (%)	1,325,975 (21.1%)	104,221 (22.1%)
Utilization		
Total ED visits, median (IQR)	7 (3–14)	7 (3–15)
Total outpatient clinic ICD 9 codes, median (IQR)	313 (129–632)	389 (160–766)
Total narcotic doses, median (IQR)	392 (90–2106)	170 (20–1012)
Initial pain score, median (IQR)	8 (5–9)	4 (0–7)
Diagnosis, n (%)		
Musculoskeletal	3,520,147 (56.1%)	332,034 (70.5%)
Soft tissue	2,322,551 (37.0%)	170,826 (36.3%)
Trauma	3,055,676 (48.7%)	267,433 (56.8%)
Cancer	1,051,614 (16.8%)	24,968 (5.3%)
Psychiatric	2,056,036 (32.8%)	133,399 (28.3%)
Medical	5,681,522 (90.6%)	407,142 (86.4%)

ED, emergency department; *HD/A,* hydrocodone/acetaminophen

abuse. The chronic pain conditions were central pain syndrome, chronic fatigue syndrome, chronic headache, chronic interstitial cystitis, chronic pain, fibromyalgia, irritable bowel syndrome, psychogenic pain, and temporomandibular joint disorder.

Analysis

We summarized the characteristics of the participants by age, gender, ethnicity, comorbidity, utilization factors, date, and diagnosis. In addition, for each ED visit, characteristics were organized by year to identify trends in prescribing habits. We used the chi-square test, with 95% confidence intervals, to examine differences among characteristics between groups. Pearson's correlation coefficient was used to evaluate prescribing trends by year. Multivariable logistic regression was used to determine the characteristics that best predicted who received a prescription for hydrocodone/acetaminophen.

RESULTS

Study Population

The ED cohort included 1,709,545 individuals who met the inclusion criteria. They accounted for 6,270,742 ED visits between January 1, 2009, and June 30, 2015. Their median age was 58 years (interquartile range, [48–66]), 91% were male, and 59% were Caucasian. Across all ED visits, the average CPS was 28 (median 24, interquartile range, [14–37]), with 22% having coronary artery disease, 32% having diabetes, and 13% having at least one chronic pain diagnosis. Roughly 36% had depression, 20% had post-traumatic stress disorder, and 21% had a dual diagnosis of a mental health condition and a substance abuse problem (Table 1). All demographic values had significant p values (less than 0.001) when comparing all ED visits to those visits where hydrocodone/acetaminophen was prescribed.

The most frequently prescribed medication for all ED visits was hydrocodone/acetaminophen (471,221 [7.5% of ED visits]), followed by ibuprofen (247,460 [4.0%]) and prednisone (245,990 [3.9%]) (Table 2). The most common ED diagnoses were back pain (264,589 [4.2%]), chest pain (233,437 [3.7%]), and skin infections (187,765 [3.0%]). The most common diagnoses among those receiving a prescription for hydrocodone/acetaminophen were back pain (76,131 [16.2%]), arthropathy (63,550 [13.5%]), and oral/dental issues (25,577 [5.4%]) (Table 3).

Table 2. Most frequently prescribed medications in the ED cohort.

Medication	Count
Hydrocodone/acetaminophen	471,224
Ibuprofen	247,460
Prednisone	245,990
Albuterol	230,602
Azithromycin	194,010
Cyclobenzaprine	162,929
Tramadol	158,027
Naproxen	154,006
Omeprazole	151,325
Amoxicillin/clavulanate	140,370

ED, emergency department

Table 3. Top diagnoses resulting in a hydrocodone/acetaminophen prescription.

Diagnosis	ICD-9 codes	ED visits	No. of prescriptions
Back pain	724	264,589 (4.2%)	76,131 (16.2%)
Arthropathy	710-719	281,336 (4.5%)	63,550 (13.5%)
Oral, dental	520-529	27,730 (0.4%)	25,577 (5.4%)
Skin infection	680-686	187,765 (3.0%)	23,291 (4.9%)
Abdominal pain	789	156,745 (2.5%)	16,616 (3.5%)
Chest pain	786.5	233,437 (3.7%)	13,593 (2.9%)
Neck pain	723	47,461 (0.8%)	12,038 (2.6%)
Nephrolithiasis	592	32,728 (0.5%)	11,795 (2.5%)
Gout	274	42,351 (0.7%)	9,771 (2.1%)
Headache	784, 339	85,502 (1.4%)	7,732 (1.6%)

ED, emergency department

Prescribing Trends

Within the VA system, the annual number of prescriptions for hydrocodone/acetaminophen peaked at 80,776 in 2011, associated with 8.7% of ED visits during that year. The number has shown a downward trend since that time, decreasing to 63,991 (6.33% of visits) in 2014 and 35,031 (5.6% of visits) for the first half of 2015. Beginning at the peak in 2011, the data show a strong linear correlation with

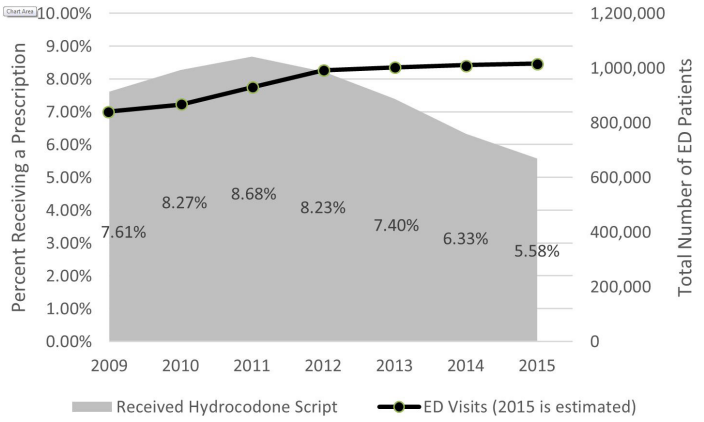

Figure 1. Hydrocodone/acetaminophen prescribing percentages.

Table 4. Hydrocodone/acetaminophen prescribing predictors.

Characteristic	Odds ratio	Lower CI	Upper CI	P-value
Demographics				
Age, ≤48 years (Q1)	1.248	1.240	1.256	<0.001
Age, >48 and <66 years (Q1-Q3)	1.079	1.073	1.085	<0.001
Age, ≥66 years (Q3)	0.679	0.670	0.688	<0.001
Male	1.112	1.100	1.123	<0.001
Caucasian	1.213	1.207	1.220	<0.001
Comorbidities				
Cardiovascular disease	0.946	0.937	0.954	<0.001
Type 2 diabetes	0.988	0.981	0.996	0.002
Chronic kidney disease	0.929	0.918	0.940	<0.001
Chronic obstructive pulmonary disease	0.909	0.900	0.918	<0.001
Osteoarthritis	0.982	0.975	0.989	<0.001
Chronic pain	0.952	0.943	0.960	<0.001
Depression	1.026	1.019	1.034	<0.001
Post-traumatic stress disorder	1.101	1.093	1.109	<0.001
Bipolar	0.963	0.955	0.972	<0.001
Schizophrenia	0.757	0.739	0.774	<0.001
Substance abuse	1.050	1.039	1.061	<0.001
Alcohol abuse	0.991	0.980	1.001	0.075
Comorbidity Indexes				
Comorbidity-polypharmacy index, ≤14 (Q1)	0.836	0.826	0.847	<0.001
Comorbidity-polypharmacy index, >14 and <37 (Q1-Q3)	1.062	1.056	1.068	<0.001
Comorbidity-polypharmacy index, ≥37 (Q3)	1.010	1.001	1.020	0.035
Dual diagnosis	0.972	0.959	0.985	<0.001
Utilization				
Total ED visits, ≤3 (Q1)	1.282	1.271	1.293	<0.001
Total ED visits, >3 and <15 (Q1–3)	1.039	1.033	1.046	<0.001
Total ED visits, ≥15 (Q3)	0.831	0.822	0.840	<0.001
Total outpatient clinic ICD 9 codes, ≤160 (Q1)	1.843	1.833	1.853	<0.001
Total outpatient clinic ICD 9 codes, >160 and <389 (Q1-Q3)	0.987	0.981	0.994	<0.001
Total outpatient clinic ICD 9 codes, ≥766 (Q3)	0.663	0.653	0.672	<0.001
Total narcotic doses, ≤20 (Q1)	0.132	0.116	0.147	<0.001
Total narcotic doses, >20 and <1012 (Q1–Q3)	1.366	1.360	1.372	<0.001
Total narcotic doses, ≥1012 (Q3)	1.506	1.499	1.513	<0.001
Initial pain score of 7 or higher	3.199	3.192	3.205	<0.001
Diagnosis				
Musculoskeletal	1.622	1.615	1.630	<0.001
Soft tissue	1.656	1.649	1.664	<0.001
Trauma	0.813	0.799	0.827	<0.001
Cancer	0.746	0.738	0.753	<0.001
Psychiatric	0.950	0.943	0.957	<0.001
Medical	1.361	1.354	1.367	<0.001

ED, emergency department

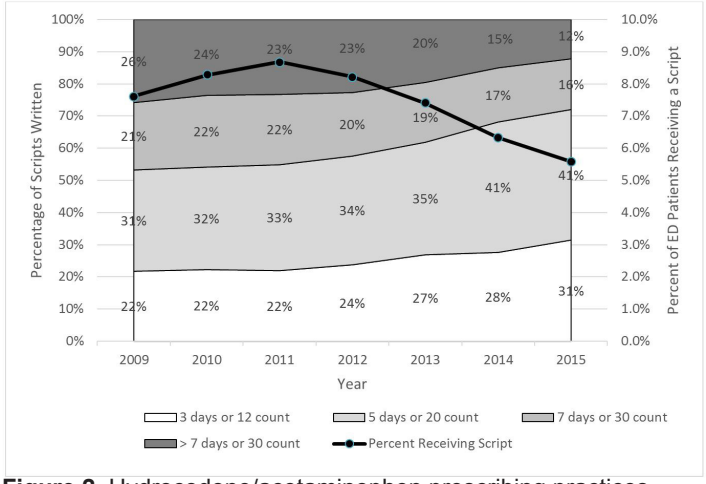

Figure 2. Hydrocodone/acetaminophen prescribing practices. *ED,* emergency department

time (r =–0.99 [p <0.001]). The number of ED visits increased from 841,256 in 2009 to 1,010,773 in 2014 and is estimated to be 1,015,968 in 2015 (Figure 1).

Overall, the average number of pills prescribed was 32 (standard deviation 38), with a median of 20 (interquartile range, [15–30]). The percentage of prescriptions limited to twelve and a three-day supply increased from 22% (13,949) in 2009 to 31% (11,026) for the first half of 2015. A similar increase was noted for prescriptions limited to 13 to 20 pills: from 31% (20,166) in 2009 to 41% (5,847) during the first half of 2015. For the same years, prescriptions of 21 to 30 pills decreased from 21% (13,412) to 16% (2,168), and prescriptions over 30 pills decreased from 26% (16,526) to 12% (4,266) (Figure 2).

Predictors of Hydrocodone/Acetaminophen Prescribing

The predictive factors found by our logistic regression model are shown in Table 4. The factors associated with patients less likely to get a prescription for hydrocodone/acetaminophen were being 66 years or older (the third quartile for age, OR 0.679, CI [0.670–0.688]), visiting the ED 15 or more times during their tenure within the VA system (third quartile for ED visits, OR 0.831, CI [0.822–0.840]), and having more than 766 total outpatient clinic ICD-9 codes (third quartile, OR 0.663, CI [0.653–0.672]). Other patients who were less likely to get a prescription were those with a CPS below 14 (first quartile, OR 0.836, CI [0.826–0.847]); those with a dual mental health/substance abuse diagnosis (OR 0.972, CI [0.959–0.985]); or those with an ED diagnosis related to trauma (OR 0.813, CI [0.799–0.827]), cancer (OR 0.7-0.46, CI [0.738–0.753]), or a psychiatric issue (OR 0.950, CI [0.943–0.957]).

A prescription for hydrocodone/acetaminophen was more likely to be written for males (OR 1.112, CI [1.100–1.123]); Caucasians (OR 1.213, CI [1.201–1.220]); those with an initial pain score of 7 or higher (OR 3.199, OR [3.192–3.205]); and those with a musculoskeletal (OR 1.622, CI [1.615–1.630]), soft tissue (OR 1.656, CI [1.649–1.664]), or medical (OR 1.361, CI [1.354–1.367]) diagnosis in the ED. Those with a CPS between the first and third quartiles were also more likely to get a prescription (OR 1.062, CI [1.056–1.068]). In addition, a prescription was more likely for those who received at least 1,012 total opioid medication doses during their tenure within the VA system (third quartile, OR 1.506, CI [1.499–1.513]), for those who visited the ED three times or less during their tenure within the VA system (first quartile, OR 1.282, CI [1.271–1.293]), or for those having 160 or fewer total outpatient clinic ICD-9 codes (first quartile, OR 1.843, CI [1.833–1.853]).

DISCUSSION

In this retrospective study of more than six million ED visits within the VA system, hydrocodone/acetaminophen was the most frequently prescribed medication. Because of its heavy and widespread utilization in the U.S., this medication has come under scrutiny. In our veteran population, for those seeking emergency medical care, prescriptions for hydrocodone/acetaminophen were written almost twice as often as for the next most common drug, ibuprofen. In fact, five of the 10 most prescribed medications given through the ED target pain relief. Back pain and arthropathy were the most common diagnoses for ED visits during which a prescription for hydrocodone/acetaminophen was given.

In the time of interest in this study, the percentage of VA patients receiving hydrocodone/acetaminophen scripts in the ED peaked in 2011. This coincides with the determination by the CDC that prescription opioids were the primary cause of a spike in drug-related deaths and predates the reclassification of hydrocodone/acetaminophen as a Schedule II controlled substance by the Drug Enforcement Agency, and predates the VA's Opioid Safety Initiative. Overall, both the number of tablets given at each ED visit and the proportion of patients receiving a prescription have decreased, despite the increasing number of ED visits. The rate of decrease has remained constant since 2011 and did not change after the reclassification in October 2014. The proportion of prescriptions consistent with the latest best-practice recommendation of no more than twelve pills and a three-day supply increased (from 22% to 29%), while the proportion of scripts for large numbers of pills decreased by more than half (from 26% to 12%) over the same period. These important improvements are likely due to the efforts of many professional societies, but the numbers are still not at goal.

The demographics of our study group match those of other studies of the Veterans Administration population. Table 1 shows a slight increase in the proportion of Caucasian females receiving prescriptions. Our logistic

regression model revealed that patients who were male (OR 1.112) and Caucasian (OR 1.213) were more likely to get scripts for hydrocodone/acetaminophen than females or other ethnicities. This finding warrants further investigation that might suggest a potential bias among the many confounding factors. It is notable that, due to our large study size, we had sufficient power to detect small effects that may not be clinically significant.

Patients who presented in severe pain (with a pain score of 7 or higher) and those who had a musculoskeletal, soft tissue, or medical diagnosis were more likely to receive a hydrocodone/acetaminophen prescription. Patients with cancer or a trauma diagnosis or with a history of chronic pain were less likely to receive a prescription for this drug. This observation might be the result of a substitution effect, that is, patients with cancer or traumatic injuries received different pain medications. With the exception of schizophrenia, psychiatric comorbidities had very little impact on prescribing habits. In addition, patients with an alcohol or a substance abuse diagnosis received prescriptions at very nearly the same rate. There also appears to be a population receiving this medication that is young, visits EDs and outpatient clinics infrequently, and is relatively healthy (Table 4).

LIMITATIONS

This study is retrospective and therefore subject to selection bias, misclassification, and confounding. Our results can only show associations, and not causation. We defined our population using administrative data and ICD-9 codes. We analyzed the veteran population, a nationwide cohort of more than six million ED visits from more than 150 hospitals across the U.S.

We did not include prescriptions filled at pharmacies outside the VA. However, the VA is designed to be a contained system, with integrated pharmacy, inpatient, and outpatient services. This analysis focused on hydrocodone-acetaminophen, and did not investigate potential substitution with other less-commonly prescribed opioid medications.

CONCLUSION

In summary, hydrocodone/acetaminophen was the most frequently prescribed ED medication within the VA system in this national sample of more than six million ED visits between 2009 and 2015. The rate of prescribing this drug has decreased since 2011. The proportion of prescriptions falling within guideline-designated safe prescribing habits increased over the same period. Relatively healthy patients, who less frequently visit the ED or outpatient clinics, with severe pain but without chronic pain, and with musculoskeletal or soft tissue diagnoses, tend to receive scripts more often than others.

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Contrast CT Scans in the Emergency Department Do Not Increase Risk of Adverse Renal Outcomes

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INTRODUCTION

It has long been accepted that intravenous contrast used in both computed tomography (CT) and plain imaging carries a risk of nephropathy and renal failure, particularly in subpopulations thought to be at highest risk.[1-3] Although early studies used high osmolality contrast media that is not typical of emergency department (ED) use today, the issue of contrast-induced nephropathy (CIN) is still an area of active interest with many studies appearing each year from many different specialties, on its pathogenesis, incidence, prevention and treatment.[4-7] The plethora of data has usually focused on the incidence of CIN, usually defined as a small (such as 25% or an absolute increase of 0.5mg/dL) increase in creatinine after receiving intravenous (IV) contrast for either a particular indication (such as cardiac catheterization) or in a particular patient group (diabetics); the meaning of a creatinine rise in this setting is not at all clear, however.[8-10] Many regimens have been proposed to ameliorate this creatinine rise, but there is a scarcity of data on what actual adverse clinical events occur and whether these can truly be ascribed to the IV contrast itself rather than the events that might well occur in a (usually) hospitalized population that required imaging. A few authors have even expressed doubt as to whether modern iodinated contrast (which is iso-osmolal) is a nephrotoxin.[11-13]

The primary objective of this retrospective, computerized chart review was to investigate an ED population of patients receiving IV contrast for CT scanning for the occurrence of two patient-oriented outcomes, death and dialysis, and compare this incidence to a contemporaneous control group of ED patients receiving similar CTs but without IV contrast. We also sought to determine if the incidence of CIN, as traditionally defined, was actually higher in the contrast group. Note that we use the traditional term "CIN" for those exhibiting a creatinine rise after CT scanning even though no patient in the control group actually received contrast.

METHODS

The study patients were all adults seen in a six-year period in the ED of an active urban teaching hospital with a census between of approximately 75,000 starting in May 2005, and concluding in May 2010. The usual practice during that time was to use IV and oral contrast for all abdominal CTs unless the creatinine was greater than 1.5mg/dL or the study was for renal colic. Rare exceptions could occur in cases of major trauma (the ED is not a Level I trauma center) or unusual clinical circumstances. Chest CTs could be either with or without contrast depending on the indication; again contrast was not used with a creatinine greater than 1.5mg/dL. To be included in the study, the patient had to have been admitted to the hospital and have at least one ED creatinine (less than 1.6mg/dL) recorded and at least one additional serum creatinine measured in the subsequent 96 hours. There were no other inclusion or external criteria applied. No patient meeting these simple inclusion criteria were excluded. We also searched for the discharge condition of "death" and the procedure, "dialysis," to identify two unambiguously relevant adverse patient-oriented outcomes. No patients were excluded if they fulfilled the inclusion criteria. The control group consisted of patients during that same period fulfilling the criteria for CT scanning, admission and creatinine testing but who received no IV contrast. All IV contrast material during the study period was non-ionic and the standard dose was 100mL per patient. Two different IV products were used during the six-year study period, Omnipaque 240 (GE Princeton, NJ) and Isovue 300 (Bracco, Italy), depending on which supplier was used at a given time. The decision as to which agent was available at any given time was dictated purely by cost considerations at the institutional purchasing level. The use of the two agents varied at least four times during the study period; Omnipaque 240 was used during the last three years of the study. Although oral contrast agents are not traditionally considered a significant risk in post-imaging creatinine elevation, the oral agent used from 2005 to 2008 was

Gastrografin (Bracco, Italy) (20mL in 950mL of water). From 2008 through 2010 the oral agent used was Omnipaque 240 (25mL in 950mL of water), a diluted concentration of the same agent used as intravenous contrast during that time.

The study received a waiver for patient consent and an expedited approval from the institutional review board. We analyzed all data using Stata 11.0. Data on adverse events (death, dialysis) were compared using chi-square; creatinines were compared using students test; alpha was set at 0.05. A single investigator was responsible for building the dataset for both the contrast and control groups. The elements of the dataset, prior to de-identification, are enumerated in Table 1. The investigator was aware that the study's purpose was to compare the incidence of CIN as traditionally defined in those ED patients who actually received IV contrast for a CT with those patients receiving a CT who did not receive contrast. We also compared the two patient-oriented outcomes of death and dialysis in the two groups. Although this investigator was not blinded to the study hypothesis, no charts were reviewed or abstracted as all patients fulfilling the inclusion criteria (two creatinine measurements in 96 hours and completion of an abdominal or chest CT) were included in the analysis.

RESULTS

There were 6,954 patients in the contrast group vs. 909 patients in the non-contrast cohort. Every patient receiving an abdominal or chest CT during the six-year period fulfilling the admission criteria was included. The contrast and non-contrast groups did not differ in any parameter examined (Table 1). The age of both groups was nearly identical (both mean 54 years with std dev. 19.4 yr vs. 18.1 yr respectively). The contrast group was 57%/43% female to male compared with a 53%/ 47% ratio in the controls. Likewise, there was no significant difference in the incidence of diabetes in the two groups. For the primary outcomes of clinically significant adverse events, see Table 2. There were 106 deaths in the 6,954 patient contrast group versus 11 deaths in the 909 patient control group (1.5%, 95% CI [1.5%-1.8%] vs. 1.3%, 95% CI [0.7%-2.3%]; p=0.24). There were 16 patients in the contrast group (0.23%, 95% CI [0.1-0.4]) who required dialysis versus none in the non-contrast controls (95% CI [0.0% -0.3%], p=0.14). Regarding the incidence of what is traditionally termed "CIN" (defined as an increase of 25% or more within 96 hours of admission, but in this case regardless whether contrast was actually administered) 598 of 6,954 (8.6%, 95% CI [0.8%-9.3%]) receiving contrast met this criterion compared with 87 of 909 (9.6%, 95% CI [0.078-0.117]) patients not receiving contrast (p=0.32) (Table 2).

It is difficult to establish whether the contrast group was inherently a "sicker" group than the non-contrast controls, but it does not appear there were major differences. To be included, both groups were admitted to the hospital as inpatients. Mean length of stay for the contrast group was 5.3 days vs. 5.0 days in the non-contrast controls (p>0.75). Five hundred seventy-nine of 6,954 patients receiving contrast had any time in the intensive care unit (ICU) (8.3%) vs. 70 of 909 patients not receiving contrast (7.7%, p=0.39).

Of the 16 patients undergoing dialysis (all in the contrast group), it did appear that they all had significant medical conditions that might predispose to renal failure, even in the absence of contrast administration. Ten of the 16 patients underwent a surgical procedure (Table 3) including such major operations as aortic resection, hemicolectomy, coronary artery bypass grafting (CABG), and bowel resection. The six non-operative patients who underwent dialysis (Table 3) also appeared to have critical illnesses including sepsis, intubation,

Table 1. Patient characteristics.

Characteristics of patient	CT with IV Contrast=6954	CT without IV Contrast=909	P-value
Age	54 +/- 19.4	54 +/- 18.1	non-significant
Gender			
Male	3964 (57%)	482 (53%)	0.70
Female	2990 (43%)	427 (47%)	0.67
Diabetes	1207 (17.4%)	179 (19.7%)	0.077
LOS (days)	5.3	5.0	0.75
ICU (# percent)	579 (8.3%)	70 (7.7%)	0.39

ICU, intensive care unit; *LOS*, length of stay; *CT*, computed tomography; *IV*, intravenous

Table 2. Outcomes in the group receiving intravenous (IV) contrast vs. those not receiving IV contrast.

Outcomes	CT with IV Contrast=6954	CT without IV Contrast (control)=909	P-value
Serum creatinine increase by 25%	598 (8.6%)	87 (9.6%)	0.32
Dialysis	16 (0.23%)	0 (0%)	0.14
Death	106 (1.5%)	11 (1.25%)	0.24

CT, computed tomography

Table 3. Medical and surgical cases associated with inpatient dialysis.

Surgical Conditions Associated with Dialysis (10 cases)	Medical Conditions Associated with Dialysis (6 cases)
1. Aortic resection and replacement	1. Diabetic with UTI
2. CABG	2. Pancreatitis and HIV
3. Laparotomy	3. GI hemorrhage requiring intubation (had bleeding scan)
4. Hemicolectomy (two cases)	4. Sepsis requiring intubation
5. Lysis of adhesions	5. Pancreatitis requiring intubation
6. Open lung biopsy	6. Pneumonia requiring intubation and lung biopsy
7. Small bowel resection	
8. Radical pancreaticoduodenectomy	
9. Thoracic vessel resection and replacement	

HIV, human immunodeficiency virus; *CABG,* coronary artery bypass graft; *UTI*, urinary tract infection; *GI*, gastrointestinal

and gastrointestinal bleeding with shock. In no case did a patient without severe intercurrent illness who received contrast require dialysis. Despite these 16 isolated incidences (comprising less than 0.3% of all patients receiving IV contrast) there was no overall difference in dialysis between the contrast group and controls.

DISCUSSION

The vast literature relating to CIN has focused almost exclusively on its detection and prevention as defined by a creatinine rise that varies from study to study; at least five different definitions have been used.[14] In the current study our 8.6% incidence of CIN after contrast was squarely within the usual range. Although it is commonly noted that individual cases of severe renal failure, dialysis and death have occurred, it is uncertain how frequent such events are and there are no studies of ED populations comparing such patient-oriented outcomes in similar patients who did not receive contrast but did receive imaging. A recent article pertaining to the ED identified six patients (out of 633) with both study-defined CIN and serious adverse outcomes and concluded that "CIN was associated with severe renal failure and death from renal failure," but all their patients had received contrast; there was no comparison group.[15] The association between a rising creatinine and an adverse outcome (which included as "severe renal failure" a creatinine above 3.0) is not surprising. It is the unproven implication that the contrast administration was causally associated with the adverse outcomes that is of clinical relevance. Interestingly, the same authors, in a second paper, noted, "the precise contribution of the contrast load as the cause of the renal failure remains a matter of debate."[16] A recent ED study with a similar methodology to our own failed to demonstrate an increased risk of either CIN or adverse outcomes in the contrast-exposed group. In fact, the incidence of CIN itself was higher in the controls while mortality was the same in both groups.[17] It appears that the temporal relationship between an increasing creatinine and receiving IV contrast has led to an assumption of causality that is not valid. As to the absolute incidence of CIN in those receiving contrast, a previous ED study in trauma patients (a younger and perhaps healthier cohort) reported an incidence of CIN of 5.1%.[18] A huge meta-analysis comprising over 40 studies and almost 20,000 patients reported a similar point estimate of 6.4%.[19]

Although the proposition that intravenous contrast administration in patients with preserved renal function may be entirely free of renal toxicity may appear heretical to the emergency clinician, there is actually strong, if indirect, support for the idea in the radiology literature. Newhouse reported on an inpatient cohort of more than 30,000 patients followed for less than one week, none of whom received intravenous contrast. Remarkably, over half the patients had an elevation in creatinine of greater than 25%. Further, the elevation was even more likely in patients with the best renal function at baseline.[20]

LIMITATIONS

Our study's most serious limitation is that the contrast and control groups are undoubtedly dissimilar in ways that are not captured by the parameters we measured, particularly age, gender and diabetic status. Although it might appear that since abdominal CTs without contrast are much more likely to be used in patients where less serious disease is suspected (for example, those with renal colic, which would make our results even more remarkable), it may be that patients with a creatinine less than 1.6mg/dL, being scanned without contrast, who are then admitted represent a subgroup of particularly ill patients, although this was not evident in our analysis of length of stay or ICU admission. Similarly, those receiving a chest CT without contrast (perhaps pneumonia or cancer) are not obviously a more or less morbid group than those who do receive contrast, which would include, for example, all those in whom pulmonary embolism is suspected.

A second limitation is that we compared the contrast and control groups for only a limited number of variables that seemed most likely to be surrogate markers for a trait that would predispose to more (or fewer) instances of creatinine rise and adverse clinical outcomes. Our finding, that these characteristics, (age, gender, and diabetic status), were not different is consistent that of Sinert et al. [17] who looked at many

other factors as well, including race, insurance status, estimated creatinine clearance, lactate, bicarbonate, HIV, and sickle cell disease. They, too, found no explanation for the similarity in creatinine rise between those receiving contrast for CT and controls. As our controls, unlike theirs, all received a CT during hospital admission, their conclusion that their findings "further bring into question the current definition of contrast-induced acute kidney injury to differentiate the outcomes of contrast-exposed and contrast-unexposed patients" are confirmed and extended by our current, much larger study. Finally, a potential weakness, that the investigator compiling the dataset was aware of the study hypothesis, is unlikely to have had any effect. All data came from the ED and inpatient electronic medical records systems (EmStat® and Prism®). No charts were retrieved and no data were abstracted from chart review; no judgment was employed in determining eligibility. We included in the analysis all patients meeting our simple inclusion criteria (admission, abdominal or chest CT and two creatinine determinations within 96 hours of admission).

CONCLUSION

A rise in the serum creatinine of 25%, usually used to define contrast-induced nephropathy, is equally common in patients admitted from the ED who received chest or abdominal CTs whether or not they received IV contrast. The important patient-oriented outcomes of death and dialysis were also not significantly more frequent in such patients receiving IV contrast than in those receiving no contrast at all. There do not appear to be demographic or clinical characteristics in either the contrast or non-contrast groups that correlate with an elevation in serum creatinine (referred to as CIN in those receiving contrast). The likelihood of serious clinical outcomes (death and dialysis) after abdominal or chest CT is also not significantly different in those two groups. As contrast CTs in published ED studies have been limited to patients with relatively preserved renal function these reassuring results should not be extrapolated to patients with significant renal compromise, a subset of the ED population in which further investigation is clearly warranted.

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Trends in Hospital Admission and Surgical Procedures Following ED visits for Diverticulitis

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Introduction: Diverticulitis is a common diagnosis in the emergency department (ED). Outpatient management of diverticulitis is safe in selected patients, yet the rates of admission and surgical procedures following ED visits for diverticulitis are unknown, as are the predictive patient characteristics. Our goal is to describe trends in admission and surgical procedures following ED visits for diverticulitis, and to determine which patient characteristics predict admission.

Methods*:* We performed a cross-sectional descriptive analysis using data on ED visits from 2006-2011 to determine change in admission and surgical patterns over time. The Nationwide Emergency Department Sample database, a nationally representative administrative claims dataset, was used to analyze ED visits for diverticulitis. We included patients with a principal diagnosis of diverticulitis (ICD-9 codes 562.11, 562.13). We analyzed the rate of admission and surgery in all admitted patients and in low-risk patients, defined as age <50 with no comorbidities (Elixhauser). We used hierarchical multivariate logistic regression to identify patient characteristics associated with admission for diverticulitis.

Results: From 2006 to 2011 ED visits for diverticulitis increased by 21.3% from 238,248 to 302,612, while the admission rate decreased from 55.7% to 48.5% (-7.2%, 95% CI [–7.78 to -6.62]; p<0.001 for trend). The admission rate among low-risk patients decreased from 35.2% in 2006 to 26.8% in 2011 (-8.4%, 95% CI [–9.6 to –7.2]; p<0.001 for trend). Admission for diverticulitis was independently associated with male gender, comorbid illnesses, higher income and commercial health insurance. The surgical rate decreased from 6.5% in 2006 to 4.7% in 2011 (-1.8%, 95% CI [–2.1 to –1.5]; p<0.001 for trend), and among low-risk patients decreased from 4.0% to 2.2% (- 1.8%, 95% CI [–4.5 to –1.7]; p<0.001 for trend).

Conclusion: From 2006 to 2011 ED visits for diverticulitis increased, while ED admission rates and surgical rates declined, with comorbidity, sociodemographic factors predicting hospitalization. Future work should focus on determining if these differences reflect increased disease prevalence, increased diagnosis, or changes in management. [West J Emerg Med. 2016;17(4):409-417.]

INTRODUCTION

Colonic diverticular disease is increasingly prevalent in the developed world and affects more than half of the population over the age of 65 years.[1] It is estimated that approximately 20% of patients with diverticulosis develop diverticulitis over the course of their lifetime.[2] Diverticulitis frequently causes abdominal pain, which accounts for approximately 8% of U.S. emergency department (ED) visits.[3] Approximately 300,000 patients are admitted to U.S. hospitals for diverticulitis each year, accounting for 1.5 million days of inpatient care per year.[4,5]

Treatment of diverticulitis is based on comorbidities and severity, with severe disease requiring admission and possible surgical intervention.[6,7] A recent meta-analysis[8] and prospective randomized control trial[9] both demonstrate the safety of outpatient management with oral antibiotics for uncomplicated diverticulitis. In 2014 the American Society of Colon and Rectal Surgeons recommended outpatient management in selected patients with uncomplicated diverticulitis.[7,10] Despite evidence to support outpatient management, the published literature has reported increased admission and surgical rates from the late 1990s to early 2000s.[11,12]

With the increasing prevalence of diverticular disease and the increasing role of the ED in management of acute conditions, we aimed to determine if there has been a change in hospital admission and surgery among ED patients with diverticulitis. This study analyzed data from a national all-payer hospital billing dataset to evaluate the prevalence, the rate of admission, and the rate of surgical intervention for patients with diverticulitis who presented to the ED. Additionally, we determined patient predictors of admission for patients. Specifically, we hypothesized that rates of admission and surgery have decreased in recent years.

METHODS

Study Design and Data Source

We conducted a cross-sectional descriptive analysis using data on ED visits from 2006-2011 to determine change in admission and surgical patterns over time. Additionally, to determine patient predictors of admission, we performed a multiple variable logistic regression analysis, adjusting for patient comorbidity using the system developed by Elixhauser.[13] This study was approved by the institutional review board at Brigham and Women's Hospital.

The Nationwide Emergency Department Sample (NEDS) was used for our analysis. NEDS is a U.S. administrative database that is part of the Healthcare Cost and Utilization Project.[14] NEDS is a component of the Healthcare Cost and Utilization Project (HCUP) of the Agency for Healthcare Research and Quality (AHRQ); it is the largest all-payer ED database publicly available in the U.S.[14] NEDS contains 26 to 29 million ED records per year from approximately 950 annually selected hospitals, which represents roughly a 20% stratified sample of hospital-based EDs in the U.S.[14]

NEDS uses a complex sampling design stratified by sampling weight, geographic region, trauma center designation, urban–rural status, teaching hospital status, and hospital ownership to allow for calculation of national estimates.[14] Visit details available in NEDS include patient demographics, visit disposition (home, transfer to another facility, admitted to hospital, or expired), and up to 15 diagnoses from the final location (e.g. inpatient diagnoses are from the hospital bill while diagnoses for patients discharged from the ED are from the ED bill). By incorporating sampling weights provided in NEDS, we were able to generate national estimates for ED utilization at both hospital and visit level in the U.S. More detailed descriptions of NEDS can be found elsewhere.[14]

Study Population

We included ED visits by adult patients, 18 years and older, who had an International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) code for diverticulitis of the large colon (562.11, 562.13) as their principal diagnosis. In sensitivity analyses, we included ED visits where diverticulitis was a secondary diagnosis and where the principal diagnosis was thought to be diverticulitis-related, e.g. abdominal pain (Appendix A).

We excluded patients with a disposition of neither discharge nor admission (left against medical advice, not admitted, destination unknown, or died in the ED; 0.38%). We also excluded hospitals with <10 cases (18.8% of hospitals; 1.1% of visits) because low hospital volumes result in unstable estimates of admission rates. We excluded patients with complicated diverticulitis as defined by the American College of Surgeons[7] (i.e., peritonitis, obstruction, perforation and abscess) and those with sepsis or shock, because virtually all such patients should be admitted to the hospital from the ED (Appendix B). We defined low-risk patients as those with no Elixhauser comorbidities and as age less than 50, which is defined as "young" by the American College of Colon and Rectal Surgeons.[7]

Study Outcome and Variables

The primary outcome of interest was hospital admission after ED visits. We classified patients as admitted if they were admitted to the hospital or transferred to an acute care hospital after the initial ED visit, because the decision to transfer a patient represents a similar use of hospital care rather than discharging the patient to outpatient management. Patients were classified as discharged if their disposition was "routine ED discharge," "transfer to skilled nursing or intermediate care facility," "home health care," or "discharge or transfer to court or law enforcement."

An additional outcome of interest was the rate of surgical procedures; the surgical rate was calculated for all admitted patients and the low-risk sub-group. Data for outpatient, elective surgery were not available. We defined surgery as patients with at least one ICD-9 procedure code that indicated the patient had

undergone a colectomy (45.7x or 45.94), a low anterior resection (48.6x), a colostomy (46.1x), an ileostomy (46.2x), a laparotomy (54.11 or 54.19), diagnostic laparoscopy (54.21), laparascopic lysis of adhesions (54.51), or percutaneous drainage (54.91).

Data Analysis

National estimates of ED visits, admission rates and surgical rates for diverticulitis were estimated accounting for NEDS's complex sampling design and sampling weights. We tested the trend in admission and surgical rates from 2006–2011 by logistic regression modeling by calendar year. The admission rate was defined as the number of patients admitted or transferred to another hospital, divided by the number of ED visits. The surgical rate was defined as the number of patients who underwent a surgical procedure, divided by the number of ED visits. Additionally, we determined an inpatient surgical rate in all admitted patients and in low-risk, admitted patients. The inpatient surgical rate was defined as the number of patients who underwent a surgical procedure, divided by the number of admitted patients. As our study population is a subset of NEDS, we applied subset analysis methods as recommended by AHRQ to obtain correct variance estimates for these descriptive statistics.

Patient predictors include age at time of visit, gender, insurance status (private, Medicare, Medicaid, self-pay/no charge, and other), median household income (quartile within the patient's home ZIP code), and comorbid illness. We adjusted for comorbity using the system developed by Elixhauser. For each ED visit, we created dummy variables for each comorbidity cluster defined by Elixhauser, based on secondary diagnosis codes [13] and also created three dummy variables for additional conditions identified as likely to increase the chance of admission for diverticulitis that are not included in Elixhauser ("GI symptom," "GI disease," "disease severity"). For example, leukocytosis and acute renal failure are examples of diagnoses grouped under "disease severity," that would increase a patient's risk of being admitted with a principal diagnosis of diverticulitis, while benign prostatic hypertrophy is not. To determine these diagnoses, one author (MBG-E) reviewed all secondary codes on patients admitted with diverticulitis and flagged those that would increase the likelihood of admission. Independently, a surgical expert (JMH) reviewed the codes, and disagreements were resolved by discussion (Appendix C).

Statistical Analyses

We report descriptive statistics and compare trends across years using chi-square tests for trend. To account for patient clustering within EDs and the associated clustering of care patterns for admission and surgery, we created hierarchical multivariate logistic regression models using validated analytical methods used by Centers for Medicare and Medicaid Services for analyzing administrative claims to determine morbidity and readmission.[15] The models included patient and hospital characteristics as covariates. As suggested by the HCUP, sampling weights were not used in multilevel modeling. All analyses were done in SAS 9.3 (SAS, Cary, NC).

RESULTS

In 2011 there were 302,612 ED visits for diverticulitis. Mean patient age was 58 years, the majority were female (56.7%), with the plurality having private insurance (43.7%), presenting to metropolitan non-teaching hospitals (50.1%), and being located in the southern region of the U.S. (41%; Table 1). ED visits increased by 21.1% from 2006 to 2011 (Figure 1). From 2006 to 2011, admission rates decreased from 55.7% to 48.5% (-7.2%, 95% CI [–7.78 to -6.62]; test for trend, p<0.001 (Figure 1 and Table 2).

The rate of surgery decreased from 6.5% in 2006 to 4.7%

Table 1. Patient and hospital characteristics for diverticulitis emergency department visits, 2011.

Characteristics	N	%
Mean age (SD)	66,656	57.6 (0.06)
Female	37,760	56.7
Insurance		
Medicare	23,264	35.0
Medicaid	5,568	8.4
Private insurance	29,078	43.7
Self-pay/no charge	6,585	9.9
Other	2,017	3.0
Income		
Lowest quartile	15,490	23.7
Second quartile	15,843	24.2
Third quartile	17,433	26.7
Highest quartile	16,604	25.4
Region		
Northeast	13,442	20.2
Midwest	12,755	19.1
South	27,331	41.0
West	13,128	19.7
Teaching status		
Metropolitan, non-teaching	33,400	50.1
Metropolitan, teaching	22,655	34.0
Non-metropolitan	10,601	15.9
Emergency department volume		
<20,000	7,087	10.6
20,000-49,999	26,591	39.9
≤50,000	32,978	49.5

Income, quartile of the median household income of the patient's home ZIP code.
Region, as defined by the U.S. Census Bureau.

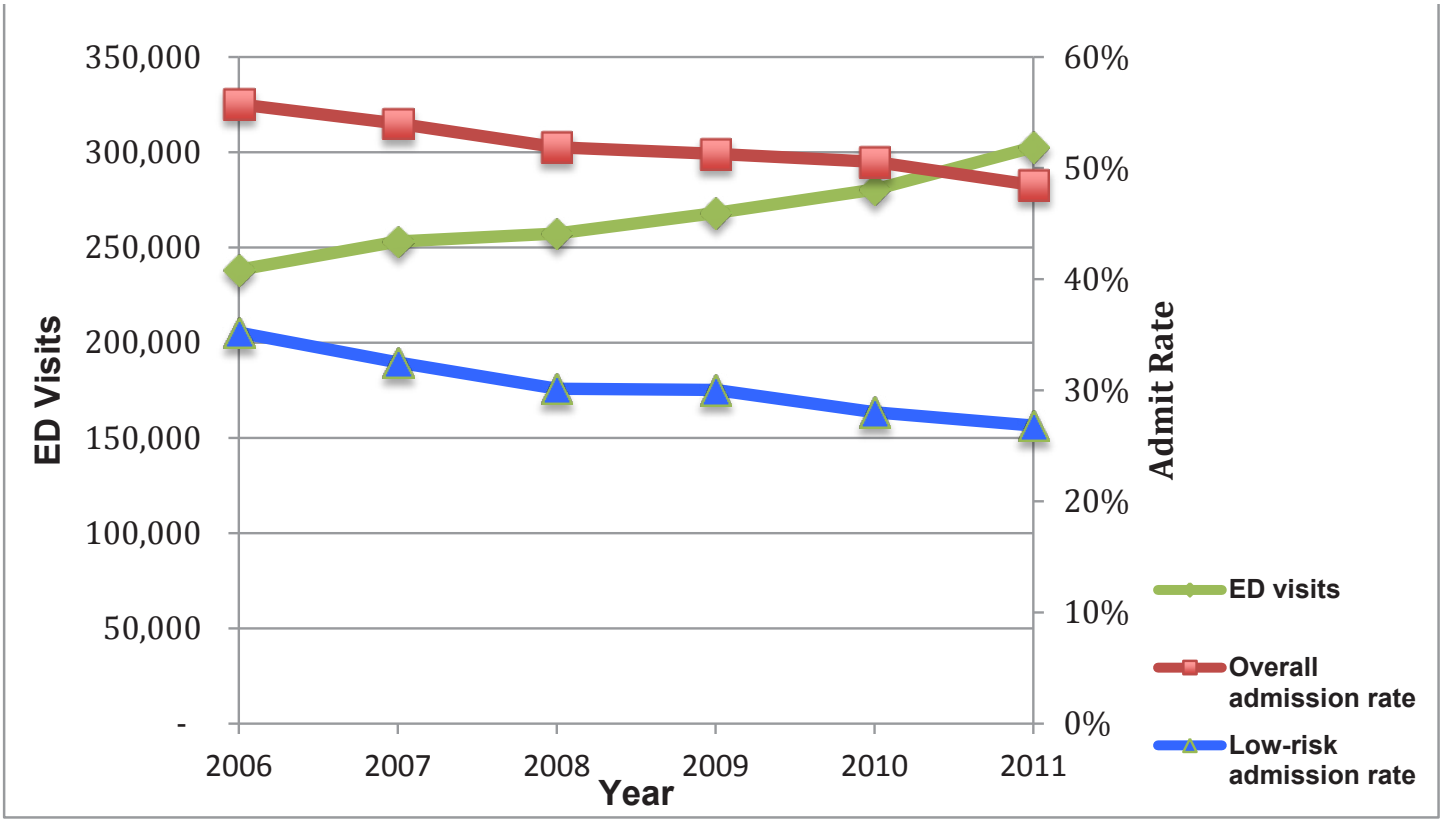

Figure 1. National trend in emergency department (ED) diagnosis and admission rates for diverticulitis, 2006-2011.
*See Table 2 for values.
For all trends, p<0.001.

in 2011 (-1.8%, 95% CI [–2.1 to –1.5]; test for trend, p<0.001) for all patients after an ED visit for diverticulitis. Among patients admitted to the hospital, the rate of surgery decreased from 11.7% in 2006 to 10.0% in 2011 (-0.7%, 95% CI [–1.2, -0.2]; p<0.001 for trend; Figure 2 and Table 3).

From 2006 to 2011, the admission rates for low risk patients decreased from 35.2% to 26.8% (-8.4%, 95% CI [–9.7 to -7.1]; test for trend, p<0.001; Figure 1 and Table 2). Among all low-risk patients, the rate of surgery decreased from 4% in 2006 to 2.2% in 2011 (-1.8%, 95% CI [–2.3 to -1.3]; test for trend, p<0.001; Figure 2 and Table 3) and among low-risk, admitted patients the surgery rate decreased from 11.5% in 2011 to 8.5% in 2006 (-3%, 95% CI [-4.5 to -1.5]; p<0.001 for trend; Figure 2 and Table 3).

The likelihood of admission varied by patient's clinical and socioeconomic characteristics (Table 4). After adjustment, increased age was not associated with increased likelihood of admission, while male gender (OR of 1.19 with 95% CI [1.13 to

Table 2. National estimates of emergency department (ED) volume and admission rate for diverticulitis, 2006–2011.

Year	Raw ED visits (N)	Raw admitted (n)	Weighted estimate of ED visits	Weighted admission rate for all patients (95% CI)*	Weighted admission rate for low-risk patients (95% CI)**
2006	50,636	28,392	238,248	55.7 (54.3, 57.2)	35.2 (33.5, 36.9)
2007	54,531	29,444	253,092	54.0 (52.6, 55,4)	32.5 (30.8, 34.2)
2008	59,191	30,968	257,257	51.9 (50.5, 53.3)	30.1 (28.7, 31.6)
2009	60,437	31,164	268,111	51.3 (50.0, 52.6)	30.0 (28.5, 31.5)
2010	62,231	31,660	280,398	50.6 (49.3, 51.9)	28.0 (26.7, 29.3)
2011	67,959	32,848	302,612	48.5 (47.2, 49.7)	26.8 (25.4, 28.2)
Average	59,164	30,744	266,620		

*p<0.001 trend, **p<0.001 trend.

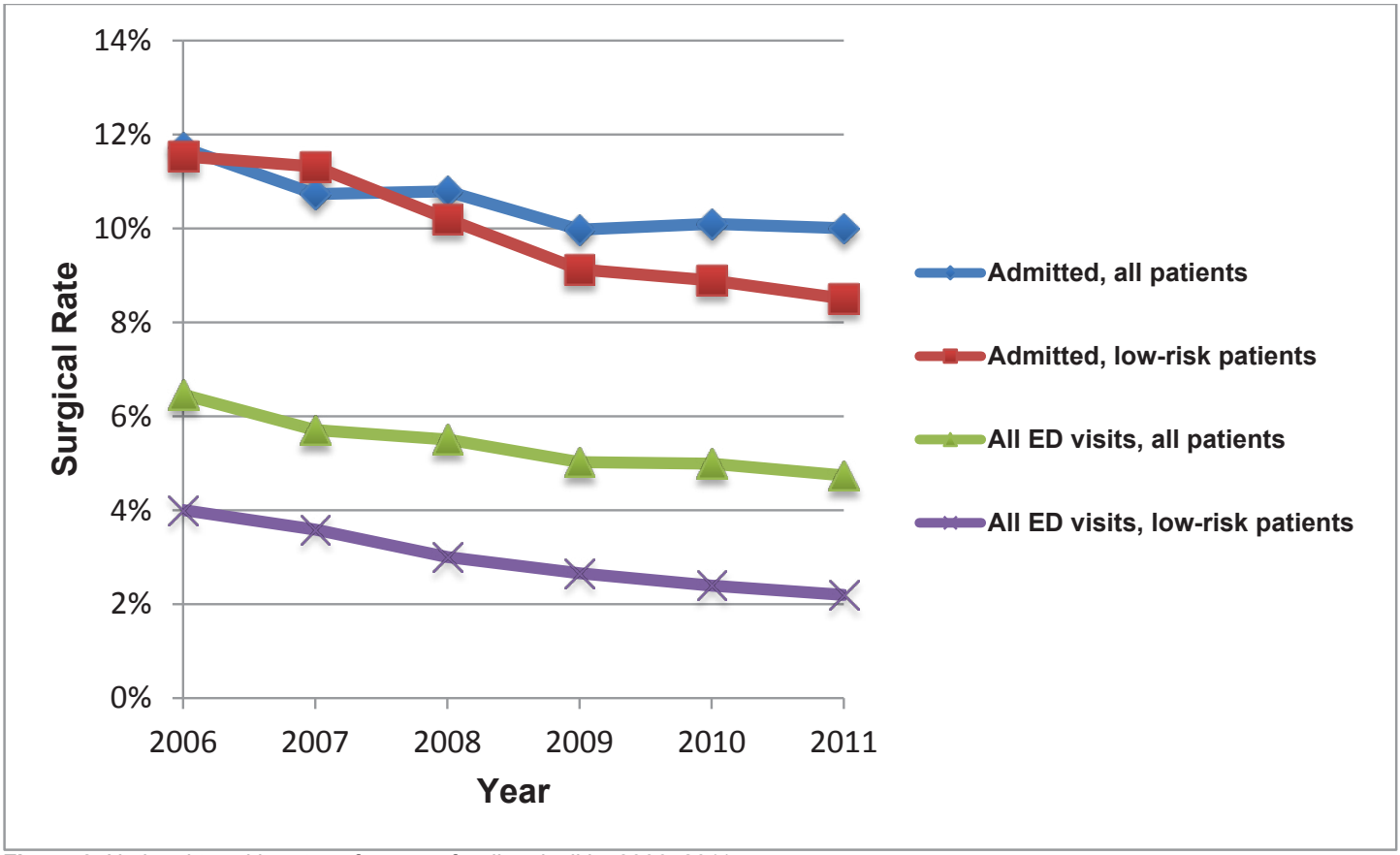

Figure 2. National trend in rates of surgery for diverticulitis, 2006–2011.
ED, emergency department
*See Table 3 for values.
For all trends, p<0.001.

1.23]) was. All Elixhauser comorbidity factors were associated with significantly increased likelihood of admission (Appendix D), except congestive heart failure (OR of 1.08 with 95% CI [0.93 to 1.25]), AIDS (OR of 1.64 with 95% CI [0.62 to 4.35]) and uncomplicated diabetes mellitus (OR of 1.03 with 95% CI [0.97 to 1.10]). Medicare and Medicaid insurance types had a decreased likelihood of admission when compared to private insurance. Other non-private insurance types (e.g., Veterans'

Table 3. National estimates of emergency department (ED) volume and surgery rate for diverticulitis, 2006-2011.

Year	National estimate of ED visits	In dataset (N)	Admitted (n)	Percentage rate of surgery for all patients (95% CI)	Percentage rate of surgery for admitted (95% CI)*	Percentage rate of surgery for all low-risk patients (95% CI)**	Percentage rate of surgery for admitted, low-risk patients (95%CI)***
2006	238,248	50,636	28,392	6.46 (6.15, 6.77)	11.72 (11.17, 12.27)	4.01 (3.59,4 .41)	11.53 (10.40, 12.67)
2007	253,092	54,531	29,444	5.71 (5.42, 5.99)	10.73(10.18, 11.29)	3.59 (3.20,3 .98)	11.31 (10.17, 12.47)
2008	257,257	59,191	30,968	5.51 (5.22,5.79)	10.792(10.25, 11.33)	3.00 (2.65, 3.36)	10.20 (9.00, 11.40)
2009	268,111	60,437	31,164	5.03 (4.78, 5.27)	9.98 (9.49, 10.47)	2.66 (2.33, 3.00)	9.12 (8.04, 10.21)
2010	280,398	62,231	31,660	4.99 (4.74, 5.24)	10.10 (9.56, 10.64)	2.40 (2.10, 2.70)	8.89 (7.76, 10.03)
2011	302,612	67,959	32,848	4.74 (4.51, 4.97)	10.00 (9.51, 10.49)	2.20 (1.91, 2.48)	8.51 (7.44, 9.57)
Average	266,620	59,164	30,744	5.36 (5.25, 5.47)	10.54(5.25, 5.47)	2.96 (2.82, 3.10)	10.01 (9.55, 10.48)

*p<0.001 trend, **p<0.001 trend, ***p<0.01 trend.

Table 4. Association of patient characteristics and emergency department (ED) admission rates for diverticulitis, 2011.

	ED visits (N)	Admission rate (%)	OR (95% CI)	
			Bivariate	Multivariate
Age				
10-year increase			1.22 (1.21, 1.23)	1.00 (0.98, 1.01)
Gender				
Male	29,222	45.8	Reference	Reference
Female	38,164	49.6	1.16 (1.12, 1.20)	0.84 (0.81, 0.88)
Insurance				
Medicare	23,541	56.6	1.73 (1.67, 1.80)	0.92 (0.87, 0.97)
Medicaid	5,631	45.7	1.04 (0.98, 1.11)	0.85 (0.79, 0.91)
Private insurance	29,355	43.7	Reference	Reference
Self-pay/no charge	6,672	39.5	0.87 (0.82, 0.92)	0.95 (0.89, 1.02)
Other	2,035	44.8	1.18 (1.07, 1.30)	1.15 (1.02, 1.29)
Income				
Lowest quartile	15,817	47.7	Reference	Reference
Second quartile	16,084	46.2	0.99 (0.94, 1.04)	1.03 (0.96, 1.09)
Third quartile	17,557	47.4	0.97 (0.92, 1.02)	1.05 (0.99, 1.12)
Highest quartile	16,620	50.6	0.98 (0.93, 1.05)	1.10 (1.02, 1.18)

Affairs) were associated with increased likelihood of admission. Self-pay was not associated with ED admission. Highest quartile income was associated with increased likelihood of admission when compared to lowest quartile.

DISCUSSION

We analyzed a large U.S. all-payer hospital claims dataset to determine recent trends in the rates of admission and rates of surgery for diverticulitis after ED visits, and assessed how patient characteristics affect admission and surgery. We found that while ED visits for diverticulitis increased by about a fifth from 2006-2011, admission rates and rates of surgical intervention declined. We identified important comorbidities and sociodemographic factors predicting hospitalization.

The rising incidence of ED visits for diverticulitis may be related to an increasing prevalence of diverticular disease, changes in care-seeking patterns, or changes in diagnostic behavior. The aging population, low dietary fiber intake, and rising rates of obesity all contribute to a rising prevalence of diverticular disease in the U.S.[16,17] This could result in more episodes of acute diverticular disease and more ED visits. As the ED has become the rapid diagnostic center of the U.S. health system, patients are more likely to get acute, unscheduled care in an ED rather than at a primary care physician's or specialist's office.[18] These changes likely are true for diverticulitis – with patients more likely to be referred to an ED initially and to receive the diagnosis of diverticulitis at the ED rather than at a primary care physician's or surgeon's office.

Finally, the increased availability, use and resolution of computed tomography (CT) have likely increased the diagnosis of diverticulitis, whereas before clinical features would have led to the diagnosis. Changes in referral patterns and increasing use of CT have likely shifted the spectrum of disease, meaning that on average ED patients diagnosed with diverticulitis have less severe cases.[11,12,16,17] Our findings are in parallel with two earlier studies based on the national inpatient sample that also found increased incidence of diverticulitis.[11,12] However, these studies, performed 10 years ago, found increased rates of admission and surgical procedures over time, contrary to our findings. Further research is needed to determine whether the change to less admission and surgery is due to changes in disease incidence or patterns of medical care.

The declining rate of overall and among low-risk patients reflects changes in the ED population with diverticulitis and changes to the surgical guidelines. Recent research and treatment recommendations, including the American Society of Colon and Rectal Surgeons' practice parameters, support outpatient management for uncomplicated diverticulitis and first attempting medical, rather than surgical management, for those admitted with diverticulitis.[7,19,20] Our findings suggest that the surgical community is changing its standard of care towards non-operative management and increased outpatient management for diverticulitis. It is unlikely that the change in management is completely explained by a shifting spectrum of disease, with lower severity cases of diverticulitis being diagnosed in the ED. The move to less surgery and more outpatient management is patient-centered on face, as few patients want surgery or to be hospitalized. Additionally, low rates of operative management

raise questions on the necessity of CT for clinical diverticulitis in younger, low-risk patients. Future research should aim to determine if the relationship between declining admission and surgical rates are related to changes in disease incidence, practice patterns or severity. Analysis of large datasets merged with electronic health record clinical data could demonstrate if severity is changing, by evaluation of clinical data including vital signs, radiology results, and lab tests to identify evidence of sepsis, abscesses or perforation.

We defined age<50 in our definition of low risk, as the American Society of Colorectal Surgeons recommends against routine elective resection in younger patients (<50 years).[7] Of note, management of young patients (less than 50 years of age) with diverticulitis is one area of controversy. The controversy arose from several papers from the 1990s that reported a more severe course of disease and higher complication rates in young patients,[21–24] while more recent studies and meta-analysis found no difference from disease behavior in older age groups.[19,25–30] Current analysis suggests that the prior studies were performed before the CT era and included only a small number of patients, putting them at risk of misclassification and selection bias due to recognition of more severe cases and exclusion of mild cases.[25] This group, similar to other age groups, has experienced an increase in rates of diagnosis,[11,12] which is likely related to increased rates of diverticulitis. The obesity epidemic and dietary preferences are associated with increased prevalence of diverticular disease. Additionally, increased use of CT in the young, and increased awareness of diverticulitis as a potential diagnosis in the this age group have likely led to more frequent diagnosis.[31,32]

Our data demonstrate a decrease in the rates of admission and surgery in ED patient visits for diverticulitis from 2006-2011, with low-risk patients having lower admission and surgical rates when compared to the overall population. This indicates these decreased rates are likely due to changes in practice pattern, though it is possible that decreased virulence of diverticulitis is playing a role. It is further notable that surgical procedures declined despite including percutaneous drainage. This was included as a surgical procedure as it indicates an intervention and would require admission. Further investigation should be done to determine if lower admission rates in low-income patients result in worse clinical outcomes as evidenced by return visits or complications. We also evaluated the rates of surgical procedure in admitted patients, and again compared the rates overall to the rates in the low-risk population. The percentage of surgery is similar for admitted low-risk patients (10.5%) when compared to all admitted patients (10.0%) with overlapping CIs. This suggests that once admitted, the primary factor affecting the decision to operate is illness severity, rather than age and comorbid conditions.

We found that patients with Medicare and Medicaid were less likely to be admitted than privately insured patients after adjustment for patient factors and comorbid conditions. The data on the effect of insurance status and the decision to admit patients with diverticulitis from the ED are mixed. One study found higher rates of "avoidable" admissions in uninsured and Medicaid patients,[33] and several other studies found lower rates of admission for uninsured and underinsured patients.[34–36] We found a similar pattern between patient's income and admission: patients residing in areas with the highest quartile of income were more likely to be admitted. As we do not have associated quality or outcomes data, in this analysis we cannot determine if this represents a quality issue – if wealthier, privately insured patients are being admitted too often or if lower-income, non-privately insured patients are being admitted too infrequently.

LIMITATIONS

Our analysis has several limitations. Administrative claims datasets are susceptible to coding errors or misclassification of the diagnosis and disposition. However, as these records are used in hospital billing, there are regulatory standards and financial incentives to have correct diagnoses and dispositions. In the NEDS, patients are not uniquely identified, so they may account for multiple visits by the same patient within the sample; similarly, we are unable to determine if readmission from an ED visit was related to recent hospital discharge for the same condition. While this happens, for diverticulitis it likely represents a small proportion of the sample. Administrative data does not include clinical data regarding the severity of illness at the time of initial ED presentation, which makes it difficult to determine if management is driven by practice change or change in disease severity. Our data analysis was risk adjusted with the Elixhauser index, a well validated predictor of in-hospital mortality, and additional conditions unique to diverticulitis were added by study authors after discussion and consensus. Yet, no co-morbidity index completely controls for all co-morbid conditions. NEDS does not include observation care, which is an increasingly used pathway for the management of certain conditions,[37] though as of 2011, diverticulitis has been an infrequent condition treated in observation.[37] NEDS includes only ED visits; therefore, our analysis is limited to patients admitted to the hospital through the ED; we cannot comment on overall hospital admission rates.

CONCLUSION

From 2006 to 2011, ED visits for diverticulitis increased while the admission rates and surgical rates decreased. The same trend was found in low-risk patients. Admission rates for diverticulitis are associated with various patient factors, with a trend towards increased admission rates for privately insured and wealthier patients. Despite increases in incidence, admission and surgery rates for younger, healthier patients decreased from 2006 to 2011. These results are in alignment

with recent studies and guidelines supporting outpatient treatment for healthy patients with diverticulitis. On face, the reductions in admission, surgery and hospitalization appear patient oriented. However, variation in rates of admission surrounding socioeconomic status raise questions about disparities in care, and more research should be done to better understand if there have been changes in patient outcomes or disparities as practice patterns have changed.

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Accuracy of Perceived Estimated Travel Time by EMS to a Trauma Center in San Bernardino County, California

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Introduction: Mobilization of trauma resources has the potential to cause ripple effects throughout hospital operations. One major factor affecting efficient utilization of trauma resources is a discrepancy between the prehospital estimated time of arrival (ETA) as communicated by emergency medical services (EMS) personnel and their actual time of arrival (TOA). The current study aimed to assess the accuracy of the perceived prehospital estimated arrival time by EMS personnel in comparison to their actual arrival time at a Level II trauma center in San Bernardino County, California.

Methods: This retrospective study included traumas classified as alerts or activations that were transported to Arrowhead Regional Medical Center in 2013. We obtained estimated arrival time and actual arrival time for each transport from the Surgery Department Trauma Registry. The difference between the median of ETA and actual TOA by EMS crews to the trauma center was calculated for these transports. Additional variables assessed included time of day and month during which the transport took place.

Results: A total of 2,454 patients classified as traumas were identified in the Surgery Department Trauma Registry. After exclusion of trauma consults, walk-ins, handoffs between agencies, downgraded traumas, traumas missing information, and traumas transported by agencies other than American Medical Response, Ontario Fire, Rialto Fire or San Bernardino County Fire, we included a final sample size of 555 alert and activation classified traumas in the final analysis. When combining all transports by the included EMS agencies, the median of the ETA was 10 minutes and the median of the actual TOA was 22 minutes (median of difference=9 minutes, $p<0.0001$). Furthermore, when comparing the difference between trauma alerts and activations, trauma activations demonstrated an equal or larger difference in the median of the estimated and actual time of arrival ($p<0.0001$). We also found month and time of day to be associated with variability in the difference between the median of the estimated and actual arrival time ($p=0.0082$ and $p=0.0005$ for month and time of the day, respectively).

Conclusion: EMS personnel underestimate their travel time by a median of nine minutes, which may cause the trauma team to abandon other important activities in order to respond to the emergency department prematurely. The discrepancy between ETA and TOA is unpredictable, varying by month and time of day. As such, a better method of estimating patient arrival time is needed. [West J Emerg Med. 2016;17(4)418-426.]

INTRODUCTION

Trauma is the leading cause of death among Americans between the ages of 1 to 46 in the United States.[1,2] Trauma patients represent a heterogeneous group that are affected by a myriad of injury mechanisms. These patients often require rapid physician evaluation followed by a multitude of diagnostic procedures, imaging studies and therapeutic treatments.[3] As such, trauma places a significant socioeconomic burden on the U.S. healthcare system and society as a whole. The Centers for Disease Control and Prevention estimates the cost of trauma to be $406 billion per year, a figure that encompasses both lost productivity and healthcare costs.[1]

Following the introduction of Advanced Trauma Life Support in the 1970s, a coherent response to trauma has been shown to reduce mortality in this patient group.[4-9] Patients with multisystem injury are assessed by an organized team of professionals from a variety of specialized services.[8,10] This multidisciplinary group is known as the trauma team (Figure 1).

When a patient meets a pre-defined criterion, trauma systems are activated which includes trauma team notification (Figure 1). Altered resource allocation as a result of trauma system activation has the potential to create ripple effects throughout hospital operations. Previous studies indicate that trauma team activation significantly delayed initial physician examination of other emergency department (ED) patients and often increased ED length of stay.[11] Imaging resources, operating rooms and laboratory services may also be placed on hold for a trauma patient's potential need, which further contributed to delays in the care of patients. As such, the timing of trauma system activation is of critical importance.

At present, many trauma centers rely solely on a prehospital provider's estimation of travel time relayed over radio or telephone in order to determine the timing of trauma system activation. Emergency medical services (EMS) personnel often give this estimation while en route to the receiving trauma center. However, unforeseen factors may affect patient transport time such as traffic or weather fluctuations, reducing the likelihood that a patient will arrive at the estimated arrival time. Additionally, a past study reported that paramedic's ability to accurately predict transportation time within two minutes of the actual duration was only 47% of the time.[12]

Accurately predicting patient arrival time has the potential to benefit not only the trauma patient, but also other hospitalized patients at the receiving trauma center. While a patient arriving early may result in lack of ED preparedness or incomplete trauma team assembly, a patient arriving late has the potential to expend valuable hospital resources and inappropriately divert care away from other patients. The current study aimed to assess the accuracy of prehospital estimated arrival time in comparison to the actual arrival time of EMS crews at a high acuity Level II trauma center in Colton, California. We hypothesized that EMS personnel often underestimate patient transport time leading to a discrepancy in estimated time of arrival (ETA) in comparison to actual time of arrival (TOA). Through a greater understanding of this time discrepancy, strategies can be developed to improve the flow of ED patient care, with a future goal of reducing length of stay and improving overall patient outcomes.

METHODS

Study Setting

This study took place at Arrowhead Regional Medical Center (ARMC) located in Colton, CA. ARMC is a 456-bed acute care teaching facility and a Level II trauma center that uses a two-tiered trauma activation system. ARMC is the only American College of Surgeons-verified Level II trauma center serving San Bernardino County, CA.[13] The ED at ARMC is the second busiest in the state of California with more than 116,000 annual visits.[13] Additionally, more than 12 ground and air providers transport patients to ARMC. These licensed providers, including paramedics and emergency medical technicians (EMT), operate within the 20,000 square miles of San Bernardino County and provide coverage for a mix of urban and rural communities with a total population of over 21 million people.[14,15]

While at the scene or en route with a trauma patient, EMS personnel contact the Mobile Intensive Care Nurse (MICN) at ARMC and the trauma is categorized as an alert or activation based on classification criteria (Figure 1). If the MICN determines that a patient meets the alert or activation criteria, he or she activates trauma systems 15 minutes prior to patient arrival when possible, including notification of the multidisciplinary trauma team via the trauma pager system (Figure 1). At the first contact with EMS, a time of initial contact, ETA and name of the transporting provider are recorded by the MICN. Upon patient arrival at the trauma bay, an actual arrival time is recorded. Paramedics and EMTs also record a time of initial contact and actual arrival time. These data are subsequently entered into the Surgery Department Trauma Registry.

Patients

We conducted a retrospective review to identify trauma patients transported to ARMC between January 1, 2013, and December 31, 2013. All alert and activation classified traumas that contained the time of initial contact by EMS personnel, ETA, TOA and transporting EMS provider were included in the current study. We excluded those with missing time information. Additionally, traumas with an arrival time noted as earlier then the call time, indicating that the patient had arrived to ARMC without prior notification, were excluded. This study was approved by the ARMC Institutional Review Board.

In considering all alert and activation classified traumas, we included transports by only four agencies – American Medical Response (AMR), Ontario Fire, Rialto

a) Alert/activation criteria

Trauma team activation criteria:

1. Glasgow Coma Scale<13
2. Airway compromise
   a. Intubated patients transferred from the scene or Operating Room
   b. Patients with respiratory compromise or obstruction - includes intubated patients who have been transferred from another facility, with ongoing respiratory compromise (does not include patients intubated at another facility and who have been stabilized from a respiratory standpoint)
3. Confirmed blood pressure <90 at any time in adults and age-specific hypotension in children
4. Penetrating injuries to head, neck, torso and extremities proximal to elbow and knee
5. Chest wall trauma with flail or open chest wound
6. Traumatic full arrest
7. Paralysis
8. Amputation proximal to wrist and ankle
9. Bone injuries:
   a. Pelvic fracture
   b. Open and depressed skull fracture
10. Patients transferred in receiving blood products to maintain vital signs.
11. Emergency physician's discretion.

Trauma team alert criteria:

1. Ejection from automobile
2. Death in same passenger compartment
3. Extrication time >20 minutes
4. Falls >20 feet
5. Rollover with significant injury
6. Auto-pedestrian/auto-bike injury with significant (5 mph) impact
7. Pedestrian thrown or run over
8. Motorcycle crash >20 mph with significant injury
9. Age >59 with blunt injury to the torso (chest and/or abdominal injury)
10. Children <5 years old
11. Two long bone fractures (femur, humerus, tibia)
12. Pregnancy 23 weeks gestation or greater.

Burn activation criteria

1. Patients with burns ≥50% body surface area
2. Airway compromise
3. Hypotension with systolic blood pressure <90 (hemodynamically unstable)
4. History of significant inhalation

b) Personnel utilization for alert/activations

Individuals responsible for reporting to the trauma Resuscitation room upon notification of the trauma activation patient are:

1. Trauma attending
2. Trauma resident
3. Trauma intern
4. Emergency Department (ED) attending physician
5. ED Resident
6. Anesthesiologist/nurse anesthetist
7. Respiratory therapist
8. Trauma nurse
9. Radiology technician
10. Other ancillary departments, services and consultants will be mobilized as needed via the telephone and computer network.

Individuals responsible for reporting to the trauma Resuscitation room upon notification of the trauma alert patient are:

1. Surgical resident
2. Surgical intern
3. ED attending physician
4. ED resident
5. Trauma/emergency department nurse
6. Radiology technician

Individuals responsible for reporting to the trauma resuscitation room upon notification of the burn activation patient are:

1. Burn resident
2. Surgical attending
3. Surgical resident
4. ED attending
5. Anesthesiologist/nurse anesthetist
6. Respiratory therapist
7. Trauma nurse
8. ED nurse
9. Radiology Department
10. Other ancillary department, services and consultants will be mobilized as needed via the telephone and computer network.

Figure 1. Trauma alert and activation criteria and the corresponding personnel utilization.

Fire and San Bernardino County Fire. These four agencies were chosen based on the volume of patients that they transported to ARMC, coverage area and ability to transport directly to ARMC. These four agencies comprised 86% of includible trauma alerts and activations. Additionally, these agencies transported directly from the scene to ARMC without handoffs. In comparison, other local ground providers based farther from ARMC must transfer their patient to another ground or air provider if they wish to send to ARMC. We excluded these transports to ensure consistency in the conditions under which EMS personnel made travel time estimations.

For data analysis purposes, if EMS personnel gave ETA as a time interval, the midpoint was used to calculate median ETA. We combined data points for all subdivisions of San Bernardino County Fire for calculations.

Statistical analysis

The primary outcome was the difference between the median of ETA and TOA. Additional variables assessed include time of day and month during which the transport took place. We analyzed data using the SAS software for Windows version 9.3 (Cary, NC). Descriptive statistics were presented as median and interquartile for continuous variable, and frequencies and proportions for categorical variables. We conducted non-parametric Wilcoxon Rank Sum-test to compare whether or not the difference of median ETA and TOA was different from zero. Kruskal-Wallis rank test was conducted to identify whether the difference of median ETA and TOA was different by month and time of the day, respectively. All statistical analyses were two-sided. p-value<0.05 was considered to be statistically significant.

RESULTS

A total of 2,454 patients classified as traumas were identified in the Surgery Department Trauma Registry between January 1, 2013, and December 31, 2013. After exclusion of trauma consults (n=432), walk-ins, handoffs between agencies, downgraded trauma or traumas that were not classified (n=752), traumas with missing ETA, TOA or provider information (n=570), traumas where the arrival time was noted as earlier then the call time (n=52), traumas transported by agencies other than AMR, Ontario Fire, Rialto Fire, or San Bernardino County Fire (n=93), we included a sample size of 555 trauma alerts and activations in the final analysis. (See Figure 2 for patient flow chart.)

When combining all transports by the included EMS agencies, the median of the ETA was 10 minutes, whereas the median of the actual TOA was 22 minutes (Table). There is a statistically significant difference between median of the estimated and actual time of arrival (median of difference=9 minutes, p<0.0001). For each EMS agency, there are statistically significant differences between the median of the estimated and actual time of arrival (p<0.0001 for all four EMS agencies). San Bernardino County Fire had the largest difference of 11 minutes and Rialto Fire had the smallest difference of six minutes. Additionally, for each EMS agency and for all four agencies combined, transports classified as trauma alerts had a larger or equal median of the estimated and actual time of arrival than those transports classified as trauma activations. Specifically, for all four EMS agencies combined, the medians of difference between ETA and TOA was 10 and seven minutes for alerts and activations, respectively (p<0.0001, Figure 3).

We conducted two more analyses to identify the median ETA and TOA by month and time of the day, respectively (Figures 4 and 5). Both month and time of the day were associated with the difference between the median of the estimated and actual arrival time (p=0.0082 and p=0.0005 for month and time of the day, respectively). The difference between these two medians peaked in June (the median difference was 12 minutes), and was smallest in February (the median difference was four minutes). Additionally, the difference between these two medians peaked at 10 to 11AM (the median difference was 16 minutes, followed by 7 to 8AM (the median difference was 14 minutes).

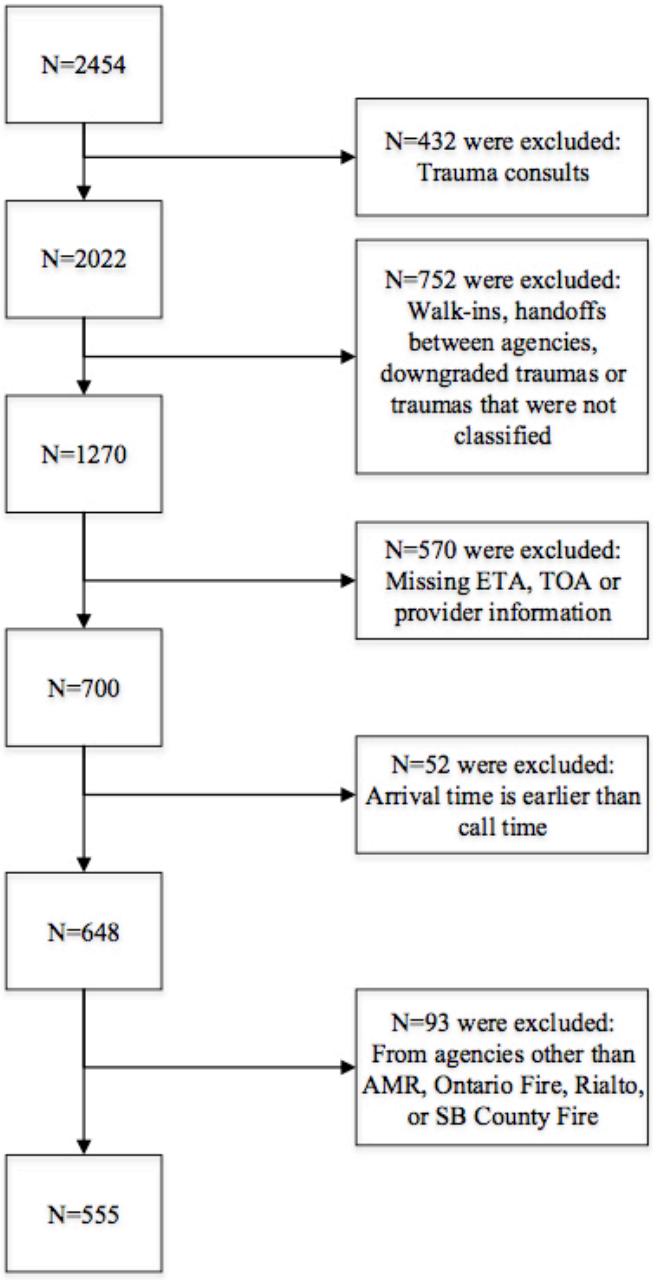

Figure 2. Patient inclusion criteria flow chart.
ETA, estimated time of arrival; *TOA,* time of arrival; *AMR* American Medical Response; *SB County Fire*, San Bernardino County Fire.

DISCUSSION

For alert and activation classified traumas, the findings of this study show that the predicted travel time by EMS personnel from the scene to the hospital is often significantly underestimated. In the majority of transports, providers

Table. Median estimated time of arrival (ETA) in comparison to median time of arrival (TOA) for all included emergency medical service (EMS) agencies: American Medical Response (AMR), Ontario Fire, Rialto Fire and San Bernardino County Fire (SB County Fire).

	Median ETA (min)			Median TOA (min)			Median difference			
EMS agency	Alert	Activation	Combined	Alert	Activation	Combined	Alert	Activation	Combined	p-value
AMR	10	10	10	23	18	21	9	7	9	<0.0001
Ontario Fire	20	15	20	31.5	22	28	10	7	9	<0.0001
Rialto Fire	5	5	5	12	12	12	8	6	6	<0.0001
SB city Fire	15	10	11	30	19.5	25	14	8	11	<0.0001
All 4 EMS agencies combined	12	10	10	24	18	22	10	7	9	<0.0001

*p-value was calculated to test whether the combined median difference was significantly different from zero. In other words, whether the median of estimated time of arrival and time of arrival are the same for each agency separately and for all four EMS agencies combined.
**Median difference is calculated as the median of the difference between ETA and TOA (using ETA-TOA). We calcualted ETA-TOA, then we calculated the median of these differences.

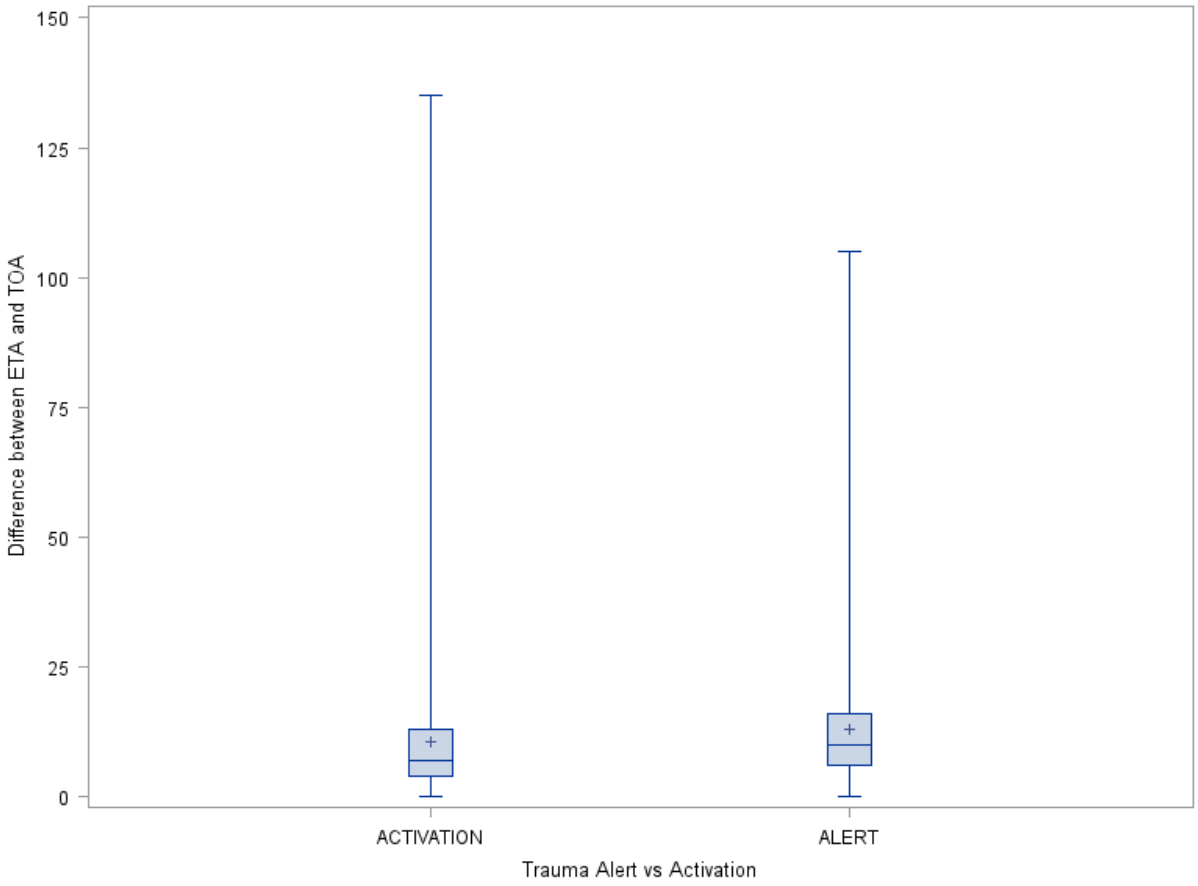

Figure 3. The boxplot of difference between the estimated time of arrival (ETA) and time of arrival (TOA) by trauma alerts or activations.
*p<0.0001 for the effect of alert vs. activation on the difference of median between ETA and TOA.

arrived to the hospital after their estimated arrival time. This results in early, and often prema ture, trauma system activation. Across nearly 2,500 trauma alerts and activations transported to ARMC in 2013, an average discrepancy of nine minutes between the estimated arrival time and actual arrival time for each trauma case has the potential to interrupt the flow of ED patient care and create significant ripple effects throughout daily hospital operations. An average of seven trauma alerts or activations per day would lead to one hour of "wait time" per day by the trauma team and around 30 hours per month. With at least eight personnel, including ED and surgery department staff, arriving for each trauma alert or activation (Figure 1), this amounts to 240 hours of total "wait time" per month and over 2,800 hours per year.

Further data analysis noted a difference in the discrepancy between the estimated arrival time and actual arrival time when comparing trauma alerts and activations. EMS personnel estimated their arrival time with a greater degree of accuracy

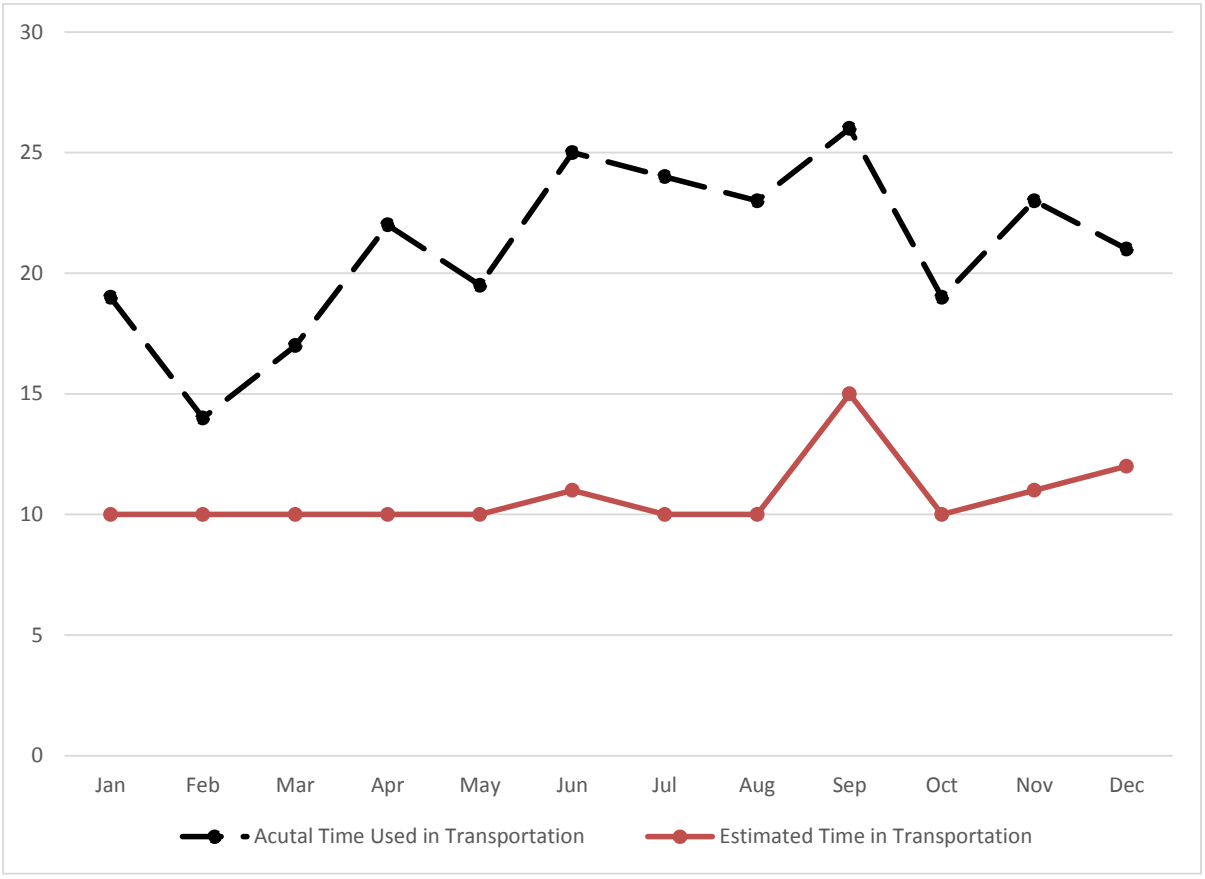

Figure 4. The median of actual and estimated transport time by month.

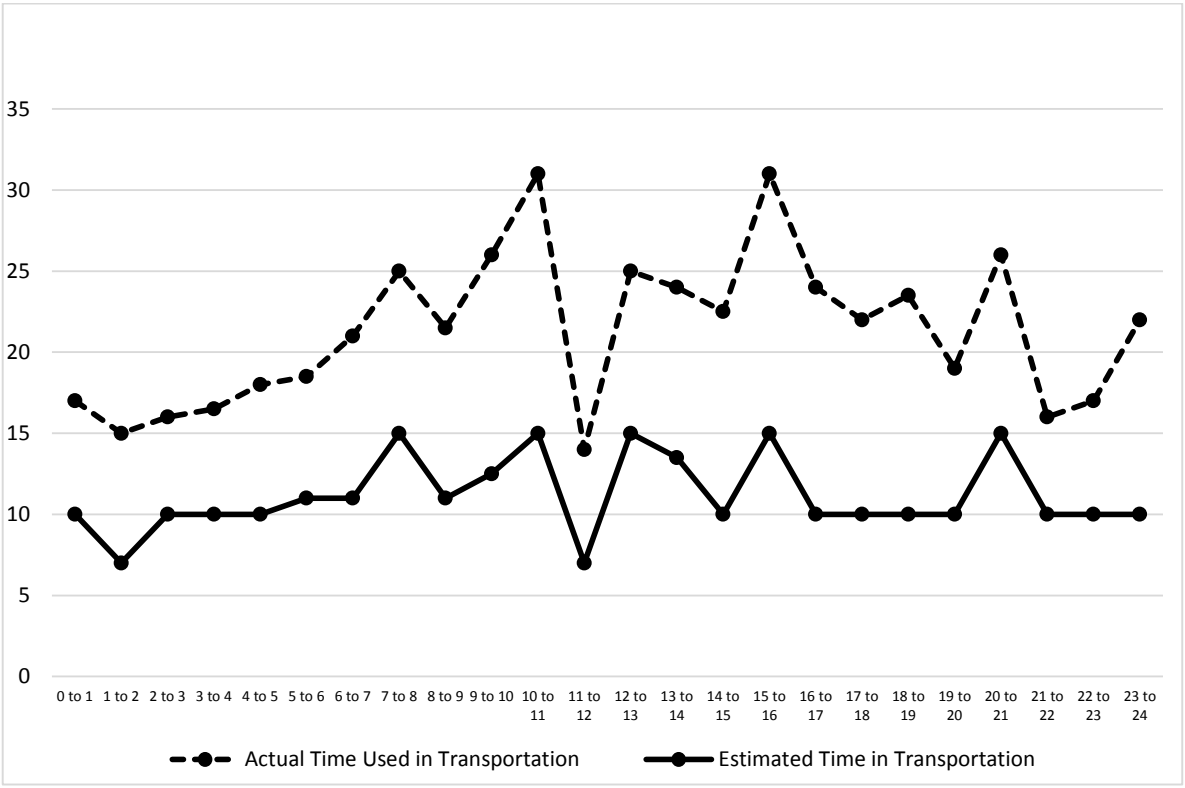

Figure 5. The median of actual and estimated transportation time by time of the day.

when transporting trauma activations. To our knowledge, the impact of trauma classification on the accuracy of the estimated arrival time has not been assessed in previous studies. Factors impacting this association may be assessed in future investigations.

One could contend that there are positive aspects to an underestimation of transport time by EMS personnel leading to an early activation of a trauma team and mobilization of hospital resources. Early arrival of a trauma team to the ED prior to a trauma patient's arrival provides time to assign roles, prepare equipment for resuscitation and set up radiological equipment. Early activation can also facilitate logistical preparation for an arriving patient. Previous investigations have shown that timely trauma system activation improves the trauma team performance as measured by time to chest radiograph.[16] However, it has further been determined that proactive trauma team activation and subsequent early trauma team arrival and mobilization of resources has no effect on ED length of stay and mortality in most patients.[16,17] Yet despite no noted increase in ED length of stay, early trauma team activation may be important in select cases such as when multiple trauma patients arrive simultaneously or for stroke and myocardial infarction cases when door-to-needle time could potentially be shortened.

Nevertheless, potentially negative factors must be weighted when assessing an underestimation of transport time and early trauma system activation. Previous studies have demonstrated that emergency physicians would alter their prehospital-directed medical management of an incoming patient 8.5% of the time if a more accurate ETA were given.[18] Further, the trauma systems at ARMC are activated 15 minutes prior to patient arrival when possible and the trauma team (Figure 1) is expected to arrive in the ED within 1-3 minutes. An additional nine minutes of "wait time," often greater than 6-8 times per day, can repeatedly divert clinicians and staff away from patient care, as well as interrupt or delay surgeries, reducing work flow not only in the ED but throughout the hospital. It has been shown that trauma system activation increases the ED length of stay by an average of 16 minutes for other patients requiring admission who arrived within three hours before or after trauma patient arrival.[11] Additionally, hospital imaging services are often placed on standby for a trauma patient's potential need.[11] A computed tomography scanner frequently placed on hold for nine minutes significantly reduces the number of patients who can receive timely care. In combining the effect of delayed physician evaluations with the priority reservation of imaging resources, operating rooms and laboratory services for trauma patients, these factors have the potential to further increase the length of time to discharge or admission. Previous studies have shown that ED crowding can influence ED and inpatient outcomes, including patient mortality.[19-21] ED crowding has also been associated with an increased cost of inpatient care.[20] Though a discrepancy in ambulance arrival time is not the only factor leading to ED crowding, it is undoubtedly a contributing factor. Understanding discrepancies in arrival times is one step toward a solution to this multifactorial, systemic issue.

At present, there appears to be no standardized aids or protocols for EMS personnel or ED staff to reliably anticipate the travel time and estimated arrival time of trauma patients. Though radio or telephone contact presents as an initial means of communication, there is the potential for EMS crews to be preoccupied with resuscitation efforts and unable to provide timely communication. Additionally, the current system forces EMS personnel to estimate delays due to traffic conditions and weather fluctuations. This assumes that crews have sufficient and up-to-date information concerning potential sources of delay.

As technology advances and becomes readily accessible, implementation of real-time global positioning systems (GPS) available to the ED staff to follow EMS vehicles presents as a possible solution to provide a consistent and accurate arrival time. GPS is already used in prehospital care for strategic deployment of ambulances, as well as in the development of ambulance deployment protocols and placement of helipads for air medical services.[22,23] Further, the effectiveness of GPS tracking to predict ambulance arrival time to a trauma center was demonstrated through the development of a web-based application that integrates GPS tracking of ambulances and Google Maps. This model took into account factors such as local traffic, time of day and use of lights and sirens. Through a retrospective analysis of nearly 50,000 patient transports, investigators were able to use this model to predict arrival time within five minutes 72.8% of the time.[24] A further retrospective study validated the use of Google Maps and other methods for route-based transport time estimation, noting the use of Google Maps as moderately accurate with a mean absolute error of 3.5 minutes for transport time estimation.[25] Based on these investigations, it appears resourceful and plausible to implement a similar system to diminish findings in this study regarding the difference between ETA and TOA between EMS crews and ED staff in San Bernardino County, CA.[26]

At present, a majority of the fire and EMS providers in San Bernardino County optimize vehicle deployment through a computer-aided dispatch (CAD) system in conjunction with satellite tracking via GPS and automatic vehicle locators (AVL). It is conceivable that these data could be shared with ED staff at ARMC. Sharing of this data would not violate Health Insurance Portability and Accountability Act regulations, as ambulance arrival time is relevant to trauma patient care. A challenge would be to create a system that is compatible with the current fire and EMS provider infrastructure. A final obstacle is the financial expense associated with the development of this new system. In considering these logistical and financial factors, initial implementation of GPS tracking available to ED staff could be

undertaken and studied in a single agency with a high volume of transports in order to assess the accuracy and benefit of arrival time prediction with GPS tracking.

LIMITATIONS

This study was subjected to several limitations. One limitation was a lack of complete information (a time of initial contact, ETA and name of the transporting provider) associated with each patient transport. We excluded 570 patients from the four included agencies due to missing data regarding the calculation of ETA and TOA. These excluded patients were similar to those included in the final analysis with respect to age, gender, mechanism of injury and time of day. As such, we believe that the included sample is a random sample of patients transported by EMS agencies and is representative of the actual situation based on the distribution of the data.

Furthermore, this study used a single hospital trauma care registry as the primary data source that relies on the notation of time entries on paper by ED staff during initial patient management. This may impact the generalizability of the findings in this study. Additional studies are warranted to validate these results in other EMS systems and explore possible solutions for more effective travel time prediction. Further, data are later entered manually into an electronic database - the Surgery Department Trauma Registry. In terms of data quality, manually recorded data has the potential for human error. Previous studies alluded to the fact that manually recorded data are subject to the human propensity to smoothen data.[16,27] For future studies, it may be beneficial for the trauma registry to move toward automatic capturing of time data.

One important aspect of the analysis to consider, also highlighted by previous studies, is the interpretation of ETA communicated by EMS as a time interval.[18] For example, an ETA given as 10 to 15 minutes can be taken as either of the two extremes or the midpoint. In this study, we chose to use the midpoint for consistent data analysis. As a result, more values will have a positive or negative "difference in time" despite falling within the given ETA interval. However, we believe that similar results would have been reached regardless of the ETA data parameter.

A parameter that we were unable to assess was the impact of the use of lights and sirens by EMS personnel on the accuracy of predicted travel time. EMS crews are not required to use lights and sirens when transporting trauma alerts and activations in San Bernardino County. However, previous studies have shown that the effect of lights and sirens does not have a significant impact on transport time for most transports. Lights and sirens have been shown to affect transport time in longer transports.[28,29] The impact of lights and sirens on predicted travel time could be assessed in future studies.

CONCLUSION

The findings demonstrated that EMS personnel consistently underestimated travel time leading to a discrepancy in their estimated arrival time and actual arrival time. This resulted in the premature activation of trauma systems in the majority of trauma alert and activations transported to ARMC. In turn, hospital personnel and trauma teams waited longer for trauma patient arrival, delaying the care of other patients and diverting hospital resources for more time than necessary.

Overall, this study calls attention to a systemic concern surrounding inaccurate ambulance arrival times. It is clear that we must determine a way to accurately and consistently predict patient arrival, regardless of whether patients frequently arrive before or after their predicted arrival time to any hospital. With advancing technology, GPS represents an immediately plausible, accurate and reproducible solution. Reducing discrepancies in ambulance arrival time is one factor that will lead us toward tackling the multifactorial causes of crowding and increased wait times in emergency departments across the United States.

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Impact of Prehospital Care on Outcomes in Sepsis: A Systematic Review

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Introduction: Sepsis is a common and potentially life-threatening response to an infection. International treatment guidelines for sepsis advocate that treatment be initiated at the earliest possible opportunity. It is not yet clear if very early intervention by ambulance clinicians prior to arrival at hospital leads to improved clinical outcomes among sepsis patients.

Methoda: We systematically searched the electronic databases MEDLINE, EMBASE, CINAHL, the Cochrane Library and PubMed up to June 2015. In addition, subject experts were contacted. We adopted the GRADE (grading recommendations assessment, development and evaluation) methodology to conduct the review and follow PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) recommendations to report findings.

Results: Nine studies met the eligibility criteria – one study was a randomized controlled trial while the remaining studies were observational in nature. There was considerable variation in the methodological approaches adopted and outcome measures reported across the studies. Because of these differences, the studies did not answer a unique research question and meta-analysis was not appropriate. A narrative approach to data synthesis was adopted.

Conclusion: There is little robust evidence addressing the impact of prehospital interventions on outcomes in sepsis. That which is available is of low quality and indicates that prehospital interventions have limited impact on outcomes in sepsis beyond improving process outcomes and expediting the patient's passage through the emergency care pathway. Evidence indicating that prehospital antibiotic therapy and fluid resuscitation improve patient outcomes is currently lacking. [West J Emerg Med. 2017;17(4)427-437.]

INTRODUCTION

Sepsis is a common and potentially life-threatening response to an infection.[1] There are an estimated 150,000 cases of severe sepsis resulting in more than 44,000 deaths each year in the United Kingdom (UK).[2] It has been reported that over 70% of sepsis cases stem from the community[3] with one study suggesting two-thirds of severe sepsis cases are initially seen in the emergency department (ED).[2] Approximately half of all ED sepsis patients will arrive via emergency medical services (EMS).[5-10] Sepsis patients transported to the ED by EMS are likely to be sicker than those arriving by other means,[6, 8-11] with up to 80% of severe sepsis patients admitted to intensive care from the ED having been transported by EMS.[7,12]

International treatment guidelines for sepsis advocate that treatment be initiated at the earliest possible opportunity.[1] It has been argued that early intervention by ambulance clinicians prior to arrival at the ED may lead to improved outcomes among sepsis patients[13] in the same manner as EMS intervention has helped to improve outcomes for other time critical, life-threatening conditions such as acute myocardial

infarction[14], stroke[15], and major trauma.[16]

METHODS

This systematic review addresses the impact of prehospital care on outcomes among patients with sepsis. The review adopted the Grading of Recommendations, Assessment, Development and Evaluation (GRADE) methodology[17] and is reported consistent with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) recommendations.[18]

Inclusion Criteria

Studies were eligible for inclusion if they reported the impact of prehospital care among adult patients with suspected sepsis (including severe sepsis and septic shock). Outcomes of interest include time to early goal-directed therapy (EGDT) related targets, admission to intensive care unit (ICU), length of stay and mortality. We included conference proceedings/ meeting abstracts to capture gray literature.

Search Strategy

Electronic Searches

We systematically searched MEDLINE, EMBASE, CINAHL, the Cochrane Library and PubMed. No language restrictions were employed.

Search Terms/Search Strategy

Search strategies were based upon the terms below: (Sepsis OR septic OR septic?emia OR systemic adj inflammatory adj response adj syndrome OR SIRS OR septic adj shock OR hypotension adj induced adj hypoperfusion OR cryptic adj shock OR bacterial adj infection) AND (emergency adj medical adj service OR EMS OR HEMS OR emergency adj medical adj technician OR EMT OR paramedic OR pre-hospital OR prehospital OR pre adj hospital OR out-of-hospital OR out adj of adj hospital OR OOH OR Ambulance).

The initial MEDLINE search was conducted in July 2014 and adapted for each subsequent database. The searches were repeated in June 2015 to identify recent publications.

Other

We contacted subject experts and scrutinized reference lists of included manuscripts in order to identify any missed studies.

Data Collection And Analysis

Study Selection

Study selection occurred in two stages. First, two reviewers (MAS and SJBM) independently reviewed each citation and abstract against the inclusion criteria. Citations rated as 'include' by either reviewer were retained; citations rated as 'exclude' by both reviewers were rejected. Second, full manuscripts of retained citations were independently screened by two reviewers (MAS and SJBM) who rated each manuscript as 'include,' 'maybe,' or 'exclude' against the inclusion criteria. If both reviewers rated a manuscript as 'include' it was included for critical appraisal. If both reviewers rated a manuscript as 'exclude' it was automatically rejected. If the two reviewers had differing opinions, the reviewers discussed the manuscript in order to achieve consensus. If the reviewers were unable to agree following discussion, a third independent reviewer (GDP) was available to adjudicate.

Risk Of Bias

For randomized controlled trials, we assessed risk of bias across the following domains: lack of allocation concealment, lack of blinding, incomplete accounting of patients and outcome events, selective outcome reporting bias and other limitations such as stopping a trial early for benefit. For observational studies, bias was assessed across the domains of failure to develop and apply appropriate eligibility criteria (inclusion of control population), flawed measurement of exposure and outcome, failure to adequately control confounding and incomplete follow up.

All papers were assessed across their respective domains with each being categorized as either high risk, low risk or level of risk unclear as per GRADE recommendations.[19] We considered studies categorized as high risk in any domain to be at high risk of bias overall. Studies categorized as low risk across all domains were considered to be at low risk of bias overall. Studies with a combination of low and unclear risk across domains were considered to have an unclear risk of bias overall.

Quality Of Evidence

We determined quality of evidence according to the GRADE framework. Study design informed initial quality presumptions; randomized controlled trials were initially presumed to be 'high quality,' while observational studies (non-randomized studies) were initially presumed to be 'low quality.' Two reviewers (MAS and SJBM) appraised each paper across the five core GRADE domains of risk of bias,[19] inconsistency,[20] indirectness,[21] imprecision[22] and other considerations (including publication bias).[23] If any concerns were identified quality of evidence was adjusted downward. Similarly, quality could be adjusted upward if, for example, a large treatment effect or dose response was noted, that subsequently raised confidence in the estimate of effect.[24] Ultimately each study is rated as follows:

- High quality: We are very confident that the true effect lies close to that of the estimate of effect.
- Moderate quality: We are moderately confident in the effect estimate: the true effect is likely to be close to the estimate of effect, but there is a possibility that it is substantially different.
- Low quality: Our confidence in the effect is limited: the true effect may be substantially different from the

estimate of the effect.
- Very low quality: We have very little confidence in the effect estimate: the true effect is likely to be substantially different from the estimate of effect.

RESULTS

Study Inclusion

Database searches yielded 4,366 citations. Duplicate citations were removed manually within EndNote® (version X7 Thompson Scientific, Carlsbad, CA) by a single reviewer (MAS) providing 2,958 unique citations. One citation was identified by contacting subject experts. After the first stage of screening 79 citations were retained and 2,880 citations were rejected. Inter-rater agreement for first stage screening, calculated using Cohens kappa statistic, was 0.87 (95% CI [0.81 to 0.92]). During the second stage of screening 79 manuscripts were reviewed; 70 were discarded following assessment and nine were retained for critical appraisal

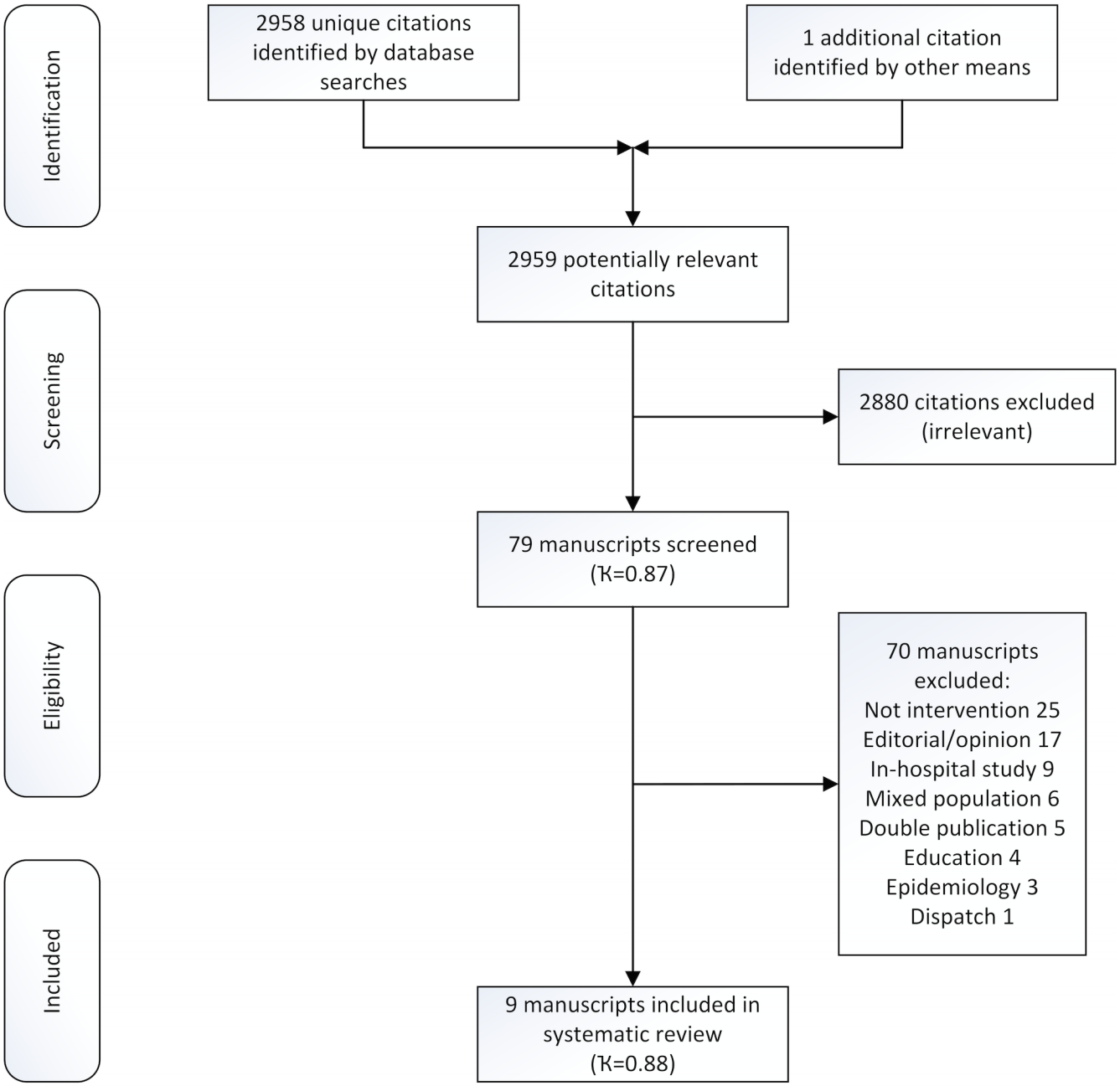

Figure. PRISMA flow chart.
PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 1. Characteristics of studies reviewed for quality of evidence regarding whether early intervention by EMS prior to hospital arrival leads to improved clinical outcomes among sepsis patients.

Characteristic	Details
Median year of publication [range]	2013 [2009-2015]
Country of origin [n, (%)]	
Australia	1 (11)
Germany	1 (11)
United Kingdom	1 (11)
United States	6 (67)
Language [n, (%)]	
English	9 (100)
Study design [n, (%)]	
Randomized controlled trials	1 (11)
Non-randomized (observational) studies	8 (89)
Publication type	
Full publication	7 (78)
Abstract publication	2 (22)

EMS, emergency medical services.

(Figure). Inter-rater agreement for second stage screening, calculated using Cohens Kappa, was 0.88 (95% CI [0.72 to 1.0]).

No additional citations were identified by scrutinizing the reference lists of included manuscripts. One additional study,[25] a manuscript pending publication (subsequently published), was identified by contacting subject experts. In total nine studies are included in the final analysis (Figure).

Characteristics Of Included Studies

Characteristics of included studies, comprising 3,470 patients in total, are summarised in the Table.

Risk Of Bias Findings

Risk of bias assessments are reported in Tables 2 and 3.

Quality Of Evidence Findings

We identified very low quality evidence from one randomized controlled trial (downgraded for risk of bias, indirectness and imprecision), and very low quality evidence from eight observational studies (downgraded for risk of bias, indirectness and imprecision across studies, see supplementary information for evidence table with quality assessment.)

Data Synthesis

There was considerable variation in the methodological approach adopted across the studies as well the outcome measures reported. The majority of studies identified involve limited numbers of participants, without comparable control and intervention cohorts. Because of these differences, the studies did not answer a unique research question thus meta-analysis was not appropriate. A narrative approach to data synthesis was adopted.

Data Extraction

The data from included studies were extracted and entered into the evidence table (see Appendix A) and summary of findings table (Table 4) by a single reviewer (MAS) and verified by a second reviewer (SJBM).

ANALYSIS

Antibiotic Therapy

Three studies indicate that ED antibiotic therapy is

Author (year)	Industry funding	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Chamberlain (2009)	No	?	?	?	?	+	+

− High risk + Low risk ? Risk unclear

Table 2. Risk of bias (randomized controlled trials).

Author (year)	Industry funding	Eligibility criteria	Exposure/Outcome	Confounding	Follow up
Seymour *et al.* (2010)	no	+	+	?	+
Band *et al.* (2011)	no	+	+	+	+
Studnek *et al.* (2012)	no	+	+	?	+
Bayer *et al.* (2013)	no	?	−	−	+
Guerra *et al.* (2013)	no	+	+	−	−
Femling *et al.* (2014)	no	+	+	?	+
Seymour *et al.* (2014)	no	+	+	?	+
McClelland and Jones (2015)	no	?	?	−	?

− High risk + Low risk ? Risk unclear

Table 3. Risk of bias (non-randomized studies).

administered 30-50 minutes sooner if EMS identify sepsis and inform the receiving clinician of their diagnosis.[5,11,26] However, this finding is not universal – Guerra et al.[27] failed to identify any significant reduction in time to antibiotic therapy (pre-alert: 72.6 minutes Standard Deviation (SD) 59.3 minutes) vs no pre-alert: 98.5 minutes (SD 89.9 minutes), p=0.07). None of the studies concerned with prehospital recognition of sepsis, without concomitant administration of antibiotics, were able to identify any significant improvement in length of stay[11,25,27] or mortality.[11,25-28]

Two studies[29,30] address prehospital administration of antibiotic therapy. Chamberlain[25] reported that antibiotics were delivered 3.4+-2.6 hours sooner while Bayer *et al.*[30] noted that among EMS sepsis patients median time to antibiotics was 19 minutes (IQR 18-24 minutes) from initial emergency call (time of administration was estimated to commence 10 minutes after arriving at scene). Bayer *et al.*[30] do not report interval to hospital nor report time to antibiotics in the ED. Chamberlain[29] suggests that prehospital antibiotic therapy leads to reduced intensive care unit (ICU) stay (Mean ICU stay: 6.8±2.1 days (intervention) vs 11.2±5.2 days (control), p=0.001) and reduced mortality (28-day mortality: 42.4% (intervention) vs 56.7% (control); odds ratio (OR) 0.56; 95% CI [0.32-1.00]). Bayer *et al.*[26] did not report mortality, ICU admission or length-of-stay data.

Intravascular Fluid Therapy

Band *et al.*.[26] reported that arrival by EMS reduces time to initiation of intravascular fluid therapy when compared with those who arrive by privately owned vehicle (POV, EMS: 34 minutes [IQR 10-88 minutes] vs POV: 68 minutes, IQR 25-121 minutes, p≤0.001), but did not improve mortality (adjusted risk ratio [RR] 1.24; 95% CI [0.92-1.66]). Similarly Bayer *et al.*[30] noted that among EMS sepsis patients median time to initiation of Intravenous fluids was 19 minutes (IQR 18-24 minutes) from initial emergency call (time of administration was estimated to commence 10 minutes after arriving at scene), with patients receiving an average of 2.5l intravascular fluid (IQR 1.5–3.01) until admission to the ED. A third study by Guerra *et al.*[27] indicated that early identification of sepsis by EMS was not associated with improved six-hour fluid resuscitation targets in the ED (EMS pre-alert: 42.97 cc/kg (SD 33.23cc/kg) vs no EMS pre-alert: 35.17cc/kg (SD 26.81 cc/kg, p=0.30).

The only study to demonstrate a positive impact following prehospital fluid administration among sepsis patients indicated that prehospital fluids were associated with reduced likelihood of organ failures (adjusted OR 0.58; 95% CI [0.34-0.98]) and reduced hospital mortality (adjusted OR 0.46; 95% CI [0.23-0.88]), but not reduced ICU admission (adjusted OR 0.64; 95% CI [0.37-1.10]).[31] The median volume of prehospital fluid administered in this study was 500mL (IQR 200-1000mL).

Early Goal Directed Therapy (EGDT) Targets

Femling *et al.*[11] reported that patients who arrived at the ED via EMS had shorter time to central line placement (required for central venous pressure monitoring) than those who arrived by other means (EMS: 200 minutes [IQR 89-368 minutes] vs non-EMS: 275 minutes [IQR 122-470 minutes], difference 75 minutes, p<0.01), while Guerra *et al.*[27] noted that when EMS provided a sepsis pre-alert to the hospital the advance notification it did not impact the

№ of studies	№ of patients	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other	Level of evidence	Findings
Impact of prehospital care upon time to antimicrobial therapy									
1	199	RCT	not serious[1]	none	not serious[2]	very serious[3]	very serious[4]	⊕⊙⊙⊙ very low	[Chamberlain 2009] prehospital antibiotics provided 3.4 ± 2.6 hours sooner (p=0.02).
5	1,927	non-RCT	very serious[5]	none	not serious[2]	very serious[6]	very serious[7]	⊕⊙⊙⊙ very low	[Band 2011] Median time to antibiotics reduced: 116 minutes (IQR 66-199 minutes) EMS vs 152 minutes (IQR 92-252 minutes) 'other means' (p≤0.001). [Studnek 2012] if arriving by EMS vs other means time to antibiotics reduced 111 minutes (EMS) vs 146 minutes (non-EMS); (p=0.001). If EMS recognized and documented sepsis time to antibiotics reduced 70 minutes (documented) vs 122 minutes (not documented) (p=0.003). [Bayer 2013] Median time of administration 19 minutes (IQR 18-24 minutes) after initial emergency call (time of administration estimated as 10 minutes after arriving at scene). [Guerra 2013] No significant reduction in time to antibiotics mean 72.6 minutes (SD 59.3 minutes, pre-alert) vs 98.5 minutes (SD 89.9 minutes, no pre-alert) (p=0.07). [Femling 2014] Time to antibiotics: 87 minutes (EMS, IQR 44-157 minutes) vs 120 minutes (non-EMS, IQR 141-271 minutes), difference 33 minutes (p=0.02).
Impact of prehospital care upon fluid resuscitation									
5	2,697	non-RCT	very serious[5]	none	not serious[2]	very serious[6]	very serious[8]	⊕⊙⊙⊙ very low	[Seymour 2010] patients who received prehospital fluids had shorter time to MAP>65 mm Hg 17/24 (70%, EMS IV fluids) vs 12/26 (44%, no IV fluids), unadjusted RR 1.53 (95% CI [0.9-2.65]), and shorter time to CVP>8 mm H_20 15/25 (60%, EMS IV fluids) vs 17/24 (70%, no IV fluids), unadjusted RR 1.2 (95% CI [0.8-1.8]). [Band 2011] Median time to initiation of IVF reduced: 34 minutes (IQR 10-88) EMS vs 68 minutes (IQR 25-121 minutes) 'other means' of arrival (p≤0.001). [Bayer 2013] Median time of administration 19 minutes (IQR 18-24 minutes) after initial emergency call (time of administration estimated as 10 minutes after arriving at scene). Patients received 2.5L intravascular fluid (IQR 1.5–3.0L) until admitted to the ED. [Guerra 2013] No significant difference in fluid administration by 6 hours 42.97 cc/kg (SD 33.23cc/kg, pre-alert) vs 35.17cc/kg (SD 26.81 cc/kg, no pre-alert, p=0.30). [Seymour 2014] Median prehospital fluid volume 500mL (IQR 200-1000mL).

Table 4. Summary of findings.

RCT, randomized control trial; *EMS*, emergency medical services; *ED*, emergency department; *IQR,* interquartile range; *CI,* confidence interval; *RR,* risk ratio; *MAP,* mean arterial pressure; *CVP,* central venous pressure, *IVF,* intravascular fluid.

Impact of prehospital care upon Early Goal Directed Therapy									
6	2,523	non-RCT	very serious[5]	none	not serious[2]	very serious[6]	very serious[8]	⊕⊙⊙⊙ very low	[Seymour 2010] patients who received prehospital fluids had shorter time to MAP>65 mm Hg 17/24 (70%, EMS IV fluids) vs 12/26 (44%, no IV fluids), unadjusted RR 1.53 (95% CI [0.9-2.65]); shorter time to CVP>8 mm H_20 15/25 (60%, EMS IV fluids) vs 17/24 (70%, no IV fluids), unadjusted RR 1.2 (95% CI [0.8-1.8]); and shorter time to SVC_{O2}>70% 13/24 (54%, EMS IV fluids) vs 9/25 (36%, no IV Fluids), unadjusted RR 1.5 (95% CI [0.8-2.9]). [Studnek 2012] if arriving by EMS vs other means time to EGDT reduced 119 minutes (EMS) vs 160 minutes (non-EMS, p=0.005). If EMS recognised and documented sepsis time to EGDT 69 minutes (documented) vs 131 minutes (not documented, p=0.001). [Guerra 2013] No significant reduction in proportion of patients with central venous line placement 62% (pre-alert) vs 68% (no pre-alert, p=0.54). [Femling 2014] Time to central line: 200 minutes (EMS, IQR 89-368 minutes) vs 275 minutes (non-EMS, IQR 122-470 minutes), difference 75 minutes (p<0.01). [Seymour 2014] Prehospital fluids reduced likelihood of increasing organ failures adjusted OR 0.58 (95% CI [0.34-0.98]). [McClelland 2015] Time to 'sepsis 6': mean 205 minutes (SD 271 minutes, range 10-720 minutes, EMS identified)* vs 120 minutes (SD 110, 17-450 minutes, not identified). (*Includes outlier where the fluid balance chart was not started for 12 hours, excluding this case mean 76 minutes [SD 95 minutes, range 10-240 minutes]).
Impact of prehospital care upon admission									
3	646	non-RCT	very serious[5]	none	not serious[2]	very serious[6]	very serious[8]	⊕⊙⊙⊙ very low	[Guerra 2013] No significant reduction in length of stay: mean 7.3 days (SD 6.8 days, pre-alert) vs 8.4 days (SD 8.8 days, no pre-alert, p=0.65). [Femling 2014] Length of stay: 15 days (IQR 13-17 days, EMS) vs 14 days (IQR 10-17 days, non-EMS), difference 1 day, not significant. [Seymour 2014] Prehospital vascular access reduced ICU admission adjusted OR 0.41 (95% CI [0.24 - 0.70]). [McClelland 2015] ICU admission: 4% (1/23, EMS identified) vs 13% (3/23, not identified).
Impact of prehospital care upon mortality									
5	2,959	non-RCT	very serious[5]	none	not serious[2]	very serious[6]	very serious[8]	⊕⊙⊙⊙ very low	[Band 2011] No significant difference in mortality was noted: adjusted RR 1.24 (95% CI [0.92 - 1.66, p=0.16). [Guerra 2013] If hospital was 'pre-alerted', unadjusted mortality was improved OR 3.19 (95% CI [1.14– 8.88], p=0.04). [Femling 2014] No significant difference in mortality was noted 113/378 (30%, EMS) vs 34/107 (31%, non-EMS), difference 1%, not significant. [Seymour 2014] Prehospital vascular access reduced mortality adjusted OR 0.31 (95% CI [0.17 - 0.57], p<0.01). [McClelland 2015] 3 month mortality 21% (5/24, EMS identified) vs 16% (4/25, not identified).

Table 4. Continued.
RCT, randomized control trial; *EMS*, emergency medical services; *IV,* intravascular; SVC_{O2}, superior vena cava oxygen, *EGDT*, early goal directed therapy; *OR,* odds ratio; *CI,* confidence interval; *ICU,* intensive care unit.

Impact of prehospital antimicrobial therapy on ICU admission									
1	199	RCT	not serious[1]	none	not serious[2]	very serious[3]	very serious[4]	⊕⊙⊙⊙ very low	[Chamberlain 2009] Mean ICU length of stay: reduced 6.8 ± 2.1 days (intervention) vs 11.2 ± 5.2 days (control, p=0.001).
Impact of prehospital antimicrobial therapy on mortality									
1	199	RCT	not serious[1]	none	not serious[2]	very serious[3]	very serious[4]	⊕⊙⊙⊙ very low	[Chamberlain 2009] 28-day mortality reduced: 42.4% (intervention) vs 56.7% (control), OR 0.56 (95% CI [0.32 to 1.00], p=0.049).
Impact of prehospital intravenous fluid therapy on ICU admission									
1	1,350	non-RCT	not serious[9]	none	not serious[2]	none	none	⊕⊙⊙⊙ very low	[Seymour 2014] Prehospital fluids did not reduce likelihood of ICU admission adjusted OR 0.64 (95% CI [0.37-1.10]).
Impact of prehospital intravenous fluid therapy on mortality									
1	1,350	non-RCT	not serious[9]	none	not serious[2]	none	none	⊕⊙⊙⊙ very low	[Seymour 2014] Prehospital fluids reduced hospital mortality adjusted OR 0.46 (95% CI [0.23-0.88], p=0.02).

1. Risk of bias unclear.
2. Single centre study may limit generalizability.
3. Small study numbers limits precision/accuracy.
4. Published in abstract only, insufficient detail to rule out other bias.
5. Concerns relating to eligibility, exposure, confounding, follow-up
6. Small study numbers limits precision/accuracy, failure to report confidence intervals (Guerra)
7. Abstract only publication (Femling), insufficient detail to rule out other bias, Publication bias likely (Guerra)
8. Publication bias likely (Guerra)
9. Risk of bias unclear

Table 4. Continued.

ICU, intensive care unit; *RCT,* non-randomized controlled trial (observational study); *IQR*, interquartile range; *EMS*, emergency medical services; *SD,* standard deviation; *MAP*, mean arterial pressure; *IV,* intravascular; *RR*, risk ratio, *CI,* confidence interval; *CVP*, central venous pressure; *EGDT,* early goal directed therapy; *OR*, odds ratio.

decision to place a central venous catheter (EMS pre-alert: 61% vs no EMS pre-alert: 68%, p=0.54). Although Seymour *et al.*[28] reported that higher proportion of patients achieved a SVC_{O2}>70% within six hours when EMS initiated fluid therapy prior to arriving at the ED, the unadjusted risk ratio found no evidence of a difference (EMS IV fluids: 13/24 (54%) vs no IV fluids: 9/25 (36%), Unadjusted RR 1.5, 95% CI [0.8-2.9]). This same study also identified no improvement in time to MAP>65mmHg (EMS IV fluids: 17/24 (70%) vs no IV fluids: 12/26 (44%), unadjusted RR 1.53 (95% CI [0.9-2.65]), and time to CVP>8 mmH_20 (EMS IV fluids: 15/25 (60%) vs no IV fluids: 17/24 (70%), unadjusted RR 1.2 (95% CI [0.8-1.8]).[28]

Studnek *et al.*[5] reported that if patients arrived by EMS they had shorter times to EGDT than if they arrived by other means (EMS: 119 minutes vs non-EMS: 160 minutes, SD/range not reported, p=0.005). Furthermore, among EMS-transported patients, if EMS documented suspicion of sepsis then time to EGDT was shorter than if they did not document suspicion of sepsis (documented suspicion: 69 minutes vs not documented: 131 minutes, SD/range not reported, p=0.001). McClelland *et al.*[25] similarly reported that time to delivery of the 'Sepsis 6' (administration of supplemental oxygen, intravenous fluids, antibiotics, measurement of venous lactate, urine output, and drawing blood to identify causative pathogen) was shorter if EMS identified sepsis prior to arrival at hospital (EMS identified: mean 205 minutes [SD 271 minutes, range 10-720 minutes] vs not identified: mean 120 minutes [SD 110, 17-450 minutes]). These data points include one outlier where the fluid balance chart was not started for 12 hours. Excluding this case, the mean time to delivery of the 'Sepsis 6' would be 76 minutes (SD 95 minutes, range 10-240 minutes).

DISCUSSION

Very few, if any, EMS systems are capable of delivering the entire initial resuscitation bundle advocated by the Surviving Sepsis Campaign guidelines.[1] Most EMS systems lack the capability to draw blood and analyze the required parameters; in addition some of the technical skills required, such as central line placement, will be beyond the scope of many non-physician providers. It is therefore unreasonable to expect EMS systems to be able to deliver all elements of the initial resuscitation bundle. However, key interventions, such as oxygen therapy, antibiotic administration, fluid resuscitation and measuring venous lactate are possible. Despite the ability of EMS to deliver the aforementioned, recent hospital trials[32-34] have brought into question several of the EGDT objectives. We therefore need to examine carefully the need to extend EMS scope of practice to deliver those elements not routinely practiced, such as measuring venous lactate and administering antibiotics.

Prehospital recognition of sepsis is challenging.[8,27,35] The limited evidence identified suggests the initiation of treatment by EMS may lead to improved process outcomes, i.e. reduces time taken to achieve initial resuscitation targets but is not necessarily associated with improved clinical outcomes.

There is currently no evidence addressing impact of prehospital oxygen therapy in sepsis. The ARISE[33], ProCESS[32] and ProMISe[34] trials have all suggested that the need to rigidly adhere to EGDT may be overstated. Furthermore, a systematic review by Sterling *et al.*[36] indicates that antibiotic administration within the first three hours is not associated with improved patient outcomes.

One study[29] identified during this review suggests that prehospital antibiotics may reduce mortality (OR 0.56 (95% CI [0.32-1.00]), p=0.049); however, this study was published in abstract only and enrolled a limited number of patients (n=198). We cannot therefore be confident that prehospital antibiotics would improve outcomes. The PHANTASi trial (NCT01988428) will hopefully provide further evidence to determine if EMS systems should extend clinical practice to deliver prehospital antibiotic therapy in cases of suspected sepsis.

Fluid therapy is an established clinical practice in many EMS systems. Seymour *et al.*[31] identified that prehospital fluid therapy was associated with both reduced organ failures (OR 0.58, 95% CI [0.34-0.98]) and mortality (OR 0.46, 95% CI [0.23-0.88]); however, the mean volume of fluid administered was only 500ml, considerably below what would normally be administered as part of the initial resuscitation bundle (30mL/kg).[1] This led the authors to question if the reduced mortality was due to the small volume of fluid or indeed if it was associated with process improvements secondary to prehospital recognition of sepsis. The latter argument is strengthened by their finding that placement of an intravenous catheter, without any fluid being administered, was also associated with reduced hospital mortality (OR 0.31, 95% CI [0.17-0.57]).[31]

One further aspect that has not been examined is the influence of EMS system design. Internationally, two distinct EMS systems, the EMT/paramedic (Anglo-American) model and physician (Franco-German) model are observed. Typically physician responders might be expected to have higher clinical acumen than paramedics/EMTs as a result of their longer, more in-depth education and training. In addition they may have greater scope to initiate a broader range of interventions, as well as direct admission to specialist services. These factors could improve recognition and indeed treatment of sepsis before arriving at hospital.

Eight of the included studies were conducted in EMT/paramedic EMS systems[5,11,25-29,31] with a single study, published in abstract only, conducted in a physician-based EMS system.[30] Studies conducted in both system designs suggested reduced times to interventions; however, Bayer *et al.*[30] did not publish data addressing mortality, ICU admission nor length of stay in their EMS physician-based study. Although Bayer *et al.*[30] reported a high proportion of suspected prehospital sepsis cases

were later confirmed in the hospital, they did not report data concerning missed cases making it impossible to determine if EMS physicians are able to accurately identify sepsis patients out of the hospital. Bayer *et al.*[30] did however report a larger mean fluid volume (2.5l intravascular fluid (IQR 1.5–3.0l)),[30] than in the paramedic-based study (mean volume 500mL (IQR 200-1000mL)) reporting this outcome,[31] which may reflect greater understanding of beneficial treatments. With such limited data it is not possible to draw any meaningful conclusions concerning the impact of EMS physicians on outcomes in sepsis.

LIMITATIONS

We employed a broad search strategy in order to capture as much published literature as possible. Inclusion criteria were similarly not restrictive so as to include as much of the evidence base as possible. To the best of our knowledge, this is the first systematic review addressing the impact of prehospital interventions upon outcomes among sepsis patients. Despite using very broad search criteria, little robust evidence regarding the impact of prehospital care of sepsis patients was identified. The studies found employed disparate methodologies, exhibit significant heterogeneity, generally involve small numbers of patients (limiting the precision of reported results) and were invariably of very low quality. The conclusions that can be drawn from this systematic review are therefore limited and findings should be interpreted with caution.

CONCLUSION

There is little robust evidence addressing the impact of prehospital interventions on outcomes in sepsis. That which is available is of very low quality and indicates that prehospital interventions have limited impact on outcomes in sepsis beyond improving process outcomes and expediting the patients passage through the emergency care pathway. Evidence indicating that prehospital antibiotic therapy and fluid resuscitation improve patient outcomes is lacking. Well-conducted studies addressing key clinical interventions, such as antibiotic administration and fluid resuscitation are required.

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Emergency Department Length of Stay for Maori and European Patients in New Zealand

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Introduction: Emergency department length of stay (ED LOS) is currently used in Australasia as a quality measure. In our ED, Maori, the indigenous people of New Zealand, have a shorter ED LOS than European patients. This is despite Maori having poorer health outcomes overall. This study sought to determine drivers of LOS in our provincial New Zealand ED, particularly looking at ethnicity as a determining factor.

Methods: This was a retrospective cohort study that reviewed 80,714 electronic medical records of ED patients from December 1, 2012, to December 1, 2014. Univariate and multivariate analyses were carried out on raw data, and we used a complex regression analysis to develop a predictive model of ED LOS. Potential covariates were patient factors, temporal factors, clinical factors, and workload variables (volume and acuity of patients three hours prior to and two hours after presentation by a baseline patient). The analysis was performed using R studio 0.99.467.

Results: Ethnicity dropped out in the stepwise regression procedure; after adjusting for other factors, a specific ethnicity effect was not informative. Maori were, on average, younger, less likely to receive bloodwork and radiographs, less likely to go to our observation area, less likely to have a general practitioner, and more likely to be discharged and to self-discharge; all of these factors decreased their length of stay.

Conclusion: Length of stay in our ED does not seem to be related to ethnicity alone. Patient factors had only a small impact on ED LOS, while clinical factors, temporal factors, and workload variables had much greater influence. [West J Emerg Med. 2017;17(4)438-448.]

INTRODUCTION

Racial disparities in emergency care have been well documented. Most investigations of racial disparities in emergency care have occurred in the United States and have addressed differences in care provided to whites as compared to black and Hispanic patients. In general, non-white patients receive less evaluation and treatment for acute conditions, and non-white patients spend longer waiting in the emergency department (ED), both before and after evaluation by an emergency physician.

In 2009, one study found that black patients admitted to hospital (intensive care unit [ICU] and non-ICU) through the ED have longer ED length of stay (LOS) compared to non-blacks.[1] In 2013, another study found that pediatric non-Hispanic black and Hispanic patients were less likely to receive any analgesic or narcotic analgesic, and were more likely to have a prolonged ED LOS than non-Hispanic white patients who presented with abdominal pain.[2] In an analysis of ED wait times for stroke patients in the U.S. in 2011, black patients had longer wait times than Hispanic or white patients, with the suggestion that this led to treatment delays and sub-optimal stroke care.[3] Sonnenfeld, et al. in 2012 also found that non-Hispanic black patients wait longer for ED care than whites,[4] while in Australia in 2009, Brown and Furyk found that

although "there was no statistically significant disparity based upon race in the management of minor head injuries," indigenous patients waited longer to be seen.[5]

In Australasia, ED LOS is currently used as a quality measure, as increased LOS has been associated with ED crowding, longer inpatient lengths of stay, and increased mortality.[6] In New Zealand, there is a strong drive to ensure that 95% of patients are admitted, discharged, or transferred from an ED within six hours;[7] in Australia, the National Emergency Access Target is for 90% of patients to have their ED visit completed within four hours.[8] As part of a demographic audit of our provincial New Zealand ED, it was noted that Maori, the indigenous people of New Zealand, had a significantly shorter ED LOS than European patients. This came as some surprise, as Maori are well documented to have poorer health outcomes overall.[9] We therefore sought to investigate the drivers of LOS in our ED, particularly looking at ethnicity as a determining factor.

METHODS

Practice Setting

This study took place in the ED of a provincial hospital located on the lower North Island of New Zealand, with a city population of approximately 80,000 people and a total catchment population of around 165,000 people. Approximately 18% of this region's population identify as Maori (about 15% of New Zealand's total population of 4.5 million people identify as Maori). To be considered "Maori" in New Zealand, you must identify culturally as being Maori and be able to identify a whakapapa, or family lineage. "Europeans," generally those people who identify as being of northern European ancestry and commonly referred to as "white" or "Caucasian" in North American literature (and sometimes referred to as Pakeha in Maori literature), make up the great majority (just under 80%) of the rest of our region's population. Pacific Islanders (people from 22 island nations, of widely varying ethnicities and cultures) comprise about 2% of our region's and our ED's population, and Asians (defined broadly as being from India, Southeast Asia, Indonesia, Malaysia, China, or Japan) make up about 10% of our region's population and about 3% of the ED population. An ill-defined "Other" category encompasses people from Africa, Central and South America, and the Middle East; these people make up approximately 0.3% of our total population.

Annual ED volumes in our hospital total about 40,000 patients per annum. Our ED has 16 beds (two large resuscitation bays, four smaller resuscitation beds, and 10 assessment beds). We have a four-bed minor works station and a five-bed, three-chair observation unit. In our group there are nine consultants (attending emergency physicians), 18 resident medical officers (RMOs) (typically four emergency medicine registrars and 14 post-graduate year two and above senior house officers (SHOs) who are not in a specialty training program and are typically in the ED for only three months), and one permanent and several locum Medical Officers of Special Scale (doctors who have not completed a training program in emergency medicine but may have trained in general practice and are significantly more senior than RMOs). Two clinical nurse specialists staff our Minor Works Station from 11am - 9pm on most days, and they see triage category 4 and 5 patients with minor extremity injuries. One or two consultants and two RMOs work clinically from 7am – 5pm, another consultant and two more RMOs work 12pm – 10pm, and another consultant and another two RMOs work 2pm – 12am. Overnight, a consultant is on call from home, and the ED is staffed by three RMOs (as often as possible, one registrar and two SHOs). General practitioners (GP) will also directly refer patients to medical or surgical specialty registrars; many of these patients will often have at least a partial outpatient workup completed and will be seen only by the non-emergency medicine registrar. Our junior doctors have six-year undergraduate medical degrees from New Zealand, the United Kingdom, or Australia. We are an Australasian Level IV trauma center (roughly equivalent to a Level II trauma center in the U.S.). For the study period, 36.68% of all patients presented by ambulance, 63.24% presented through our front reception/triage area, and 0.07% presented by helicopter.

Study Design

This was a retrospective cohort study that reviewed 80,714 electronic medical records (PIMS, or Patient Information Management System, Avant Version 2.31, written by Adrian Hunter, copyright 1999-2012) of ED patients from December 1, 2012, to December 1, 2014 (inclusive). All data were collected in March 2015. For this study, we used total ED LOS, as data regarding waiting times to see a nurse or doctor, as well as referral times to specialties, were found to be inconsistent and unreliable.

The decision was made to exclude from the analysis Asian and Pacific Islander patients, as well as patients defined as being "Other" and those patients who did not state an ethnicity. We felt that these categories were too broad and ill-defined, while European and Maori definitions/identity were relatively firm.

We carried out univariate and multivariate analyses on the raw data, and a complex regression analysis was used to develop a predictive model of ED LOS. A subset of 80,029 records with complete data for all variables was used in model development. We initially performed exploratory graphs, t-tests, contingency tables, and chi-squared tests of association to explore associations between pairs of variables. Poisson regression analysis was used to model the effect of temporal factors on patient numbers. Log transformed LOS (log (LOS + 1 minute) was used to change the raw data to a more normal distribution in order to meet the assumptions of our linear regression model. We used regression trees to model LOS, and classification trees were used to model LOS greater than six hours. In the modeling process, we removed variables from the model if they did

not improve the model. Akaike information criterion (AIC) was used to compare models. Statistical significance was taken as p-value<0.05.

The primary outcome measure was ED LOS. Potential covariates were broken down into four large categories: patient factors (age, gender, socioeconomic deprivation level (see Appendix 1 for an explanation of the New Zealand Deprivation Index), and ethnicity); clinical factors (presenting complaint, Australasian Triage Scale category, disposition/outcome, seniority of ED staff caring for the patient, identification of a GP (general practitioner), and diagnostic tests performed); temporal factors (hour of day, day of week, month of year); and workload variables (the volume and acuity of patients presenting three hours before and two hours after the arrival of any given patient) were all considered in developing a model to predict ED LOS.

Initially, the date a patient filled a prescription written in the ED was examined as a clinical factor, but records were found to be sparse and unreliable. Therefore, we excluded prescription data from the analysis.

We also found data about time to triage, time to be placed in an ED bed/to be seen by an ED nurse, time to be seen by a doctor, and time of referral to an inpatient specialty to be inconsistently recorded. Therefore, these data were also excluded from the analysis.

Repeat visits by the same patient were not excluded.

We used patient factors and temporal factors to investigate any potential bias in the assignment of Australasian Triage Scale (ATS) category.

Categorization of presenting complaint was done manually, resulting in 62 categories with at least 90 patients in each, including a large "other" category with 31,723 patients.

To evaluate the impact of patient volume and acuity on ED LOS, we created four workload variables to account for the number of patients who presented to the ED in the three hours prior or two hours after the arrival of a baseline patient.

We performed the analysis using R studio 0.99.467 with the packages ggplot2 1.0.1, knitr1.11, lattice 0.20-33, rattle 3.5.0, rcolorBrewer 1.1-2, rpart 4.1-9, rpart.plot 1.5.3 and xtable 1.7-4. R studio is available from RStudio Team (2015); all packages are available from CRAN at http://CRAN.R-project.org/.

In summarizing the medical literature, the decision was made to keep the ethnic terms used in the original papers; most commonly, in American literature, "black" and "Hispanic" were used instead of "African-American" or "Latino." It should be noted that in New Zealand the terms "black" and "white" are generally unacceptable.

Ethical approval was received from the New Zealand Ethics Committee, and local approval for the study was received from our District Health Board's chief medical officer, operations manager, and clinical director of the ED. Formal consultation was also sought with the Director of Maori Health.

RESULTS

Raw Data

During our study period, 60,601 Europeans (75.1% of the total) and 13,939 Maori (17.3%) presented to our ED. There were 40,300 females and 40,411 males. Most patients (39,138) were triage category 3, and of all ATS categories, these patients had the longest average ED LOS (346.8 minutes).

Mean LOS for all patients was 302.9 minutes. European patients had a mean LOS of 315.9 minutes, while Maori patients had a mean LOS of 266.8 minutes. Mean age of European patients was 46.85 years, and mean age of Maori patients was 29.89 years. See Appendix 2 for more raw data.

Baseline Patient

For the predictive model, a baseline "average" patient was created from the data: a European male aged between 20 and 50 years with socioeconomic deprivation level 9 who presented with "other" as chief complaint at 11 am on a Monday in January 2013. This patient was ATS category 3, identified a GP, was seen by an ED SHO, had bloodwork and radiographs done, and was discharged home at the conclusion of his ED visit. In our model, there were no patients who presented to the ED in the previous three hours or subsequent two hours relative to his presentation time. The LOS for this baseline patient was 171.8 minutes.

Patient Factors

Ethnicity dropped out in the stepwise regression procedure. Cohorts were not the same independent of ethnicity. The regression model identified which variables were significant predictors of LOS in the modeling process; variables were removed from the model if they did not significantly improve the model. When patient factors of age, gender, and deprivation score were taken into account, ethnicity did not have a statistically significant effect on LOS; in light of the demographic variables other than ethnicity, there was not independence between ethnicity and the other patient factors.

Age distribution varied across ethnic groups, with Maori overrepresented in the younger age groups and underrepresented in the older age groups compared to Europeans (Figure 1). Patients were broken into five age groups (under two years old, 2-20, 20-50, 50-80, and over 80), and distribution of ED LOS within age groups was found to be similar for different ethnic groups. Average LOS increased with increasing age. Within the five age groups, Maori patients had significantly longer average ED LOS than Europeans for patients 0-2 years old and over 80 years old. Maori patients 20-50 years old and 50-80 years old also had a longer ED LOS than Europeans, but this difference did not reach statistical significance (p=0.059 and p=0.75, respectively). There was no signficant interaction between age and ethnicity. We found that having adjusted for age across ethnic groups equally, making an adjustment for the

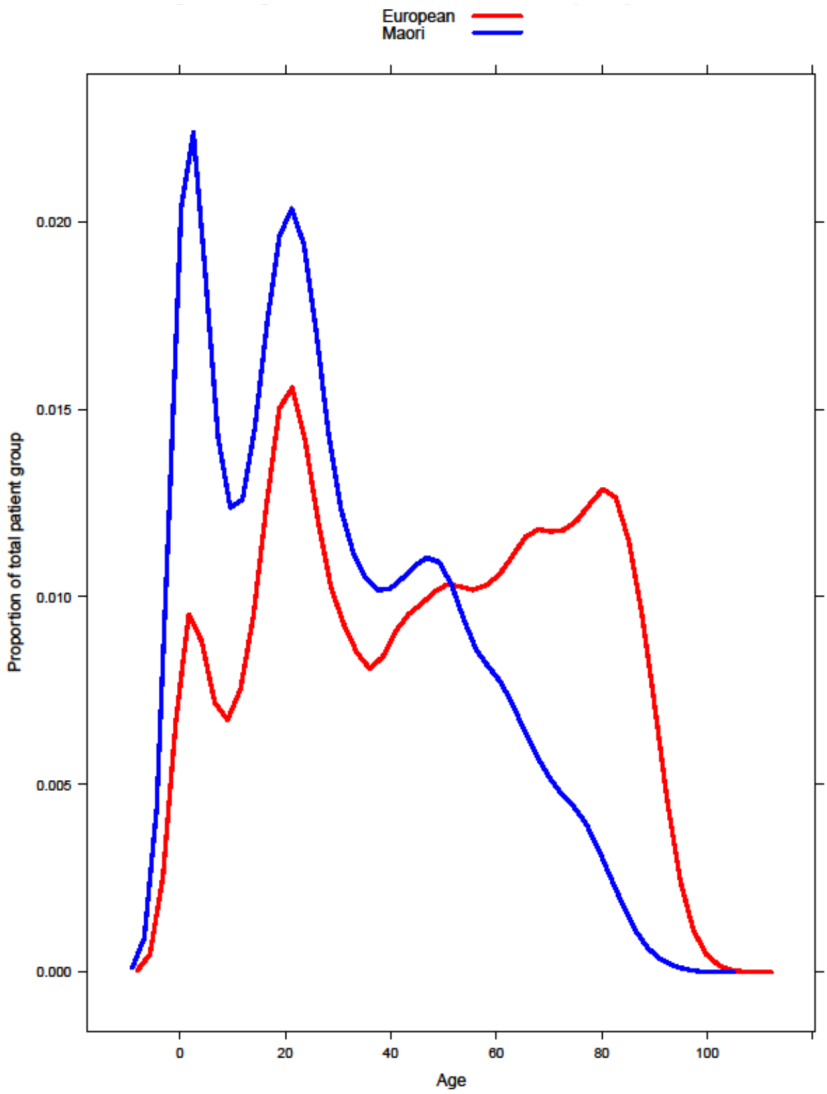

Figure 1. Age distribution among ethnic groups: Maori were statistically younger than Europeans. Average age of 13,939 Maori patients was 29.89 years and average age of 60,601 European patients was 46.85 years.

age of Maori patients was not relevant or necessary.

In general, younger patients had shorter expected LOS, but the relationship was not simple, as the effect of age depended on gender; the interaction between gender and age was statistically significant (Table 1).

Maori patients were more likely to have higher deprivation scores (were more deprived) and the effect of deprivation level was independent of other factors. ED LOS of deprivation levels 7,8, and 10 were not significantly different to that of baseline deprivation level 9. However, deprivation levels 1-6 had significantly shorter ED LOS compared to baseline (Table 2).

Clinical Factors

Clinical factors had greater impact on ED LOS than patient factors.

Table 1. Estimated length of stay (LOS) by age and gender (all other factors at baseline).

Age	Male LOS (minutes)	Female LOS (minutes)
0-2 yo	163.0 (CI 153.2-173.3)	156.0 (CI 146.6-166.0)
2-20 yo	161.5 (CI 152.3-171.2)	170.4 (CI 160.7-180.6)
20-50 yo	171.8 (CI 162.2-181.9)	180.7 (CI 170.6-191.3)
50-80 yo	178.9 (CI 169.0-189.5)	185.6 (CI 175.3-196.5)
80-110 yo	185.1 (CI 174.4-196.5)	193.0 (CI 181.9-204.7)

Table 2. Estimated LOS by socioeconomic deprivation level (all other factors at baseline). Level 1 is least deprived and 10 is most deprived; see Appendix 1 for details of the New Zealand Deprivation Index.

Socioeconomic deprivation level (from least to greatest)	ED LOS (minutes)
1	163.4
2	162.9
3	167.4
4	166.6
5	165.2
6	168.5
7	169.6
8	171.9
9	171.8
10	173.0

LOS, length of stay

We could not predict ATS category from patient factors (age, gender, ethnicity, deprivation level) or temporal factors (hour of day, day of week, month of year).

In our predictive model, the seniority of ED staff caring for the patient had a significant impact on their expected LOS. The greater the experience of the ED doctor, the shorter the expected LOS for the patient (Table 3).

Maori patients were more likely than Europeans to be seen only by a nurse, and were more likely to be discharged home and to self-discharge.Outcome/disposition had a significant and sizeable effect on LOS. Patients sent to an on-site outpatient specialty clinic had the shortest expected ED LOS, while those who were admitted as an inpatient, were transferred to another hospital, or died in ED remained longest in the department (Table 4).

Maori patients were less likely than Europeans to have labs and radiographs done, and less likely to go to our ED

Table 3. Estimated length of stay (LOS) by practitioner (all other factors at baseline).

Category of practitioner	LOS (minutes)
ED registered nurse (RN)	78.7 (CI 74.1-83.7)
Emergency clinical nurse specialist (CNS)	115.1 (CI 108.2-122.3)
Other specialty registrar	123.3 (CI 116.2-130.8)
Consultant emergency physician	148.9 (CI 140.3-157.9)
ED medical officer special scale (MOSS)	153.2 (CI 143.8-163.1)
Emergency medicine registrar	162.6 (CI 153.4-172.3)
ED senior house officer (SHO)	171.8 (CI 162.2-181.9)

ED, emergency department

Table 4. Length of stay (LOS) estimates by outcome/disposition (all other factors at baseline).

Outcome / disposition	LOS (minutes)
On site specialty clinic	121.9 (CI 112.9-131.6)
Discharged home	171.8 (CI 162.2-181.9)
Self discharge	172.0 (CI 161.7-183.0)
Mental health emergency team	199.7 (CI 167.3-238.3)
Admitted as inpatient	219.0 (CI 206.8-232.0)
Transfer to another hospital	231.7 (CI 209.6-256.1)
Deceased	314.7 (CI 269.0-368.1)

Table 5. Length of stay estimates in minutes according to emergency department observation area, lab, radiograph and GP-known or not (all other factors at baseline).

	Admission to emergency department observation area	Lab (blood tests performed)	X-ray performed	General practitioner known
Yes	348.0	171.8	171.8	171.8
No	171.8	119.0	137.5	166.5

GP, general practitioner

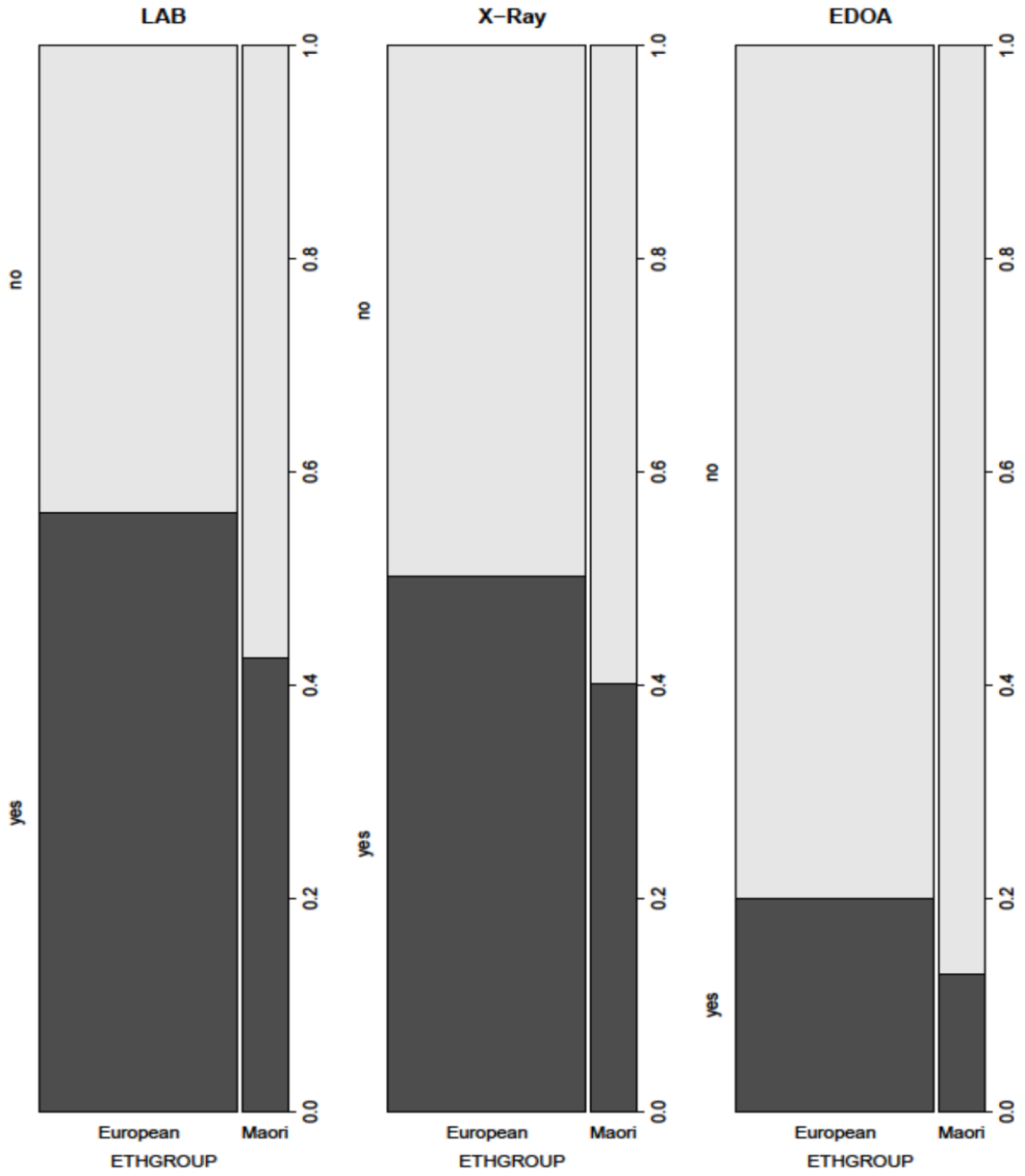

Figure 2. Proportion of Maori and European patients admitted to our emergency department observation area (EDOA), had blood tests performed (Lab), or had radiographs performed.

observation area (Figure 2). Not having lab tests done while in the ED decreased LOS by about 30% from baseline, while not having radiographs decreased LOS by about 20% from baseline. Lab tests and radiographs were strongly interdependent, with patients who had lab tests being more likely to have radiographs, and vice versa. The clinical factor with the biggest impact on ED LOS was going to the ED observation area (EDOA), which approximately doubled expected LOS. Patients who breached the six-hour target were more likely to go to EDOA than those patients who did not breach.

Additionally, patients identifying a GP had statistically significant but minimal impact, increasing predicted ED LOS by about 3%. See Table 5 for LOS estimates by EDOA, lab, radiograph, and GP.

Some presenting complaints had statistically significant impact on expected ED LOS. However, the impact tended to be minor compared to the impact of other clinical variables. The largest effects were from diarrhea and vomiting (increased LOS by nearly 30%), crisis (psychiatric evaluation) (increased LOS by 28%), overdose (increased LOS by 25%), toothache (decreased LOS by 15%), SVT (supraventricular tachycardia) (decreased LOS by 12%), and palpitations (decreased LOS by 12%) (Table 6). See Appendix 3 for table of presenting complaint by ethnicity.

Triage category had a significant impact on expected LOS, with triage 1 patients having the shortest expected ED

Table 6. Presenting complaints that significantly increased or decreased length of stay (LOS) from baseline.

Presenting complaint	LOS (minutes)
Diarrhoea and vomiting	240.1
For crisis (psychiatric evaluation)	223.9
Diarrhoea	218.1
Overdose	209.9
Palpitations	149.0
SVT (supraventricular tachycardia)	147.7
Toothache	146.2

Table 7. Length-of-stay (LOS) estimates according to triage level (other factors at baseline). Level 1 is most acute; level 5 is least acute.

Australasian triage scale category	LOS (minutes)
1	99.4
2	151.5
3	171.8
4	154.7
5	108.3

LOS and triage 3 patients having the longest (Table 7).

Workload Variables

Workload variables had a statistically significant influence, and their impact on ED LOS was complex. Patients who were triaged as less urgent than our baseline patient had only a small impact on our baseline patient's expected LOS (regardless of whether they arrived before or after that patient). However, every more urgent patient who arrived before our baseline patient was associated with an increase in that patient's expected LOS.

Temporal Factors

Temporal factors (hour of day, day of week, month of year) had a significant impact on LOS even when patient volume and acuity were taken into account. Expected ED LOS followed a roughly cyclical pattern during the day, with a peak at 11 am and a low at 4 pm. Expected LOS was shortest on Fridays and greatest on Sundays, shortest in January (summer) and longest in August (winter). Day alone was not a statistically significant predictor of ED LOS, but some combinations of day and month were significant. Time of day had more impact on patient numbers during the weekend than on weekdays. The effect of days of the week and months of the year had a small impact compared to differences across hours of the day.

Hourly and daily presentation patterns of different ethnicities were not significantly different (please see Figure 3 for hourly presentation patterns by ethnicity), but monthly presentation patterns were significantly different by group.

Summary

Overall, there was longer ED LOS on average for women, older people, patients presenting during the middle months of the year (June-August), patients presenting late at night, patients seen by junior doctors, and for ATS category 2 and 3 patients. Although older age, female gender, and greater socioeconomic deprivation level had statistically significant effects on ED LOS, this effect was small compared to clinical factors, temporal factors, and workload variables. After controlling for other factors, ethnicity was not a statistically significant predictor of length of stay.

DISCUSSION

Our study reinforces some previous findings about ED LOS. A recent systematic review of ED LOS studies found that admission, older age, diagnostic testing, and moderate acuity were related to longer LOS.[10] In a study of American patients with psychiatric illness, ED LOS was prolonged not only by alcohol on toxicology screening, but by older age, being uninsured (potentially a marker of socioeconomic deprivation), and diagnostic imaging.[11] Also similar to our study, Kocher et al. in 2012 found that discharged patients had a shorter ED LOS than admitted patients, and that blood tests and advanced imaging significantly prolonged LOS, particularly among discharged patients.[12]

Similar to the findings in our paper, Payne and Puumala found that nonwhite (Native American, African American, Hispanic, or biracial) children were also less likely to receive laboratory and radiological testing.[13] Hambrook in 2010 found that white, insured American pediatric patients who presented with chest pain were significantly more likely to receive diagnostic testing.[14]

In 2010, using quantile regression to analyze data from four academic EDs in the U.S., Ding and colleagues found that triage level 3 patients waited the longest, and temporal factors had the greatest impact on their waiting times; they also found that temporal factors were strong predictors of service completion times.[15] Ding also found that patient characteristics had minimal influence on ED service completion time, although ethnicity/race was not included as a demographic feature.[15] Ding also found that ED volume was highest in the late morning and afternoon hours and lowest at night and in the early morning hours.[15] In keeping with the findings of our study, and similar to findings of a study in Australia,[16] the study by Fee et al. in 2012 also found that junior doctors were associated with prolonged ED LOS for admitted, discharged, and transferred patients compared to senior emergency physicians.[17] However, Fee, in this same study, found that nonwhite race was associated with longer ED LOS among admitted patients,[17] and Bekmezian et al found that Hispanic ethnicity (as well as winter season and early

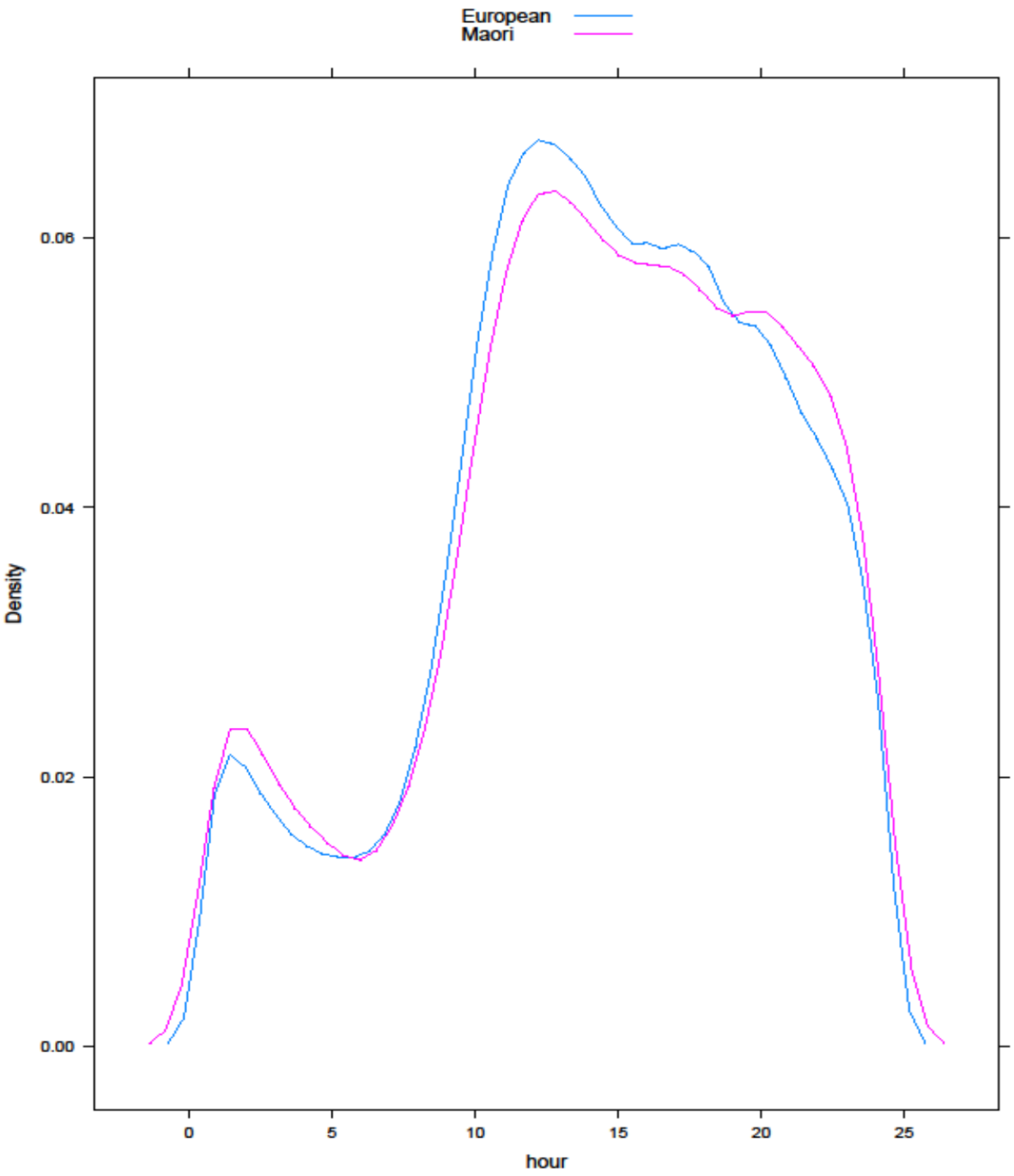

Figure 3. Hourly presentation patterns to the emergency department by ethnicity.

morning arrival) were associated with prolonged ED LOS.[18] This association of ethnicty with prolonged ED LOS is somewhat different to what we found.

While our study did not find an association between ethnicity and ED LOS, in 2007 Gardner et al. found that advanced imaging and Hispanic ethnicity were independently associated with longer LOS; also unlike our study, emergency physician seniority did not impact significantly on ED LOS.[19] Mansbach et al. also found that Hispanic race/ethnicity in children with bronchiolitis was associated with increased ED LOS.[20] Unlike our findings, racial disparities in ED triage scoring have also been found in more recent papers.[21-23]

One finding that seems to be consistent across several papers over several years is that nonwhite (especially indigenous) and socioeconomically deprived patients are more likely to leave the ED before the completion of evaluation and treatment.[24-27] We, too, found this to be the case in our study.

LOS in our ED does not seem to be directly related to ethnicity alone. Among other factors, the age distribution of Maori patients is very different to that of European patients; Maori in general have an average life expectancy 7.1 years less than non-Maori patients,[28] and this is reflected in their age distrubtion in our ED. The age structure of the Maori population nationwide is also heavily skewed toward younger people.[29] When age group is taken into account, Maori do not have a shorter average LOS than European patients; at the extremes of age, the average LOS is significantly longer for Maori.

Additionally, females in New Zealand have a life expectancy 3.7 years higher than males,[28] which may partially account for their increased LOS.

Deprivation level was a significant confounder, as it was an independent predictor of LOS.

Clinical factors were of greater significance than patient factors, with the biggest influence on LOS being whether a patient went to our ED observation area or not. Interestingly, many patients who had already been in the ED for six hours or more were more likely to go to EDOA. This suggests that EDOA was perhaps being used as a surrogate inpatient ward for admitted patients during the study period, and that there was impeded flow into or through the hospital.

Other important clinical factors that significantly impacted on ED LOS were triage category, the seniority of the doctor seeing the patient, disposition, and whether or not labs or radiographs were obtained. As ATS category appeared to be unpredictable by patient factors or temporal factors, it could reasonably be argued that ATS category was an objective evaluation of patient acuity. This, in turn, suggests that the seniority of practitioner seeing the patient, the need for bloodwork, radiographs, and observation or admission were also not subject to significant bias, although these were not specifically tested. Maori were less likely to identify a GP, less likely to have radiographs or blood tests, and more likely to be discharged and to self-discharge, all factors which decreased their LOS.

In our predictive model, Maori were less likely to go to EDOA, one of the biggest extenders of ED LOS, but this may be related to their younger age; they could reasonably be assumed to have fewer comorbidities, although information about comorbidities was not available to us and this lack of information might have introduced significant bias.

Workload variables had an important and complex impact on LOS for all patients. Both volume and acuity were important before and after any given patient's arrival. However, hour of day, day of week, and month of year also had a significant effect on ED LOS, even when workload variables were taken into account. This suggests that the predictable hourly, daily, and seasonal variation as well as the unpredictable viscosity (volume *and* acuity) of the ED have significant impacts on LOS for any patient.

LIMITATIONS

We did not have access to comorbidities, as these were not recorded electronically. Comorbidity would be an important variable to include in any future study of ED LOS. We also found data about time to triage, time to be placed in an ED bed, time to be seen by a doctor, time to be seen by an ED nurse, and time of referral to an inpatient specialty to be inconsistently recorded; these times, too, would be important to include as additional variables in a future study, as they might uncover important disparities not reflected in total ED LOS. Total ED LOS might not have been attributable to physician or departmental factors.

As a retrospective study on all patients presenting over a given time period, the cohorts were not matched. We recognize that cohort matching is desirable but it was not a requirement for our model. Aside from the practical difficulties, not knowing which factors were significant for LOS made matching cohorts problematic. We did not try to make predictions for any ethnic group or the differences among them because after adjusting for other factors, ethnicity became irrelevant.

Patients who self-discharged - or were discharged home by a nurse - were not of equal severity and cohort and this, too, was a limitation.

Presenting complaint was a problematic category, as it could be recorded as free text by a triage nurse, a staff nurse, a charge nurse, or a receptionist (without a medical background). Including presenting complaint added even more complexity to our model, without significantly improving it. Most presenting complaints did not seem to affect LOS in a significant way.

Ideally, this model could be applied in a multicenter review that would include similar-sized EDs within New Zealand.

CONCLUSION

There were many confounders in determining length of stay in our emergency department. It would seem that social issues (perhaps including access to primary care) and calendar events outside the ED, as well as unpredictable workload variables within the ED, strongly impact on ED length of stay for all patients. Why do Maori have a shorter ED LOS? They are younger, less likely to have a GP, and less likely to receive blood tests, radiographs, be admitted, or go to EDOA; they are also more likely to be discharged and to self-discharge. *Why* these things are so is an open question and provides direction for further study.

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Comparison of Result Times Between Urine and Whole Blood Point-of-care Pregnancy Testing

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Introduction: Point-of-care (POC) pregnancy testing is commonly performed in the emergency department (ED). One prior study demonstrated equivalent accuracy between urine and whole blood for one common brand of POC pregnancy testing. Our study sought to determine the difference in result times when comparing whole blood versus urine for the same brand of POC pregnancy testing.

Methods: We conducted a prospective, observational study at an urban, academic, tertiary care hospital comparing the turnaround time between order and result for urine and whole blood pregnancy tests collected according to standard protocol without intervention from the investigators. After the blood was collected, the nurse would place three drops onto a Beckman Coulter ICON 25 Rapid HCG bedside pregnancy test and set a timer for 10 minutes. At the end of the 10 minutes, the result and time were recorded on an encoded data sheet and not used clinically. The same make and model analyzer was also used for urine tests in the lab located within the ED. The primary outcome was the difference in mean turnaround time between whole blood in the ED and urine testing in the adjacent lab results. Concordance between samples was assessed as a secondary outcome.

Results: 265 total patients were included in the study. The use of whole blood resulted in a mean time savings of 21 minutes (95% CI 16-25 minutes) when compared with urine ($p<0.001$). There was 99.6% concordance between results, with one false negative urine specimen with a quantitative HCG level of 81 mIU/L.

Conclusion: Our results suggest that the use of whole blood in place of urine for bedside pregnancy testing may reduce the total result turnaround time without significant changes in accuracy in this single-center study. [West J Emerg Med. 2016;17(4)449-453.]

INTRODUCTION

Point-of-care (POC) pregnancy testing is commonly performed in the emergency department (ED). Studies have demonstrated that patient sexual history is unreliable,[1] and many patients may need radiographic procedures or administration of potentially teratogenic medications during the course of their ED visit. In many United States EDs, pregnancy testing is performed by POC urine pregnancy testing. However, with the exception of bladder catheterization, awaiting urine specimens may result in significant delays if the patient is not yet able to provide urine, or may be impossible if the patient is anuric due to illness or injury. Fromm et al previously demonstrated in 633 patients that urine and whole blood have similar test characteristics when used in one common brand of POC pregnancy testing, with a higher sensitivity and a lower human chorionic gonadotropin (hCG) threshold level observed in the whole blood specimen group.[2]

There has been increasing pressure to increase efficiency and throughput in the modern ED. Previous studies have suggested that lab turnaround times may play a significant factor in patient throughput, which can affect both ambulance diversion rates and overall departmental efficiency.[3-8] Despite multiple studies assessing improvement in turnaround time when performing laboratory studies in the ED and at the bedside instead of in a separate laboratory, none have assessed the potential time savings of replacing urine pregnancy testing with whole blood. Our aim was to investigate whether the use of whole blood in place of urine for bedside POC pregnancy testing would result in a decrease in the turnaround time for results. As secondary outcomes, we assessed net decrease in turnaround time when selecting the faster result and concordance among both test results.

METHODS

Study Design

This was a prospective, observational study of female patients of childbearing age presenting to the ED who had both blood obtained and a pregnancy testing performed as a routine part of their care. This study was conducted at an urban, academic, tertiary care hospital with an annual census of 110,000 patients per year.

Study Setting and Population

All female patients aged 18 to 55 years who presented to the ED and had both blood drawn and a pregnancy test ordered as a routine part of their care were eligible for inclusion. Exclusion criteria included prior hysterectomy, known or obvious pregnancy, hemodynamic instability, blood obtained prior to the placement of any orders, and presentation when one of the trained nurses was not available.

The study complied with the recommendations of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement.[9] The study was approved by the local institutional review board with waiver of informed consent. There was no manufacturer support for this study and none of the study investigators have conflicts of interest to declare.

Study Protocol

All blood was obtained per standard nursing protocol without intervention by the study team. Patients were only enrolled if they were having blood drawn for non-pregnancy purposes. Once blood was obtained, three drops from a syringe were placed onto a Beckman Coulter ICON 25 Rapid hCG bedside pregnancy test and a timer was set for 10 minutes. Blood was placed directly into the Beckman Coulter ICON 25 Rapid hCG bedside pregnancy test without any special handling or centrifugation. The Beckman Coulter ICON 25 Rapid hCG POC pregnancy tests were already stocked in this ED and required no special machinery and limited provider training. The decision to wait 10 minutes was based upon the prior accuracy study protocol from Fromm et.[2] After 10 minutes, the time and result were recorded in a study binder. The blood results were not used clinically in any manner. Urine was also collected and brought to our ED laboratory (located next to the nursing station) for pregnancy testing as per the standard protocol at our institution. All urine POC pregnancy testing was performed using the same Beckman Coulter ICON 25 Rapid hCG bedside pregnancy test described above. Per the manufacturer lab manual, the threshold for positivity for this test is 25 mIU/mL.

Outcome Measures

The primary outcome of this study was the difference in turnaround time between POC whole blood and POC urine pregnancy test results. We calculated the whole blood turnaround time as the time difference between when the first blood order was placed (obtained via electronic timestamp of order placement) and the result time (as noted by the study nurses in the binder). The urine turnaround time was calculated as the difference between when the urine pregnancy test order was placed and when the result was made available to the physician in the computer (both obtained via electronic timestamps). Our electronic medical records system allows the user to identify when laboratory results are specifically made available for the provider to view them, thereby allowing for a more accurate measurement of turnaround time. Secondary outcomes included an assessment of the concordance between urine and whole blood POC pregnancy test results and a comparison of turnaround times when selecting the faster alternative across all samples.

Data Analysis

We calculated a sample size of 225 subjects based upon a 90% power with a two-tailed alpha=0.05 to detect a difference of 15 minutes in the turnaround time, which was estimated to be the lowest clinically significant difference and was confirmed with pilot testing. Mean values were calculated with 95% confidence intervals and compared using a paired t-test.

RESULTS

We obtained 265 total samples with 87 (32.8%) positive urine pregnancy tests and 178 (67.2%) negative urine pregnancy tests; 173 (65.3%) were obtained during the morning shift (07:00-15:00), 80 (30.2%) were obtained during the afternoon shift (15:00-23:00), and the remaining 12 (4.5%) were obtained during the overnight shift (23:00-07:00). The use of whole blood resulted in a mean time savings of 21 minutes (95% CI 16-25 minutes) when compared with urine (Figure 1 and 2) ($p<0.001$). Urine turnaround time was faster in 204 patients, with an average time savings of 31 minutes, while blood turnaround time was faster in 61 patients, with an average time savings of 12 minutes. When assessed according to shift, no significant difference was noted.

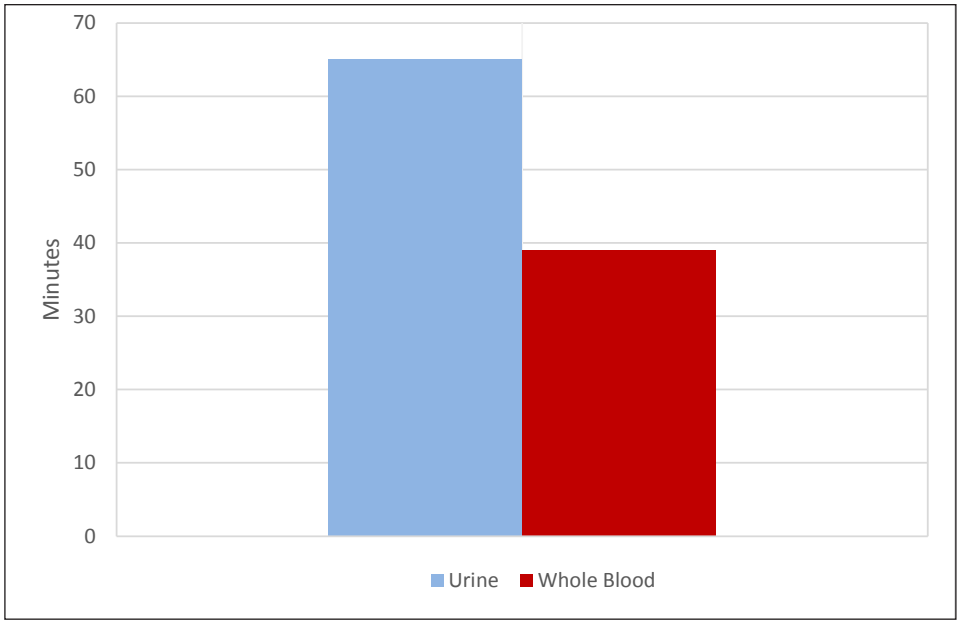

Figure 1. Difference in result turnaround times between whole blood and urine pregnancy tests.

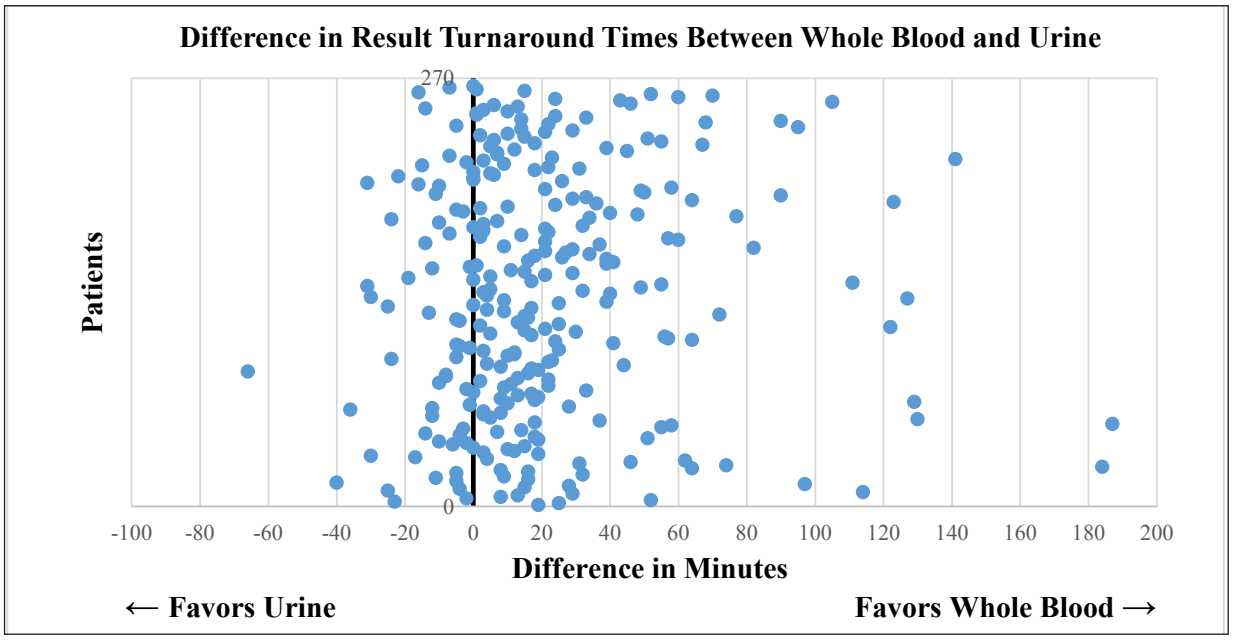

Figure 2. Scatter plot demonstrating the differences in the turnaround time between whole blood and urine pregnancy tests.

When selecting the faster alternative across all samples, the mean time savings for the whole blood group increased to 26 minutes (95% CI 23-30 minutes). Of interest, the maximum time differences ranged from 40 minutes in favor of the urine pregnancy test to 187 minutes in favor of the whole blood pregnancy test.

Concordance between samples was 99.6%. The single discordant value was a woman following up after a completed abortion who mistakenly had a urine pregnancy test ordered. Both tests were obtained and she had a positive whole blood pregnancy test and a negative urine pregnancy test. Quantitative serum hCG testing was also obtained on the patient and was determined to be 81 mIU/mL, thus demonstrating that the urine test was a false negative.

DISCUSSION

In United States EDs, POC pregnancy testing is common and it is important to know a patient's pregnancy

status prior to obtaining certain radiographic studies or administering a number of medications. However, this is often contingent upon the patient providing a urine sample, which may result in prolonged result times and ED stays. Given increasing concerns about ED crowding, there have been multiple studies assessing mechanisms to improve throughput.[3-8] Our study provides the first assessment of replacing urine with whole blood in POC pregnancy testing to compare result turnaround times and is only the second study comparing these modalities.

In our study, we found that replacing urine with whole blood for POC pregnancy testing resulted in a mean decrease of 21 minutes in result turnaround times. More interestingly, the range of maximum turnaround times for results ranged from 40 minutes in favor of the urine pregnancy test to 187 minutes in favor of the blood pregnancy test and preferentially selecting the faster alternative across all samples resulted in a mean time savings of 26 minutes. After thorough discussion with the nurses involved in the study, the longer delays in blood most commonly involved multiple orders being placed at the same time on different patients, while longer delays in urine were predominately secondary to delays in patients providing the urine specimen. This suggests that although replacing urine with whole blood resulted in a decreased turnaround time, the largest benefit may be in providing the option to run whichever is available first.

With regards to concordance, the data demonstrated a 99.6% concordance rate between whole blood and urine. The single discordant value was a positive whole blood result and negative urine result, which was subsequently demonstrated to be a false negative urine result. It is important to note that concordance was a secondary outcome and that quantitative hCG testing was not sent out on most patients. However, Fromm et al previously assessed test accuracy as a primary outcome in a large group of patients, demonstrating similar test characteristics with a slightly improved sensitivity and decreased hCG threshold noted in the whole blood sample.[2] One potential reason for the improved sensitivity in the whole blood specimen is the decreased dilution of whole blood samples compared with urine when patients are given large quantities of water prior to obtaining the urine sample.

It is important to note that the use of whole blood for POC pregnancy testing is not FDA approved. Our study does support one prior study[2] that demonstrated similar accuracy. Moreover, our study is the first to support the potential for significant time savings. It is our hope that this will incite further research and encourage this or other companies to apply for FDA approval of the use of whole blood for pregnancy testing.

LIMITATIONS

A number of potential limitations to this study must be considered. This was a prospective, observational trial and, therefore, it is not known whether these results would be re-demonstrated in a randomized controlled trial. Despite initial data suggesting equivalent test characteristics to whole blood,[2] this product is not yet FDA approved for whole blood and consenting each patient for use of a non-FDA-approved product would have been likely to alter the true result times. Therefore, it was not feasible to perform a randomized controlled trial at this time. Additionally, this was performed at a single, large, county hospital and may not be applicable to other ED settings. Further studies will be necessary to validate these findings at other sites.

This was also a convenience sample obtained only when trained nurses were available, so it is possible that there may be a selection bias present. Although it would have been preferable to perform this study with the entire nursing staff, our resources would only allow us to perform this using the nurses in the fast track and intermediate acuity areas of the ED. However, the involved nurses were blinded to the study outcome and instructed not to alter any of their collection techniques. Additionally, there were a disproportionate number of morning and evening shifts compared with overnight shifts, so this may not apply to patients presenting overnight. However, nurses were selected who worked all three shifts and were instructed to include all patients on their shifts regardless of the time. It is also known that additional factors, such as crowding and staffing, may affect lab turnaround times. However, since both tests were performed on the same patient in close proximity, these are unlikely to have significantly influenced the difference in turnaround times.

Additionally, because the product was not FDA approved for whole blood, we were unable to perform the whole blood testing in our ED laboratory. However, the whole blood samples were performed at the nursing station, which is in close proximity to where the ED laboratory is located and is unlikely to have significantly influenced time. Moreover, since the whole blood testing was performed by nurses working clinically, as opposed to a dedicated laboratory technician, any delay would likely be in favor of the urine specimen. With regards to applicability, there is extensive evidence demonstrating that nurses can perform testing as efficiently as laboratory staff.[10,11]

Our study was further limited in that only one commonly used POC pregnancy test was assessed. However, this is the current test used for POC urine pregnancy testing in our ED, as well as the one studied by Fromm et al.[2] It is possible that alternative POC pregnancy tests may demonstrate different test characteristics.

Finally, quantitative hCG testing was not sent on all patients and it is possible that there may be concordant false negative pregnancy tests; however, chart review of all cases did not demonstrate any repeat presentations for positive pregnancy testing. Moreover, the accuracy has already been assessed as a primary outcome in a prior study.[2]

Although we showed that, on balance, blood hCG testing took less time that urine, we did not study any potential

downstream effects on patient length of stay or alterations in diagnostic testing.

CONCLUSION

Our results suggest that the use of whole blood in place of urine for bedside pregnancy testing may reduce the total result turnaround time without significant changes in accuracy in this single-center study.

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Body Mass Index is a Poor Predictor of Bedside Appendix Ultrasound Success or Accuracy

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Introduction: The objective of this study was to determine whether there is a relationship between body mass index (BMI) and success or accuracy rate of beside ultrasound (BUS) for the diagnosis of appendicitis.

Methods: Patients four years of age and older presenting to the emergency department with suspected appendicitis were eligible. Enrollment was by convenience sampling. After informed consent, BUS was performed by trained emergency physicians who had undergone a minimum of one-hour didactic training on the use of BUS to diagnose appendicitis. We ascertained subject outcomes by a combination of medical record review and telephone follow up. Calculated BMI for adults and children were divided into four categories (underweight, normal, overweight, obese) according to Centers for Disease Control and Prevention classifications.

Results: A total of 125 subjects consented for the study, and 116 of them had adequate image data for final analysis. Seventy (60%) of the subjects were children. Prevalence of appendicitis was 39%. Fifty-two (45%) of the BUS studies were diagnostic (successful). Overall accuracy rate was 75%. Analysis by chi-square test or Mann-Whitney U test did not find any significant correlation between BMI category and BUS success. Similarly, there was no significant correlation between BMI category and BUS accuracy. The same conclusion was reached when children and adults were analyzed separately, or when subjects were dichotomized into underweight/ normal and overweight/ obese categories.

Conclusion: BMI category alone is a poor predictor of appendix BUS success or accuracy. [West J Emerg Med. 2016;17(4)454-459.]

BACKGROUND

In recent years studies have been published on the use of beside ultrasound (BUS) to diagnose appendicitis in the emergency department (ED).[1-4] Its popularity is likely due to the improving ultrasound skills of emergency physicians, as well as the obvious BUS advantages of no ionizing radiation emission, and ease of performance and interpretation at the bedside. Use of ultrasound in suspected appendicitis is also supported by American College of Radiology recommendations, especially in the pediatric population.[5]

Body habitus can be a limiting factor in appendix ultrasound. Several studies have reported decreased ultrasound success rate and accuracy with increasing body mass index (BMI).[6-11] Nevertheless, such findings are by no means universal.[12-15] Furthermore, none of the studies was conducted with BUS performed in the ED setting.

The purpose of the current study was to determine whether there is a relationship between BMI and success or accuracy of BUS for the diagnosis of appendicitis.

METHODS

This was a single-site, prospective study on patients

treated at the Advocate Christ Medical Center Emergency Department for suspected appendicitis. It was approved by our institutional review board. The hospital is a community tertiary referral center with approximately 100,000 ED visits per year. The ED is staffed entirely by board-certified emergency physicians, and sponsors a three-year emergency medicine residency training program. On-site staff radiologists provide interpretation of radiologic studies at all hours.

Patients four years of age and older presenting to the ED with abdominal pain concerning for appendicitis (as determined by the ED attending physician after history and physical examination) were eligible for enrollment. Exclusion criteria included previous appendectomy, pregnancy, unstable vital signs, frank peritonitis, neurological deficits interfering with the ability to localize abdominal pain, wards of the state, and subject/ guardian refusal of consent. Enrollment was by convenience sampling, depending on whether a study investigator was available. Investigators were emergency physicians who had undergone a minimum of one-hour didactic training given by the senior investigator (ML) on the use of ultrasound to diagnose appendicitis. Study investigators were allowed to simultaneously function as treating emergency physicians, and were not blinded to the presentation and clinical history of the subjects.

After informed consent, a focused clinical history and physical examination was obtained from each study subject, followed by an abdominal BUS performed with a Zonare Z. One (Mountain View, CA) or Sonsite M-Turbo (Bothell, WA) machine, using graded compression technique. Investigators concluded their BUS when, in their judgment, the best possible images in the subjects were obtained. All BUS studies were completed prior to any radiology department studies or surgical consultations. Patients were treated according to the judgment of the ED attending physicians or consultants.

Subject data collected included age, sex, height, weight, BMI, components of history and physical examination, and laboratory test results. Sonographic findings were recorded on the data collection form. Investigators' overall impressions of the BUS, based on real-time sonographic findings at the bedside, were documented in the patients' medical records.

Diagnostic test and imaging results, pathological reports, intra-operative findings, and subject hospital course, if available, were obtained by review of the medical record. A research nurse made follow-up telephone calls at 24 hours and 30 days to subjects who were discharged from the ED or who did not receive operative intervention. Three separate attempts to establish contact were made before subjects were deemed lost to follow up. Final patient outcome was adjudicated by one of the investigators (SL) based on the information obtained by the above-mentioned means.

All study information was recorded on patient data sheets, and then entered onto an Excel (2007, Microsoft Corp., Redmond, WA) spreadsheet for analysis. We divided calculated BMI for adults and children (18 years of age and younger) into four categories (underweight, normal, overweight, obese) according to United States Centers for Disease Control and Prevention (CDC) classifications. We defined adults as those over 18 years, instead of the CDC criterion of over 21 years, to conform to the standard in the prevailing appendix ultrasound literature. We analyzed data by SPSS (version 20.0, IBM Corp., Armonk, NY). BUS studies were considered successful when the operator was able to make the diagnosis of "appendicitis" or "no appendicitis" as recorded in the data entry form or the medical record. We calculated the accuracy of ED BUS studies using the outcomes above as the gold standard. Correlation between BMI and BUS success and accuracy were analyzed using chi-square test and Mann-Whitney U test.

RESULTS

This study examines the relationship between BMI and BUS success and accuracy. A total of 125 subjects were consented,and 116 had adequate image data for final analysis. (Images on nine subjects failed to transfer to database after recording.) Mean age of the subjects was 20.2 years, and 51% were male. Sixty percent were 18 years of age or younger. Table 1 shows the distribution of subject BMI according to CDC classifications. Prevalence of appendicitis was 39%.

Fifty-two (45%) of the 116 BUS studies were diagnostic (successful). Figure 1 and Table 2 illustrate the BUS success rate according to subject BMI categories.

Among the diagnostic BUS studies, there were 33 true positive, 13 false positive, 6 true negative, and no false negative BUS studies. This corresponds to an overall accuracy of 75%. Figure 2 and Table 3 describe BUS accuracy categorized by BMI.

No obvious trend was observed when BUS success and accuracy was plotted against individual BMI/ BMI percentile in adult and pediatric patients (Figures 3, 4, 5, and 6).

Statistical analysis by chi-square test or Mann-Whitney U did not find any significant correlation between BMI

Table 1. Subject body mass index distributions according to Centers for Disease Control and Prevention classifications.

	Adult (%)	Children (≤age 18) (%)	
Underweight (<18.5)	0 (0)	3 (4)	Underweight (<5th %tile)
Normal (18.5-24.9)	17 (37)	41 (59)	Normal (5-84.9th %tile)
Overweight (25-29.9)	13 (28)	11 (16)	Overweight (85-94.5th %tile)
Obese (≥30)	16 (35)	15 (21)	Obese (≥95th %tile)

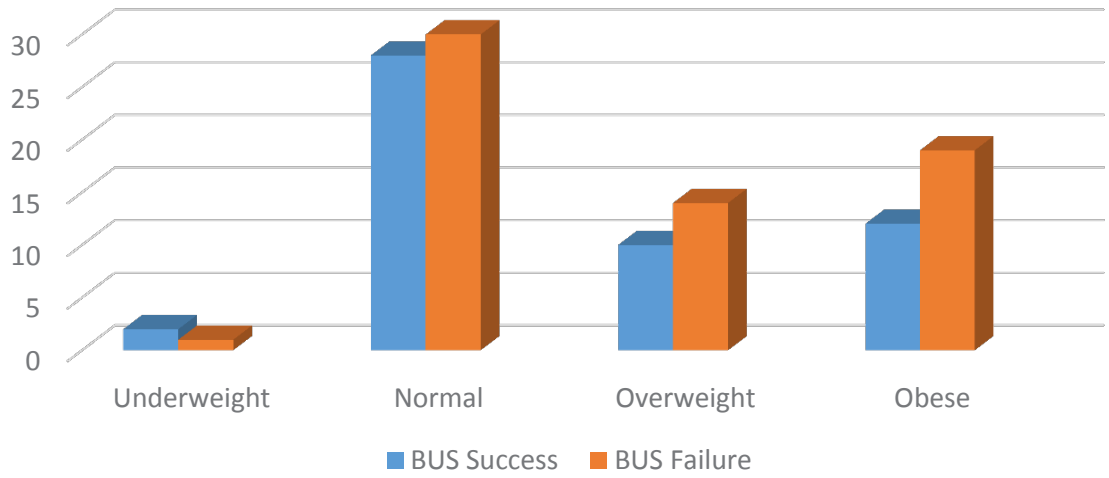

Figure 1. Bedside ultrasound (BUS) success rate categorized by body mass index.

Table 2. Beside ultrasound (BUS) success rate categorized by body mass Index (BMI).

BMI category	BUS success (%)	BUS failure (%)
Underweight	2 (67)	1 (33)
Normal	28 (48)	30 (52)
Overweight	10 (42)	14 (58)
Obese	12 (39)	19 (61)

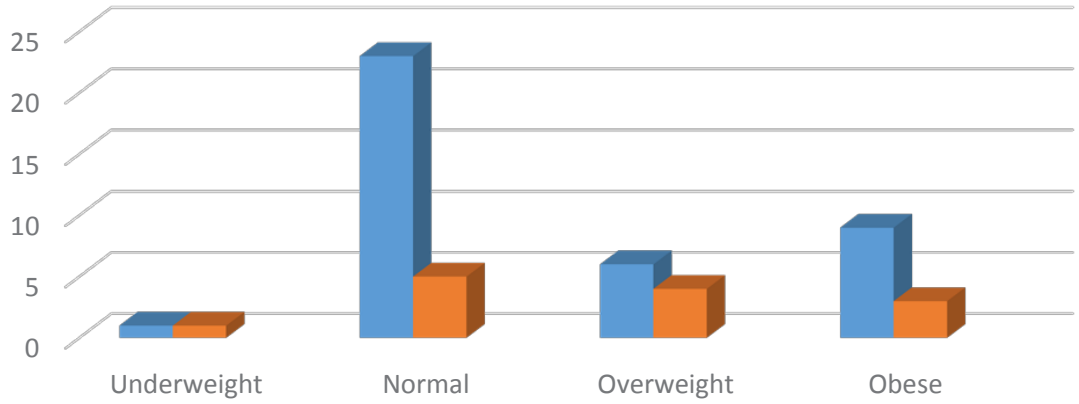

Figure 2. Beside ultrasound (BUS) accuracy rate categorized by body mass index

Table 3. Beside ultrasound (BUS) accuracy categorized by body mass index (BMI).

BMI category	BUS accurate (%)	BUS inaccurate (%)
Underweight	1 (50)	1 (50)
Normal	23 (82)	5 (18)
Overweight	6 (60)	4 (40)
Obese	9 (75)	3 (25)

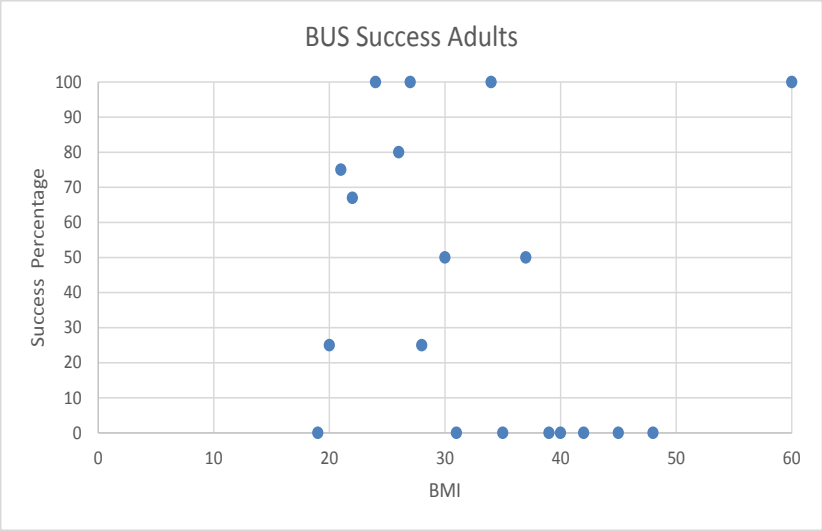

Figure 3. Beside ultrasound (BUS) success rate versus body mass Index (BMI) in adult patients.

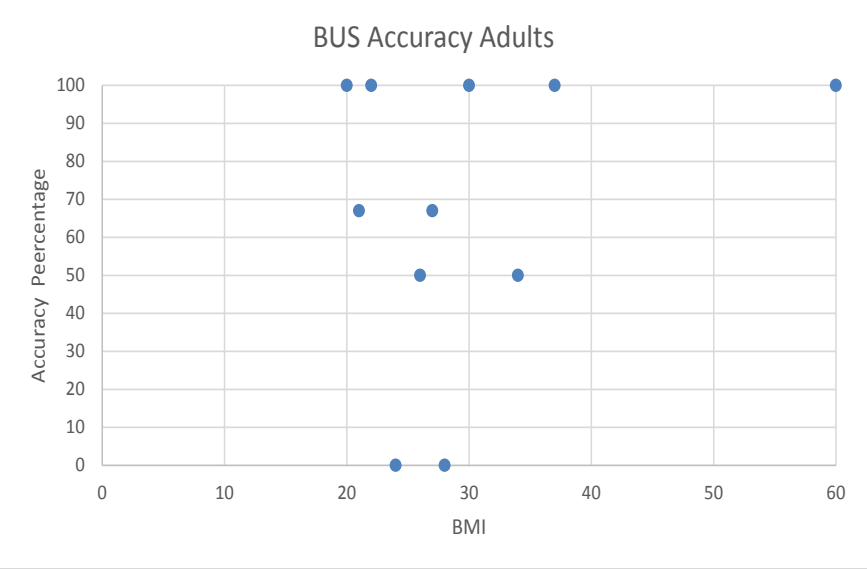

Figure 4. Beside ultrasound (BUS) accuracy rate versus body mass index (BMI) in adult patients.

category and BUS success rate. Similarly, there was no significant correlation between BMI category and BUS accuracy. We reached the same conclusions when adults and pediatric populations were analyzed separately, or when subjects were dichotomized into underweight/normal and overweight/obese categories.

We also examined the outcome of the 64 subjects whose BUS was non-diagnostic. Twenty-eight of them underwent radiology department-performed ultrasound, with only nine studies interpreted as diagnostic. The overall accuracy of these nine studies (4 positives, 5 negatives) was 67% (2 false positives, 1 false negative). Forty-two of the subjects had abdominal and pelvis computed tomography performed, with an overall accuracy of 98% (1 false positive, no false negative).

DISCUSSION

As far as the authors are aware, ours is the first study examining the relationship between BMI and accuracy and success rate of bedside appendix ultrasound performed in the ED setting.

Multiple studies have investigated the relationship between BMI and accuracy and success rate of radiology department-performed appendix ultrasound, and the conclusions have been inconsistent. Josephson et al. found that sensitivity (but not specificity or accuracy) of appendix ultrasound was significantly lower in patients with BMI≥25 compared with those<25.[6] Their findings were echoed in a study by Blebea et al.[7] On the contrary, Keyzer et al. found BMI had no effect on the accuracy or success rate of appendix

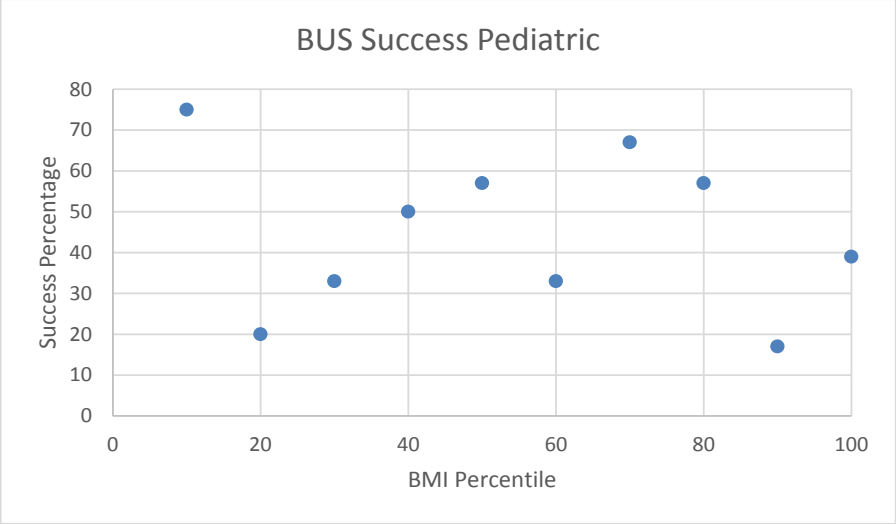

Figure 5. Beside ultrasound (BUS) success rate versus body mass index (BMI) percentile in pediatric patients.

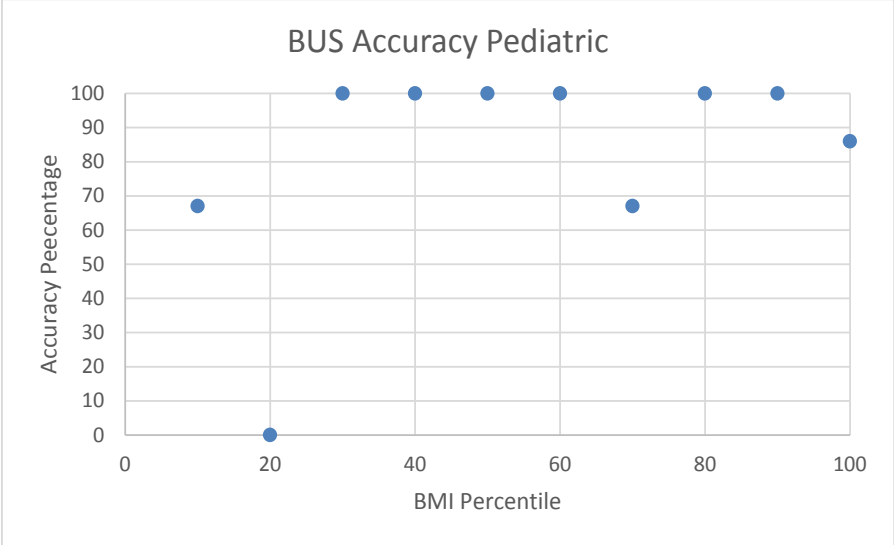

Figure 6. Beside ultrasound (BUS) accuracy rate versus body mass index (BMI) percentile in pediatric patients.

ultrasound, regardless of the expertise of the performing radiologist.[12] A recent study by de Oliveira Peixoto came to the same conclusion.[13]

Similarly, the topic has been researched in pediatric patients with mixed findings. Two studies found that children with BMI≥85th percentile have lower appendix ultrasound accuracy,[8,9] and two other studies found that obese children have lower appendix identification rate on ultrasound.[10,11] Other studies have failed to find any relationship between BMI of children and accuracy[14,15] or success[14] of appendix ultrasound. Nevertheless, Abo et al. did observe a trend of decreasing ultrasound sensitivity with increasing BMI in their study of 176 children with suspected appendicitis.[14]

While it makes intuitive sense that increasing BMI might lead to decreasing appendix ultrasound accuracy and success due to generally poor penetration of the high frequency (5-15MHz) transducer commonly used for the application, it is likely not the sole determining factor. Operator experience, duration of symptoms (hence the degree of inflammatory changes present), ultrasound machine make and model, location of the appendix, and patient cooperation can all affect the outcome of such examination. Although no statistical significant relationship was found, we observed a trend that as BMI increased, appendix ultrasound success and accuracy declined to the degree of approximately10-20%. This magnitude of difference parallels those found in previously cited studies, whether statistical significance was found or not.[8,9,14,15]

BUS has been found to be moderately sensitive and specific in making the diagnosis of appendicitis.[1-4] Given the relatively small impact BMI has on its diagnostic accuracy and success rate, and the obvious advantages of no ionizing radiation and potential facilitated clinical decision-making, we believe that BUS should be attempted in all ED patients presenting with suspected appendicitis, regardless of BMI, by clinicians who are trained in the application.

LIMITATIONS

A major limitation of the study was convenience sampling of the subjects, leading to possible selection bias. Nevertheless, nearly half of our included subjects had BMI in the overweight or obese range, which would argue against patient selection according to body habitus by investigators. Investigators were unblinded to the history and clinical examination findings of the subjects. Awareness of these findings, however, is exactly what distinguishes BUS from ultrasound performed by non-clinicians. Hence, we do not consider this a weakness of our study. Our sample size was relatively small, limiting the power of our conclusions, and this was a single-center study. All investigators who performed BUS in our study were ED ultrasound fellows or faculty, with ultrasound experience exceeding that recommended by the American College of Emergency Physicians.[16] Hence, our study findings may not be applicable to operators with different BUS skill levels. Study results might also be different in institutions using different point-of-care ultrasound machines than ours.

CONCLUSION

We failed to demonstrate any significant relationship between body mass index and success or accuracy of bedside appendix ultrasound performed in the emergency department.

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Check the Head: Emergency Ultrasound Diagnosis of Fetal Anencephaly

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Background
Early pregnancy complaints in emergency medicine are common. Emergency physicians (EP) increasingly employ ultrasound (US) in the evaluation of these complaints. As a result, it is likely that rare and important diagnoses will be encountered. We report a case of fetal anencephaly diagnosed by bedside emergency US in a patient presenting with first-trimester vaginal bleeding.

Case Report
A 33-year-old patient at 10 weeks gestation presented with vaginal bleeding. After initial history and physical examination, a bedside US was performed. The EP noted the abnormal appearance of the fetal cranium and anencephaly was suspected. This finding was confirmed by a consultative high-resolution fetal US. Making the diagnosis at the point of care allowed earlier detection and more comprehensive maternal counseling about pregnancy options. This particular patient underwent elective abortion which was able to be performed at an earlier gestation, thus decreasing maternal risk. If this diagnosis would not have been recognized by the EP at the point of care, it may not have been diagnosed until the second trimester, and lower-risk maternal options would not have been available. [West J Emerg Med. 2016;17(4)460-463.]

INTRODUCTION

Vaginal bleeding during pregnancy is a common complaint encountered by emergency physicians (EP) and one that can be anxiety inducing for patients and their families. Approximately 20%-40% of pregnant women will experience some amount of vaginal bleeding during their first 20 weeks.[1] Approximately 1.6% of all emergency department visits can be attributed to vaginal bleeding during early pregnancy. Most commonly, vaginal bleeding during early pregnancy can be attributed to ectopic pregnancy, threatened/complete/incomplete abortion, physiologic implantation of the pregnancy, or some uterine/cervical structural abnormality. EPs have been shown to be capable of accurately determining the presence of an intrauterine pregnancy using ultrasound (US), and ultrasound is commonly employed by EPs.

Early pregnancy complaints are common and can create a diagnostic challenge for the EP. EPs are more commonly using point-of-care ultrasound (POCUS) to evaluate these and a multitude of other complaints. US has been shown to detect common etiologies of first-trimester bleeding;[3] however, there are some uncommon and important diagnoses that, if recognized early, may have important implications in patient care. With the increasing use of US by EPs, it is likely these uncommon but important diagnoses will be encountered.[4] We present a case of one of these uncommon anomalies, fetal anencephaly, in which POCUS led to earlier detection, less invasive management, and improved patient care.

CASE REPORT

A 33-year-old, pregnant woman at approximately 10 weeks gestation presented with mild vaginal bleeding of a few hours duration. She denied any prior bleeding or clots and

denied abdominal pain and cramping. There were no other abdominal or genitourinary symptoms. Past medical history was positive for polycystic ovarian disease and two previous spontaneous first trimester abortions.

Physical examination revealed a well-appearing female with normal abdominal and pelvic inspections. Pelvic exam revealed no blood in the vaginal vault and the cervical os was closed. Abdomen was non-tender, without rebound or guarding.

The differential diagnosis included ectopic pregnancy, spontaneous abortion, threatened abortion, inevitable abortion, septic abortion, gestational trophoblastic disease, and mechanical trauma.[5]

A POCUS was performed to confirm intra-uterine pregnancy and evaluate fetal viability. Initial transabdominal ultrasound revealed a single intrauterine pregnancy at approximately 10 weeks gestation. Fetal cardiac activity and movement were confirmed along with absence of hemorrhage or free fluid. Amniotic fluid volume was grossly adequate. During measurement of crown-rump length, the EP noted an abnormal appearance of the fetal head. Transvaginal views were obtained to investigate further. Transvaginal ultrasound revealed more detailed findings that suggested fetal anencephaly. The specific findings included a smaller than expected fetal head (as seen in Figure 1A), the "frog eye" sign and "Mickey Mouse" sign (as seen in Figures 1B and 1C, and Supplemental video), and absence of the fetal calvarium (as seen in Figure 1D, and Supplemental video).

Findings also included presence of the "Elvis Presley profile" (as seen in Figure 2A and Supplemental video) (credit Debra Williams, MS, RDMS, RVT, RT(R))**.** Compare these abnormal findings to a normal fetus where the head appears much larger with a larger, round, better-defined fetal cranium as seen in Figures 2B and 2C (see also Supplemental video).

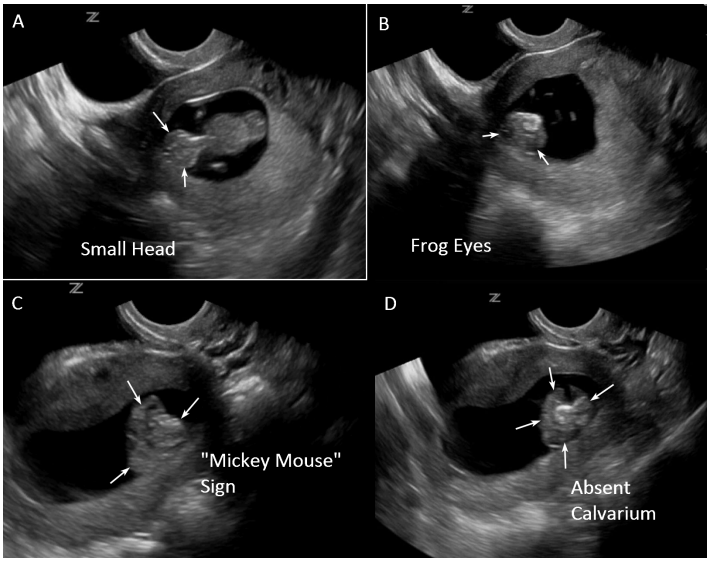

Figure 1A-D. A. Small head. Coronal axis view of the fetus demonstrating a smaller than expected fetal head (arrows). The fetal head is noticeably smaller than the torso. **B.** Frog Eye Sign. Coronal view of the fetal head demonstrating protruding orbital structures (arrows) consistent with the "frog eye sign" and anomalous development of the fetal cerebrum as seen in acrania-anencephaly. **C.** Mickey Mouse Sign. Coronal view of the head and neck demonstrating the "mickey mouse sign." The two abnormal hemispheres (the ears) are noted without an associated cranial vault (arrows). **D.** Small head, absent cranium. Transverse view of the fetal head demonstrating an absence of the fetal cranium (arrows) with the cortex floating in the hypoechoic amniotic fluid.

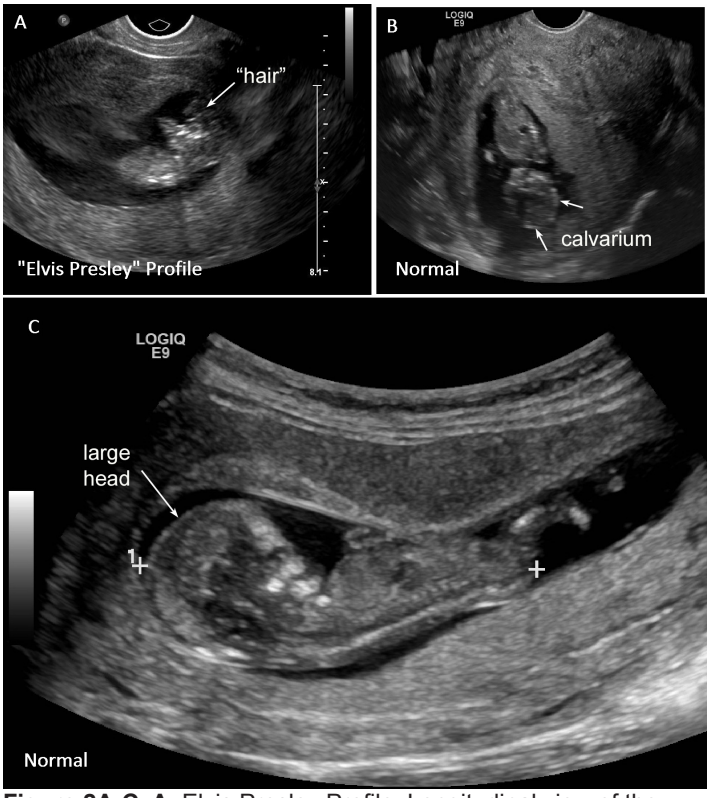

Figure 2A-C. A. Elvis Presley Profile. Longitudinal view of the fetus demonstrating the "Elvis Presley profile". The cerebral hemisphere is jutting forward, giving the illusion of Elvis Presley's hair (arrow). **B.** Normal comparison. Coronal view of a normal fetus developing appropriately. Image demonstrates a normally developing cranial vault, well defined calvarium (arrows), and cerebral structures. **C.** Normal comparison. Longitudinal view of fetus developing appropriately. Image demonstrates presence of the cranial vault and a large fetal head (arrow) that is larger than the torso.

A short video clip detailing the common sonographic findings in anencephaly can be found in Supplemental video.

A consultative high-resolution fetal US confirmed the diagnosis, and obstetrics was consulted. The patient was counseled regarding pregnancy options. She elected for

pregnancy termination and underwent a subsequent dilation and evacuation procedure. Pregnancy termination at this early gestation was lower risk; if the diagnosis had been delayed, lower-risk options would not have been available.

DISCUSSION

In this case, an uncommon fetal anomaly, anencephaly, was discovered by the EP. Fetal anencephaly is believed to be a result of congenital lack of mesenchymal migration in the fourth week of gestation leading to absence of the calvarium and abnormal development of the cortical structures.[6] The early recognition of this diagnosis allowed pregnancy decisions to be made earlier. The patient was able to be counseled, and lower-risk options for pregnancy termination, if desired, were available. EPs using POCUS to evaluate early pregnancy complaints should be aware of the appearance of fetal anencephaly. The sonographic findings are relatively straightforward and can be recognized during a brief routine evaluation. Early recognition of this diagnosis should improve patient care, specifically allowing earlier, lower-risk intervention if necessary.[7,8,9]

Early pregnancy complaints are common in emergency medicine and primary care. General POCUS evaluation is typically performed to confirm intra-uterine pregnancy, evaluate for signs or risks of ectopic pregnancy, and to assess fetal viability. In addition, measurements of fetal gestational age and a gross assessment of amniotic fluid volume should be carried out. During this evaluation, a brief, focused anatomic survey should be performed to confirm a grossly normal appearance of the fetal head. The normal fetal head should be relatively large, nearly the size of the torso, with a rounded cranium and the eyes centered. These characteristics can usually be appreciated from approximately 10 weeks gestation forward and can be recognized by EPs with some experience in early pregnancy ultrasound.[10] Evaluation of the fetus can be done rapidly.[11]

In diagnosing fetal anencephaly using POCUS, a very important finding is absence of the fetal calvarium. Two diagnostic signs have been described to aid in diagnosis: the "Mickey Mouse" sign and the "frog eye" sign. The "Mickey Mouse" sign depicts the fetal cortex floating in the amniotic fluid without cranial structures above it, giving it the look of Mickey Mouse ears.[7] The "frog eye" sign depicts the protruding orbital structures associated with anomalous development of the cortex seen in anencephaly-acrania.[12,13] Other findings may include echogenic particles in the amniotic fluid consistent with fragmented cortex that occurs during the transition from acrania to anencephaly,[14,15] polyhydramnios,[16] and a crown-rump length falling below the fifth percentile.[7]

Ultrasound is the ideal imaging method for the early detection of fetal anomalies given its high diagnostic capacity, non-invasiveness, rapid detection, low cost, and availability.[8,17] Moreover, ultrasound offers the advantage of earlier detection beginning at 10 weeks gestation[10] to allow more comprehensive parent counseling and earlier decisions regarding the future of the pregnancy.[15,18,19,20].Early ultrasound may help to avoid additional imaging, multiple healthcare visits, and provide EPs with a rapid method to ascertain the etiology of early pregnancy complications.

Public concern regarding fetal cranial anomalies has increased in recent months with the emerging threat of the Zika virus. The Zika virus has been shown to cause fetal cranial abnormalities, specifically microcephaly.[21] Zika virus is being identified more frequently in the United States and may carry with it an increased incidence of fetal cranial abnormalities.[22] The World Health Organization (WHO) declared Zika virus a Public Health Emergency of International Concern (PHEIC) in February 2016.[23] Zika virus is an RNA flavivirus transmitted primarily through the Aedes spp. mosquito vector, although sexual transmission has also been documented.[24,25] Officials in Brazil first noted an increase in the number of fetal microcephaly cases in late 2015, and have since demonstrated a 20-fold increase in the incidence of fetal microcephaly in areas where a known Zika virus outbreak was occurring.[23,24,25] A similar retrospective study conducted in French Polynesia demonstrated a similar association during a Zika virus outbreak in 2013-2014.[23,24, 25] With the presence of Zika virus in South America and ease of international travel, we can expect to see rates of Zika virus infections in the US rise in the coming years.[25] In light of this emerging threat, it becomes increasingly important to recognize fetal cranial abnormalities early. As emergency physicians are on the front line of care for early pregnancy complaints, taking the time to quickly survey the fetal head during pregnancy POCUS can be an important step in early recognition of these abnormalities.

In summary, we report a case of anencephaly-acrania diagnosed by emergency POCUS in a pregnant female in her first trimester. To the authors' knowledge, this diagnosis has not been reported in emergency medicine literature. Ultrasound is a rapid, cost-effective, noninvasive, accessible tool for the diagnosis of fetal abnormalities and the differentiation between specific diagnoses with regards to vaginal bleeding during the first trimester. Although the evaluation of complex fetal abnormalities is not part of routine emergency POCUS, routinely performing a brief survey to evaluate for a normal fetal head may allow early recognition of the important diagnosis of fetal anencephaly with subsequent benefits in patient care. In any unclear or concerning case, consultative ultrasound should be pursued as soon as feasible. Emergency physicians should have a low threshold for performing routine point-of-care ultrasound in pregnant women presenting with bleeding in early pregnancy.

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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.

Video. Annotated and narrated clip demonstrating the common sonographic findings associated with acrania-anencephaly including a smaller than expected fetal head, the Frog Eye Sign, the Mickey Mouse Sign, and an absent fetal cranium.

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Diagnosis of Pyomyositis in a Pediatric Patient with Point-of-Care Ultrasound

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CASE DESCRIPTION

A three-year-old girl presented to the emergency department (ED) for five days of pain and decreased mobility of the left shoulder. She had been evaluated in the ED five days prior for shoulder pain after a minor slip and fall with negative clavicle radiographs, and was discharged home with supportive care. Since the initial visit, her shoulder pain increased and she would not use her arm. Physical examination demonstrated subtle swelling of the left anterior shoulder without erythema, warmth, or fluctuance. Her exam yielded mild tenderness to palpation and markedly decreased range of motion secondary to pain. Point-of-care shoulder ultrasound revealed an enlarged deltoid muscle with a heterogeneous fluid collection within the muscle, but no joint effusion (Video).

DIAGNOSIS:

Pyomyositis of deltoid and pectoralis major muscles. Based on the ultrasound results, magnetic resonance imaging of the shoulder was ordered, which showed a multiloculated fluid collection within the anterior head of the deltoid and distal pectoralis major muscles consistent with pyomyositis and abscess (Figure). The patient was admitted on parenteral antibiotics; cultures from an incision and drainage grew oxacillin-resistant Staphylococcus aureus. By post-operative day 4, she had complete resolution of her symptoms.

Pyomyositis is an infection of skeletal muscle commonly associated with abscess formation. It is a rare disease in the United States, but is common in tropical areas.[1] The pathogenesis is unknown but is speculated to develop secondary to hematogenous spread from transient bacteremia, likely in the setting of minor skeletal muscle injury.[2] Common bacteria implicated are skin flora; antibiotic coverage for methicillin-resistant *S. aureus* and streptococci is recommended. However, in immunocompromised individuals, broad-spectrum coverage is warranted. When combined with surgical incision and drainage, complete resolution can be expected in the majority of cases.

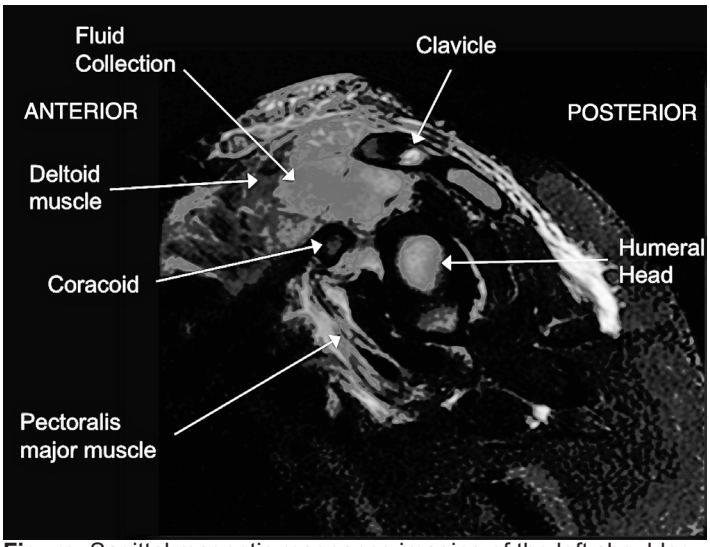

Figure. Sagittal magnetic resonance imaging of the left shoulder shows a multiloculated fluid collection within the anterior head of the deltoid and distal pectoralis major muscles.

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Video. Sagittal ultrasound of the left shoulder demonstrates a heterogenous fluid collection within the deltoid muscle.

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Pneumorrhachis Secondary to a Sacral Decubitus Ulcer

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An elderly woman with a chronic decubitus sacral ulcer presented to the emergency department with sepsis. A computed tomography of her abdomen showed diffuse gas extending throughout the thoracolumbar spinal canal. Pneumorrhachis is a rare radiographic finding defined as gas within the spinal canal. There are many causes of pneumorrhachis ranging from trauma to infection. In this case the pneumorrhachis was caused by direct spread of gas-forming organisms from vertebral osteomyelitis. Emergency physicians should know about the implication of gas in the spinal canal in the setting of sepsis. [West J Emerg Med. 2016;17(4):466-468.]

INTRODUCTION

In this case report, we describe our emergency department (ED) care of an elderly woman with a chronic decubitus sacral ulcer associated with sepsis and meningitis. A computed tomography (CT) of her abdomen showed gas in her thoracolumbar spinal canal. Pneumorrhachis, a rare radiographic finding, is defined as gas within the spinal canal. In this case, the pneumorrhachis was caused by direct spread of gas-forming organisms from vertebral osteomyelitis. Causes and suggested therapeutic approaches are discussed.

CASE REPORT

A 76-year-old woman with multiple sclerosis and diabetes mellitus was transported to the ED by ambulance from her private residence. Her family had called 9-1-1 because they had perceived a change in her mental status. Over the course of two days, the patient had become non-verbal and the family had noticed intermittent episodes of "arm spasms" followed by prolonged periods of unresponsiveness. At baseline, the patient was fully alert and oriented and capable of coherently communicating. She had been chronically bed-bound because of paralysis of her lower extremities. During the past three months, a large bed sore had developed on her sacral area.

The patient's vital signs were significant for hypothermia (95.7F rectal) and tachycardia (109 beats/min). Her blood pressure, respiratory rate and pulse oximetry were within normal limits. Her bedside serum glucose concentration was elevated (327mg/dL).

Physical examination revealed an elderly woman mumbling incoherently. She did not follow any commands. Her mucus membranes were dry. Her neck was supple. Her heart and lung exams were unremarkable beyond the tachycardia. She had diffuse abdominal discomfort with palpation, indicated by facial grimacing. Her lower extremities were atrophied and contracted. Examination of her back revealed a large stage 4 decubitus ulcer extending from her sacrum to her lower lumbar spine. There was purulent and malodorous discharge with surrounding cellulitis of the wound edges.

The patient was assessed to be septic and was started on broad-spectrum antibiotics (piperacillin/tazobactam and vancomycin). She was hydrated with two liters of normal saline.

Initial laboratory tests included two sets of blood cultures, a complete blood count and a basic metabolic panel. Results showed a white blood cell count of 34.6K/cm^2, hemoglobin of 10.7gm/dL, and platelet count of 540K/cm^2. Her basic metabolic panel showed the following concentrations: sodium 137mEq/L; chloride 88mEq/L; potassium 4.1mEq/L; bicarbonate 26mEq/L; blood urea nitrogen 23mg/dL; creatinine 0.80mg/dL; and glucose 298mg/dL. A chest radiograph was unremarkable.

Within one hour after her arrival in the ED, the patient had another episode of "arm spasm" that lasted less than one minute. It was reported by the family members who were with the patient at the time but was not witnessed by medical personnel. This event was presumed to be a seizure, so the patient was intubated to protect her from possible aspiration and prevent hypoxia. Given her apparent abdominal tenderness on

physical examination, the presumed seizure, and her altered mental status, CTs of her abdomen and brain were ordered. The abdominal CT (Figures 1 and 2) showed diffuse gas extending throughout the thoracolumbar spinal canal. A small amount of subcutaneous emphysema was noted near the sacrum, and the radiologist was concerned about sacral bone osteomyelitis. Her brain CT showed gas within the right frontal horn and the subarachnoid spaces of the craniocervical junction.

Levetiracetam was administered for seizure prophylaxis, and the initial empiric antibiotic coverage was augmented with cefepime and metronidazole for improved cerebrospinal fluid (CSF) penetration and anaerobic bacterial coverage. Her family refused a lumbar puncture. The patient was admitted to the intensive care unit (ICU) with a diagnosis of sepsis, meningitis, and infected sacral ulcer.

Blood cultures were negative for growth, but a sacral wound culture grew fecal flora. After 36 hours in the ICU, the patient's condition had not improved, and the family requested comfort measures for her. She died six days after initial presentation.

DISCUSSION

Pneumorrhachis, a rare radiographic finding, is defined as gas in the spinal canal.[1,2] Gordon and Hardman first reported this phenomenon in 1977.[1] Since then, it typically has been described as a result of trauma[2-4] or spine surgical procedures[2] or in connection with other conditions such as pneumomediastinum.[1-7] In our review of the literature, there are limited case reports of pneumorrhachis linked to an infectious disease process including epidural abscess,[6] hematogenous spread of intraperitoneal sepsis,[8] and as a complication of decubitus pressure ulcer.[9]

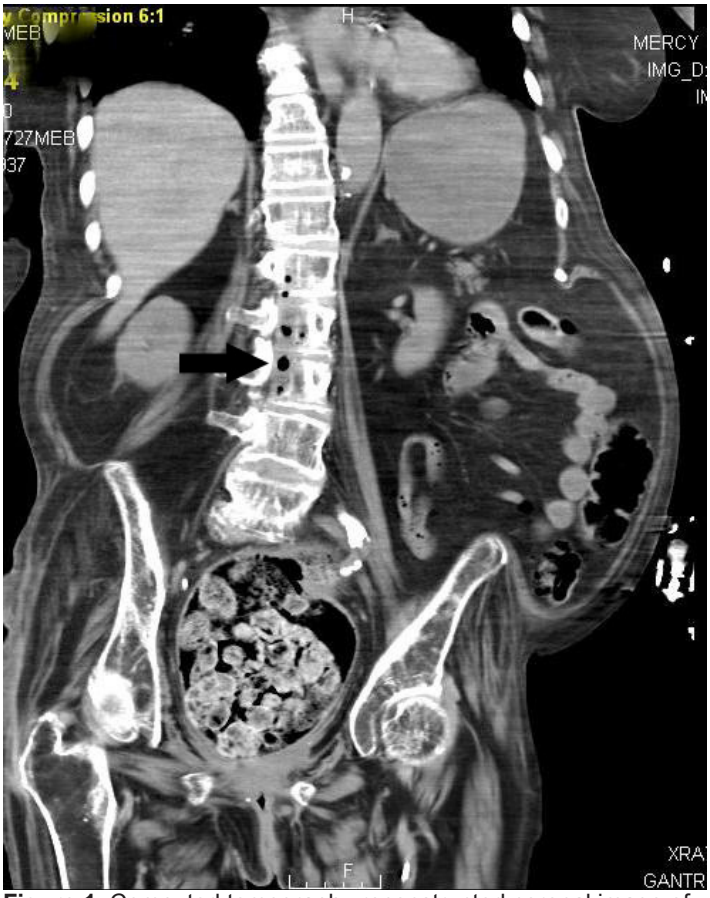

Figure 1. Computed tomography reconstructed coronal image of the abdomen and pelvis demonstrating gas in the thoracolumbar spinal canal (arrow).

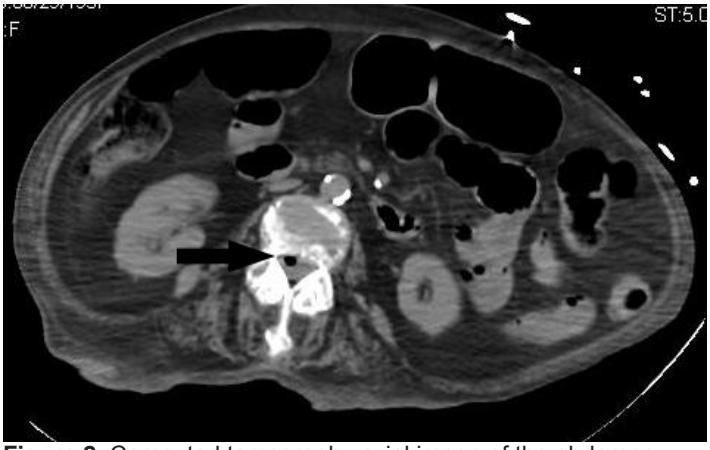
Figure 2. Computed tomography axial image of the abdomen demonstrating gas in the thoracic spinal canal (arrow).

Pneumorrhachis can be iatrogenic (usually a result of spine surgery or lumbar puncture), traumatic (both penetrating and blunt), or non-traumatic (resulting from inhalation drug abuse or invasive tumor progression or from a spontaneous mechanism such as a violent coughing fit).[2] Half of the 71 reported cases identified in a literature review by Oertel and colleagues were the result of trauma.[2]

Most patients with an incidental finding of pneumorrhachis on CT imaging are asymptomatic. Infection must be on the differential diagnosis for any septic patient with a CT demonstrating pneumorrhachis, especially in the absence of trauma. Infectious pneumorrhachis can be caused by hematogenous spread, as described by Amit et al,[8] but can also be a direct extension of a local process, such as vertebral osteomyelitis caused by a gas-forming organism. Concomitant pneumocephalus might also be seen in these patients, as in our case.[5,8,9]

Because of the rare nature of pneumorrhachis as well as its variety of causes, no standard guidelines exist as to its management. Patients with traumatic or surgical pneumorrhachis are typically asymptomatic and are thus managed conservatively with a high concentration of supplemental oxygen, which aids in the redistribution of air back into the bloodstream.[1-8] In some instances, surgical intervention is required to relieve spinal compression or correct a fistula.[2,7] If an infectious process is suspected, lumbar puncture should be performed whenever possible to culture for the responsible organism. Broad-spectrum antibiotics that can cross the blood-brain barrier should be

initiated as soon as possible and should include coverage for anaerobic bacteria.

Infectious pneumorrhachis is a rare but important CT finding. Emergency physicians should know about the significance and implication of gas in the spinal canal in the setting of sepsis. Furthermore, in the evaluation of septic and delirious patients with potential osteomyelitis of the spine, meningitis caused by direct extension into the spinal canal should be considered.

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Tachyarrhythmia in Wolff-Parkinson-White Syndrome

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CASE PRESENTATION

A 29-year-old female with no significant past medical history presented with palpitations, nausea, diaphoresis and lightheadedness. Symptoms began 15 minutes prior to arrival. She reported several similar episodes previously that self-resolved within seconds, but had no previous medical evaluations for these symptoms. Initial vital signs were significant for blood pressure of 93/61, irregular heart rate between 180 and 200, respiratory rate of 18, and oxygen saturation of 99% on room air. Physical examination was otherwise unremarkable. The electrocardiogram (ECG) is shown in Figure 1. This was interpreted as atrial fibrillation with rapid ventricular rate, and the patient was treated with rate control with no effect. The patient later spontaneously converted to normal sinus rhythm and repeat ECG was notable for delta waves concerning for Wolff-Parkinson-White Syndrome (WPW) as seen in Figure 2. She was admitted to cardiology for cardiac ablation.

DIAGNOSIS

Wolff-Parkinson-White (WPW) syndrome is a conduction disorder of the heart caused by pre-excitation accessory pathway resulting in tachyarrhythmias. The prevalence is approximately 0.07% of the population, and many patients often present with the chief complaint of "palpitations."[1] A diagnosis of WPW is made by certain characteristics identified on an ECG. These characteristics include a short PR interval < 0.12 seconds caused by faster electrical conduction through the accessory pathway than the atrioventricular (AV) node, and a delta wave, or upsloping of the QRS (Figure 2), due to rapid ventricular depolarization caused by the rapid conduction through the accessory pathway.[2,3] Diagnosing this disorder can be challenging, specifically when patients present with tachyarrhythmias and the pathognomonic delta wave becomes buried. The inherent rate of the AV node is approximately 180-200. Therefore, when a patient presents in an arrhythmia with a rate upwards of this intrinsic rate, an orthodromic atrioventricular reentrant tachycardia (AVRT) with a re-entrant component, such as WPW, should be immediately suspected [3].

In our case, the patient demonstrated a heart rate of up to

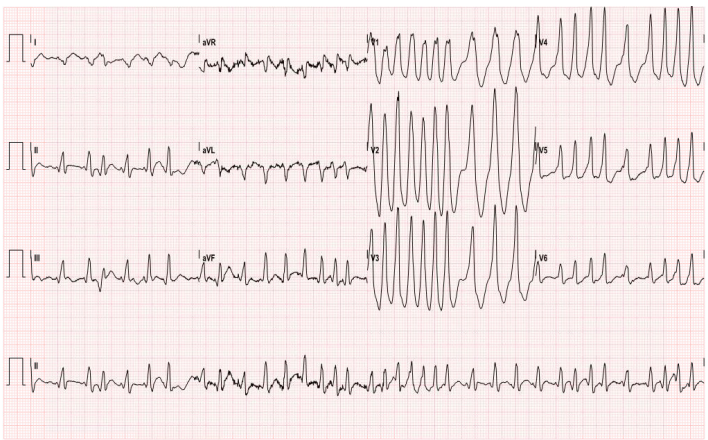

Figure 1. ECG showing tachyarrhythmia on initial presentation.

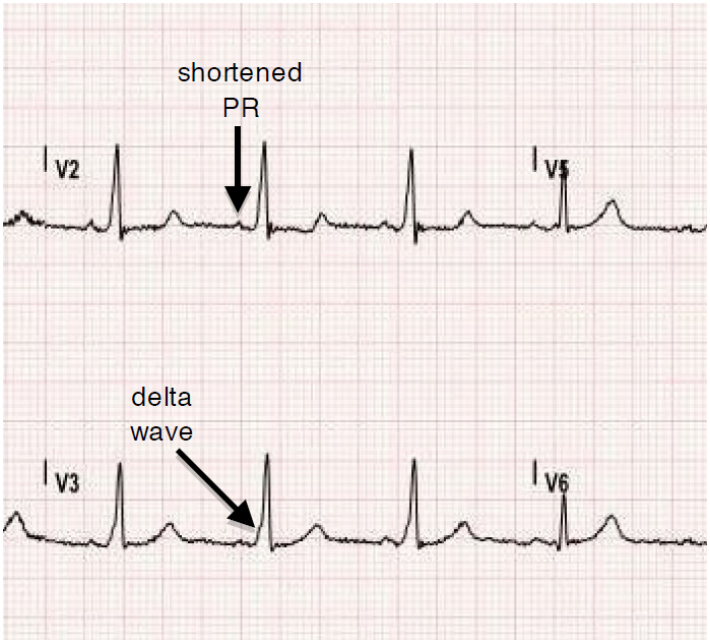

Figure 2. ECG after patient spontaneously converted to normal sinus rhythm. Delta waves and shortened PR interval appreciated.

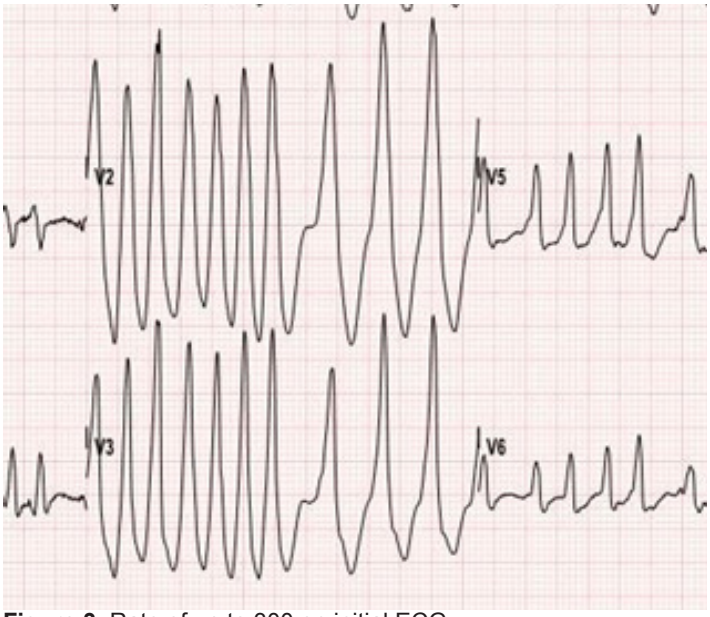

Figure 3. Rate of up to 300 on initial ECG.

300 on the ECG (Figure 3). Once this patient converted back to normal sinus rhythm, the classic delta wave and short PR interval was easily identifiable (Figure 2). According to the 2014 American Heart Association guidelines for management of patients with atrial fibrillation, the class I recommendation regarding management of patients with pre-excited atrial fibrillation with rapid ventricular response includes IV infusion of procainamide if patient is hemodynamically stable, immediate synchronized cardioversion if the patient is unstable, and subsequent catheter ablation of the accessory pathway.[4, 5] Administration of amiodarone, adenosine, beta blockers, and calcium channel blockers should be avoided as these will isolate the accessory pathway and thus predispose to fatal arrhythmias such as ventricular fibrillation by increasing the ventricular rate.[3, 4, 5, 6, 7]

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A Woman with Vaginal Bleeding and an Intrauterine Device

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CASE

A sexually active 35-year old woman presented to the emergency department with intermittent vaginal spotting and pelvic cramping over the preceding four weeks. She had an intrauterine device (IUD) placed three months prior and has never been pregnant. The threads of the IUD and a small amount of blood coming from the cervix were seen on pelvic exam. Laboratory testing revealed a β-human chorionic gonadotropin level of 70,000 mIU/mL. Pelvic ultrasound imaging showed the IUD (Figure 1) and a viable intrauterine pregnancy (IUP, Figure 2).

DIAGNOSIS

Failure of an IUD in a bicornuate uterus: IUDs are generally a reliable method of contraception, with a pregnancy prevention rate of approximately 99.8%.[1] However, IUD failure can be seen with uterine malformations: uterine septum, didelphys, and bicornuate uterus, all of which arise from a failure of the Mullerian ducts to fuse in-utero. The incidence of these is approximately 0.4%, and they are frequently found incidentally during pregnancy or delivery.[2] Case studies have reported the successful placement and prevention

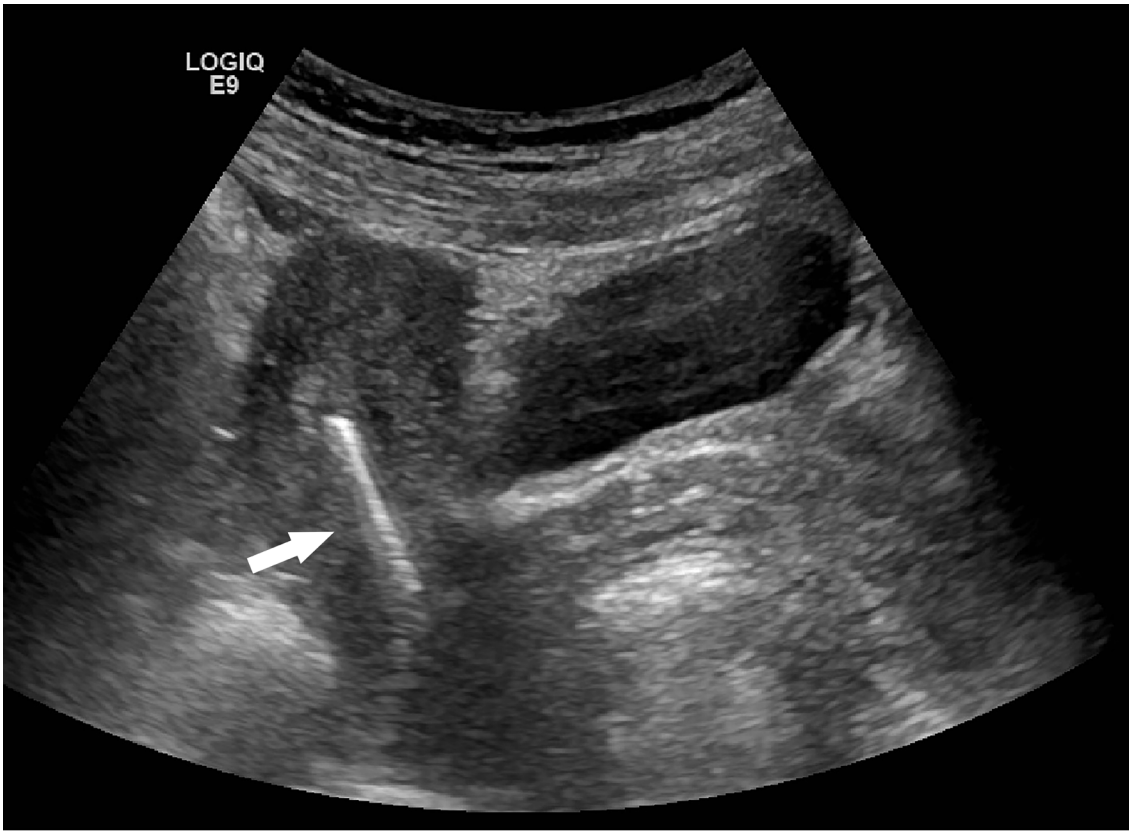

Figure 1. Transvaginal, sagittal sonogram demonstrating an intrauterine device in the left horn (bright white bar, see arrow).

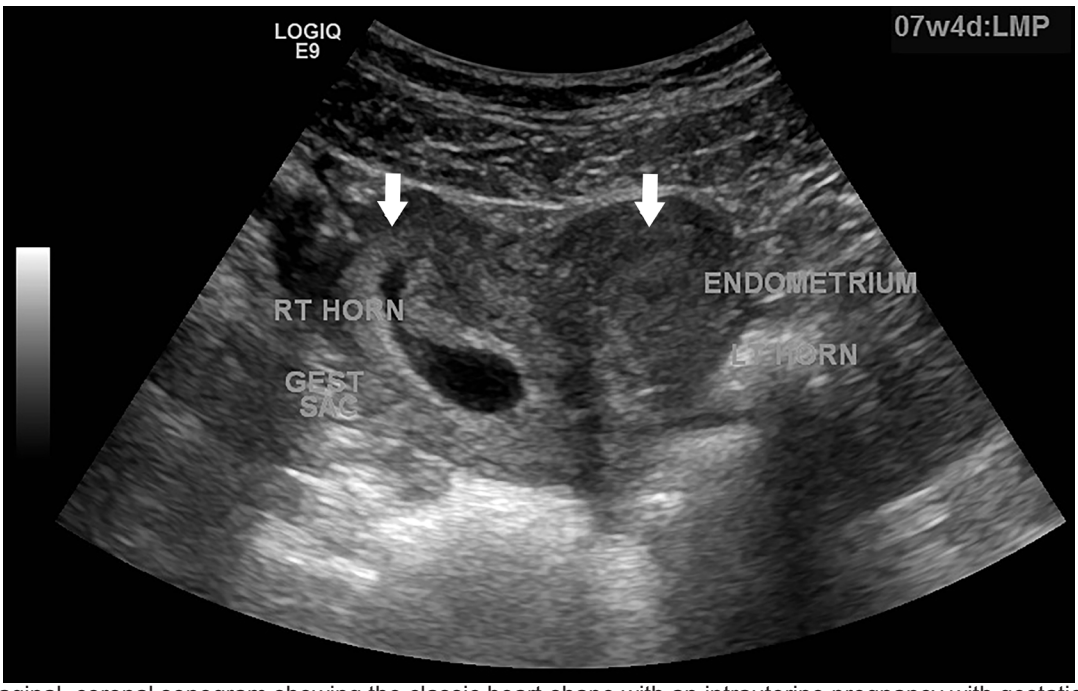

Figure 2. Transvaginal, coronal sonogram showing the classic heart-shape with an intrauterine pregnancy with gestational sac in the right horn (see arrow).

of pregnancy using IUDs in a bicornuate uterus, though it is recommended that an IUD be placed in each uterine horn. These malformations often present with symptoms consistent with an ectopic pregnancy, an important differential diagnosis. These malformations decrease the effective volume of the uterus, increasing the risk of recurrent fetal loss, fetal malformations, and uterine rupture (as early as 10 weeks gestation).[3] A pregnancy in the presence of an IUD should alert the physician to further evaluate the patient for a uterine malformation.

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Don't Forget What You Can't See: A Case of Ocular Syphilis

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This case describes an emergency department (ED) presentation of ocular syphilis in a human immunodeficiency virus (HIV) infected patient. This is an unusual presentation of syphilis and one that emergency physicians should be aware of. The prevalence of syphilis has reached epidemic proportions since 2001 with occurrences primarily among men who have sex with men (MSM). This is a case of a 24-year-old male who presented to our ED with bilateral painless vision loss. The patient's history and ED workup were notable for MSM, positive rapid plasmin reagin (RPR) and HIV tests and fundus exam consistent with ocular syphilis, specifically uveitis. Ocular manifestations of syphilis can present at any stage of syphilis. The 2010 Centers for Disease Control and Prevention guidelines now recommend that ocular syphilis be treated as neurosyphilis regardless of the lumbar puncture results. There is a paucity of emergency medicine literature on ocular syphilis. For emergency physicians it is important to be aware of iritis, uveitis, or chorioretinitis as ocular manifestations of neurosyphilis especially in this high-risk population and to obtain RPR and HIV tests in the ED to facilitate early diagnosis, and treatment and to prevent irreversible vision loss. [West J Emerg Med. 2016;17(4):473-476.]

BACKGROUND

Syphilis is known as the "great imitator" for its ability to infect any organ and cause diverse symptoms.[15] Currently there is a re-emergence of syphilis for which the case count and rate is the highest recorded since 1995 in the United States.[1,3,4,9] In 2000, the rates of syphilis were at an all-time low (2.2 cases per 100,000 persons) but by 2013 had more than doubled (5.5 cases per 100,000 persons).[1] Syphilis is a common worldwide sexually transmitted infection and is notorious for facilitating the transmission of the human immunodeficiency virus (HIV). The incidences of syphilis were highest among women in age groups 25 to 29 years and 20 to 24 years in men, especially in men who have sex with men (MSM).[1-9] Most of the case studies on ocular syphilis are isolated to the ophthalmology literature. As emergency physicians we should be aware and be able to recognize manifestations of ocular syphilis as a cause of painless vision loss and its high rate of coinfection with HIV. Painless bilateral loss of vision may be the only presenting symptom of syphilis, which can be observed in up to one-third of patients with neurosyphilis.[10,11] Centers for Disease Control and Prevention (CDC) guidelines now recommend that any ocular manifestation of syphilis such as iritis, uveitis, or chorioretinitis, be treated as neurosyphilis, with a 14-day course of intravenous (IV) penicillin G, regardless of the stage of clinical presentation of syphilis or lumbar puncture (LP) results.[1, 3, 4, 5] Delay or lack of treatment may lead to long-term neurologic complications such as blindness, paralysis, dementia, psychosis and stroke.

CASE REPORT

A 24-year-old male presented to the emergency department (ED) with five days of acute painless progressive bilateral loss of vision without photophobia, discharge, trauma, or contact lens use. Review of systems was negative except for recent alopecia[18,19] The patient was a sexually

active homosexual male with a negative HIV test three months prior. Social history included marijuana, cocaine and methamphetamine use.

ED vital signs reported a temperature of 98.7 degrees F, respiratory rate of 16 breaths per minute, heart rate of 90 beats per minute, blood pressure of 113/70 mmHg, 98% O2 saturation on room air, visual acuity of 20/600 bilaterally and intraocular pressures of 8 mmHg in the left eye and 10 mmHg in the right eye. Pupils were equal, round, reactive to light and accommodation and extra ocular movement intact, without Argyll Robertson (AR) pupils. Anterior chamber was clear, without conjunctival injection, foreign body, abrasion or ulceration. No afferent pupillary defect was appreciated. Ophthalmology was urgently consulted to evaluate the patient and perform a dilated fundus exam. Fundoscopy revealed bilateral vitritis (Figure 1) with scattered white tufts and globular white opacities inferiorly suggestive of posterior uveitis (Figure 2). These findings on the fundus exam are consistent with syphilis. The neurological exam was otherwise normal.

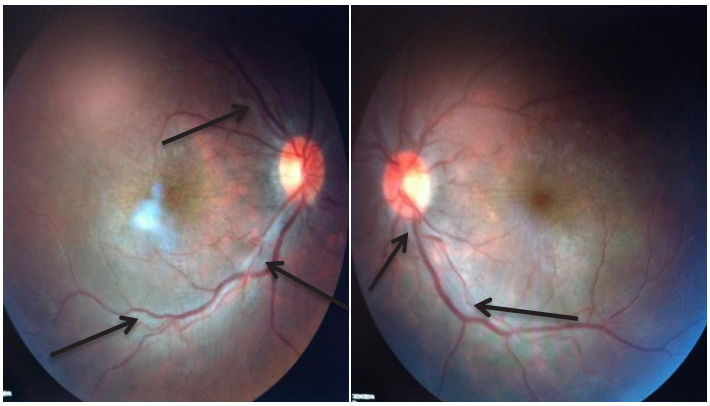

Figure 1. Vitritis Bilateral fundus photos. Vitreous haze, ½ +, retina is flat 360 degrees with arrows pointing to periphlebitis and diffuse homogenous retinal pallor.

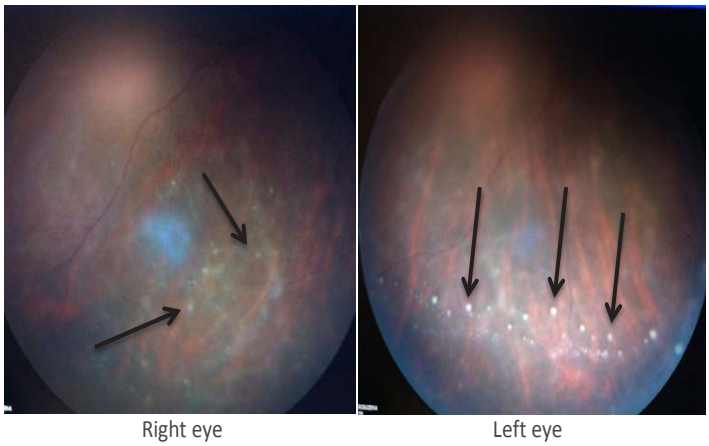

Figure 2. Uveitis Bilateral fundus photos: Inferior vitreous with arrows pointing to vitreous " snowballs," which represent aggregates of inflammatory cells at the level of the pre-retinal vitreous and peripheral retina.

Given the patient's social history and risk for sexually transmitted infections, specifically syphilis that can cause vision loss, and confirmation with ED rapid plasmin reagin (RPR) and HIV tests, ocular syphilis was high on the differential. Syphilitic posterior uveitis was the presumed diagnosis after the ED ophthalmology fundus exam and the first dose of a 14-day course of IV penicillin G was initiated in the ED with a medicine admission. Inpatient cerebral spinal fluid (CSF) results were a white blood cell (WBC) count of 33 cells/μL, red blood cell (RBC) count of 26 cells/μL, a protein level of 44 mg/dL, glucose 53 mg/dL, and a Venereal Disease Research Laboratory (VDRL) titer of 1:2. CSF ink stain, quantiferon gold, Lyme Ig, Bartonella Henselae, HBsAg, HCVAb were negative, as were bacterial and fungal cultures. The patient had an absolute CD4 count of 1347 cells/μL and a viral load of 52,900 c/mL HIV RNA. Magnetic resonance imaging of the brain and orbits were normal.

Current CDC guidelines recommend that any ocular manifestation of syphilis (irits, uveitis and choroidoretinitis) now be treated as neurosyphilis, regardless of the outcome of the LP.[3-5] This is a departure from the past, where the clinical stage and CSF results (+VDRL, WBC cell count > 10 cells/μL, protein > 50 mg/dL) were the deciding factor for the treatment regimen for ocular syphilis. Since ocular manifestations can occur in secondary or tertiary syphilis the CSF results had previously been used to determine the presence of neurosyphilis. Current CDC guidelines recommend that all ocular manifestations of syphilis regardless of the stage of presentation or CSF results be treated as neurosyphilis with a 14-day course of IV penicillin G. An LP is still recommended since analysis provides additional evidence of other central nervous system (CNS) infections especially if the patient has a co-infection with HIV.[1-5]

DISCUSSION

This is the case of a 24-year-old male who was assumed to be otherwise healthy presenting with painless vision loss due to uveitis as an ocular manifestation and presenting symptom of syphilis and concurrently found to be HIV positive. Ocular syphilis is a slow painless decrease in vision and there are no signs that are pathognomonic.[12,13] A case report suggests a triad of headache, red eye or eye pain, and elevated erythrocyte sedimentation rate should prompt clinical suspicion for ocular syphilis.[12] The AR pupil is highly specific for neurosyphilis, but as in this case it was not present. AR pupil has historically been associated with neurosyphilis but it has also been associated with diabetic retinopathy, multiple sclerosis, Wernicke's encephalopathy, Dejerine-Sottas hypertrophic neuritis, Charcot-Marie-Tooth disease, herpes zoster, Lyme disease, sarcoidosis, midbrain lesions, and von Economo's encephalitis.[12,14] Other clinical findings

of neurosyphilis may include third and sixth cranial nerve palsies, and visual field defects from brain involvement.[12]

Uveitis may manifest during secondary or tertiary syphilis, with iritis being the most common ocular finding in secondary syphilis.[5,7,8,15] Syphilitic uveitis is the most common presentation of syphilis in older adults[3,6,8] The findings on the dilated eye exam were consistent with posterior uveitis, but non-specific for syphilis. However, in the setting of positive serum RPR and CSF leukocytosis and titers positive for VDRL confirmed the diagnosis of syphilitic uveitis, and other infectious and rheumatologic etiologies were concurrently excluded.[7,8,15,16] The differential at the time of presentation included but was not limited to the following: Lyme disease, sarcoidosis, tuberculosis (TB), toxoplasmosis, toxocariasis, bartonella, brucellosis, herpes simplex virus, inflammatory bowel disease and rheumatologic conditions such as juvenile idiopathic arthritis and human leukocyte antigen (HLA)-B27-associated disease. [12]

Uveitis is a state of inflammation involving the uvea (iris, ciliary body, choroid) or retina. This may be caused by autoimmune conditions, infections, or trauma, but up to 50% of cases are idiopathic. [8] Regardless of etiology, uveitis represents a breach in the blood-ocular barrier. Disruption of this barrier is the result of inflammation, a breakdown that allows neutrophils and other inflammatory mediators to incite the acute phase of uveitis. Both the anterior and posterior chambers, as well as the vitreous cavity, are susceptible to uveitis. Identification of the predominantly involved location can narrow the differential. Anterior uveitis (iritis, iridocyclitis), is primarily due to rheumatologic and idiopathic etiologies with herpes being the most common infectious cause. White blood cells invade the aqueous humor, with inflammatory changes often resulting in precipitation of inflammatory cells (neutrophils or macrophages) on the posterior cornea (keratic precipitates), as well as other iris changes. Intermediate uveitis or pars planitis, is rare and commonly idiopathic, but when present it is classically associated with multiple sclerosis. Posterior uveitis (choroiditis, retinitis, chorioretinitis, retina vasculitis) is more commonly associated with an infectious cause in up to 40% of reported cases with pathogens that include syphilis, toxoplasmosis, and cytomegalovirus. Panuveitis is the rarest form of uveitis that involves the entirety of the eye, which comprises only 10% of all cases of uveitis. Infectious causes include syphilis, TB and endophthalmitis, either bacterial or fungal.[8,15,16]

The presence of HIV may alter the presentation of syphilis, with possibly a more rapid progression to neurosyphilis.[1] Syphilis is an important facilitator of HIV transmission with current reported co-infection rates of 50-70%.[5,7,17] In 2001 the prevalence of syphilis was at its nadir, but infection rates have since reached their highest levels since 1995. A review of the current epidemiology of syphilis has described the syphilis epidemic occurring primarily among men, especially MSM.[1-4,]

Similar case reports were published primarily in the ophthalmology literature in the late 1990s and early 2000s but none recently. [20-22] Following are the CDC guidelines for the treatment regimen, which have been in place since 2010, and new recommendations for LP for ocular syphilis.

Why Should Emergency Physicians Be Aware of This?

As emergency physicians we commonly see patients with vision complaints who have not had any prior evaluation by an ophthalmologist or a primary care physician. For this reason, ocular syphilis should be considered in all patients presenting to the ED with non-traumatic bilateral vision loss, especially among MSM. 2010 CDC guidelines recommend that any ocular manifestations of syphilis now be treated as neurosyphilis regardless at which stage it occurs with a 14-day course of IV Penicillin G. In addition, an LP is no longer required for CSF VDRL titers to determine the treatment regimen as previously had been required. However, an LP is still recommended for analysis of other concomitant CSF infections since syphilis has a high co-infection rate with HIV. With the current syphilis epidemic it is important for emergency physicians to recognize ocular manifestations of syphilis, and to order emergency department RPR and HIV tests in order to facilitate an urgent ophthalmology consultation, early diagnosis and treatment and to prevent permanent vision loss.

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Giving Your Cell Phone Number to Patients

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Below is a letter concerning contact with patients. I have found this practice useful. It decreases anxiety on the part of the patient and the doctor. I write to recommend it to emergency physicians everywhere.

I give my cell phone number to patients all the time. By that I mean 2-3 times a shift. I have been doing it for years, almost since I first got a cell phone. I have given it out hundreds of times. I recommend that we encourage our emergency medicine (EM) residents to do so also. It is an easy option, and it can help avoid all sorts of problems. Discretion is in order, but there are not a lot of exceptions. There are some types of patients that I do not give it to.

I give it to patients for several different reasons. Often I want to know what happened to the patient. Did they get better? Did my recommended treatment work? For instance, they had abdominal pain, and I want to know if they got over it. I say, "Call me in 48 hours and let me know what happened." Out of 100 of these types of requests I may get one call back. I assume that they get better and that they forget about it. Our medical system is good, and we generally get it right.

I give it to the unsatisfied patient very often. I think you know the interaction. You have finished your workup, and you are discharging the patient. You are giving your summary, and the patient or family member obviously thinks that you have either not done enough, ought to admit the patient, or that you are wrong. They will not state this, but it is obvious that they are not entirely happy. At that point, I say my standard discharge spiel. "With this treatment you should get better and better. If you get worse, notify your doctor immediately. If unable to reach him/her, return immediately to the emergency department (ED). By the way, here is my phone number. Call me if you have a problem or are getting worse. I don't sleep with the phone, so I may not answer in the middle of the night. If you call once and I don't answer, call me again. Sometimes I cannot be reached, so if you are worsening and cannot reach me right away, go to the ED immediately. But call me if you have a problem."

At that point everything changes. The patients usually are very pleased. You have told them two things very clearly. First, you think that your diagnosis and treatment are correct. Second, that you care about them. You are not going to hide behind a wall of secretaries who will not connect you. You believe in your care.

I also give my number to patients that I am a little worried about. I think that I am right. However, I want to make sure that they get timely care if things turn worse. A patient has a tender area that I think is cellulitis, and I treat with an antibiotic. If they get worse, call me.

And what if they do call? It is a 30-second conversation. "Go to the ED. I will call them and tell them to be looking for you."

During the eight or so years that I have been doing this, I have been called back perhaps six times. It has never been "abused." Only once did I have to have the patient return to the ED, and it was not a major issue. My patient satisfaction scores are the best in the department.

Physicians in other specialties who see patients repeatedly might have difficulty with this. Because we in the ED do not have ongoing relationships with our patients, this practice should not create a problem. Residents might want to use their beeper numbers instead, until they are comfortable with the process.

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Increasing Completion Rate of an M4 Emergency Medicine Student End-of-Shift Evaluation Using a Mobile Electronic Platform and Real-Time Completion

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Introduction: Medical students on an emergency medicine rotation are traditionally evaluated at the end of each shift with paper-based forms, and data are often missing due to forms not being turned in or completed. Because students' grades depend on these evaluations, change was needed to increase form rate of return. We analyzed a new electronic evaluation form and modified completion process to determine if it would increase the completion rate without altering how faculty scored student performance.

Methods: During fall 2013, 29 faculty completed paper N=339 evaluations consisting of seven competencies for 33 students. In fall 2014, an electronic evaluation form with the same competencies was designed using an electronic platform and completed N=319 times by 27 faculty using 25 students' electronic devices. Feedback checkboxes were added to facilitate collection of common comments. Data was analyzed with IBM® SPSS® 21.0 using multi-factor analysis of variance with the students' global rating (GR) as an outcome. Inter-item reliability was determined with Cronbach alpha.

Results: There was a significantly higher completion rate (p=0.001) of 98% electronic vs. 69% paper forms, lower (p=0.001) missed GR rate (1% electronic. vs 12% paper), and higher mean scores (p=0.001) for the GR with the electronic (7.0±1.1) vs. paper (6.8±1.2) form. Feedback checkboxes were completed on every form. The inter-item reliability for electronic and paper forms was each alpha=0.95.

Conclusion: The use of a new electronic form and modified completion process for evaluating students at the end of shift demonstrated a higher faculty completion rate, a lower missed data rate, a higher global rating and consistent collection of common feedback. The use of the electronic form and the process for obtaining the information made our end-of-shift evaluation process for students more reliable and provided more accurate, up-to-date information for student feedback and when determining student grades. [West J Emerg Med. 2016;17(4)478-483.]

INTRODUCTION

The end-of-shift evaluation is a common method used to assess medical student clinical performance in emergency medicine (EM).[1] Evaluation forms are completed at the end of each shift; they form the basis for formative feedback and contribute to the summative portion of a medical student's rotation grade. End-of-shift forms used for formative feedback give students an opportunity to improve their performance on subsequent shifts and provide mid-rotation feedback for behavioral changes prior to their final evaluation.[2] Nearly 80% of EM programs use an end-of-shift form, and these are commonly compiled into a cumulative, summative score that accounts for an average two-thirds of a student's final grade.[1] Despite the implications for student grades, there is a wide

variety of methods used to obtain these forms and completion rates are highly variable.[3-5]

Challenges in the use of end-of-shift evaluations in EM include students working with different faculty throughout a given rotation, the wide variety of clinical experiences, and the variable experience and interest of students in the specialty.[6] All of these challenges increase the difficulty of obtaining the forms and assessing the learner's progress over time.[7,8] Even with the widespread adoption of electronic technology in the medical profession, evaluative forms still remain paper-based and this creates additional logistical problems with the collection of data.[5] The literature is sparse with reports on how to improve completion rates of these forms. No information could be found that describes using a mobile platform specifically for increasing completion rates of end-of-shift evaluations in EM.

The Department of Emergency Medicine at the Medical College of Wisconsin had used a paper-based end-of-shift evaluation form for fourth-year medical students until June 2014. The scores from these forms determined a significant portion of the students' final rotation grade, but collecting completed forms was challenging. Forms would either be handed in incomplete or frequently would be misplaced. Consequently, we identified the need to more securely collect end-of-shift evaluations and improve their completion rate. We created an electronic student evaluation form that could be used on the students' mobile electronic devices to replace the existing paper-based form and rolled out the new process in our department. The purpose of this study was to determine if the implementation of a new electronic evaluation form and modified completion process would increase the faculty completion rate without altering how faculty scored student performance by comparison with the previously used paper-based form.

METHODS

The Medical College of Wisconsin has fourth-year medical students rotate at Froedtert Hospital, the primary clinical site for our EM residency program and a Level I trauma center with over 65,000 annual visits. Each month, up to 10 fourth-year students participate in an elective month-long rotation. Students are evaluated at the end of each shift using seven competencies and an overall global rating (Table 1) that aligns with the institution's end-of-rotation global competencies for fourth-year students. During each shift, students are paired with both residents and faculty for their entire shift, but faculty provide the primary source of evaluation scores of the students' daily shift performance. Students could opt out of having their data used for the study at any time, but the evaluations were a required component for determining clinical performance and the final rotation grade. This study was classified as exempt by the institutional review board at the Medical College of Wisconsin.

Table 1. End-of-shift assessment components.

Communication: interpersonal skills/teamwork
Communication skills: presentation/documentation
History & physical exam skills/time management
Technical procedures: list type and proficiency
Patient care: medical problem-solving and decision-making
Patient care: management
Professional behavior and development
Overall

Data Collection

At their rotation orientation the students were provided the end-of-shift form – paper for 2013-14 and the electronic link for 2014-15 – and instructed to ask the faculty to complete the respective form near the end of each shift. Faculty scored each student's performance using an identical scale from "1" (lowest rating) to "9" (highest rating) for each competency on either form. The rotation form uses the same nine-point scale as our institution uses for the final rotation competencies, which allowed easy translation of the end-of-shift data into scores used with the institution's previously existing end-of-rotation format.

Paper Form

In the fall of 2013 faculty completed the paper form at the end-of-shift per our existing process. Students would complete the fields that included their name, date and shift time and then give the form to their faculty near the end of a shift. The form included competency items, an area for comments and a signature area for the faculty. Faculty members were responsible for placing the completed and signed form into a dedicated box located in the emergency department (ED), which was then emptied approximately once per week by our student coordinator. The form was usually completed by faculty before leaving their shift, but in some cases forms left the department with faculty and were intended to be completed in the following days or were accidentally left in the ED. Once a form was recognized as being missing, it would be placed in the faculty's mailbox or attached via a reminder email. This resulted in variable response rate, and therefore a final analysis at the end of the month revealed which forms still needed completion. The data on the collected forms were transferred manually into a Microsoft Excel spreadsheet for data warehousing and subsequent analysis.

Electronic Form

At the beginning of the 2014-15 academic year, an online survey program was used to design an electronically accessed and submitted student end-of-shift evaluation form. All competencies and scales from the paper form were transcribed verbatim into the electronic format (Table 1). The

form was compatible with mobile and desktop platforms. The consistent use of electronic devices by all students was possible because each student was required by the medical school to have an electronic tablet device before they entered into their clinical rotations.

Prior to implementing the form, faculty were provided an overview of the challenges with the current form and the plan for switching to an electronic format. The new system for collection was described by email and in a four-minute podcast that demonstrated the completion of the electronic form. This was followed by periodic communication and discussion in faculty meetings updating them on the form completion rates.

The process for completing the form required that students first complete basic demographic and shift information, including their name, shift type, date and faculty name on the form. Students then gave the device with the open form to the faculty who completed the components and submitted the form, subsequently handing the device back to the student. Submission of the form was not possible until required fields were completed. Faculty "signed" the electronic form by using a five-digit individual identifier. If this identifier was missing or incorrect the evaluation would be considered invalid. Once submitted, the data were automatically uploaded to the survey database and were immediately available to be viewed by the student coordinator and downloaded into a spreadsheet for analysis.

Comments

Using qualitative content analysis, we analyzed the comments written on the paper forms for the fall 2013-14 to determine common themes. Beginning with an inductive process, two authors used open coding to determine initial themes. Seven themes emerged based on the words used most frequently, both positively and negatively. After determining these themes, the authors used a deductive approach to revise the categories, which were then inserted into the electronic form where each theme was an individual checkbox item. These checkboxes were further separated by what the student did well and what the student needed to work on (Table 4). An area for additional comments was included.

Outcomes

The primary outcome of this study was the comparison of overall faculty completion rate of both the paper and electronic formats in the fall cohorts for 2013-14 and 2014-15, respectively. Each shift was expected to result in one evaluation per student, and the number of evaluations expected was compared to the actual number of evaluations completed. Secondary outcomes included comparing the paper and electronic forms for the number of missing data points for the seven competencies and global rating, whether or not faculty members would score students consistently using the global rating and the frequency and usage of feedback checkbox and free text comments. Tertiary outcomes included analyzing the electronically submitted data between fall and winter student cohorts of 2014-15 since student interest in securing an EM residency is much higher in the fall.

We analyzed all data with IBM® SPSS® 21.0. Pearson chi-square tests assessed differences in completion rates of the different forms. We used analysis of variance (ANOVA) to determine differences in competencies and global ratings due to evaluation platform (paper or electronic) and interest in EM as a specialty (fall vs winter). Inter-item reliability of the seven competencies was determined with Cronbach alpha.

RESULTS

Table 2 reports the descriptive statistics and Table 3 reports the mean competency scores and differences for the outcomes from the paper and electronic forms.

The paper form for fall 2013-14 was completed by 29 faculty N=339 times for 33 students. The electronic form for fall 2014-15 was completed by 27 faculty N=319 times for 25 students. Of these 319 evaluations, faculty completed 283 forms (89%) on tablets, 24 (8%) on a desktop computer and 12 (4%) on a smartphone. The overall completion rate was significantly higher (p=0.001) for the electronic form (98%) than for the paper form (69%).

The number of missing global ratings demonstrated a statistically significant improvement (p=0.001) from 39 (12%) on the paper form to near zero (0.6%) on the electronic form.

Overall, faculty scored students statistically higher for the global rating section on the electronic form versus the paper form (p=0.001).

Table 2. Descriptive statistics of evaluation forms.

Form	Alpha	# Evaluations completed	% Completion	# Faculty	# Students	Mean evaluations completed	Missing global rating
Paper - EM	0.95	339	69	29	33	10.2/14	39
Electronic - EM cohort	0.95	319	98	27	25	12.8/13	2
Electronic - non-EM cohort	0.94	131	92	23	11	11.9/13	1

EM, emergency medicine

Table 3. Mean competency scores for M-4 emergency medicine students (N=787).

	Mean (SD)				
	Paper	Electronic		Statistical significance of pairwise differences between groups	
Competency	Fall 13/14 (Group 1)	Fall 14/15 (Group 2)	Win 14/15 (Group 3)	1/2	2/3
Communication: interpersonal skills/ teamwork	6.8 (1.2)	7.2 (1.1)	7.1 (1.0)	0.001	1.00
Communication skills: presentation/ documentation	6.7 (1.3)	7.0 (1.2)	7.0 (1.1)	0.002	1.00
History and physical exam skills/time management	6.5 (1.2)	6.8 (1.2)	6.9 (1.0)	0.003	1.00
Technical procedures: list type and proficiency	6.9 (1.1)	7.3 (1.2)	7.5 (1.1)	0.020	1.00
Patient care: medical problem-solving and decision-making	6.7 (1.2)	6.8 (1.2)	6.8 (1.0)	0.289	1.00
Patient care: management	6.7 (1.2)	6.9 (1.2)	6.8 (1.0)	0.128	1.00
Professional behavior and development	7.2 (1.1)	7.7 (1.0)	7.7 (0.9)	0.001	1.00
Global rating	6.8 (1.2)	7.0 (1.1)	7.1 (1.0)	0.018	1.00

Table 4. Frequency and percentages of comments on paper and electronic forms.

	Paper free text	Electronic feedback checkboxes	
Item	Frequency (%) (N=339 evaluations)	Student did well: frequency (%) (N=319 evaluations)	Student needs to work on: frequency (%) (N=319 evaluations)
Proactive/motivated	63 (19)	191 (60)	37 (12)
Personal interactive skills	56 (17)	271 (85)	8 (3)
Case presentations	54 (16)	129 (40)	129 (40)
Differential diagnosis	52 (15)	62 (19)	163 (51)
Teamwork	47 (14)	191 (60)	25 (8)
Medical knowledge	44 (13)	100 (31)	98 (31)
Time management	32 (9)	128 (40)	67 (21)
Total	348	1072	527

Free text comments were documented on 89% of the written forms and 52% of the electronic forms. Feedback checkboxes for what the student did well were completed on 100% of the electronic forms and had a 90% completion rate for what the student needed to work on (10% documented no deficiencies for the shift). Table 4 shows the frequency of themes on the paper and electronic forms.

The winter electronic form cohort for 2014-15 was compared to the fall electronic 2014-15 cohort and demonstrated no significant differences for completion rate (p=0.872), missing global rating scores (p=0.872) and mean global rating scores (p=1.00).

To determine the internal consistency of scoring the seven competencies between the paper and electronic forms, we calculated Cronbach-alpha values and reported them to be 0.95 for data collected from both forms.

DISCUSSION

The use of end-of-shift evaluation forms in EM is commonplace, yet there are challenges to consistently collecting completed forms. Paper forms can easily be left in the ED, misplaced, accidentally discarded, or found after students' grades are submitted. Most studies in other specialties have reported the use of "encounter cards" to increase student satisfaction and improve the amount of formative feedback given during rotations, but the use of end-of-shift evaluations in EM has not been well described.[9-11]

Despite the regular use of electronic platforms in

education, there are few descriptions in the literature of current practices that have successfully been implemented to increase evaluation completion rates. Manchester Medical School described the deployment of iPads to all of their students and successfully implementing the use of eForms to replace their paper-based systems, and reported that it was a more efficient system.[12] Paukert, et al, described using encounter cards to improve student satisfaction with verbal and written feedback on a surgery clerkship.[13] Bandiera and Lendrum examined the use of daily encounter cards based on the 2005 CanMEDS competency framework and found that EM teachers provided specific competency-based feedback after individual shifts, which when compiled covered the breadth of the competencies.[3,14] To the best of our knowledge, no studies have compared the use of an electronic mobile platform to paper forms with the goal of increasing the collection of shift evaluations for summative purposes.

In our study, we identified the need to improve our end-of-shift evaluation completion rate and chose to use a new electronic platform with a modified completion process as our primary outcome. The design of the form and data collection were simple, and our electronic form mirrored our paper form with the exception of the feedback checkboxes. While the use of an electronic mobile platform was the main contributor to the success of the study, we believe that the process used to collect these electronic end-of-shift forms had the strongest impact on the improved rate of form return. This is likely related to several factors that influenced our outcomes.

First, the faculty used students' devices to complete and submit the form. The expectation was that by providing their device to the faculty to use to complete the form, the student would get it back immediately. Visiting students from other institutions always had the option to open the form on any handheld device (including smartphones) or any available desktop computer in the department. Surprisingly, 11% of the forms were completed in one of these two alternate ways.

Second, the electronic format allowed the designers to indicate required fields. The evaluator would be redirected to the incomplete sections if submission of the form was attempted before all sections were complete. This required the evaluator to complete the form in its entirety "on the spot" once started, and forms could not be saved or completed at a later date. This completely resolved the missing data issue on submitted forms. The "missing" global rating scores we reported were actually a result of faculty marking "N/A" and choosing not to provide a score, although it is not known why. There were no actual missing data points for any submitted forms.

Finally, there were planned and purposeful communications with the faculty as we implemented the change in the platform and process of form completion. Creating awareness is an important component of change management, but was not the only factor that made our overall process successful. While we had considered steps to increase the response rate with the paper forms, doing so would have still resulted in the same limitations and challenges that come with their use. The change to the platform and process of form completion and collection turned out to be more valuable than just simply increasing completion of paper forms.

The secondary outcomes examined changes in the number of missing data points, whether or not faculty members would score students consistently with either the electronic or paper format and frequency and usage of feedback checkbox and free text comments. There were no missing data points for submitted forms in the electronic format, which yielded a significant improvement over the paper format. Additionally, it turns out that faculty scored students marginally higher using the electronic form, even though the content and organization of the form was the same between the paper and electronic form, using the same competencies, scales, and labels. We suspect that the reason for this was that, unlike the paper form in which it was not uncommon to have missing forms, all electronic forms that were started were completed and therefore represented a near-complete data set. While difficult to prove, the higher scores were therefore likely a more accurate representation of their performance, as opposed to inflation of the students' grades by simply using the electronic platform, although inflation was still possible, but for unknown reasons.

The feedback checkboxes allowed faculty to click on the most common themes traditionally written about in the paper comments section. Organizing the themes into checkboxes allowed faculty to focus their comments on other areas that they felt were important in the free text section. We found it encouraging that half of the time for the electronic form faculty decided to type additional comments above and beyond the feedback checkboxes. While the frequency of free text comments was greater on the paper forms, using the electronic checkboxes allowed a simple method for identifying patterns of feedback to provide students across multiple shifts and over the course of the rotation, such as the need to work on their differential diagnosis. This was viewed as an improvement in our feedback process for our mid-rotation feedback sessions, since many paper forms were not even available to review with the students. We now have up-to-date qualitative and quantitative data available to share with students at any point.

Tertiary outcomes examined faculty patterns of scoring for students' interest in securing an EM residency versus those who were not (fall versus winter 2014 cohorts, respectively). Using the electronic form, there was no difference in how faculty scored students, regardless of their interest in EM. This demonstrates consistency in evaluating students and lack of a bias favoring either group of students.

In the process of using this form, we learned there were a few drawbacks to using the electronic format with the students' mobile device based on feedback from our faculty. First, the faculty identified that it was more difficult and time consuming to type comments into a mobile electronic device

than write them on paper. However, the paper form had posed challenges with the comments section including being able to read what was written, receiving generic feedback such as "good job" and the lack of comments being written at all. Second, faculty commented that some students tended to wait near them as they completed the form, which the faculty felt was awkward. This was an unintended consequence of having the students use their own devices to allow faculty to complete the form, and was not monitored in our study.

LIMITATIONS

This was a single institution with a single evaluation form and a limited number of students. However, even though each institution or department develops their own form and method of data collection, the overall process of increasing our completion rate was effective and used a commercially available product that was easy to use. With the dearth of free and for-cost survey platforms available, the user can review and choose the one that works best for them and work to make it fit their needs.

The use of checkboxes provided an efficient way for faculty complete the form and a more consistent availability of feedback for students and faculty at mid-rotation feedback sessions. However, we do not have data to suggest whether this method was adequate for students' feedback needs compared to written or typed comments.

The use of the form for formative purposes was not a part of our study. Ideally, we would have had faculty review the students' performance using the form as a guide. By doing this, it may have increased the completion rate further and provided students a learning opportunity with the feedback they would receive at the end of a shift.

CONCLUSION

The use of a new electronic form and modified process for evaluating students at the end of shift demonstrated a higher faculty completion rate, a lower missed data rate, a higher global rating and consistent collection of commonly used feedback. Switching to electronic end-of-shift evaluations improved the evaluation process for faculty and students and has become more reliable, providing more accurate, up-to-date information for student feedback and to determine student grades, which continues to date. The use of an electronic form with our process has the potential to provide a way for others to improve their end-of-shift evaluation completion rate.

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Reaching Out of the Box: Effective Emergency Care Requires Looking Outside the Emergency Department

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INTRODUCTION

Patients do not start to exist when they arrive at the door of our emergency departments (ED), nor do they stop existing when they leave. Instead, before they fall ill or become injured they live and exist somewhere and when they are discharged from our care they will likely return to that same somewhere. As emergency providers (EPs), our attention must be focused on the patients in front of us, but fundamentally the details of this "somewhere" directly affect our ability to provide safe and effective emergency care. Specifically, both patient-specific factors like homelessness, immigration status, living situation, or insurance coverage, and structural factors arising from broader community and societal forces like food deserts, community violence, and poor housing quality can strongly impact both emergency presentations and our ability to safely and effectively discharge patients. Here, we argue that our duty as EPs extends beyond the four walls of our EDs into life in our communities, and that understanding and addressing the unique strengths and needs of the communities we serve is a crucial component of our ability to provide effective emergency care.

WHERE DID YOU COME FROM?

A 45-year-old female patient presenting with a cough might raise different sets of concerns if she comes to the ED from her apartment, a homeless shelter, or Western Africa. Context and community obviously matter in terms of the pre-test probabilities assigned to potential diagnoses, and EPs need to be aware of the community-level risk factors they are likely to see. This connection is especially true for vulnerable populations such as homeless individuals whose social context might influence their potential exposures or ability to access care.[1] However, the interaction between the details of the reality outside of the ED and acute emergency health needs runs deeper than simple adjustments of pre-test probability.

Consider, for example, if our patient's cough is due to an exacerbation of her asthma; ED visits for asthma flares have been linked to outside-the-ED factors like socioeconomic status and local levels of ozone exposure.[2] Difficulties obtaining the needed controller medications such as cost and variability in access to commercial pharmacies and affordable generic drugs might also play roles in a patient transitioning from a manageable degree of symptoms into an acute episode requiring emergency care.[3] These effects are not limited to visits for asthma or other chronic disease states; outside of the ED factors such as race and insurance status have similarly been shown to be related to exposure to and survival after non-accidental trauma.[4]

As EPs, we often ask patients why they presented here and now with this specific complaint as opposed to presenting at a different time or place. Rarely do they respond with a multi-factorial analysis of relative levels of ozone exposure and driving distance to their local pharmacies, but the truth is that there is a densely connected network of social factors existing outside the walls of the ED that can directly impact our patient's emergency needs. Significant amounts of mapping and analyses of these networks of factors have been performed in non-ED settings, most notably led by the World Health Organization's (WHO) Social Determinants of Health Unit, and more work is needed to understand social factors at the patient and community levels that influence emergency care needs.[5] To paraphrase Sir Michael Marmot, former chair of the WHO Commission on Social Determinates of Health, having an emergency may be a personal issue, but the rate of needing an ED is a societal issue.[6]

WHERE ARE YOU GOING?

Continuing our example, our patient with an asthma flare

has improved after treatment and we make a plan to discharge her home with a short course of steroids, refill her albuterol inhaler, and instruct her to see her primary care doctor in one week. Safely discharging patients back into their communities is a key skill for EPs; however, some discharges fail and patients may return for "bounce back" ED visits or otherwise suffer adverse health outcomes.

EPs may think of our discharge plans as perfect and an inability to follow through with it as a failure on the part of our patients. In reality, however, both patient-specific and structural factors originating outside the ED can make our discharge plans impractical if not impossible to execute. Poverty, hunger, and lack of insurance or underinsurance have all been shown to be related to patients' probabilities of following through with ED discharge plans or even simply purchasing recommended medicines.[7] In Boston, MA, work by our team and others has highlighted several patient-level and structural factors that can significantly impact the efficacy of discharges from our EDs; for example, homeless individuals with chronic lung disease were found to be largely unable to use their recommended maintenance or rescue medications in Boston-area homeless shelters due largely to a lack of electrical outlets in shelters.[8]

Within the Knowledge, Skills, and Abilities (KSAs) profiles set out by the American Board of Emergency Medicine (ABEM), KSA DI0 ("Disposition-0") states that EPs should be able to "[e]stablish and implement a comprehensive disposition plan that uses appropriate consultation resources; patient education regarding diagnosis; treatment plan; medications; and time and location specific disposition instructions."[9] To accomplish this, EPs need to recognize groups of patients in the ED who are vulnerable for failing outpatient discharge based on the characteristics of their emergency presentation and course of ED treatment, as well as groups who might be unable to complete a discharge plan because of barriers they face outside of the ED. These barriers might be broad, such as hunger, health literacy, or insurance issues, or they might be unique to the microenvironment of a particular ED: for example, EDs discharging patients in Boston's neighboring cities might find homeless shelters with sufficient electrical outlets but a host of different potential barriers that require understanding and potential intervention outside of the ED. Discharge instructions represent a plan to be carried out by a particular person in a particular community and if patients are to succeed at these plans, EPs need to understand the unique strengths and constraints of the communities they expect the plan to function in.

WHERE CAN WE GO TOGETHER?

If visits to and discharges from EDs are significantly impacted by conditions outside of the ED, how should EPs begin to account for these conditions in the context of patient care? KSA MF0 ("Modifying Factors-0") states that EPs should be able to "[a]djust treatment of patients according to factors such as culture, gender, age, language, disability, and social status;" however, it does not define "social status," nor does it offer specifics on how that might influence our care.[7] We believe that more work is needed to recognize and develop training and competencies addressing the social realities that shape our patients' emergency needs. Toward that end, we would offer the following potential structure for improving the ways EPs and EDs respond to the needs of their communities.

First, all EPs should be able to understand and identify key factors at the patient-specific and structural level that might influence a patient's presentation or discharge plan. This would include an improved screening system using validated tools to identify social determinants of health, as well as a more in-depth understanding of the broader forces at work in the community served by the ED. Implicit in this idea are the assumptions that (1) each community has a different profile of risks and strengths much like each patient does, that (2) EPs will need to actually leave the ED (themselves or by proxy) in order to understand how their community actually works, and that (3) these factors are likely to change over time and EPs will need to maintain open communication with their communities to identify new and changing barriers to care.

Second, once EPs have identified social factors, we should use, where available, pre-existing resources that are designed to address these factors. These might include social workers or case managers already embedded in the ED, or referrals to programs outside of the ED like food pantries, free clinics, or programs like the Boston-based Breathe Easy at Home program, which conducts home visits for children with asthma to assess for sub-standard housing conditions that might contribute to asthma flares and then provides legal support for changing these conditions.[10] Using this type of resource, EPs could direct further resources outside the ED to particular patients within their community that they identify during their work inside the ED.

Finally, EPs with particular interest in the social determinates of their patients' health could go even further and work to develop new ED resources tailored to address these factors, for example, centers of research like the Oakland, CA-based Andrew Levitt Center for Social Emergency Medicine, or peer-education based programs like Boston-based Project ASSERT.[11,12]

In order to accomplish these goals, we as EPs need to make thinking outside the walls of our ED a new priority: while the core of our specialty remains the provision of the highest quality emergency medical care to all who are in need of it, we must recognize that our ability to provide this care is directly linked to our ability to deeply understand the reality of the lives of our patients and our communities.

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Addressing Social Determinants of Health from the Emergency Department through Social Emergency Medicine

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Dialogue and policy surrounding healthcare reform have drawn increasing interest to the social factors, accountable for nearly one-third of annual deaths in the United States,[1] that affect the health of populations. The Affordable Care Act (ACA) includes provisions for health systems to address social determinants of health, but how this is to be accomplished remains uncertain. If we are to make progress as a health system in addressing social determinants of health, we must open a dialogue and practice that reaches patients at the front lines of the medical system and population health – including in the emergency department (ED). The fact that emergency physicians care for patients who are complicated both medically and socially is no surprise, but the idea that we have an important role to play in the social determinants of health of our patients is, while controversial, gaining increasing attention among emergency physicians across the country. This interest comes largely from necessity, as we face a daunting task of providing care to the large volume of vulnerable patients who seek refuge in our EDs.

The ED is a window into the community, which starkly frames the contributions of the social determinants underlying the trauma resuscitations, repeat child visits for asthma exacerbation, or sepsis due to delay in seeking care. In the ED, we diagnose and treat the medical problem – but in order to improve the health of our patients we need to expand our role to diagnose and treat their social determinants of health as well. We urge our colleagues to not only consider the social determinants underlying health and illness, but to also develop systematic interventions, measure their effects, collaborate with others, and advocate for policies that will improve the health of our patients. We advocate physicians to address the social determinants of health from the ED, in other words, to practice Social Emergency Medicine.

The World Health Organization defines the social determinants of health as "conditions in which people are born, grow, live, work, and age. These circumstances are shaped by the distribution of money, power and resources at global, national and local levels."[2] It seems obvious that poverty, racial and ethnic inequities, and lack of preventive care, would lead to poor health. But the social determinants of health extend beyond these more tangible aspects of our lives. Every aspect of how we live, including social class, influences health profoundly. Even among London-based British civil servants leading relatively stable lives with guaranteed employment, salary and health insurance, there is a steep and inverse correlation between job classification level, morbidity and death.[3] From a policy standpoint, this gradient is compelling, as it affects all of our patients, not just those living in poverty, but the middle class as well.

Given that the structure of our daily lives are the social determinants of health, doing something about them requires moving our focus from the single patient to the population level, from diagnostics and medications to environmental and social structures and the policies that create them. While it would be clear to most emergency physicians that a patient's frequent visits for hyperglycemia reflect poorly managed diabetes, what is easily labeled willful noncompliance might instead be a lack of access to healthy foods, and ultimately insufficient social and technical support for the entire community. Thus, medical treatment of a disease such as diabetes, without regard to the social determinants of health, suffers the danger of being ineffective. Just as we cannot treat volume overload without understanding the physiology of the kidney, heart, lungs and their interaction, we cannot begin to treat a patient's medical problems without understanding the social factors, the life he lives.

Necessity mandates action. While the ACA tasks primary

care with managing these social determinants, access to medical care increasingly occurs through the ED for insured, as well as poor and marginalized populations.[4] The ED is the only door open to anyone for comprehensive medical and social services, 24 hours a day, 7 days a week, regardless of acuity or complaint, age, or insurance status. The status of the ED as society's "safety net" is reinforced by a legal imperative, embodied in the Emergency Medical Treatment and Labor Act of 1986, which requires Medicare-participating hospitals offering emergency services to provide a medical screening examination and stabilization of emergency conditions regardless of ability to pay. What we face practicing in this safety net is an imperative to act. We must embrace this role and adopt our practice to our *de facto* environment, as a critical part of out healthcare safety net. Applying knowledge about social determinants of health to the bedside and developing effective, systematic interventions that reach out into the community is the practice of Social Emergency Medicine.

With increasing ED volumes and ED crowding in the headlines, some argue that taking on this burden would interfere with the ED's primary mission of caring for the acute and emergent medical problems of the patients, and only when funded appropriately, should EDs take on this mammoth task. However, practically speaking, patients inadequately treated will continue to return to the ED. Many EDs already screen for vulnerable patients and offer some preventive services. ED directors are not philosophically opposed to offering these services within the ED, but are concerned with added costs, effects on ED operations, and potential lack of follow up.[5] We believe that to ignore the contribution of social determinants on disease simply because addressing them requires unbudgeted resources, including sophisticated coordination of clinical, statistical, social and policy expertise, is as great an omission as ignoring the contribution of genetics simply because we do not yet have the tools to reliably control gene expression.

EDs are beginning to take ownership of social determinants of health for their patients. Recent examples of successful Social Emergency Medicine interventions have focused on the development of coordinated care models providing ED patients in need with comprehensive medical and social services. Emergency medicine researchers worked with the Housing First partnership between the Centers for Medicare and Medicaid Services and New York City, which provided housing for high-risk homeless patients, resulting in improved health and cost savings for the city.[6] Boston Medical Center has a robust youth violence intervention program integrated into ED clinical care.[7] Emergency medicine has advocated for policies and programs to improve the care of patients with substance use disorders such as implementing screening, brief intervention, and referral to treatment programs and providing take-home naloxone to prevent opioid overdose.[8,9]

A fundamental step towards making the practice of Social Emergency Medicine more feasible requires integrating the study of the social determinants of health into our education. Medical training in the social determinants cannot be relegated to a single lecture or seminar, but rather requires a proportional emphasis along with anatomy, pharmacology and pathophysiology of disease. Similarly, we must not only teach the relationship of social determinants and health, but also teach the tools to translate theory into practice. We should teach methods to collaborate with community groups and design interventions so that young doctors do not segregate their medical and social diagnoses and interventions.

A fitting consequence of developing a subspecialty of Social Emergency Medicine would be that while all medical practitioners must know some theory, basic diagnostics and treatment; complicated cases require expert consultation and a systemwide effort. A single physician recognizing that a patient's unstable housing is an impediment to proper management of his health is important, but the next steps can feel daunting – especially in the face of a full waiting room and critically ill patients. This burden cannot fall on the individual clinician; isolated interventions will fail. Although a physician can recognize that her patient is suffering an ST elevation myocardial infarction, she requires a system to achieve timely medical and procedural intervention resulting in favorable outcomes. Accordingly, successful Social Emergency Medicine interventions require specialty training, resources, and a multidisciplinary team.

Physicians practicing Social Emergency Medicine must also network, establish, and foster collaborations. Screening programs and innovative interventions cannot be solely well intentioned, but must be needs based and proven effective. Sharing of resources, best practices, standardization of data collection, and research networks with the dissemination of findings are imperative. Social Emergency Medicine initiatives should culminate in advocacy for policies to combat the adverse health impacts that stem from the vastly disparate conditions in which people are born, grow, live, work, and age.

One can view the ED (by law, the most accessible door into our healthcare system) as the social barometer of its community. Within the waiting room the emergency physicians witness the confluence of social determinants of health and their deconstruction into pathology. Our daily practice compels us to act, to systematically and collaboratively act on upstream social factors to positively and comprehensively influence downstream health outcomes. This paradigm shift is critical to effectively care for our patients. In the words of Rudolph Virchow, "Medicine has imperceptibly led us into the social field and placed us in a position of confronting directly the great problems of our time."[10]

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