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Integrating Emergency Care with Population Health

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Does Young Age Merit Increased Emergency Department Trauma Team Response?

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Introduction: To determine if increased trauma team response results in alterations in resource use in a population of children <6 years, especially in those least injured.

Methods: We conducted a retrospective before and after study of children <6 years sustaining blunt trauma and meeting defined prehospital criteria. We compared hospitalization rates and missed injuries (injuries identified after discharge from the emergency department/hospital) among patients with and without an upgraded trauma team response. We compared the computed tomography (CT) rate and laboratory testing rate among minimally injured patients (Injury Severity Score [ISS] 6).

Results: We enrolled 352 patients with 180 (mean age 2.7 ± 1.5 years) in the upgrade cohort and 172 (mean age 2.6 ± 1.5 years) in the no-upgrade cohort. Independent predictors of hospital admission in a regression analysis included: Glasgow Coma Scale <14 (odds ratio [OR]=11.4, 95% confidence interval [CI] 2.3, 56), ISS (OR=1.55, 95% CI 1.33, 1.81), and evaluation by the upgrade trauma team (OR=5.66, 95% CI 3.14, 10.2). In the 275 patients with ISS <6, CT (relative risk=1.34, 95% CI 1.09, 1.64) and laboratory tests (relative risk=1.71, 95% CI 1.39, 2.11) were more likely to be obtained in the upgrade cohort as compared to the no-upgrade cohort. We identified no cases of a missed diagnosis.

Conclusion: Increasing the trauma team response based upon young age results in increased resource use without altering the rate of missed injuries. In hospitals with emergency department physicians capable of evaluating and treating injured children, increasing ED trauma team resources solely for young age of the patient is not recommended. [West J Emerg Med. 2013;14(6):569–575.]

INTRODUCTION

Trauma is the leading cause of morbidity and mortality in children age 1 to 18 years.[1,2] To care for these injured patients, designated trauma centers provide immediate, specialized treatment. Within these trauma centers, predefined trauma teams respond to the emergency department (ED) to provide such expert care.

The composition of these teams may include surgeons, emergency physicians (EP), anesthesiologists, ED nurses, respiratory therapists, and radiology technicians. In centers with resident training programs, resident physicians frequently compose a substantial membership. The members of these teams, however, vary by hospital, and many centers modify the composition of the trauma team by the severity of the patient's injuries, known as a tiered response.

Trauma team activation is dependent on the prehospital provider report. The prehospital report is used to determine the extent of the trauma team activation with the most severely injured met in the ED by the entire trauma team and the less severely injured met by a subset of the trauma team. This practice is designed to appropriately match and conserve limited resources and is often referred

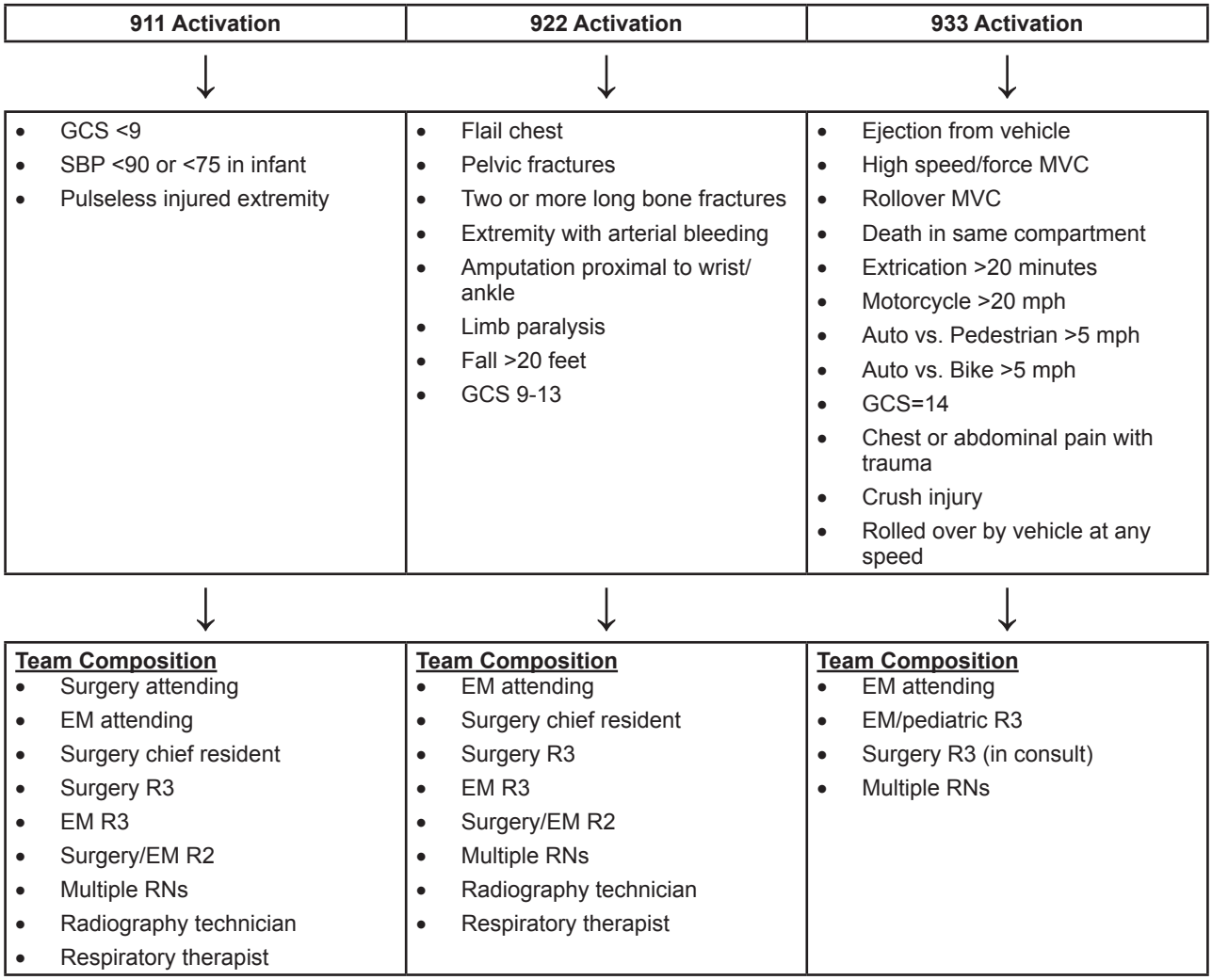

Figure. Trauma team activation and composition based upon prehospital report in patients with a blunt traumatic mechanism. *GCS*, Glasgow Coma Scale; *SBP,* systolic blood pressure; *MVC,* motor vehicle collision; *vs,* versus; *mph,* miles per hour; *EM,* emergency medicine; *R*, resident; *RN,* registered nurse

to as "secondary trauma triage." "Primary trauma triage" is the initial determination to transport an injured patient to a trauma or non-trauma center.

Criteria for internal trauma team activation and degree of response vary by hospital.[3,4] Limited data exist for determining appropriate internal trauma team response.[5-12] Due to the limited physiologic reserve and poor response to injury in the elderly, many centers upgrade trauma team response solely for patient age, although this practice is controversial.[7,13] Similarly, some centers increase trauma team response solely for young age as the evaluation of these patients may be difficult. However, no data supporting or refuting this practice currently exist.

The study objective was to determine if increased trauma team response results in alterations in resource utilization in this population, especially in those least injured. We hypothesized that an upgraded trauma team response would result in increased resource utilization (hospitalization rates, radiologic and laboratory testing) without decreasing the rate of missed injuries.

METHODS

Study Design

This is a retrospective before-and-after cohort study of children less than 6 years of age with blunt trauma. The study was approved by the study site's institutional review board.

Study Setting

The study was performed at a single center with both adult Level 1 and pediatric Level 1 trauma center designations. The annual ED census is approximately 65,000 patients/year, including 12,000 children/year. The pediatric ED is staffed at all times by board certified/prepared EPs or pediatric EPs and supports training programs in emergency medicine, pediatrics, and surgery.

Selection of Participants

Eligible patients included those younger than 6 years of age sustaining a blunt trauma mechanism and meeting defined prehospital criteria (Figure). This included patients

transported by prehospital providers and those arriving by private vehicle. Patients transferred from another facility were excluded. We identified patients from the study site's trauma registry, which collects data on all patients meeting defined prehospital criteria resulting in trauma team activation. We then searched the pediatric ED patient logs to identify any additional patients with trauma activations who were not included in the trauma registry.

Interventions

The study site has a 3-tiered trauma team response (Figure). Prior to December 2006, patients younger than six years of age were upgraded one level of trauma team response solely because of their age (i.e. patients meeting "933" activation criteria were upgraded to "922" activation response and patients meeting "922" activation criteria were upgraded to "911" activation response). In December 2006, the protocol for trauma team response to the ED was changed such that children younger than 6 years of age did not have the upgraded trauma team response (i.e. patients meeting "933" activation criteria were treated as "933" activations).

We compared patients who had upgraded trauma team response (May to December 2006) with those who did not have upgraded trauma team response (May to December 2007). This time period was chosen to capture the same months, such that the mechanisms of injuries would be similar between 2 groups (avoid bias by including different months and potentially different mechanisms between the 2 cohorts).

The "933" trauma team was composed of the following personnel: emergency medicine (EM) faculty, a second- or third-year pediatric/EM resident, ED nurses, and trauma surgery team consultation by the third-year trauma surgery resident. The third-year trauma surgery resident consultation is mandatory on all "933" patients and occurred at any time prior to patient discharge. This consultation was performed so that the trauma team would be aware of all trauma patients in the ED in case of the need for admission. The "922" trauma team added the following physicians present on patient arrival to the ED: surgery chief resident, third-year surgery resident, second-year surgery/EM resident, and a third-year EM resident. A "911" trauma activation simply added the attending trauma surgeon. Additionally, the "911" and "922" trauma response teams added additional nurses, a respiratory therapist, and a radiology technician, all present in the ED at the time of patient arrival.

Data Collection

Data collection from chart abstraction followed previously published guidelines for conducting retrospective studies.[14,15] We standardized data collection with variables of interest defined prior to chart abstraction via investigator meetings. Variables collected included age, mechanism of injury, initial ED Glasgow Coma Scale (GCS) score, initial ED systolic blood pressure (SBP), laboratory testing (including chemistry and hematocrit measurements), abdominal and cranial computed tomographies (CT), Injury Severity Score (ISS), and hospital admission from the ED. GCS and SBP were abstracted from the triage summary/attending EM note (not from the trauma registry). ED data abstraction information was done prior to documenting ISS and hospitalization data. We abstracted ISS data from the radiologic results, procedure notes, and discharge summaries.[16,17] The ISS allows stratification of injury severity and is a standard score to identify patients who benefit from trauma center care.[18,19] Three investigators (JH, RC, and MM) abstracted all data. Prior to data abstraction, a manual of operations (MOO) was created to define all data points and methods of abstraction. Prior to any abstraction, all investigators met to agree and revise the MOO. After abstraction of 20 cases each, abstractors met to review and finalize the MOO. To minimize any potential abstractor bias, each abstractor abstracted one third of the data from each cohort.

The primary outcome measurements were missed injuries and hospitalization. A missed injury was considered to have occurred if the injury was identified after discharge from the hospital (either discharge from the ED to home or from the hospital to home). An injury not identified in the ED but identified during initial hospitalization was not considered missed by this definition. This was based on return visits to the participating ED or referral to the trauma or ED continuous quality improvement (CQI) committees. Secondary outcome measurements included: 1) CT use, defined as obtaining either a cranial or abdominal CT, and 2) laboratory testing, defined as obtaining a hematocrit level or chemistry measurements.

A random sample of 10% (n=36) of the subjects were abstracted by 2 abstractors to measure inter-rater reliability of the abstractors. Inter-rater reliability was calculated measuring the kappa statistic (weighted kappa for ordinal data).

Data Analysis

We performed data analysis using STATA 11.0 statistical software (STATA Corp, College Station, TX, copyright 2009). Continuous data are presented as the mean ± standard deviation (SD) if normally distributed or median with interquartile range (IQR) if non-normally distributed. Prevalence rates are presented with 95% confidence intervals (CI). We assessed differences in categorical data between the 2 cohorts with chi-square test or Fisher's exact test (cases of small cell size). We analyzed differences in continuous data with Student's t-test if normally distributed data. Wilcoxon rank-sum test was used for non-parametric data or ordinal data.

We performed a multivariable logistic regression analysis to identify variables independently associated with hospital admission. We included trauma team upgrade in this analysis to determine if upgrading the trauma team response was associated with hospital admission while including variables to control for degree of injury (mechanism of injury, ISS and GCS).

Finally, we compared minimally injured patients (defined a priori as an ISS less than 6) in the 2 cohorts with regards

Table 1. Baseline characteristics of the study population.

	Upgraded trauma response	No upgraded trauma response
	n = 180	n = 172
Age (mean)	2.7 ± 1.5 years	2.6 ± 1.5 years
Mechanism of Injury		
Motor vehicle collision	99 (55%)	84 (49%)
Fall	37 (21%)	46 (27%)
Auto versus pedestrian/bike	32 (18%)	26 (15%)
Other	12 (7%)	16 (9%)
Systolic blood pressure (mean)	111 ± 20 mmHg	110 ± 20 mmHg
Heart rate (mean)	121 ± 2	122 ± 2
Glasgow Coma Scale (median)	15 (15, 15)	15 (15, 15)
Injury Severity Score (ISS) (median)	1 (1,5)	1 (1,5)
ISS >15	17 (9%)	24 (14%)
ISS <6	144 (80%)	131 (76%)

All comparisons with p-values >0.05

to the number of CT scans, laboratory tests, and missed diagnosis (injuries identified after discharge from the ED or hospital) and described the risk of obtaining diagnostic testing or missed diagnosis with relative risk (RR) ratios.

RESULTS

We entered 352 patients with a mean age of 2.7 ± 1.5 years into the study. Motor vehicle collisions (183, 52%), falls (83, 24%), and automobile versus pedestrian/bike (58, 16%) were the most common mechanisms of injury. The median ISS was 1 (IQR 1, 5), range 0 – 45. Seventy-five patients (21%) had an ISS greater than 8, and 41 (12%) had an ISS greater than or equal to 16. Excellent reliability between the abstractors existed as kappa values ranged from 0.80 to 0.94.

The upgrade trauma team cohort included 180 patients (mean age 2.7 ± 1.5 years), and 172 patients (mean age 2.6 ± 1.5 years) were in the no-upgrade trauma team cohort. Baseline characteristics of those in the upgrade trauma team cohort and those in the no-upgrade trauma team cohort are presented in Table 1. The 2 cohorts appeared similar in age, mechanism of injury, initial SBP, GCS score, and ISS.

One-hundred twenty-one (67%, 95% CI 60, 74%) patients in the upgrade trauma team cohort and 73 (42%, 95% CI 35, 50%) in the no-upgrade trauma team cohort were admitted. We performed a multivariate analysis to identify variables independently associated with hospital admission. After controlling for head injury with the GCS score and severity of injury with the ISS, the upgrade trauma team cohort was independently associated with hospital admission (Table 2).

A total of 275 patients had an ISS less than 6, including 144 (80%) in the upgrade trauma team cohort and 131 (76%) in the no-upgrade trauma team cohort. An increased likelihood of receiving a CT as part of the ED evaluation was identified in those patients in the upgrade trauma team cohort (97/144, 67%, 95% CI 59, 75%) as compared to those in the no-upgrade trauma team cohort (66/131, 50%, 95% CI 42, 59%, Relative risk = 1.34, 95% CI 1.09, 1.64). Similarly, an increased likelihood of receiving laboratory testing occurred in those patients in the upgrade trauma team cohort (111/144, 77%, 95% CI 69, 84%) as compared to those in the no-upgrade trauma team cohort (59/131, 45%, 95% CI 36, 54%, Relative risk = 1.71, 95% CI 1.39, 2.11).

Six patients had return visits to the ED (4 in the upgrade and 2 in the no upgrade cohort). No cases of missed diagnosis were identified in the upgrade cohort (0%, 95% CI 0, 1.7 %) or the no-upgrade cohort (0%, 95% CI % 0. 1.7%). The 6 patients returned for the following: vomiting (2), abdominal pain (1), radiology call back for possible hepatic injury on abdominal CT scan (1), suture removal (1), transient ataxic gate (1). The patient with possible hepatic injury on abdominal CT was initially admitted to the hospital. The faculty radiologist reviewed the initial CT interpretation of normal and considered a possible hepatic injury to be present. The patient was re-evaluated in the ED by both the ED team and pediatric surgery team and felt not to have a definitive hepatic injury and discharged home. This patient was in the upgrade cohort.

DISCUSSION

The study demonstrates that increasing the trauma team response simply due to young age of the injured patient does not result in appreciable clinical benefit. No cases of missed injury from the ED were identified regardless of the trauma team composition. Furthermore, increasing the trauma team resulted in a notable increase in resource use. Rates of hospitalization, CT use, and laboratory testing all increased when the trauma team response was increased, regardless of the degree of patient injury.

We believe the increased resource use is a result of a "framing bias."[20-22] The upgraded trauma team is normally

Table 2. Multivariate logistic regression model to predict hospital admission.

	Odds ratio (95% confidence interval)	p-value
Upgraded trauma team	5.66 (3.14, 10.2)	<0.001
Age	1.00 (0.84, 1.21)	0.95
Motor vehicle collision	1.03 (0.32, 3.34)	0.96
Fall	1.70 (0.48, 6.03)	0.41
Auto vs. Pedestrian	2.36 (0.61, 9.16)	0.21
Glasgow Coma Scale <15	11.4 (2.30, 56.0)	0.003
ISS*	1.55 (1.33, 1.81)	<0.001

Injury Severity Score (ISS) was included as a continuous variable in the model.

activated for the most-injured patients. Once the team is activated, the members expect to provide care to a severely injured patient and thus evaluate and treat the patient as if he were seriously injured. The team is "anchored"[22] to the pre-arrival belief that the patient will be seriously injured, thus an expectation for an aggressive diagnostic work-up and planned hospitalization is made. When this belief is removed (patient does not undergo secondary triage as a severely injured patient), less diagnostic testing and fewer hospitalizations occur as the clinicians' expectations originate at a different origin.

Evaluating injured children is potentially difficult due to their young age and limited verbal skills.[23] Injured children are known to have special needs that must be addressed to provide the best quality of care.[24] Recognition of these difficulties has resulted in different evaluation strategies for those who are very young.[25,26] Concerns regarding the difficulty in evaluating the youngest children likely generated the impetus to upgrade trauma team response simply due to young age of the injured child.

Surveys demonstrate that significant variation exists among the composition and activation criteria for trauma teams outside of the United States.[3,4] Such variation is not known to occur within the U.S. but is highly likely. Variation in pediatric trauma care is a known problem and is considered a cause of decreased quality of care.[23,27-29] In the current era of providing quality, cost-effective care, determining appropriate resource use is paramount. Although this study identifies a particular variable (upgrading trauma team response for young age of the patient) that appears to not be effective, further investigation is necessary to determine the most appropriate response for pediatric trauma patients arriving to the ED.

Previous work on "secondary trauma triage" has primarily focused on appropriate indications for trauma team activation in adult patients.[5,9,10,12] Despite this work, definitive indications for trauma team activation in adult patients remain unidentified. The data are more confusing in the pediatric population, likely due to the limited data available and the complexity of these patients.

A prior study evaluating 2,311 children from a single trauma registry suggested that activating the surgeon for a pediatric trauma code was of low utility unless the mechanism was penetrating trauma. This decision would significantly decrease the need for a surgeon during the initial ED evaluation as patients without penetrating injury had a low likelihood of needing emergency surgery. This decision instrument, however, has not been validated, and it did not assess for possible improvements in care that may occur with the presence of a surgeon (decreased missed injuries).[11] A second study modified the pediatric trauma score and used it to predict trauma team activation.[9] This retrospective study identified all seriously injured children (ISS > 10) with the modified pediatric trauma score. The study, however, applied the instrument at the time of patient arrival to the ED and did not assess its use by prehospital providers. As decisions on "secondary trauma triage" are made from prehospital provider reports, the tool requires assessment when implemented using information from the prehospital providers. Finally, a retrospective study of 152 "surgeon-directed trauma team activations" suggests that physiologic variables are sufficient to determine secondary triage.[30]

These 3 studies highlight the confusion in determining the need for surgeon presence in the ED at the time of patient arrival. Two of these studies considered the trauma surgeon necessary only in instances of emergency surgery,[11,30] whereas another considered an ISS cutoff (ISS >10)[9] as the outcome of interest. Although improvements in care may be recognized by having a surgeon available for patients who do not require surgery, it is not necessarily a requirement that a surgeon be present at the time of ED arrival for all patients with an ISS >10. In the current era, with EPs and pediatric EPs trained in providing pediatric trauma care, many of these patients can be properly evaluated and initially treated by EPs with selective determinations made about the need for a surgeon. In addition, further triage may be performed at the time of patient arrival (i.e. dismiss the trauma team) if the patient is clearly minimally injured. This process requires future study.

LIMITATIONS

This study was retrospective and therefore subject to the limitations of a medical record review. However, we performed the review following methodologically rigorous guidelines to minimize the potential bias from the review.[14,15] In addition, this was a before-and-after study and subject to the bias inherent with such design. We are not aware of temporal changes at the institution that resulted in significant changes in hospitalization or evaluation practices (CT use) during the study period. In addition, recent evidence indicates that despite knowledge of radiation risks associated with CT, its use continues to increase across the entire U.S. and Ontario.[31] Furthermore, this study demonstrated ED CT use in children <5 years of age nearly doubled from 2003 to 2008. Thus, if temporal changes biased our study, we would expect CT use to have increased in the later cohort (not decrease as was identified).

The 2 populations appeared similarly injured based on vital signs, age, mechanisms of injury, GCS scores, and ISS. Furthermore, we performed a regression analysis in an attempt to control for possible confounding variables. Finally, the study was conducted at a pediatric Level 1 trauma center with personnel experienced in the care of injured children. The results may not be generalizable to all centers. We did not identify any cases of missed injuries (injuries identified after discharge to home). It is possible that a missed injury was identified at another hospital and the patient was never referred to the study site. At such a low rate (<1%), the sample size required to identify differences between the 2 cohorts would be so large that it would not be feasible to review records to this degree. A multicenter study would facilitate a larger sample size. Although the rate of missed injuries was zero, the current sample size allows for very small confidence intervals around the rate of missed injuries.[32] We did not study other potential improvements that may be recognized by increased trauma team response.

We did not conduct a formal cost-effectiveness analysis. However, no clinical benefit was identified with increasing the trauma team response, such that a cost-effectiveness analysis would not be appropriate as it would demonstrate increased costs with no clinical benefit. Finally, due to the retrospective methodology, we were unable to determine any potential harm by additional testing (i.e. unnecessary hospitalization for false positive test results).

CONCLUSION

Increasing the ED trauma team response based upon young age of the patient results in increased resource use without apparent clinical benefit. For locations with EPs capable of evaluating and treating injured children, increasing ED trauma team resources solely for young age of the patient is not recommended.

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Emergency Department Visits by Older Adults for Motor Vehicle Collisions

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Introduction: To describe the epidemiology and characteristics of emergency department (ED) visits by older adults for motor vehicle collisions (MVC) in the United States (U.S.).

Methods: We analyzed ED visits for MVCs using data from the 2003–2007 National Hospital Ambulatory Medical Care Survey (NHAMCS). Using U.S. Census data, we calculated annual incidence rates of driver or passenger MVC-related ED visits and examined visit characteristics, including triage acuity, tests performed and hospital admission or discharge. We compared older (65+ years) and younger (18-64 years) MVC patients and calculated odds ratios (OR) and 95% confidence intervals (CIs) to measure the strength of associations between age group and various visit characteristics. Multivariable logistic regression was used to identify independent predictors of admissions for MVC-related injuries among older adults.

Results: From 2003–2007, there were an average of 237,000 annual ED visits by older adults for MVCs. The annual ED visit rate for MVCs was 6.4 (95% CI 4.6-8.3) visits per 1,000 for older adults and 16.4 (95% CI 14.0-18.8) visits per 1,000 for younger adults. Compared to younger MVC patients, after adjustment for gender, race and ethnicity, older MVC patients were more likely to have at least one imaging study performed (OR 3.69, 95% CI 1.46-9.36). Older MVC patients were not significantly more likely to arrive by ambulance (OR 1.47; 95% CI 0.76–2.86), have a high triage acuity (OR 1.56; 95% CI 0.77-3.14), or to have a diagnosis of a head, spinal cord or torso injury (OR 0.97; 95% CI 0.42-2.23) as compared to younger MVC patients after adjustment for gender, race and ethnicity. Overall, 14.5% (95% CI 9.8-19.2) of older MVC patients and 6.1% (95% CI 4.8-7.5) of younger MVC patients were admitted to the hospital. There was also a non-statistically significant trend toward hospital admission for older versus younger MVC patients (OR 1.78; 95% CI 0.71-4.43), and admission to the ICU if hospitalized (OR 6.9, 95% CI 0.9-51.9), after adjustment for gender, race, ethnicity, and injury acuity. Markers of injury acuity studied included EMS arrival, high triage acuity category, ED imaging, and diagnosis of a head, spinal cord or internal injury.

Conclusion: Although ED visits after MVC for older adults are less common per capita, older adults are more commonly admitted to the hospital and ICU. Older MVC victims require significant ED resources in terms of diagnostic imaging as compared to younger MVC patients. As the U.S. population ages, and as older adults continue to drive, EDs will have to allocate appropriate resources and develop diagnostic and treatment protocols to care for the increased volume of older adult MVC victims. [West J Emerg Med. 2013;14(6):576–581.]

INTRODUCTION

Background

Currently, there are approximately 30 million licensed drivers in the United States (U.S.) who are over the age of 65.[1] As the older adult population grows, it is anticipated that the number of older drivers will also increase; by the year 2030, an estimated 57 million drivers will be over the age of 65.[2,3] Drivers over age 65 have higher rates of motor vehicle crashes (MVCs) per mile driven. On a per-crash basis, older motorists also have higher rates of death[4,5] and serious injury, and incur greater costs for acute care and rehabilitation.[6] Compared to other types of trauma in older adults, MVCs are responsible for the largest number of intensive care unit days and overall hospital charges.[7] In addition, while only 10% of trauma patients are over the age of 65 years, they accrue an estimated 25 percent of total hospital costs for trauma care.[7]

Among adults aged 65 years and older, MVCs are the second leading cause of injury-related death and the fourth-leading cause of injury-related emergency department (ED) visits.[8] As the U.S. population ages, and as older adults continue to drive, EDs will have to allocate appropriate resources and develop diagnostic and treatment protocols to care for the increased volume of older adult MVC victims. Previous research to investigate the care of older adults with MVC-related injuries has focused on the pain management[9] and inpatient characteristics of these patients.[10-14] However, less is known about how ED visits after MVCs by older patients compare to those by younger patients. Given older adults' increased propensity for injury from a given mechanism and their decreased physiologic reserve,[10-11] we hypothesized that older MVC patients would require more ED resources and would be more likely to be admitted to the hospital after MVC-related injuries when compared to younger MVC patients.

The primary objective of this study was to use a national, population-based data set to examine the demographic and visit-related characteristics of older adults presenting to EDs after motor vehicle crashes. Specifically, we sought to: (1) compare the characteristics of MVC-related ED visits by older (65+ years) and younger (18-64 years) adults in terms of emergency medical services (EMS) arrival, visit acuity, use of imaging studies, and injury diagnoses; and (2) compare the likelihood of hospitalization of older and younger MVC patients, after adjustment for injury severity.

METHODS

Study Design and Setting

We conducted a cross-sectional analysis of visits to EDs for MVCs in the United States using 2003–2007 data from the National Hospital Ambulatory Medical Care Survey (NHAMCS). These surveys are conducted annually by the National Center for Health Statistics and use multi-stage probability sampling to derive national estimates of patient visits. The NHAMCS design is based on: primary sampling units within geographic areas; nonfederal, acute care general hospitals within those primary sampling units; EDs within those hospitals; and patients within those EDs. The NHAMCS data files include a patient-weighting variable for generating national estimates based on sampling designs and response rates adjusted for non-response. Detailed descriptions of the survey methodologies are available in the technical documentation that accompanies the data set.[15]

Between 2003 and 2007, an annual average sample of 438 EDs was included in NHAMCS, which represents approximately 10 percent of all U.S. EDs (based on American Hospital Association ED Counts).[16] Hospital staff in the sampled EDs completed patient record forms for a systematic random sample of visits during a randomly assigned 4-week period. The overall annual average sampling response rate between 2003 and 2007 was 89.4% across all EDs.

We defined visits in the NHAMCS data files as MVC-related using the cited external causes of injury, which are the activities from which the injury resulted. Each visit has up to 3 external causes cited; we clustered these using the Centers for Disease Control and Prevention's (CDC) groupings of ICD-9 CM External Causes of Injury and Poisoning codes.[17] Specifically, we included ED visits with at least 1 external cause from a traffic-related MVC (E810-E816; E818-E819; E823). We excluded an estimated 1.58 million motor vehicle injury visits (n = 469 observations) that resulted from off-road motor vehicle crashes (e.g., dirt bikes or snowmobiles) or injuries resulting from a stationary vehicle (e.g., slammed finger in car door or fall from vehicle); these accounted for 9% of all motor vehicle injury visits for adults aged 18 and older. The NHAMCS files also contain questions concerning the episode of care ("initial visit"; "follow-up visit"; "unknown") and the duration of the injury problem ("acute problem, <3 months onset"; "routine chronic problem"; "flare-up of chronic problem"; "pre-/post-surgery"; "preventive care"). For this analysis, we were interested in the total burden of MVC-related ED visits, so we included all episodes of care and all durations of injuries.

For this analysis, we categorized patients into 2 age groups: younger adults (aged 18–64 years) and older adults (≥65 years). The surveys included separate variables for race (white, black, Asian, Native Hawaiian/other Pacific Islander, Native Alaskan/American Indian, and ≥2 races reported) and ethnicity (Hispanic, non-Hispanic and unknown/blank). Because of the high proportion of missing ethnicity data in all of the surveys (range 15.1%-21.9%), we used the imputed ethnicity variable (Hispanic and non-Hispanic).

We further categorized the MVC-related injuries reported using the CDC's Barrell Injury Diagnosis Matrix, which classifies injuries based upon body region and nature of injury; we defined a "significant injury diagnosis" as an ICD-9 diagnosis of a traumatic brain, spinal cord or internal torso injury.[18] Metropolitan statistical areas were classified in the survey data using definitions from the U.S. Census

Table 1. Comparison of demographic and geographic characteristics of motor vehicle crash patients treated in emergency departments by age, United States 2003-2007.†

Demographic characteristic	Younger patients (18-64 years) number in 1000s (%)	Older patients (<65 years) number in 1000s (%)	Total number in 1000s (%)
Total MVC visits	15,217 (93)	1,183 (7)	16,400 (100)
Gender			
Female	7,894 (52)	653 (55)	8,547 (52)
Male	7,323 (48)	530 (45)	7,853 (48)
Hispanic ethnicity	2,048 (13)	735 (6)	2,122 (13)
Race			
White	5,481 (70)	931 (79)	6,411 (70)
Black	8,410 (28)	361 (15)	8,772 (27)
Other	1,326 (3)	214 (6)	1,540 (3)
Geographic region			
Northeast	2,780 (18)	227 (19)	3,007 (18)
Midwest	510 (18)	494 (21)	6,074 (19)
South	239 (47)	1,366 (39)	1,605 (46)
West	39 (16)	1,013 (21)	1,052 (17)
Metropolitan status			
MSA	11,182 (87)	1,005 (85)	12,187 (87)
Non-MSA	4,035 (13)	356 (15)	4,391 (13)

MSA, metropolitan statistical area; *MVC*, motor vehicle collision
† Defined as visits for injuries from MVCs in traffic. Numbers may not add to totals because of rounding. Source: 2003–2007 NHAMCS.

Bureau.[16] As proxies for injury severity, variables of interest included significant injury diagnoses; EMS arrival (yes or no); high triage acuity (level 1 or 2, versus levels 3 to 5); and ED imaging (at least radiography, computed tomography or magnetic resonance image study) as identified in the NHAMCS database.

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

Primary Data Analysis

The data analysis proceeded in 3 steps. First, we estimated the number (reported as a weighted estimate and proportion) and population-based incidence rates of driver or passenger MVC-related ED visits for younger and older adults. Rates were calculated per 1000 population using annual denominators based on the civilian, non-institutionalized U.S. population for 2003–2007, as estimated by the U.S. Census Bureau.[18]

Second, we used logistic regression to test for associations between age and each of the ED visit characteristics of interest (EMS arrival, triage level, ED imaging, and significant injury diagnosis). We decided *a priori* to simultaneously adjust for potential confounders including gender, race (white versus other) and Hispanic ethnicity, since these demographic characteristics could impact the age distribution of MVC patients, arrival by EMS, and the decision to assign a high triage acuity or order an imaging study. To measure the strength of these relationships, we calculated adjusted odds ratios (OR) with 95% confidence intervals (CIs).

Third, to examine the association between age and hospital admission, we conducted an additional multivariable logistic regression. Hospital admission was the dependent variable, and age group, gender, race, ethnicity, and markers of injury severity (EMS arrival, high triage acuity, imaging studies performed, and injury diagnosis) were identified *a priori* to be included simultaneously as factors that could be related to hospitalization after injury. We performed all data analysis using Stata 11.0 (Stata Corporation, College Station, TX), using the program commands designed for analysis of weighted survey data.

RESULTS

From 2003–2007, there were an average of 237,000 annual ED visits by older adults for MVCs (Table 1). MVC-related visits accounted for 1.4% (95% CI 1.2–1.6) of ED visits by older adults, as compared with 4.3% (95% CI 4.1-4.6) of ED visits for younger adults. The annual ED visit rate for MVCs was 6.4 (95% CI 4.6-8.3) visits per 1,000 for older adults and 16.4 (95% CI 14.0-18.8) visits per 1,000 for younger adults. The proportion of MVC-related visits among older and younger adults did not differ significantly by gender, geographic region or metropolitan status. Although blacks accounted for a greater proportion of younger MVC patients (27.6%; 95% CI 24.3-30.9) than older MVC patients (15.3%;

Table 2. Comparison of visit characteristics of motor vehicle crash patients treated in emergency departments by age, United States 2003-2007.

Visit characteristic	Younger patients (18-64 Years) number in 1000s (%)	Older patients (<65 Years) number in 1000s (%)	Adjusted odds ratio (95% confidence interval)‡
Arrival***			
EMS	6,476 (43)	650 (55)	1.47 (0.76–2.86)
Other	8,742 (58)	533 (45)	Reference
Triage level***			
1 or 2	7,934 (52)	746 (63)	1.56 (0.77–3.14)
3+	7,289 (48)	437 (37)	Reference
Imaging study			
1+ radiography***	9,748 (64)	883 (75)	2.22 (1.00–4.94)
1+CT or MRI*	3,383 (22)	339 (29)	0.34 (0.04–2.56)
1+ of any**	10,667 (70)	937 (79)	3.69 (1.46–9.36)
None	4,550 (30)	245 (21)	
Diagnosis			
Head Injury	157 (1)	†	†
Spinal cord injury*	†	†	†
Torso Injury*	2,029 (13)	22 (19)	1.08 (0.47–2.46)
Any of above*	2,227 (15)	229 (19)	0.97 (0.42–2.23)

CT, computed tomography; *MRI,* magnetic resonance imaging; *EMS*, emergency medical service(s)
***P <0.001, **P <0.01, *P <0.05 under Pearson chi-square tests corrected for survey design
†Estimate based on fewer than 30 cases in the sample data
‡Older patients versus reference group of younger patients; adjusted for gender, race and ethnicity
Numbers may not add to totals because of rounding. Source: 2003–2007 NHAMCS.

95% CI 10.7-19.9), they also accounted for a larger proportion of all ED presentations by younger patients (24.4%, 95% CI 21.8-26.9) than by older patients (14.0%, 95% CI 12.2-15.8).

Approximately half of MVC patients were transported by ambulance or had a high triage acuity (Level 1 or 2; Table 2). There was a non-statistically significant trend for older MVC patients as compared to younger MVC patients to be transported by ambulance (OR 1.47, 95% CI 0.76-2.86) or to have a high triage acuity (OR 1.56, 95% CI 0.77-3.14) after adjustment for gender, race and ethnicity. However, after adjusting for other variables, older MVC patients were significantly more likely than younger MVC patients to have at least 1 imaging study performed in the ED (OR 3.69, 95% CI 1.46-9.36). Approximately 15% (95% CI 13.5-16.4) of ED visits for MVCs—or 2.5 million visits by adults aged 18 and older—resulted in a diagnosis of a head, spinal cord or torso injury, without significant differences between older and younger patients after adjustment for gender, race and ethnicity (OR 0.97, 95% CI 0.42–2.23).

Overall, 14.5% (95% CI 9.8-19.2) of older MVC patients and 6.1% (95% CI 4.8-7.5) of younger MVC patients were admitted to the hospital. After controlling for gender, race, ethnicity, and injury severity (EMS arrival, high triage acuity, ED imaging, and diagnosis of a head, spinal cord or internal injury), there was a trend for older MVC patients to be admitted to the hospital as compared to younger MVC patients (OR 1.78, 95% CI 0.71-4.43) (Table 3). Of MVC patients hospitalized, 2.3% of older patients and 1.2% of younger patients were admitted to an intensive care unit (ICU). Older MVC patients had a higher odds than younger MVC patients to be admitted to the ICU if hospitalized (OR 6.86, 95% CI 0.91-51.90) after adjustment for gender, race, ethnicity, and markers for injury severity, although this also was not statistically significant and younger patients accounted for a much larger absolute volume of total estimated MVC-related ICU admissions (189,000) compared with older patients (28,000).

DISCUSSION

Between 2003 and 2007, there were 1.2 million MVC-related ED visits by older adults. As the number of older adult drivers continues to rise, it is anticipated that the annual ED visit volume for older MVC victims will also increase. As such, understanding the healthcare resources used by these patients will be increasingly important to inform diagnostic and treatment protocols for older MVC patients. In this analysis of 5 years of data, we found that older MVC patients were more likely than younger ones to have imaging studies performed but were equally likely to have a final ED diagnosis of a head, spinal cord or torso injury or to be admitted to the hospital.

In general, older adults have an increased propensity for injury and decreased physiologic reserve to respond to

Table 3. Multivariate model of factors associated with hospitalization of MVC patients treated in emergency departments by age, United States 2003-2007.

Visit characteristic	Adjusted odds ratio (95% confidence interval)†
Age ≥65	1.78 (0.71-4.43)
Male	0.83 (0.42-1.63)
Nonhispanic	0.59 (0.20-1.79)
Nonwhite	1.28 (0.67-2.43)
EMS arrival	2.09 (1.09-4.00)
Triage level 1 or 2	2.24 (0.65-7.72)
≥1 Imaging study	2.63 (0.82-8.43)
Diagnosis of ≥1 head, spinal cord or torso injury	3.66 (2.11-6.36)

†Adjusted for all other factors shown; *MVC*, motor vehicle collision
Source: 2003–2007 NHAMCS.

injury.[10-14,19] As individuals age, physical changes in bone density, muscle mass and tissue pliability lead to decreased ability to tolerate forces experienced in an MVC with a consequential increased susceptibility to injury.[20] These same physical changes can also lower an older adult's physiologic reserve to compensate and heal from injury. In this study, however, no trend was identified to suggest that older MVC patients were more likely than younger ones to have a head, spinal cord or torso injury based on their final ED diagnoses. It is possible that this somewhat surprising finding may be a result of the small subgroup sample sizes (which did not allow for stable estimate generation) or from the age categories we used, but it does merit further investigation in the future.

Older adults' generally increased propensity for injury and decreased physiologic reserve may be important to consider in the determination of triage criteria and decision rules for imaging in the older adult population. Indeed, we found a trend toward ED visits by older MVC patients to have a higher triage acuity level as compared to younger MVC patients, which may reflect triage consideration of age, although the difference was not statistically significant. Previous research suggests that the emergency severity index is a valid tool to predict hospitalization, length of stay, and 1-year survival in older adult trauma patients.[21]

Over three-fourths of ED visits for older MVC patients included imaging studies, and older patients were more likely than younger ones to have at least 1 imaging study performed, after adjustment for gender, race and ethnicity. The high rate of imaging may also be related to ED provider consideration of age, although this database does not include information about why a particular study was ordered. These data also do not allow determination of whether imaging was necessary, and in future work it will be useful to examine how age affects the sensitivity and specificity of clinical decision rules for imaging in order to optimize older adult care.

A greater proportion of ED visits by older MVC patients than by younger MVC patients resulted in hospitalization, and there was a trend toward increased odds of admission in older patients after adjustment for other factors. Compared with younger cohorts, older trauma patients have been previously shown to have higher admission rates, longer stays and higher morbidity and mortality,[12-14] although this is the first study to describe the patterns of ED care for older MVC patients. We believe it is possible that issues such as co-morbidities, perceived safety of the living situation, limited physiologic reserve, and diagnostic uncertainties in older adults may have influenced the admission decisions for these patients. We were unable to adjust for these factors in the present analysis, an additional investigation into this topic is warranted to better identify the factors that impact the decision by the clinician to admit older adult MVC patients. It is also important to recognize that the majority (85%) of older MVC patients were discharged home, and previous work has suggested that many of these patients may have significant pain.[16] Finding ways to optimize pain control (and functional outcomes) while minimizing adverse events, including falls, from narcotic medications will be critical in the coming years.

LIMITATIONS

The NHAMCS database provides reliable, census-weighted estimates of ED use across the U.S., but it does not include some information, such as injury severity score and driver versus passenger status, that may vary by age or may affect admission Other variables, such as imaging, are limited by their classification categories in NHAMCS. We included initial and follow-up MVC-related visits in our study to estimate the total volume of visits. The episode of care was unknown for almost half of MVC-related older (46%) and younger (44%) patients, and there were also no significant differences in the proportions of older and younger MVC patients presenting for initial (53% each) or follow-up (1.7% vs. 2.6%, respectively) visits (p=0.55 under Chi Square). Sampling and non-sampling errors, including coding inaccuracies, misclassification of injuries, and non-response, are also potential limitations to the use of this kind of survey data in research. However, the NHAMCS is a well-established survey tool that uses multiple standardized procedures to minimize these problems, such as pretesting, quality control, and adjustment of weights for non-response items.

A common limitation in survey research is missing data; some variables may not have been assessed by the surveys, and others may have had high proportions of missing or blank responses. In our analysis, data were missing for a high proportion (17%) of the external cause of injury (e-code). It is difficult to determine how the total injury estimates reported for this study would change if these data were available for analysis. It is also possible that the acuity level of the patient impacted those patients with missing or blank responses, which may have affected the findings of this study. Finally, some of the response subgroups had small numbers, limiting our ability to generate reliable estimates for national trends.

CONCLUSION

Although population-based MVC-related ED visit rates for older adults are lower than for younger adults, older MVC victims appear to require significant ED resources in terms of increased use of diagnostic imaging. In addition, a greater proportion of older than younger MVC patients were admitted to the hospital and ICU. As the U.S. population ages and adults continue to drive into old age, EDs will have to allocate appropriate resources and develop diagnostic and treatment protocols to care for the increased volume of older adult MVC victims.

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Vital Signs
from the Centers of Disease Control and Prevention's MMWR

Emergency Departments and Older Adult Motor Vehicle Collisions

In conjunction with the Morbidity and Mortality Weekly Report published by the Centers for Disease Control and Prevention

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In 2009 the Centers for Disease Control and Prevention reported that there were 33 million licensed drivers 65 years and older in the U.S. This represents a 23 percent increase from 1999, a number that is predicted to double by 2030. Although motor vehicle collisions related to emergency department visits for older adults are lower per capita than for younger adults, the older-adults MVCs require more resources, such as additional diagnostic imaging and increased odds of admission. Addressing the specific needs of older adults could lead to better outcomes, yet not enough research exists. It is important to continue training emergency physicians to treat the increasing older-patient population, but it is also imperative that we increase our injury prevention and screening methodology. We review research findings from the article "Emergency Department Visits by Older Adults for Motor Vehicle Collisions: A Five-Year National Study," with commentary on current recommendations and policies for the growing older-adult driving population. [West J Emerg Med. 2013;14(6):582–584.]

"TRAUMA CODE NOW" sounds overhead throughout the emergency department (ED). The emergency physician (EP), the resident, and the trauma team begin to gown, glove, and prepare for patient arrival. On arrival the patient is moved from the stretcher to a hospital bed, and a methodical process ensues. The paramedics begin to report their findings as the team is assessing the pale, 79-year-old female, who lies covered with blood under a white sheet. Both arms appear deformed, and there is shattered glass strewn in her hair and lacerations along her orbits and nose. After assessment, it was determined that the patient had a possible polypharmacy side effect that impaired her vision and driving abilities, causing her to collide with the center divider at 65mph. As the geriatric population increases, these types of events will become a more recurrent image in EDs.[1,2] From 2001 to 2009 there was a 79% increase in older adult visits to EDs in the western United States, thus making it one of the fastest growing demographics.[3]

According to the Centers for Disease Control, in 2009 there were 33 million licensed drivers 65 years and older in the U.S. This represents a 23 percent increase from 1999, a number that is predicted to double by 2030.[1,4] An increase in the number of older drivers will result in increasing ED visits as a result of older-adult motor vehicle collisions (MVC).[1,4] According to Vogel et al., the MVC-related ED visit rates for older adults are lower per capita than for younger adults, yet older-adult MVCs require more resources, such as additional diagnostic imaging. There is also a trend toward increased odds of admission. Furthermore, they conclude that allocation of healthcare resources in the ED is important for implementation of appropriate diagnostic and treatment protocols for optimized care of this growing older-adult patient population.[1]

Many government and private agencies have concentrated their efforts on understanding and reducing the risk associated with MVC in older drivers.[5] However, very few have focused on implementing more appropriate resources for older-adult MVCs.[6-11] Not enough research currently exists to show the significance of addressing the specific needs of older-adult trauma patients and whether this will lead to better outcomes.[9,12,13] According to Mangram et al, older-adult patients with specialized treatment resources have a decrease

in all the following areas: average ED length of stay (LOS), average ED to operating room time, average surgical intensive care unit LOS, average hospital LOS, and a decrease in mortality rate.[9,12]

Driving is important for older adults because it helps them remain mobile and independent, but as adult drivers increase in age, this also represents an increased risk of being injured or killed in a MVC.[4,14-15] In older patients the presence of multiple comorbidities, age-related decline in vision and cognitive functioning, such as ability to remember and reason, as well as other physical changes, can affect older adults' driving ability and increase their susceptibility to injury.[2,4,8,11,16-19] These factors can make it difficult for a healthcare provider to recognize the "red flags" that indicate an older driver should no longer be driving. Therefore, it is important to continue training EPs and other healthcare providers to treat the increasing older-patient population, but it is also imperative that we increase our injury prevention and screening methodology. The American College of Emergency Physicians (ACEP) believes that EPs have the responsibility to affect the health of the public by leading the integration of injury prevention and control into their practices as they interact in different practice settings.[20] One way we can lead this effort is to increase injury prevention education in emergency medicine residents, medical students, and healthcare providers.[20-24] ACEP has a list of recommendations that includes education in medical schools and hospitals to encourage the development of evidence-based injury prevention education and its inclusion into routine clinical practice to identify patients at risk for injury.[20] ACEP also recommends educating the public, policy makers, and community leaders about injury prevention and screening methods.

Education can be essential in preventing older-adult MVCs.[24,25] The CDC has established several steps that older adults can take to stay safe on the road. These recommendations include: consulting their physician or pharmacist to review medicine side effects and interactions that can inhibit driving abilities; regular visual function testing;[26] finding the safest route with well-lit streets; and exercising regularly to increase strength and flexibility.[4] Unfortunately, many of the screening and assessment tools of fitness-to-drive of older persons have not been validated or do not exist in an evidence-based methodology.[27-28] This leaves EPs to rely more on subjective impression then on objective methods.[28] Therefore, more research is needed in this area to help develop clinical measures and practical tools that can be used in EDs to objectively assess fitness-to-drive.[27,28]

Many of the recommendations might not reach our patients in time if clinicians and older drivers wait to discuss prevention mechanisms for safer driving until there are specific "red flags,"[29] such as being a MVC victim, which at times can be too late – as in our 79-year-old female patient. Recent studies have shown that older drivers are open to discussing their driving plans with physicians, support the idea of mandatory age-based testing, and are more likely to follow recommendations from physicians or family members.[30-31] Older drivers who are asked to take a driving test at the Department of Motor Vehicle (DMV) often do not meet the DMV's minimum vision requirement or have been referred because of a physical or mental condition or lack of driving skills.[32] Many times law enforcement officers, relatives, friends, and physicians refer older drivers to the DMV to check driving abilities.[32] This supports the important role an EP can play when assessing the driving abilities of older drivers.[30] It is important that EPs, as care providers of this population, partner with different agencies and community leaders to increase awareness of the specific needs and resources of this growing older adult population in efforts to prevent the increase of older-adult MVC victims.

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The Impact of Working with Medical Students on Resident Productivity in the Emergency Department

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Introduction: Academic emergency departments (ED) strive to balance educational needs of residents and medical students with service requirements that optimize patient care. No study to date has evaluated whether resident precepting of medical students affects residents' clinical productivity. Understanding the interplay of these variables may allow for ED staffing that maximizes productivity. We sought to determine whether the precepting of medical students impacts resident productivity.

Methods: This study was performed at a tertiary care ED with a 70,000 annual patient census. We performed a computer-based (Verinet Systems, Alachua, FI) retrospective review of patient encounters initiated by second- and third-year emergency medicine residents (PGY2 and PGY3) assigned to medical student precepting shifts and compared these shifts with those of the same residents when not working with students. Data collection over 12 months included shift length from the monthly schedule and number of patients and relative value units (RVUs) from the Verinet System. Patients seen per hour (pt/hr) and relative value unit per hour (RVUs/hr) were calculated. We compared parameters using two-tailed t-tests. The hospital's institutional review board approved this study.

Results: Daily census was 202 on days without medical student rotators and 200 on days with student rotators (p=0.29). While precepting students, PGY3s saw 1.40 pt/hr versus 1.39 pt/hr without students (p=0.88) and PGY2s saw 1.28 pt/hr with students compared to 1.28 pt/hr without students (p=0.94). PGY3s generated 3.97 RVU/hr with students and 4.03 RVU/hr while working independently (p=0.68) and PGY2s generated 3.82 RVU/hr working with students versus 3.74 RVU/hr without (p=0.44). There were no productivity differences between resident precepting shifts and regular shifts.

Conclusion: In this study, resident productivity was not affected by precepting medical students. [West J Emerg Med. 2013;14(6):585–589.]

INTRODUCTION

Emergency departments (ED) are a setting where patient care and medical education occur simultaneously. As part of their education, emergency medicine (EM) residents learn to balance academic and clinical responsibilities. An area of growing interest is the evaluation of the interplay between these two integrally related facets of medical education, especially regarding the role of residents as teachers. In addition to the inherent educational framework of residency wherein instructing others is a means of learning, the Accreditation Council for Graduate Medical Education requires all residency programs to provide evidence of "structured learning activities that demonstrates how the program supports the development of teaching skills."[1]

A large body of literature has shown that instructing residents in educational methodology can improve residents'

teaching performance and attitudes toward teaching.[2-7] However, one study showed that residents have concerns that teaching and related activities (for example, precepting students) interfere with their ability to perform clinical duties, and that this concern was more marked among more junior residents.[8]

While no significant relationship exists between clinical productivity and teaching among EM faculty, to date no study has evaluated whether precepting medical students affects resident productivity, as measured by patients per hour (pt/hr) and relative value units (RVUs) per hour (RVU/hr).[9-11] Given that residents are not just active learners but also teachers of their fellow residents and students, it is important to understand how their clinical and teaching responsibilities are interrelated. In this study, we sought to assess whether resident productivity is impacted by teaching activities, and whether the impact is more marked on junior residents.

METHODS

We performed a computer-based retrospective chart review of patients evaluated in the ED by second (PGY2, n=12) and third (PGY3, n=12) year EM residents in a university-affiliated community-based ED with a 70,000 annual patient census, from September 2009 to June 2010. We used resident schedules to determine which residents were scheduled for which shifts (7AM–5PM, 12PM–10PM, 2PM–12AM, 4PM–12AM, and 1PM–9PM), and this was cross-referenced with the Verinet System (LightSpeed Technology Group, Inc. © 2004-2012), an independent system used in our ED for tracking, coding, patient encounters, and other departmental metrics. Residents were assigned to between 1 and 3 medical student precepting shifts on their monthly schedule, and this information was also recorded. During these entire shifts, a resident is assigned to a medical student. In addition to informal bedside teaching, residents hear presentations from medical students, review patients' radiographic and laboratory studies, and discuss differential diagnosis and care plans. Residents also provide verbal and written feedback. No more than one medical student is scheduled to work with a given resident.

All patients seen by residents must be presented to an attending physician, who then sees the patient, regardless of whether or not a student is involved in care. There are no specific standards or guidelines by which residents use students in this ED. All residents worked both precepting and non-precepting shifts. We excluded night shifts from data collection as students were not scheduled to work overnight.

We queried the Verinet System to determine the number of patients seen and number of RVUs generated by residents during clinical shifts, and from this we calculated patients per hour and RVUs per hour. The daily census was also recorded from the Verinet system to determine if patient volume contributed to productivity.

First-year residents were excluded, as they do not precept medical students. We excluded shifts if Verinet documented no patients seen that day, as the resident had likely traded out of the shift. Shift trades in which the residents did not change the names on their computerized and paper schedule were excluded. If the residents traded shifts and the change was verified on the schedule, the traded shift was included.

Data were entered into an Excel spreadsheet (Microsoft, Redmond, Washington) by trained data abstractors who were not blinded to the resident groups. We analyzed numerical data using descriptive statistics. A chi-square analysis was performed to determine that residents worked similar proportions of day and evening shifts with students and without. Two-tailed t-test compared daily census data to determine if differences in volume contributed to resident productivity with and without medical students. We evaluated the calculated values for pt/hour and RVUs/hour as a function of both resident level of training and presence or absence of medical student precepting. These parameters were compared using two-tailed t-test for normally distributed data. The institutional review board reviewed and approved this study.

RESULTS

Ninety shifts when residents were precepting students and 618 shifts without were included in this study. The mean daily census with student rotators was 200 ± 25.9, versus 202 ± 24.5 without (p=0.29). Residents worked a similar proportion of day and evening shifts with and without students (chi-square p=0.18).

Intraclass comparisons

PGY3s saw a similar number of patients whether or not they were working with students (1.4 versus 1.39 pt/hr, p=0.88) and generated a similar number of RVUs (3.97 versus 4.03 RVUs/hr, p=0.68). PGY2s also saw a similar number of patients regardless of whether they were working with students (1.28 versus 1.28, p=0.94) and generated a similar number of RVUs (3.82 versus 3.74, p=0.44).

Interclass comparisons

While precepting medical students, PGY3s saw 1.40 pt/hr (confidence interval [CI] 1.27-1.53). Their PGY2 counterparts saw 1.28 pt/hr (CI 1.22-1.34, P = 0.07). While working with students, both groups generated similar RVUs, with the PGY3 residents generating 3.97 RVU/hr and the PGY2 residents generating 3.82 RVU/hr (P = 0.39).

While working independently, PGY3s saw 1.39 pt/hr (CI 1.25 – 1.54), while PGY2s working independently saw 1.28 pt/hr (CI 1.20 – 1.36, P = 0.10). PGY3s working independently generated 4.03 RVUs/hr, and PGY2s working independently generated 3.74 RVUs/hr.

DISCUSSION

In our study, PGY2 and PGY3 residents showed no difference in productivity whether working alone or precepting a medical student. This is somewhat surprising,

given numerous previous studies showing that PGY3 residents are more productive than PGY2 residents.[12-16] Certainly one would hope that productivity increases over the course of training, so that residents are ready to handle the workload of a busy ED when they graduate. The fact that productivity did not differ in this case may be related to PGY3s intentionally carrying lighter patient loads to facilitate the training of their more junior peers. (In other words, they were pushing PGY2s to see more patients.) Additionally, this may be evidence of unmeasured systems issues within the study center that potentially prevent residents from being more productive as they advance through training. Or it may be a factor of senior faculty physician availability, as a resident cannot turn over a bed without presenting the patient to a senior faculty physician, who then must also see the patient.

It would stand to reason that an additional responsibility, such as precepting a student, would create more work for a resident and reduce his or her productivity. Since both teaching and providing patient care require time, as one spends more time teaching, one has less time to see patients. Studies have found that productivity in senior faculty physicians is not inversely related to the quality of teaching they provide in academic institutions.[9-12] However, these studies performed at teaching institutions have relied upon resident, student, and faculty perceptions of teaching interactions and have used regression or mixed-effect models to determine relationships between teaching and productivity. They have not directly compared individual practitioners' productivity while teaching as compared to while they have not been teaching. Other studies done during resident work strikes have shown that academic EDs have faster turnaround times when there are no residents, and practices that had been community-based become less productive with the introduction of residents.[16-20] This is likely not merely a byproduct of attending physicians taking time to teach residents, but also a result of slower care that is rendered by less experienced trainees as they develop their diagnostic, procedural, and multitasking skills. Based on these studies that show productivity decreases with introduction of new learners, it is expected that resident productivity should fall when less experienced medical students are added to the patient care team.

Our study did not show this. It is possible that the time taken to teach and precept students is balanced and offset by the contributions of students to a residents' clinical duties, thereby resulting in a net neutral time balance. In our department, each student performs the initial assessment of his or her patient. While the student does this, the resident often sees another patient independently in order to not waste time. The student then presents his or her patient to the resident. While the resident performs an assessment of the student's patient, the student is often charged with finding and interpreting old records, reporting lab values and radiographic studies, and re-evaluating patients (for instance, giving patients routine updates or assessing adequacy of pain control). It is likely that these contributions save time that would otherwise have been spent by the resident on these tasks, thus freeing up residents for teaching students or picking up additional patients. It is also possible that residents find additional time for teaching students when they would ordinarily be doing other tasks, such as documenting, and that they may then delay their documentation until after completion of their shifts. Perhaps residents are more proficient at managing their time on days when they have students and simply exercise a higher degree of multi-tasking, integrating teaching into the tasks they are already performing.

Another possible reason productivity is unaffected by precepting students is that pt/hr and RVUs/hr are partly dependent on a critical volume of patients waiting to be seen. It is possible that there were times for both precepting and non-precepting shifts when a resident's productivity was limited by a lack of available patient encounters. Our precepting shifts were limited to day shifts when, although there is a generally high volume of patients, there is also a maximum of resident coverage. Perhaps repeating this study during night shifts – when there are patients awaiting evaluation a larger proportion of the time – would yield different results. Whether precepting students would enhance or detract from productivity in this scenario is a matter of speculation. It is conceivable that their contribution to performance of ancillary tasks could increase overall productivity in the setting of more consistently available patient encounters, but it is also possible that time spent teaching them could result in a productivity decrease. There is also the chance that it may make no difference at all, as patient volume and time may not be the limiting factors for productivity. Senior faculty physician availability, nursing responsiveness, and systems issues may also be key contributing factors.

Regarding ED staffing, this study suggests that PGY2 and PGY3 EM residents are equally suited to manage the clinical duties required during an ED shift and precept a medical student without adversely affecting productivity. Thus, no additional accommodation needs to be given to scheduling residents to ensure that they are not working with students during peak ED hours. This suggests that students can be scheduled for day or evening shifts with no untoward effects.

LIMITATIONS

There are several limitations to this study. We may not have adequately controlled for patient acuity. Clearly, acuity level could influence productivity comparisons, and it is possible that residents of different levels of training or residents working with students might gravitate toward differing levels of acuity. Although at our institution it is the policy that residents see patients in the order in which they arrive to the ED within their given acuity level, there are occasions when residents might "cherry-pick" through charts. We did attempt to limit the impact differences in acuity would

have on our data analysis by incorporating RVU data into our analyses, in addition to patients seen per hour.

Another limitation involves the use of RVUs in our analysis. Although generally accepted as a reasonable productivity standard, RVU scores are highly dependent on patient length of stay and on the documentation done by the residents. Our residents do undergo documentation training, and all their documentation is reviewed by the attending physician. However, it is possible that residents of different levels of training document with different proficiency, which may introduce potential bias.

Additionally, we did not explore patient length of stay in this study. Our focus was primarily on resident productivity, and we found no differences in any productivity parameters among or between PGY2s or PGY3s. However, there may be an unappreciated impact of precepting medical students on resident efficiency, or residents' ability to move the patients they pick up through the ED and disposition them in a timely fashion. This would be an area for further study.

Although both precepting and non-precepting shifts took place in the same ED with similar patient volumes and similar staffing, there may be fluxes in inpatient bed availability or nursing staffing, both on the inpatient wards as well as in the ED, for which we did not control. Throughput, efficiency, and productivity are very complex parameters, and there is no way to control for all the variables that affect them. Our focus was on measures of productivity that have been used in the literature in prior studies to perform an initial exploration of the impact medical students have on these measures. This study is in no way meant to be a comprehensive assessment of all the other factors that impact productivity at academic institutions.

We did not attempt to control for the number of patients "handed off" at change of shift. These patients could theoretically impose a burden on a resident, causing reduced productivity on a given shift.

Our study did not evaluate medical student perceptions of the quality of teaching and feedback they received from residents. It is possible that although PGY2 and PGY3 residents were equally productive that one group was more effective at teaching than the other. Future evaluations of student perception of teaching are important, as medical student ED rotations have been shown to strongly impact their interest in EM.[21]

Finally, our data were drawn from a single institution and may not be able to be generalized to other institutions.

CONCLUSION

In this institution, resident productivity was not affected by precepting medical students. PGY2 and PGY3 emergency medicine residents are equally capable of precepting medical students without changing their clinical productivity on day and evening shifts.

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Predictive Value of Capnography for Suspected Diabetic Ketoacidosis in the Emergency Department

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Introduction: Metabolic acidosis confirmed by arterial blood gas (ABG) analysis is one of the diagnostic criteria for diabetic ketoacidosis (DKA). Given the direct relationship between end-tidal carbon dioxide ($ETCO_2$), arterial carbon dioxide ($PaCO_2$), and metabolic acidosis, measuring $ETCO_2$ may serve as a surrogate for ABG in the assessment of possible DKA. The current study focuses on the predictive value of capnography in diagnosing DKA in patients referring to the emergency department (ED) with increased blood sugar levels and probable diagnosis of DKA.

Methods: In a cross-sectional prospective descriptive-analytic study carried out in an ED, we studied 181 patients older than 18 years old with blood sugar levels of higher than 250 mg/dl and probable DKA. ABG and capnography were obtained from all patients. To determine predictive value, sensitivity, specificity and cut-off points, we developed receiver operating characteristic curves.

Results: Sixty-two of 181 patients suffered from DKA. We observed significant differences between both groups (DKA and non-DKA) regarding age, pH, blood bicarbonate, $PaCO_2$ and $ETco_2$ values ($p \leq 0.001$). Finally, capnography values more than 24.5 mmHg could rule out the DKA diagnosis with a sensitivity and specificity of 0.90.

Conclusion: Capnography values greater than 24.5 mmHg accurately allow the exclusion of DKA in ED patients suspected of that diagnosis. Capnography levels lower that 24.5 mmHg were unable to differentiate between DKA and other disease entities. [West J Emerg Med. 2013;14(6):590–594.]

INTRODUCTION

Diabetes mellitus, defined by high levels of glucose and impaired carbohydrate and lipid metabolism, is the most common endocrine disorder and includes a wide group of metabolic diseases whose major characteristic is hyperglycemia caused by impaired insulin secretion and/or function.[1] Patients with diabetes mellitus are prone to important and disabling complications. One of the most important complications of the diabetes is diabetic ketoacidosis (DKA).[2] DKA mostly occurs in patients with type I diabetes; however, patients with type II diabetes are also prone to DKA at early ages under stress conditions including trauma, surgery, or infection.[3]

DKA is defined as blood sugar levels ≥250 mg/dl, ketonuria, ketonemia, and metabolic acidosis (pH<7.3 or blood bicarbonate levels <15 meq/dl).[4] Blood sugar measurement can be quickly performed using glucometry devices widely available in emergency departments (ED). Ketones in urine could be assessed rapidly using urine

dipsticks. However, measurement of the acid-base levels is more challenging. Commonly, arterial blood gas (ABG), pH, and bicarbonate levels are used to diagnose acidosis and evaluate its severity. Yet, obtaining ABG samples can be a painful and time-consuming procedure.[5]

Alternatively, capnography may be used as an alternative, non-invasive and inexpensive (in comparison with ABG) method of assessing ventilatory response to typical metabolic acidosis of DKA.[5-10] In our center, the cost of capnography is 1 United States Dollar (USD) whereas each ABG costs 2.5 USD (1 USD for blood sampling and 1.5 for the analysis).

Numerous studies have evaluated the relationship between acidosis and $ETCO_2$, most of which are in the pediatric patients or the patients without DKA.[11-15] In the current study, we aimed to evaluate the relationship between blood bicarbonate and end-tidal carbon dioxide ($ETCO_2$) values and the predictive value of $ETCO_2$ in DKA diagnosis in adult patients with increased blood sugar levels referred to the ED.

METHODS

We carried out a prospective cohort study of a convenience sample of patients in the ED of Imam Reza Medical Research and Training Hospital, Tabriz, East Azarbaijan, Iran, 110,000 admission per year, during a 4-month period (December 2011–March 2012).[16] Sample size determination was based on the previous studies (11) in which capnography sensitivity in diagnosing DKA was reported to be 83%. Considering α=0.05, power of 80% and 6 units acceptable absolute difference in the reported sensitivity, we selected 176 people which was later increased to 181 people to compensate for expected dropouts or missing data. Patient collection was performed from 8AM until 4PM seven days a week, while no sample collection was performed in the evening or night shifts.

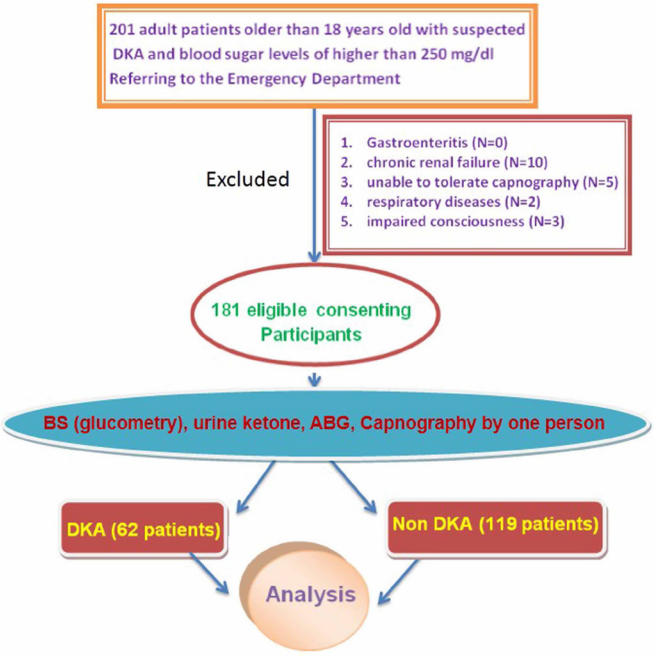

Figure 1. Flow diagram of study involving patients with suspected diabetic ketoacidosis.

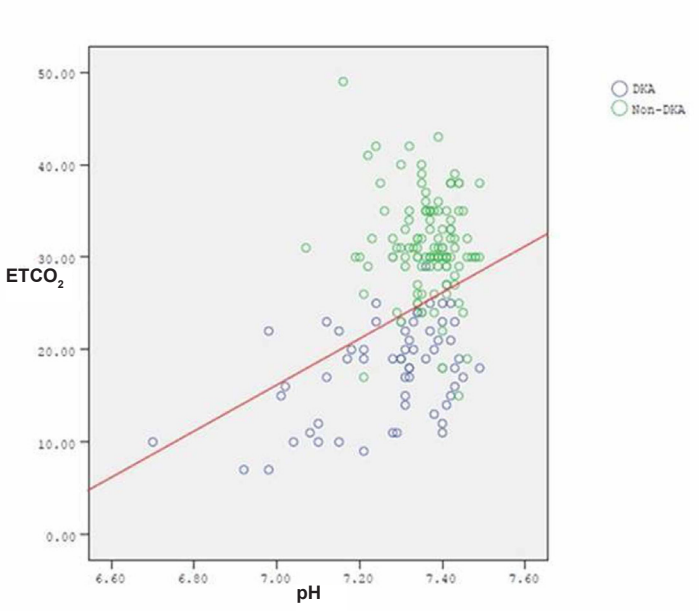

Figure 2. The correlation between pH and $ETCO_2$ levels in 2 groups (diabetic ketoacidosis [blue], non-DKA [green]).

Inclusion criteria for the study: All adult patients older than 18 years old with suspected DKA by an attending emergency physician in charge of the shift and blood sugar levels of higher than 250 mg/dl referred to our ED.

Patients likely to have metabolic disturbances from other causes were excluded from the study, including:

1. Gastroenteritis
2. Chronic renal failure
3. Patients unable to tolerate capnography
4. Respiratory diseases
5. Impaired consciousness

This study was approved by the Ethics Committee of "Tabriz University of Medical Sciences" and registered under the Code Number 90104.

On arrival vital signs of all patients were checked and blood sugar levels were measured by glucometer (Clever check, model TD 4209, San Chung, Taipei). Complete blood count, serum levels of sodium, potassium, urea and creatinine, urine ketone levels, and ABG were measured. Patients with blood sugar levels higher than 250 mg/dl, probable DKA diagnosis, and symptoms including nausea, vomiting, abdominal pain, and fatigue were further evaluated. ABG samples were taken for all patients by the same person, and in order to avoid human error in registering $ETCO_2$ values by different people, capnography values were recorded by one person simultaneously using a RESPIRONICS device (model number: 7100, RESPIRONICS California Inc, California).

Capnography was performed for 1 minute at the same time the ABG sample was taken, and the total number of the registered $ETCO_2$ in every breath in 1 minute was divided

Table 1. Demographics characteristics and laboratory findings of both groups (diabetic ketoacidosis [DKA] and non-DKA).

	DKA Patients	Non DKA patients	p-value
Age (years)	51.01 ± 18.86	61.53 ± 16.13	0.001
Sex	23 male	51 male	0.454
Blood sugar levels (mg/dL)	458.66 ± 193.16	361.88 ± 92.94	0.001
pH	7.24 ± 0.13	7.36 ± 0.07	<0.0001
Bicarbonate (mEq/dL)	12.76 ± 4.00	21.81 ± 3.61	<0.0001
$PaCO_2$	28.99 ± 7.92	37.93 ± 6.74	<0.0001
$ETCO_2$	17.98 ± 5.24	31.23 ± 5.45	<0.0001

Table 2. Comparison of the associated symptoms between two groups at admission.

	All patients	DKA patients	Non-DKA patients
Nausea/vomiting	114 (63%)	40 (64%)	74 (62%)
Abdominal pain	120 (66%)	45 (72%)	75 (63%)
Polyuria/polydipsia	94 (52%)	39 (63%)	55 (46%)
History of diabetes mellitus	165 (91%)	46 (74%)	119 (100%)
Fatigue	172 (95%)	62 (100%)	11 (92%)

DKA, diabetic ketoacidosis

by the respiratory rate per minute; the calculated mean was considered as the $ETCO_2$ value of each patient.

At the time of discharge, patients were divided into 2 groups, DKA and non-DKA, based on clinical consensus of their course and other supporting data.

DKA patients were hospitalized after consultation with the internal medicine service whereas non-DKA patients, after calculation of their serum osmolarity, were hospitalized in case of having hyperosmolar sera or discharged from the ED. We analyzed the results using SPSS (model number: 17.0.1, SPSS Inc, Chicago). We used descriptive statistical approaches (domains, frequency, percentage, mean ± SD and variance). To compare the qualitative data, chi-square test was used. To compare quantitative data, we used t-test and, if required, Non-Parametric Mann-Whitney U tests.

We studied normal distribution of the data using Kolmogrov-Smirnov test. Non-Parametric Mann Whitney U test was used in case of non-normal distribution of the data. To evaluate the relation between $ETCO_2$ and ABG findings (pH, arterial carbon dioxide [$PaCO_2$] and HCO_3) in patients with increased levels of blood sugar, we used the Spearman correlation coefficient and regression curves. To define $ETCO_2$ cut off point in diagnosing DKA, we used receiver operating characteristic curve analysis ROC). In all cases, we considered p-value less than 0.05 significant. A flow diagram of our study is presented in Figure 1.

RESULTS

In the current study, 181 patients including 107 females were studied. The mean age was 57.9 ± 17.8 years. Sixty-two patients had DKA (%) while 119 had other conditions associated with metabolic acidosis. Table 1 shows a statistically significant difference between the 2 groups (DKA and non-DKA) regarding age, blood pH, bicarbonate, $PaCO_2$, blood sugar and $ETCO_2$. Table 2 presents the difference between groups for associated symptoms at admission. Spearman test revealed a significant linear correlation between pH and $ETCO_2$ ($p>0.0001$, $r=0.253$) (Figure 2), $PaCO_2$ and $ETCO_2$ ($p>0.0001$, $r=0.572$) (Figure 3) and HCO_3 and $ETCO_2$ ($p>0.0001$, $r=0.730$) (Figure 4).

To study the sensitivity and specificity of capnography in diagnosing DKA patients with increased blood sugar levels, we used ROC curves. The surface area under the curve is 0.037. Given the low surface area and low sensitivity and specificity of the $ETCO_2$ test, a determination of the cut-off point was not possible. ROC curves were also used to evaluate the sensitivity and specificity of capnography in ruling out DKA in patients with increased blood sugar levels. In Figure 5, the area under the curve is 0.963. Using this curve, a cut-off point of 24.5 with a sensitivity of 0.90 and specificity of 0.90 was achieved for $ETCO_2$ revealing that $ETCO_2$ >24.5 mmHg rules out DKA with a moderate confidence (Figure 5).

DISCUSSION

Numerous factors are used to diagnose DKA, including blood sugar levels higher than 250 mg/dL, ketones in urine and metabolic acidosis.[3] A conventional method of determining metabolic acidosis is to use ABG, which can be a painful, time-intensive and expensive procedure with undesirable complications. Venous blood gases have been shown to closely approximate arterial for DKA.[4] An alternative method suggested by our study is to replace ABG with noninvasive capnography for determining $ETCO_2$ and severity of metabolic acidosis.[11-15]

Numerous studies have been performed on the association of metabolic acidosis and capnography; these, however, have been of small sample sizes mostly focusing on either pediatric patients or other metabolic acidosis disorders. Diedre et al[11], in a study of 42 pediatric patients, concluded that $ETCO_2$ values have a direct linear relation with blood bicarbonate

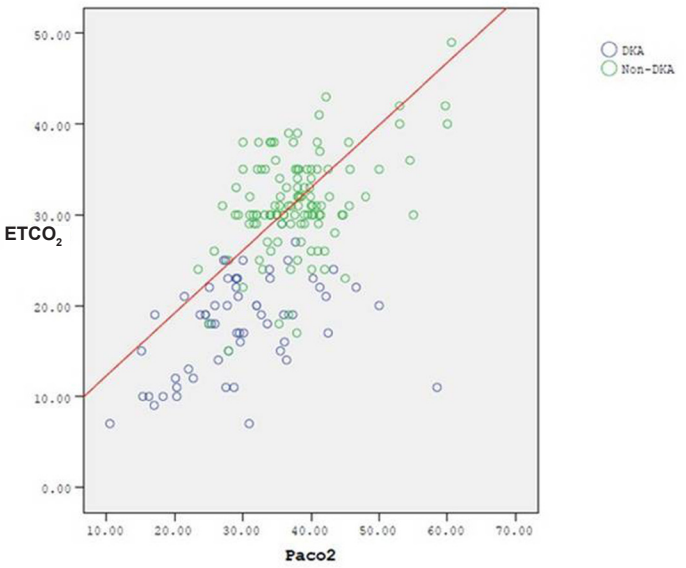

Figure 3. The correlation between $PaCO_2$ and $ETco_2$ levels in two groups (diabetic ketoacidosis (DKA) [blue], non-DKA [green]).

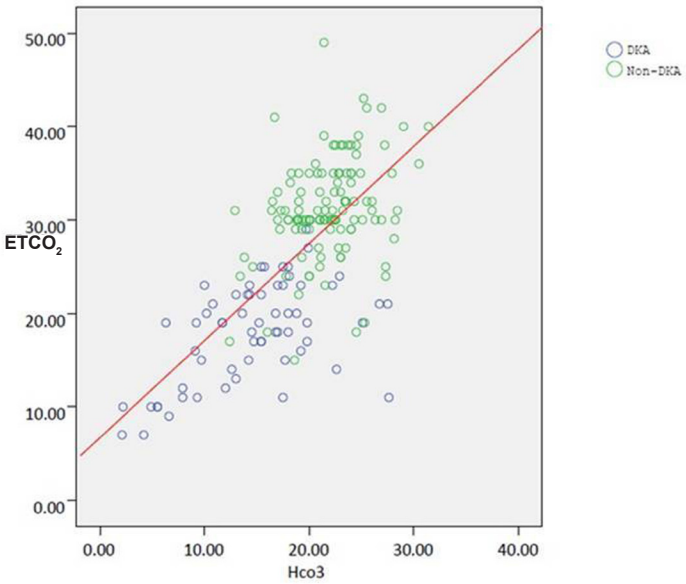

Figure 4. The correlation between HCO_3 and $ETco_2$ levels in two groups (diabetic ketoacidosis (DKA) [blue], non-DKA [green]).

levels being at their low levels in DKA patients. Patients with $ETCO_2$ values less than 29 suffered from DKA (sensitivity of 83% and specificity of 100%), whereas patients with $ETCO_2$ values more than 36 did not have DKA (specificity of 100%). Further, Mutlu et al[12], in a study on 240 non-intubated patients with metabolic disorders, suggested that a significant relationship existed between $ETCO_2$ values and blood bicarbonate levels (r=0.506); $ETCO_2$ values less than 25 and more than 36 were respectively suggestive of metabolic acidosis with a specificity of 83.8% and lack of metabolic acidosis with a sensitivity of 98%. Additionally, normal values of capnography closely correlated with a normal metabolic status. Agus et al[13] conducted a study on 72 patients (1-21 year-olds) with DKA; significant relationships between $ETCO_2$ values and blood bicarbonate and $PaCO_2$ levels were found (r=0.84 and r=0.79 respectively). Moreover, Gilhorta et al[14] conducted a study on 58 pediatric patients (1-18 year-olds) with type 1 diabetes. Capnography was felt to be of predictive value for DKA in combination with the clinical evaluation. $ETCO_2$ values more than 30 could rule out DKA diagnosis with sensitivity of 100% and specificity of 86%.[14]

The study of Garcia et al[15] on 126 DKA patients suggested a statistically significant and direct relation between $ETCO_2$ and $PaCO_2$ and pH.

In our study, we focused on predictive value of $ETCO_2$ in the diagnosis of DKA in adult patients with blood sugar levels higher than 250 mg/dl and probable diagnosis of DKA.

$ETCO_2$ levels were significantly lower in patients with DKA compared to other patients with high blood sugar levels. The more severe the acidosis and the more reduction in the blood bicarbonate levels, the more we found reduction in $ETCO_2$ levels. Finally, based on our results, capnography can be used to rule out DKA in the patients with increased blood sugar levels; cut-off point of 24.5, sensitivity of 0.90 and specificity of 0.90.

We studied adults, and a larger sample of patients than previous investigators, 4 times (181 versus 42 people) and 3 times (181 versus 58 people) the studies of Dierdre[11] and Gilhotra[14], respectively.

LIMITATION

Our study had some limitations as it was of a descriptive nature and lacked a control group. Patient collection was performed in specific hours of the day only (8AM until 4PM); we did not track nor report the number of the patients with high blood glucose levels referring to the ED.

Moreover, some patients were unable to undergo capnography due to their severe nausea and were excluded

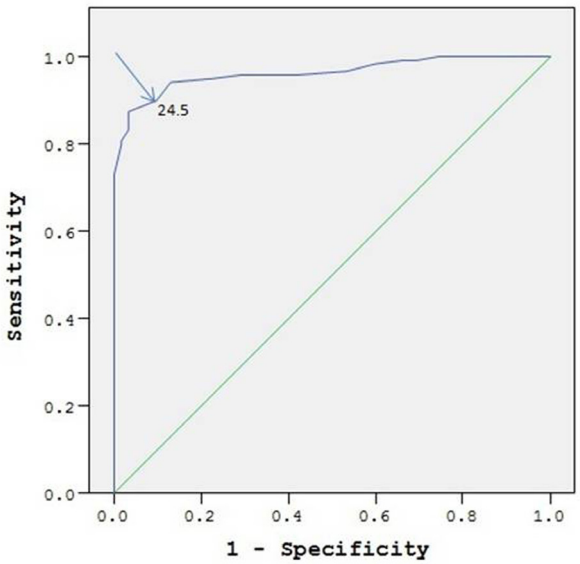

Figure 5. Receiver operating characteristic curve for sensitivity and specificity of capnography for diagnosis of diabetic ketoacidosis (DKA). $ETCO_2$>24.5 mmHg with sensitivity and specificity of 0.90 rules out DKA .

from the study (Figure 1). Based on the study design, we included the results of the ABG and capnography only once and did not evaluate the changes in ABG and capnography values throughout the treatment course.

CONCLUSION

DKA patients do require decisive and prompt treatment. The aim of the current study was to introduce capnography as a screening tool for DKA diagnosis. Capnography is a simple, noninvasive and inexpensive method that could be performed at bedside. A linear relation could be detected between capnography and blood bicarbonate values. Capnography could be used to rule out DKA in patients with increased blood sugar levels with a cut-off point of 24.5 mmHg, with sensitivity of 0.90 and specificity of 0.90.

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Does High Body Mass Index Obviate the Need for Oral Contrast in Emergency Department Patients?

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Introduction: High body mass index (BMI) values generally correlate with a large proportion of intra-peritoneal adipose tissue. Because intra-peritoneal infectious and inflammatory conditions manifest with abnormalities of the adipose tissue adjacent to the inflamed organ, it is presumed that with a larger percentage of adipose surrounding a given organ, visualization of the inflammatory changes would be more readily apparent. Do higher BMI values sufficiently enhance the ability of a radiologist to read a computed tomography (CT) of the abdomen and pelvis, so that the need for oral contrast to be given is precluded?

Methods: Forty six patients were included in the study: 27 females, and 19 males. They underwent abdominal/pelvic CTs without oral or intravenous contrast in the emergency department. Two board certified radiologists reviewed their CTs, and assessed them for radiographic evidence of intra-abdominal pathology. The patients were then placed into one of four groups based on their body mass index. Kappa analysis was performed on the CT reads for each group to determine whether there was significant inter-rater agreement regarding contrast use for the patient in question.

Results: There was increasingly significant agreement between radiologists, regarding contrast use, as the study subject's BMI increased. In addition, there was an advancing tendency of the radiologists to state that there was no need for oral or intravenous contrast in patients with higher BMIs, as the larger quantity of intra-peritoneal adipose allowed greater visualization and inspection of intra-abdominal organs.

Conclusion: Based on the results of this study, it appears that there is a decreasing need for oral contrast in emergency department patients undergoing abdominal/pelvic CT, as a patient's BMI increases. Specifically, there was statistically significant agreement, between radiologists, regarding contrast use in patients who had a BMI greater than 25. [West J Emerg Med. 2013;14(6):595–597.]

INTRODUCTION

Background

An estimated 62 million computed tomographies (CT) are performed annually in the United States (U.S.).[1] A substantial number of these are performed in emergency departments (ED). Many scans targeting the abdomen and pelvis require oral and intravenous contrast, which is currently believed to enhance the accuracy of the radiologist's read of the scan. However, in a study in the *American Journal of Surgery* in 2005, no difference in sensitivity was found when

radiologically diagnosing acute appendicitis whether or not the patient received oral contrast.[2]

Intra-abdominal infectious and inflammatory conditions often manifest with abnormalities of the adjacent fat of the peritoneal cavity and omentum, which are detectable without oral contrast. Because intra-peritoneal infectious and inflammatory conditions manifest with abnormalities of the adipose tissue adjacent to the inflamed organ, it is presumed that with a larger percentage of adipose surrounding a given organ, visualization of the inflammatory changes would be more readily apparent. In addition, abdominal abscesses can be detected without oral contrast. Bowel wall pathology may be better delineated with bowel distension secondary to contrast, but given the time constraints in the ED, oral contrast doesn't usually reach the colon in time for the scan. Also, the detection of pneumatosis intestinalis is not improved by oral contrast. Lee and colleagues did a prospective study of 100 ED patients with abdominal pain. These patients were initially scanned without oral contrast and then again 90 minutes after oral contrast was given, with identical scanning parameters. Experienced radiologists were given no information about medical history before they interpreted the noncontrast CTs; the interpretation of the noncontrast scans matched scans in which the patients were given oral contrast.[3]

Because the yearly patient census at most U.S. EDs is increasing, rapidly examining, treating, and dispositioning patients is crucial for effective ED operation, maintaining patient safety, and sustaining hospital revenue.[4] Eliminating the need to give oral contrast for abdominal/pelvic CTs performed on patients would greatly reduce the time some patients spend in the ED, allowing more to be seen, and improving ED throughput.

Do higher body mass index values sufficiently enhance the ability of a radiologist to read a CT of the abdomen and pelvis, so that the need for oral contrast to be given is precluded?

METHODS

Study Design, Setting, and Selection of Participants

This was a comparative study. An institutional review board exemption was granted for this study as no direct intervention was performed on the patients involved. Heights and weights were recorded on ED patients who underwent an abdominal/pelvic CT without oral contrast during the dates 12/4/10–1/4/11, and 4/22/11–5/20/11. This data was either obtained by weighing and measuring patients in triage by ED nurses (58 patients), or in the patient's room, by the principle investigator (12 patients). It was collected at various times of the day and night, including weekdays, and weekends. We obtained data using a single scale/tape measure that recorded weight in kilograms and height in centimeters, and could be rolled from triage to the patient's room. We excluded patients from the study if they presented to the ED secondary to any type of trauma. Individuals younger than 18 were excluded, as were any individuals who received oral contrast. In addition, we used only the data from a patient's initial CT if the patient presented to the ED, and was scanned multiple times within the patient data collection period.

Table. Spreadsheet compiling the grader's data, from which Kappa analysis was performed.

BMI category		Contrast need	MD #2		Total
			No	Yes	
Normal	MD #1	No	9	4	
		Yes	1	2	16
Overweight		No	16	0	
		Yes	2	1	19
Obese		No	11	0	
		Yes	1	1	13
Morbidly obese		No	6	0	
		Yes	0	0	6

Methods of Measurement

We calculated body mass indices (BMI) on these patients using the collected data, and the formula: weight (in kilograms) divided by height (in meters) squared. The remaining patients were divided into 4 groups using the National Institute of Health's BMI categories: <24.9, 25–29.9, 30–39.9, and >40. Two board-certified radiology attendings, including the department chair, and an expert in body CT reviewed the cases. The radiologists were blinded as to the purpose of the study; their objective was to read the scans as they normally would.

The radiologists filled out a form as they reviewed the CT for each patient. Both radiologists were assigned a number, which they would place atop each form to identify it as theirs. They also identified each form with the patient's medical record number. The radiologists were to then specifically examine 4 organs on every CT: the gallbladder, appendix, pancreas, and colon. For each organ, they were to answer the question, "how well can you visualize the following anatomic structure for pathology?" by making a mark on a modified Likert scale located below the name of each organ. The scale was 12 cm long with the phrases, "Not at all" on the extreme left, and "Excellent" on the extreme right, without any marks or numbers in between. The radiologist was to place a mark on the line corresponding to how well each organ was visualized. If the radiologist could visualize a specific organ and completely identify all pathology related to that organ, he/she was to place a mark on "Excellent" for that organ. If the organ could not be visualized at all, a mark was to be placed on "Not at all." If the organ could be identified with average difficulty, a mark was to be placed midway between the two ends of the scale, etc. The radiologists, while assessing each organ for pathology, were not instructed to delineate the pathology they identified on the grade sheet, but only to assess the difficulty

with which they identified it and their ability to identify it. At the lower portion of the form was an additional question for the radiologists to answer, based on how accurately each preceding organ was identified. That question asked, "was there a need for contrast in this patient?" The radiologist was to circle, "yes," or "no."

Data Collection and Processing

Seventy patients identified during the data collection period met criteria for inclusion in the study. Five were excluded initially: 1 for receiving intravenous contrast, 3 because they had undergone recent surgery secondary to metastatic carcinoma, and 1 because his CT was of poor technical quality and unreadable. One additional patient was overlooked during the CT reading period and was excluded because there was no read for his scan. It was determined that an additional 18 patients had missing data on their grade forms, after the radiologists finished reading their CTs, and were excluded from the study as well due to missing data. Any attempt to have the radiologists re-read these scans was futile, as they maintain a robust clinical and academic schedule and did not afford the time necessary to re-read 18 CTs.
Forty-six patients were included in the study: 27 females, and 19 males. The average age was 37 years, and average BMI was 29. The average age for patients in the "normal BMI" category was 36, and percent female was 46. The average age for patients in the "overweight" category was 37, and percent female was 56. The average age for patients in the "obese" category was 38, and percent female was 72. The average age for patients in the "morbidly obese" category was 35, and percent female was 66.

Primary Data Analysis

We performed Kappa analysis on the data to ascertain whether there was a statistical measure of inter-rater agreement between radiologists in determining whether or not oral contrast was needed in the study subjects.

RESULTS

In the "normal BMI" group (<24.9), the radiologists agreed that no contrast was needed in 9 of 16 cases. In the "overweight" group (25–29.9), they agreed no contrast was needed in 16 of 19 cases. In the "obese" group (30–39.9), they agreed no contrast was needed in 11 of 13 cases. And in the "morbidly obese" group (>40), they agreed no contrast was needed in all 6 cases.

In the "normal BMI" group, a Kappa value of 0.259 was calculated, with a p-value of 0.247. In the "overweight" group, a Kappa value of 0.457 was calculated, with a p-value of 0.018. In the "obese" group, a Kappa value of 0.629 was calculated with a p-value of 0.015. And in the "morbidly obese" group, a Kappa value of 1.0 was calculated with a p-value of 0.00.

CONCLUSION

There was increasingly significant agreement between radiologists regarding contrast use, as the study subject's BMI increased. In addition, there was an advancing tendency of the radiologists to state that there was no need for contrast to be administered in patients with higher BMIs. Eliminating the need to give oral contrast to patients undergoing abdominal and pelvic CTs in the ED (even if only eliminating the need to give contrast to patients with higher BMIs), would greatly reduce the length of stay for some ED patients, decrease wait times, increase ED throughput, increase hospital revenue, and theoretically decrease the percentage of complications from patients receiving contrast material. In addition, this and future studies regarding this topic could be helpful medico-legally as they provide a degree of evidence (albeit small) to defend a practice that is becoming increasingly popular among ED providers: that of scanning patients who present to the ED with abdominal pain without oral contrast. Perhaps there is a subset of these patients - those with a high BMI - who deserve to be scanned without oral contrast. A larger study is needed to verify the results of this pilot study and to determine at what BMI radiologists feel comfortable scanning patients without contrast.

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Mid-level Providers Working in a Low-acuity Area are More Productive than in a High-acuity Area

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Introduction: Mid-level providers (MLP) are extensively used in staffing emergency departments (ED). We sought to compare the productivity of MLPs staffing a low-acuity and high-acuity area of a community ED.

Methods: This is a retrospective review of MLP productivity at a single center 42,000-volume community ED from July 2009 to September 2010. MLPs staffed day shifts (8AM-6PM or 10AM-10PM) in high- and low-acuity sections of the ED. We used two-tailed T-test to compare patients/hour, relative value units (RVUs)/hour, and RVUs/patient between the 2 MLP groups.

Results: We included 49 low-acuity and 55 high-acuity shifts in this study. During the study period, MLPs staffing low-acuity shifts treated a mean of 2.7 patients/hour (confidence interval [CI] +/- 0.23), while those staffing high-acuity shifts treated a mean of 1.56 patients/hour (CI +/- 0.14, $p<0.0001$). MLPs staffing low-acuity shifts generated a mean of 4.45 RVUs/hour (CI +/- 0.34) compared to 3.19 RVUs/hour (CI +/- 0.29) for those staffing high-acuity shifts ($p<0.0001$). MLPs staffing low-acuity shifts generated a mean of 1.68 RVUs/patient (CI +/- 0.06) while those staffing high-acuity shifts generated a mean RVUs/patient of 2.05 (CI +/- 0.09, $p<0.0001$).

Conclusion: MLPs staffing a low-acuity area treated more patients/hour and generated more RVUs/hour than when staffing a high-acuity area. [West J Emerg Med. 2013;14(6):598–601.]

INTRODUCTION

Background

Emergency department (ED) patient visits have risen significantly in recent years. The National Hospital Ambulatory Medical Care Survey estimates that ED visits have grown from 94.9 million in 1997 to 123.8 million in 2008.[1,2]

Many EDs use mid-level providers (MLPs) to help augment the emergency physician workforce in the face of a rising ED census. The proportion of EDs reporting use of MLPs has increased from 28.3% in 1997 to 77.2% in 2006 and is likely even higher in academic EDs.[3,4] The number of ED patients seen by MLPs has also increased dramatically from 5.5% in 1997 to 12.7% in 2006.[3]

Using MLPs has allowed EDs to better manage increasing patient volumes and helps to offset the need for more emergency physicians.[4,5] MLPs typically see a low-acuity case mix; however current guidelines do not address the function of the MLP in the care of high-acuity patients.[6] As a result, MLPs may serve in a variety of roles depending on state law and hospital policy.[4] Although MLPs are most commonly tasked with the care of patients triaged as low-acuity rather than high-acuity, there is little evidence to support this practice.

Objective

This study evaluates the productivity of MLPs when staffing low-acuity and high-acuity areas by examining patients/hour, relative value units (RVUs)/hour, and RVUs/patient.

METHODS

Study Design

This is a retrospective chart review of patients seen by MLPs staffing a low-acuity and high-acuity area of a single ED. The institutional review board reviewed this study and found it to be exempt.

Setting

This study was performed at a single center 45,000-volume community ED from July 2009 to September 2010. The ED has a low-acuity area staffed with single coverage by 9 MLPs (8 physician assistants and 1 nurse practitioner), and about 20% of the ED census is seen in this area. Additionally, the same group of MLPs works 2 high-acuity day shifts each week, on Monday and Thursday. Monday has MLP high-acuity staffing to account for the higher census that occurs on Mondays. This community ED also hosts emergency medicine (EM) residents on an irregular basis, as it is a community affiliate of a residency training program, and MLPs staff the high-acuity area on Thursdays because it is a resident conference day. Low-acuity area patients have triage Emergency Severity Index (ESI) scores of 4 and 5. Patients with ESI scores of 1, 2, and 3 are seen in the high-acuity area of the ED.

Data Collection and Processing

A single researcher trained all research associates, and data were entered into a standardized Excel spreadsheet. The research associates collected census and productivity data through query of the Verinet coding system (LightSpeed Technology Group, © 2004-2005). The Verinet system records individual provider shift data regarding the total number of patients seen, the total number of RVUs generated, and the mean RVUs generated per patient (RVU/patient). In the event of patients being signed over from shift to shift, the transfer of care to the next provider is recorded on the electronic medical record, but the system credits the original provider with care of the patient. Shift hours and location (low-acuity vs. high-acuity area) were recorded from the MLP work schedule and cross-referenced with the Verinet system on a day-by-day basis to ensure accuracy of the schedule. We calculated RVUs per hour (RVU/hour) and patients seen per hour (patients/hour) using the data from the Verinet system and the monthly schedule. We also recorded census data to ensure that there were no differences in overall daily ED census for high-acuity and low-acuity shifts used in this study. Only day shifts (8AM-6PM for high-acuity or 10AM-10PM for low-acuity) staffed by MLPs on Monday and Thursday were included. We excluded shifts worked on other days of the week or other times of day to help control for volume and resident and nursing staffing fluctuations, as residents are permitted to change their schedules liberally, and documentation delineating the specific shifts they work is sparse.

Data Analysis

A power calculation determined that a sample size of 60 (at least 30 per group) was required to determine a 25% difference in productivity between MLPs working high-acuity and low-acuity shifts with an alpha of 0.05. This calculation used prior data regarding the same MLP's productivity extrapolated from low-acuity shifts at another site.[7] We analyzed data using the two-tailed T-test to compare patients/hour, RVUs/hour, RVUs/patient, and daily census between the 2 MLP groups. Simple linear regression was used to determine the correlation of patients/hour to RVUs/hour.

RESULTS

The mean daily census for low-acuity shifts was 129, and the mean census for high-acuity shifts was 130 (P = NS).

We included 49 low-acuity and 55 high-acuity shifts in this study. All low-acuity shifts were 12 hours in length (10AM-10PM) and all high-acuity shifts were 10 hours in length (8AM-6PM). During the study period, MLPs staffing low-acuity shifts treated a mean of 2.7 patients/hour (confidence interval [CI] +/- 0.23) while those staffing high-acuity shifts treated a mean of 1.56 patients/hour (CI +/- 0.14, $p<0.0001$). MLPs staffing low-acuity shifts generated a mean of 4.45 RVUs/hour (CI +/- 0.34) compared to 3.19 RVUs/hour (CI +/- 0.29) for those staffing high-acuity shifts ($p<0.0001$). MLPs staffing low-acuity shifts generated a mean of 1.68 RVUs/patient (CI +/- 0.06), while those staffing high-acuity shifts generated a mean of 2.05 RVUs/patient (CI +/- 0.09, $p<0.0001$).

Linear regression for correlation between RVUs/hour and patients/hour showed an R^2 of 0.87 on low-acuity shifts. Linear regression for correlation between RVUs/hour and patients/hour showed an R^2 of 0.74 on high-acuity shifts.

During the study period, 0.16% of the total patients seen at the institution were coded out to 99281 (E/M Level 1), 0.30% were coded out to 99282 (E/M Level 2), 49.5% were coded out to 99283 (E/M Level 3), 29.9% were coded out to 99284 (E/M Level 4), 17.9% were coded out to 99285 (E/M Level 5), and 2.27% were coded out to 99291 (E/M Critical care). In terms of RVUs, this translates to 0.03% of RVUs generated from E/M Level 1 charts, 0.12% of RVUs generated from E/M Level 2 charts, 30.3% of RVUs generated from E/M Level 3 charts, 34.3% of RVUs generated from E/M Level 4 charts, 30.4% of RVUs generated from E/M Level 5 charts, and 4.90% of RVUs generated from E/M Critical Care charts. Therefore, taking all-comers (both low-acuity and high-acuity areas of the ED), the mean RVUs/patient for the study institution was 2.79 during the study period.

DISCUSSION

MLPs are rapidly being incorporated into EDs throughout the country, yet few data exist on how to best use this resource.[5] In this study of one community ED, we demonstrated that MLPs treated significantly more patients/hour and generated more RVUs/hour when staffing low-

acuity shifts compared to high-acuity shifts. MLPs also generated higher RVUs/patient when staffing a high-acuity area, as one would expect in light of the higher levels of resource use and acuity.

There are several potential explanations for the improved productivity of MLPs in a lower acuity setting. Literature has shown that RVU generation is directly correlated to patients/hour, particularly in a low-acuity setting.[8] Our study also supports this, with high correlation between productivity as measured by RVUs/hour and patients/hour in the low-acuity area ($R^2 = 0.87$). MLPs may be able to see more patients and maintain this linear relationship between RVUs generated and patients seen because they may be more comfortable in the management of low-acuity patients. MLPs are typically used in lower acuity settings, and their training is often targeted toward this patient population.[9,10] Therefore, this might simply represent a training effect, where MLPs are best at performing in environments similar to the ones in which they trained. This increased comfort may translate to a more expedited ordering of tests and completion of disposition.

The correlate to this is that MLPs may be less comfortable with the management of high-acuity patients. MLPs spend fewer years in training as compared to physicians, with most providers completing a single year of classroom time and an additional year of clinical time. Although there are physician assistant fellowships in EM, these are very few, and currently the majority of MLPs in practice in EM have no specific specialty training beyond on-the-job training from their peers. Specialized ED training has been shown to be a predictor of MLP ability to render care with increased RVU generation.[11]

This potential knowledge gap could cause delays in ordering appropriate testing or making disposition decisions. Additionally, MLPs may have a perceived or actual need for additional attending physician supervision for high-acuity patients, which may create delays related to waiting for the attending physician to become available, presenting the patient, and altering the initial treatment plan after involvement of the attending physician. There is also the potential that, even in an area of high acuity, MLPs may choose to see the lowest available acuity within that area due to level of comfort and familiarity. This may explain why, in the high-acuity area of the ED, MLPs averaged 2.05 RVUs/patient, but the department as a whole averaged 2.79 RVUs/patient.

Another theory regarding the differences in productivity is that MLPs may be deficient in their documentation. Because MLPs spend large amounts of time working in low-acuity environments, they may be habituated to documenting to a lower standard than physicians who are accustomed to a higher-acuity patient base. MLPs working in the high-acuity area only generated 2.05 RVUs/patient, which is just slightly above the RVUs generated by an E/M Level 3 visit (1.80 RVUs) and significantly lower than expected. High-acuity patients often qualify for E/M Level 4 or 5 coding, which is highly influenced by documentation effectiveness as compared to low-acuity patients, who may only qualify for E/M Level 2 or 3 coding and require only minimal documentation.[12] Studies examining the effectiveness of documentation education at increasing RVU generation have shown positive results when applied to residents in an academic setting, and it is possible such an intervention could show similar gains with MLPs, although this has not been studied.[8,13] Finally, in this institution, there are no productivity incentives for MLPs, and although attending physicians sign MLP charts, documentation oversight is minimal. This may limit MLP interest in improving their documentation and coding.

LIMITATIONS

Our study was performed in a single community ED. Some of the productivity differences may be inherent in the layout, setup, and staffing of the low-acuity area compared to the high-acuity area. The low-acuity area may be more conducive to seeing patients in an expedient manner, with more point-of-use equipment and supplies and shorter distances needed to travel between patients, as compared to the high-acuity area. Also, differences in nursing and ancillary staff coverage between the low- and high-acuity areas could contribute to differences in productivity. If some of the productivity differences are inherent in the layout, setup, and staffing of the low-acuity area compared to the high-acuity area, then perhaps other providers, such as attending physicians, would realize similar productivity differences.

With a limited number of MLPs (n = 9) evaluated, individual differences in MLP productivity may have skewed results. Although the CIs for productivity were fairly small, several MLPs regularly treated more patients and generated more RVUs than the rest of the group. It is unclear whether our 9 MLPs are representative of the national pool of MLPs working in EDs.

CONCLUSION

Understanding how to best utilize MLPs can help to optimize ED staffing. This study demonstrated improved MLP productivity in a low-acuity area compared to a high-acuity area. However, our conclusions are limited by only evaluating one ED, and noted lower-than-expected productivity in both high- and low-acuity settings. Further study is needed to further evaluate factors influencing MLP productivity in high- and low-acuity areas of the ED.

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Implementation of a Successful Incentive-Based Ultrasound Credentialing Program for Emergency Physicians

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Introducion: With the rapid expansion of emergency ultrasound, resident education in ultrasound has become more clearly developed and broadly integrated. However, there still exists a lack of guidance in the training of physicians already in practice to become competent in this valuable skill. We sought to employ a step-wise, goal-directed, incentive-based credentialing program to educate emergency physicians in the use of emergency ultrasound. Successful completion of this program was the primary outcome.

Methods: The goal was for the physicians to gain competency in 8 basic ultrasound examinations types: aorta, focused assessment with sonography in trauma, cardiac, renal, biliary, transabdominal pelvic, transvaginal pelvic, and deep venous thrombosis. We separated the 2.5 year training program into 4 distinct blocks, with each block focusing on 2 of the ultrasound examination types. Each block consisted of didactic and hands-on sessions with the goal of the physician completing 25 technically-adequate studies of each examination type. There was a financial incentive associated with completion of these requirements.

Results: A total of 31 physicians participated in the training program. Only one physician, who retired prior to the end of the 2.5 year period, did not successfully complete the program. All have applied for and received hospital privileging in emergency ultrasound and incorporated it into their daily practice.

Conclusion: We found that a step-wise, incentive-based ultrasound training program with a combination of didactics and ample hands-on teaching was successful in the training of physicians already in practice. [West J Emerg Med. 2013;14(6):602–608.]

INTRODUCTION

Emergency ultrasound (EUS) has grown rapidly over the last 10-15 years, and is now a commonplace tool in academic and community emergency departments (ED). Literature describing the role of ultrasound in improved patient outcomes, decreased ED length of stays, decreased costs, and decreased procedural complications is ubiquitous.[1-6] As the use of EUS has increased, however, so has the need to assure that practicing clinicians are properly trained to competently obtain and interpret ultrasound images, as well as to integrate ultrasound effectively into patient care.

Much has been previously published on the training of emergency medicine residents in ultrasound. A combination of didactics and hands-on teaching has proven effective.[7-12] There is, however, a general lack of guidance for those seeking to train physicians already in practice and without any previous ultrasound experience. The training of practicing clinicians is inherently different than residents. Residents do not practice according to long-established patterns, so implementing a new diagnostic tool is less challenging. Years of clinical practice patterns can be difficult to change. Second, residents have dedicated time incorporated into their

program for learning new skills. Practicing clinicians are often unwilling to devote additional time when not working in the ED, and secondary incentives may be needed. Even for those physicians eager to learn ultrasound, it can be challenging to incorporate this new skill under the pressures of a crowded and busy shift. Finally, residency is geared toward the successful acquisition of a comprehensive skill for the practice of emergency medicine, and ultrasound is taught along with a complement of other skills.

A common training tool for practicing clinicians is a 1-3 day ultrasound course, which includes lectures and hands-on practice.[13-15] These courses, however, often leave clinicians without guidance after the course is complete. Enthusiasm tends to wane and ultrasound skills deteriorate with time. It is generally accepted that strong and enthusiastic ultrasound leadership is needed to provide continued education over time.[7,16]

To our knowledge there have been no detailed, published descriptions of successful EUS training programs for practicing clinicians. In this paper, we describe a successful step-wise, goal-oriented, incentive-based ultrasound credentialing program for emergency physicians (EP) that emphasizes hands-on teaching, quality assurance, and physician feedback. The primary outcome measure is successful completion of all requirements of each training block by each physician.

METHODS

This is a descriptive study of a departmental educational program rather than a research study, and as such was exempt from institutional review board approval at our institution.

Study Setting and Population

The training program took place in a busy academic ED with 110,000 annual patient visits per year and a separate pediatric ED. The group of 33 EPs included 2 dedicated ultrasound faculty members and 6 fellowship-trained pediatric EPs. Physicians were 1-35 years post-residency completion. The emergency medicine residency consists of 12 residents per year in a 1-2-3 format. For purposes of the EUS training program, we excluded the ultrasound faculty and residents.

Four Sonosite M-turbo (Sonosite Inc, Bothell WA) emergency ultrasound machines were available 24 hours per day, each with curvilinear, linear, and phased array probes. Four endocavitary probes were also available for transvaginal pelvic examinations. An on-site wireless archiving system, developed by an EM faculty member, was used to catalog examinations for review and quality assurance purposes.

Program Description

To avoid overwhelming physicians with the technical aspects of multiple ultrasound examination types at once, we divided the training into 4 6-month discrete blocks. Two examination types were taught during each block. The blocks were as follows:

1. Aorta and focused assessment with sonography in trauma (FAST)
2. Cardiac and Renal
3. Biliary and Transabdominal (TA) pelvic
4. Transvaginal (TV) pelvic and deep venous thrombosis (DVT)

At the start of each block physicians were provided a didactic lecture introducing each examination type. These were followed by hands-on teaching sessions 3-4 times per month, in which physicians had the opportunity to practice each examination with direct supervision and teaching. Sessions were typically 2-3 hours in length and consisted of an ultrasound faculty member as well as 2-5 attendees. Patients in the ED were used for training and informed that scans were purely for educational purposes. Physicians had the opportunity to attend lectures and receive hands-on training for other examination types outside of the current block, but were not held to deadlines or incentives for those examination types until the commencement of that block.

Each physician was expected to perform 25 technically adequate examinations for each study type. These examinations were typically performed on ED patients, mostly during the course of a regular clinical shift. Physicians did perform some scans during non-clinical hours on ED patients, typically during weekly trainings sessions with ultrasound faculty, although these scans usually accounted for less than a third of their exam totals. If scans were performed in conjunction with residents, both participants were required to manipulate the transducer for the examination to count towards credentialing. Studies that were judged to be "technically inadequate" in terms of image quality were not included in their totals, and physicians were targeted for re-education if they submitted multiple technically inadequate exams in a specific exam type.

We sought to make the process of recording and submitting images as easy as possible to enhance compliance. Still images and video clips were saved for each training exam. These were automatically and wirelessly transmitted to a central archive in the ED. Physicians were able to electronically enter their interpretation alongside their images, a process taking only a few seconds per exam. Training examinations were reviewed on a biweekly basis and direct feedback was electronically provided. Monthly updates on the number of ultrasound examinations each faculty member had successfully completed were tabulated and distributed by email.

At the completion of each block, competency in image acquisition was assessed at a bedside hands-on session with one of the ultrasound faculty. Skill in image interpretation was assessed with a 25-question quiz, including at least 10 abnormal or pathologic findings. Physicians were provided a written explanation for the questions that they missed.

Administrative Considerations

Several concerns were raised by the department of radiology regarding an EUS training program for EPs. Chief among these were the number of studies required for competency. The EPs cited published articles demonstrating that competence in bedside ultrasound can be obtained with limited training.[17-22] The 2008 ACEP Ultrasound Policy Statement, which requires a minimum of 25 studies, were also cited.[23] Their second concern was the potential decrease in study volume for ultrasound examinations performed in their department as a result of the EP training program. The EPs cited an article demonstrating negligible impact of an EUS program on radiology departmental volumes.[24]

An outline of the credentialing pathway was submitted and approved by the hospital credentialing committee before initiation of the program. We presented a written plan for the training program to the faculty members by email and again at the monthly faculty meeting. They were given a chance to disagree or voice concerns. All faculty members verbally agreed to abide by the conditions of the training program prior to beginning. Upon successful completion of each training block, physicians applied for and obtained hospital credentialing for that examination type and were eligible to begin billing for those studies.

Monetary Incentives

Faculty salaries are a combination of "base salary" (guaranteed) and "variable compensation" (not guaranteed). A total of 90% of the salary is guaranteed as base compensation, with the remaining 10% being "variable," and dependent on various productivity and educational goals. For the 2.5-year ultrasound training period, the variable component included ED productivity and 3 weighted performance measures: timely and successful completion of each ultrasound module, compliance with national pneumonia treatment guidelines, and time to patient-physician contact after triage assessment. Meeting ultrasound requirements accounted for 6.66% of the total variable compensation package per year. During the period of the training program, total variable compensation was estimated to be $27,240 per physician per year, with $1,860 resultant from ultrasound goals. We believe that this incentive component was an important factor in assuring 100% compliance with training requirements. During the 2.5 years of training, only one faculty member failed to complete a module therefore forfeiting the incentive payment. This individual retired from practice shortly thereafter.

Cost

The approximate costs of the EUS training program are summarized in Table 1. Although variable compensation payments to physicians totaled about $125,550 and equaled 30.2% of the program costs, these incentive payments are part of each physician's total salary package and continue for other quality measures even after completion of the EUS training program. The two ultrasound faculty were provided a total of 9 hours per week of release time for ultrasound training, with each hour requiring $6,000 of administrative funding per year. Training materials were obtained for a total of approximately $12,000. Major items included a transvaginal pelvic model ($5000), 3 transvaginal ultrasound workshops with paid live models ($4565) and central and peripheral vascular access models ($3000). The department of obstetrics and gynecology agreed to split the cost of the pelvic model since it could also be used to train their residents.

Table 1. Ultrasound training program costs over 2.5 years.

Ultrasound faculty administrative time (2 faculty, 9 total hours administrative time per week)	$135,000
Faculty variable compensation incentive (total for average of 27 physicians)	$125,550
Ultrasound machines (4 Sonosite M-turbo machines with cart and 3 transducers each)	$140,000
Training materials and workshops	$12,000
Digital archiving system	$3,000
Total	$415,550

Other Considerations

There were 6 full-time pediatric EM faculty who did not participate in training for the aorta, biliary, transvaginal pelvic, and DVT examinations because they believed these examinations to have limited utility in their daily practice. Other performance measures were more heavily weighted to achieve their target variable compensation. This allowance was agreed to prior to initiation of the program. All EPs treating adult patients participated in the training for each application.

To supplement training in the transvaginal pelvic examination, a Blue Phantom endocavitary training model (Blue Phantom, Redmond WA) was used. In addition, 3 workshops were held in which 3-4 female standardized patients were employed as models for transvaginal ultrasound. Standardized patients were obtained from an agency providing medical models. Faculty members that performed examinations on standardized patients had these examinations count towards their total number.

RESULTS

Baseline characteristics of the physician population before the first block are described in Table 2. Seventy-nine point two percent (23/29) of physicians had been out of training for >5 years and 62.1% (18/29) described themselves as "not comfortable with any applications of emergency ultrasound." In those who had been out of residency >6 years, 78% (18/23) were uncomfortable with any ultrasound applications. In the group of physicians who had been out of training for 0-5 years, all stated they were comfortable with at least 1-2 applications and two thirds were comfortable with at least three. No physicians in the group were comfortable with all 8 applications of EUS.

Table 2. Baseline characteristics of the physician group before the first training block.

	Total number of physicians (n=29)
Years since residency completion	
0-5	6 (20.7%)
6-10	3 (10.3%)
11-15	4 (13.8%)
16-20	5 (17.2%)
21-25	6 (20.7%)
26-30	3 (10.3%)
31-35	2 (6.9%)
Comfort level with ultrasound exam types	
Not comfortable with any exam types	18 (62.1%)
Comfortable with 1-2 exam types	3 (10.3%)
Comfortable with 3-4 exam types	5 (17.2%)
Comfortable with 5-6 exam types	3 (10.3%)
Comfortable with 7-8 exam types	0

All physicians participating in a training block successfully completed the training and credentialing requirements of that block, with the exception of one who retired in the middle of a block. Results are shown in Table 3. The training period spanned 810 days, and total number of examinations were counted at regular intervals with the exception of the last month of each block when results were reported weekly. Exams were counted until each physician performed the requisite 25 studies per examination type. Several physicians had been partially credentialed for some exam types before initiation of the program, either during their residency or during less formal training at our institution. Exams previously performed at our institution had been assessed for technical adequacy and accuracy of interpretations. These exams are noted on "Day 0" of the program. The figure shows a graphical representation of each ultrasound examination type and total time needed for completion as a function of days since the beginning of the training period.

For the first block, 29 EPs were eligible for credentialing in the FAST examination and 23 for credentialing in the aorta examination. Four had previously finished credentialing requirements in the FAST exam and five in the aorta examination before the program began. The EPs completed a total of 1300 training examinations in 180 days.

For the second block, 1 physician left the group and another went on sabbatical. Three new physicians were added to the group. This yielded a total of 30 physicians eligible for credentialing in the cardiac examination and 30 in the renal examination. Five had previously completed requirements for credentialing in the cardiac examination and five in the renal examination. The block was extended by 1month as it became clear that a significant proportion of physicians would not be able to finish on time, so the total length of the block was 210 days. The physicians completed a total of 1500 training examinations during this time.

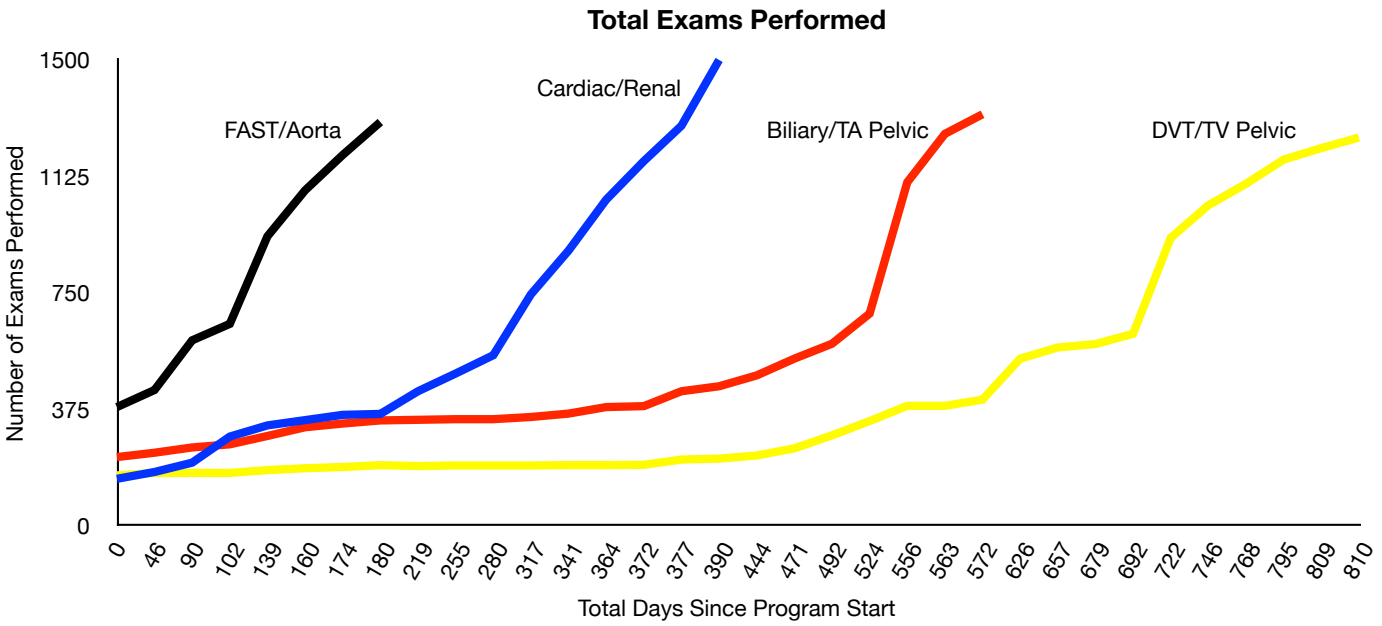
For the third block, one EP retired. This yielded a total of 24 EPs eligible for credentialing in the biliary examination and 29 for the transabdominal pelvic examination. Five had previously completed requirements for credentialing in the transabdominal pelvic examination and 6 in the biliary examination. The third block was 210 days. The physicians completed a total of 1325 examinations during this time.

For the fourth block, 2 physicians were hired, 1 left, and 1 returned from sabbatical. This yielded a total of 25 physicians for the transvaginal pelvic examination and 25 for the DVT examination. The last block was again extended by 2 months as it became clear that a significant proportion of physicians would not be able to finish on time, so the total length of the

Table 3. Total numbers of ultrasound exams performed since initiation of the training program.

Days Since Start of Training	FAST/ Aorta	Cardiac/ Renal	Biliary/TA Pelvic	DVT/TV Pelvic
0	382	151	221	162
46	437	173	235	170
90	597	203	252	170
102	650	287	262	170
139	932	323	289	179
160	1080	340	317	185
174	1194	357	329	189
180	1300	360	339	195
219		433	341	192
255		490	343	194
280		549	343	194
317		745	350	194
341		886	361	195
364		1050	382	195
372		1174	385	196
377		1288	433	213
390		1500	449	216
444			484	226
471			538	249
492			586	291
524			683	337
556			1106	386
563			1262	386
572			1325	406
626				538
657				574
679				585
692				618
722				927
746				1032
768				1101
795				1179
809				1216
810				1250

FAST, focused assessment with sonography for trauma; *TA,* transabdominal; *DVT,* deep venous thrombosis; *TV,* transvaginal



FAST, focused assessment with sonography for trauma; *TA,* transabdominal; *DVT,* deep venous thrombosis; *TV,* transvaginal
Figure. Total numbers of ultrasound exams performed since initiation of the training program.

block was 240 days. The physicians completed a total of 1250 training examinations during this time.

During the 2-year training program, several physicians left or joined the group. Of the physicians who joined, all except for one were previously trained in EUS by their residency programs. This physician had been previously credentialed in trauma and aorta sonography and fortunately joined just as the group finished this first block. She was able to complete her training with the rest of the group. Physicians who left were provided with a letter from the ultrasound director detailing the numbers of ultrasounds completed.

In general, physicians spent an average of 1.5 hours in lecture and 3.5 hours in hands-on training for each training block.

DISCUSSION

As EUS becomes increasingly prevalent in the specialty of emergency medicine, it is important that EPs are appropriately trained in this skill. We describe the successful implementation of a structured, step-wise and incentive-based educational program geared towards EPs already in practice. Although our program was implemented in an academic ED, we believe the basic tenets of this model could be exported to community practice settings. These include structured goals and deadlines, physician incentives, adequate equipment, and appropriate time and resources for the ultrasound faculty.

At our hospital, 10% of total annual compensation is "variable," and individual departments are allowed to apportion this towards the achievement of various productivity, educational, and quality measures. During the 2.5-year EUS training period, our department chose to define the accomplishment of ultrasound goals as a small component of the overall variable compensation package and employed this as a monetary incentive. Although it appears generous at first glance, this incentive was possible because it did not require the generation of new funds but rather a re-allocation of funds that were already budgeted for physician compensation. The authors realize that similar monetary incentives, although effective, may not be available at other institutions as compensation packages will vary. It is possible, however, that non-monetary incentives may be substituted. These might include preferential considerations in shift scheduling, vacation time, or release time for continuing medical education.

Incentives and deadlines were a key part of our training program. As demonstrated in the figure, exam totals for each examination type remained relatively stable until formal training for each block began. Even though EPs had ready access to lectures and hands-on training for other examinations throughout the entire 2.5-year period, we believe they were not motivated to accrue ultrasound exams until deadlines and incentives for each block were introduced.

A significant upswing of recorded examinations was usually noted towards the end of each block. This was partially explained by a predictable tendency to procrastinate. At this point, verbal encouragement from the ultrasound faculty, admonishment from the department chair, the possibility of losing monetary incentives, and the demonstration that other physicians were able to achieve the goals all played key roles in the successful completion of each block.

For several of the training blocks, it was necessary to extend the deadline by 1-2 months after it became evident that more than 20% would not be able to finish in time. We met with these individuals separately and provided additional

hands-on training sessions. All were eventually able to meet the training requirements within the extended timeframe. Rather than penalizing a large minority of the group, we believed that a better overall outcome could be achieved by slightly extending the training period.

While initial ultrasound learning is clearly the most time and labor-intensive portion of the educational process, continuing education is crucial. We achieve this through weekly resident conferences that incorporate ultrasound material, ongoing quality assurance and feedback, a circulated "case of the week," and bi-monthly ultrasound-dedicated conferences. Further education also included "advanced" ultrasound applications, such as thoracic, ocular, regional anesthesia, and critical care.

Two years after completion of the program, EPs in our ED perform approximately 3,700 clinically-indicated ultrasound examinations per year, averaging 0.86 scans/physician/shift (range 0.07-2.26). The department generates bills for these examinations, resulting in approximately $400,000 in hospital revenue and $64,000 in ED revenue per year. Since initiation of the program 3.5 years ago, EUS has generated $1,385,900 in hospital revenue and $224,177 in ED revenue. The total cost of the training program, $415,550, was remunerated within 1.5 years. To date, the return on investment (ROI) is 2.87. Ultrasound scans performed by newly credentialed physicians account for 73% of this activity.

There were several important lessons learned during our implementation of this program. First, for different reasons, several individuals required extra attention during the process. A few were initially intimidated by the technology and needed more coaching to approach the machine and use it daily. Some were more spatially challenged and required extra training sessions. Second, the importance of having the physicians agree to abide by conditions of the training program prior to its start became increasingly apparent towards the end of each block. Physicians who procrastinated in obtaining their training examinations were reminded of their agreement, and this provided more incentive to finish. Finally, this was a very labor-intensive undertaking for the ultrasound faculty, and it was imperative that they were adequately compensated and provided additional academic time to fulfill their duties.

LIMITATIONS

There were several potential areas of improvement with our training program. After the introduction of each block, EPs recorded a significant number of scans but that rate rapidly declined after the initial enthusiasm waned. Several routinely submitted their examinations just before the deadline. This contributed to some examinations being done with sub-standard technique and left limited time for feedback and correction. We attempted to compensate for this by adding more hands-on sessions and encouraging attendance through targeted emails.

We did not require them to re-take quizzes if they scored below a certain percentage. Although no physician scored below 70% on any quiz, a better policy might be to ask low-scoring physicians to take a second quiz with ultrasound images from different patients but with similar normal or abnormal findings. Since they were provided written explanations of answers after the first test, a second test could be used to demonstrate that they learned from their mistakes.

Our training program was not designed to track patient-oriented outcomes, although these would have been good quality measures to report. We did examine a sampling of 20 first-trimester pregnant patients that presented to the ED with vaginal bleeding or pelvic pain. These patients received both a bedside pelvic ultrasound as well as a formal study. In this group, time to diagnosis of intrauterine pregnancy (and exclusion of ectopic pregnancy) by bedside ultrasound took 32 minutes, while the formal study required an additional 111 minutes.

Since completion of the program 2 faculty members have left the institution and 3 others have joined. Before hiring the new members, it was made clear that ultrasound proficiency was a pre-requisite for working in the department. The new faculty members had all finished residency within the last 5 years and had already completed ultrasound training and demonstrated proficiency in most examination types before joining the group. Training in transvaginal pelvic ultrasound is variable in residency training programs, and 2 new hires were notably lacking in this skill. They were separately provided with didactics and hands-on training and were required to complete 25 training examinations before they could make clinical decisions based on their examinations. This time was uncompensated.

Our program had very strong support from hospital leadership and the departmental chairman. Institution of a successful incentive-based training program at other facilities without this support would be much more difficult since a significant up-front investment is required.

CONCLUSIONS

We believe this training program can be realistically implemented by clinicians in practice despite the constraints of busy clinical schedules. Using this model, we were able to train and credential 31 EPs over a 2.5-year period with nearly 100% successful completion. Although our program was fairly rigorous and time-consuming for both the physicians and ultrasound faculty, we felt it to be a worthwhile investment. We believe the end result is better ultrasound training and knowledge retention, ultimately producing better patient care.

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National Study of Non-urgent Emergency Department Visits and Associated Resource Utilization

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Introduction: Reducing non-urgent emergency department (ED) visits has been targeted as a method to produce cost savings. To better describe these visits, we sought to compare resource utilization of ED visits characterized as non-urgent at triage to immediate, emergent, or urgent (IEU) visits.

Methods: We performed a retrospective, cross-sectional analysis of the 2006-2009 National Hospital Ambulatory Medical Care Survey. Urgency of visits was categorized using the assigned 5-level triage acuity score. We analyzed resource utilization, including diagnostic testing, treatment, and hospitalization within each acuity categorization.

Results: From 2006-2009, 10.1% (95% confidence interval [CI], 9.2-11.2) of United States ED visits were categorized as non-urgent. Most (87.8% [95% CI, 86.3-89.2]) non-urgent visits had some diagnostic testing or treatment in the ED. Imaging was common in non-urgent visits (29.8% [95% CI, 27.8-31.8]), although not as frequent as for IEU visits (52.9% [95% CI, 51.6-54.2]). Similarly, procedures were performed less frequently for non-urgent (34.1% [95% CI, 31.8-36.4]) compared to IEU visits (56.3% [95% CI, 53.5-59.0]). Medication administration was similar between the 2 groups (80.6% [95% CI, 79.5-81.7] vs. 76.3% [95% CI, 74.7-77.8], respectively). The rate of hospital admission was 4.0% (95% CI, 3.3-4.8) vs. 19.8% (95% CI, 18.4-21.3) for IEU visits, with admission to a critical care setting for 0.5% of non-urgent visits (95% CI, 0.3-0.6) vs. 3.4% (95% CI, 3.1-3.8) of IEU visits.

Conclusions: For most non-urgent ED visits, some diagnostic or therapeutic intervention was performed. Relatively low, but notable proportions of non-urgent ED visits were admitted to the hospital, sometimes to a critical care setting. These data call into question non-urgent ED visits being categorized as "unnecessary," particularly in the setting of limited access to timely primary care for acute illness or injury. [West J Emerg Med. 2013;14(6):609–616.]

INTRODUCTION

In 2009 healthcare spending accounted for 17.9% of the gross domestic product in the United States (U.S.), a number that has nearly doubled in the last 30 years.[1] One of the stated goals of policymakers is to slow this growth and increase the value of healthcare spending.[2,3] Some have advocated for policies that reduce "unnecessary" emergency department (ED) visits as a way to generate significant cost savings for the healthcare system.[4]

ED visits classified at triage as non-urgent are often considered to represent an "unnecessary" ED visit,[5-7] as some argue that similar medical services could be provided at alternative sites of care for a lower cost.[8,9] However, there is no standard definition of a non-urgent visit and estimates of the number of annual non-urgent ED visits vary and are dependent on the nature of categorization. Classification based on triage acuity or presenting complaint tends to predict a lower proportion of non-urgent visits, whereas retrospective

assessments based on explicit criteria (i.e. final ED diagnosis or resource utilization) tend to result in a higher proportion of non-urgent visits.[4-7] One systemic review found that the most commonly used definition of a non-urgent visit depended on whether care could be delayed and reported that an overall median of 32.1% of ED visits could be classified as non-urgent.[5]

Currently, limited data exist that describe the resource needs and disposition of patients presenting to the ED with non-urgent triage acuity.[5,7] Therefore, we sought to use national data to compare resource utilization of ED visits characterized as non-urgent at triage to those visits with higher triage acuity levels. We hypothesized that although non-urgent visits would have less intense resource utilization than higher acuity visits, some non-urgent visits would involve important ED interventions, including hospitalization.

METHODS

Study Design and Setting

We performed a retrospective, cross-sectional analysis of the 2006-2009 National Hospital Ambulatory Medical Care Survey (NHAMCS). This study received institutional review board approval as an exempt protocol with a waiver of informed consent. A detailed description of the NHAMCS survey methods is provided elsewhere.[10] Briefly, the NHAMCS is a stratified, multi-stage probability sample conducted annually by the National Center for Health Statistics (NCHS). Data were collected by trained NCHS personnel using a standardized data abstraction form, which were similar between the study years. During 2006-2009, a total sample of 1,932 U.S. non-institutional general and short-stay hospitals was selected for participation in NHAMCS. Of the 1,566 hospitals that were deemed eligible, 1,408 (90%) participated and a total of 140,415 ED visits were abstracted.

Study Protocol

ED visits were grouped by a 5-level triage acuity score representing immediate, emergent, urgent, semi-urgent, or non-urgent, based on the triage nurse's judgment about the patient's need for immediacy of evaluation, stabilization, and/or treatment. A level 1, or immediate visit, was a severe condition where any delay in medical attention would likely result in death and included a major trauma or medical problem. A level 2, or emergent visit, required evaluation within 1-14 minutes and represented a severe illness or injury requiring immediate care to combat danger to life or limb and where any delay would likely result in deterioration. A level 3, or urgent visit, was an illness or injury requiring treatment within 60 minutes. A level 4, or semi-urgent visit, could be evaluated in between 1-2 hours. A level 5, or non-urgent visit, represented conditions where a delay of up to 24 hours would make no appreciable difference to the clinical condition and where subsequent referral may be made to the appropriate alternative specialty. Triage acuity was missing for 19,024 (13.5%) visits and were therefore excluded from the primary analysis. Comparative analysis was undertaken to evaluate the excluded visits with the remainder of the charts with triage level recorded. We evaluated all remaining ED visits for clinical characteristics and resource utilization.

We analyzed the visit data in terms of patient-level characteristics including age, sex, race/ethnicity, and source of payment. We also analyzed the data by hospital facility characteristics, including U.S. region (Northeast, Midwest, South, and West), the hospital metropolitan statistical area status (urban and nonurban), and hospital ownership (nonprofit, government [non-federal], and private/for profit). Regional and metropolitan statistical area categories were included representing standardized geographical divisions as defined by the U.S. Bureau of the Census. Additionally, we analyzed visit characteristics including arrival time, day of arrival (weekend or weekday), mode of arrival, and ED length of stay.

We analyzed resource utilization, including imaging, diagnostic tests, procedures, or medications ordered. Imaging utilization was subcategorized as cross-sectional imaging, including computed tomography, magnetic resonance imaging, and ultrasound. Diagnostic tests included blood and urine tests, cardiac monitoring, electrocardiography, wound culture, and influenza test. Procedures included intravenous hydration, casting or splinting, wound repair, incision and drainage, foreign body removal, nebulizer therapy, bladder catheterization, pelvic examination, central line placement, performance of cardiopulmonary resuscitation, or endotracheal intubation. Medications included those given in the ED, as well as those prescribed at discharge. Finally, we included visit disposition, including rate of hospitalization and admission to a critical care unit, operating room, or catheterization lab.

Statistical Analysis

The primary analysis was descriptive, with 95% confidence intervals (CIs). We adhered to published checklists regarding recommendations for NHAMCS data analysis.[11,12] We analyzed clinical characteristics and resource utilization within each triage categorization and compared the characteristics of non-urgent visits with those of higher acuity visits, categorized as immediate, emergent and urgent (IEU), and semi-urgent visits. We performed the statistical analyses using Stata 12.1 (StatCorp, College Station, TX) and used survey commands to adjust for the complex survey design and weight the sample to provide estimates for all U.S. ED visits.

RESULTS

In 2006-2009, 10.1% of the estimated 110 million annual U.S. ED visits included in the primary analysis were categorized as non-urgent. Table 1 shows clinical characteristics of ED visits, stratified by triage categorization. Non-urgent visits were more likely to be younger, non-

Table 1. Clinical characteristics of 2006-2009 United States emergency department (ED) visits by triage acuity.

Characteristics	Immediate/ Emergent/Urgent % (95% CI)	Semi-urgent % (95% CI)	Non-urgent % (95% CI)
Total	61.2 (59.2-63.2)	28.7 (27.2-30.2)	10.1 (9.2-11.2)
Patient characteristics			
Age, years, median (IQR)	39 (21-58)	29 (15-47)	28 (16-46)
0-17	19.0 (18.0-20.0)	28.3 (26.3-30.4)	27.7 (25.7-29.8)
18-44	40.3 (39.5-41.2)	44.6 (43.1-46.1)	46.9 (45.3-48.6)
45-64	21.9 (21.3-22.5)	17.5 (16.7-18.3)	17.3 (16.3-18.3)
≥65	18.8 (18.0-19.6)	9.6 (8.8-10.4)	8.1 (7.2-9.2)
Female sex	55.0 (54.3-55.7)	53.9 (53.1-54.6)	53.0 (51.8-54.1)
Race/ethnicity			
Non-Hispanic White	61.9 (59.4-64.4)	59.6 (56.1-62.9)	56.7 (52.3-61.0)
Non-Hispanic Black	21.9 (19.3-24.7)	23.5 (20.5-26.8)	28.2 (23.8-33.1)
Hispanic	12.3 (10.7-14.1)	13.4 (11.3-15.9)	12.8 (10.4-15.7)
Other	3.9 (3.2-4.7)	3.5 (2.8-4.4)	2.3 (1.9-2.9)
Insurance			
Private	33.7 (32.5-35.0)	35.0 (33.4-36.7)	31.1 (28.8-33.5)
Medicaid	23.2 (21.8-24.5)	27.1 (25.1-29.2)	29.1 (27.0-31.2)
Medicare	19.9 (19.1-20.7)	11.2 (10.3-12.2)	10.4 (9.2-11.6)
Self-pay	13.8 (12.9-14.7)	16.9 (15.7-18.2)	18.8 (17.1-20.7)
Other/unknown	9.5 (8.0-11.1)	9.7 (8.5-11.2)	10.7 (8.7-13.0)
Visit characteristics			
Time of Day			
8AM – 3:59PM	43.3 (42.8-43.7)	43.5 (42.6-44.4)	45.7 (44.1-47.4)
4PM – 11:59PM	41.3 (40.7-41.8)	42.8 (41.9-43.7)	41.3 (39.8-42.8)
12PM – 7:59AM	15.5 (15.0-16.0)	13.7 (13.1-14.3)	13.0 (12.0-14.0)
Day of week			
Weekday	71.4 (71.0-71.8)	70.7 (70.1-71.2)	70.2 (69.0-71.4)
Weekend	28.6 (28.3-29.0)	29.3 (28.8-29.9)	29.8 (28.6-31.0)
Arrival by ambulance	22.2 (21.0-23.5)	9.0 (8.1-10.0)	6.5 (5.4-7.7)
ED length of stay, hours, median (IQR)	3.0 (1.8-4.7)	2.2 (1.3-3.5)	2.0 (1.2-3.3)
<1	8.9 (8.0-9.8)	14.7 (13.1-16.5)	20.0 (17.5-22.7)
1-1.9	20.9 (19.5-22.4)	30.8 (29.6-32.2)	30.7 (28.6-32.8)
2-2.9	20.6 (19.9-21.3)	22.3 (21.3-23.3)	19.7 (18.3-21.2)
≥3	49.7 (47.1-52.2)	32.2 (30.0-34.5)	29.7 (25.9-33.8)
Hospital characteristics			
United States region			
Northeast	18.3 (16.0-20.9)	19.8 (16.8-23.1)	20.6 (16.4-25.6)
Midwest	21.0 (16.6-26.1)	19.9 (15.4-25.3)	24.2 (18.8)
South	40.9 (35.7-46.3)	42.9 (37.7-48.3)	43.2 (36.8-49.8)
West	19.8 (16.2-24.1)	17.4 (14.1-21.4)	12.1 (9.0-15.9)
Non-urban location	15.9 (9.2-26.1)	16.0 (9.0-26.7)	20.2 (11.7-32.4)
Hospital ownership			
Non-profit	75.1 (69.9-79.7)	78.2 (72.9-82.8)	77.3 (70.7-82.8)
Government (non-federal)	14.4 (11.1-18.6)	11.2 (8.3-15.0)	13.0 (9.0-18.3)
Private/for profit	10.5 (7.2-15.0)	10.6 (7.5-14.7)	9.7 (6.1-15.2)

CI, confidence interval; *IQR*, interquartile range

Table 2. Resource utilization of 2006-2009 United States emergency department visits by triage acuity

Characteristics	Immediate/Emergent/Urgent % (95% CI)	Semi-urgent % (95% CI)	Non-urgent % (95% CI)
Any imaging, diagnostic test, procedure, or medication	94.6 (93.9-95.1)	91.6 (90.6-92.4)	87.8 (86.3-89.2)
Any imaging	52.9 (51.6-54.2)	37.8 (36.5-39.1)	29.8 (27.8-31.8)
Cross-sectional imaging*	21.8 (20.7-23.1)	10.0 (9.1-10.9)	7.3 (6.2-8.6)
Any diagnostic or screening service	80.5 (78.9-82.0)	60.9 (59.0-62.9)	53.4 (50.2-56.7)
Any procedures performed	56.3 (53.5-59.0)	38.9 (36.9-40.9)	34.1 (31.8-36.4)
Any medication ordered	80.6 (79.5-81.7)	80.0 (79.0-81.0)	76.3 (74.7-77.8)
Hospital admission	19.8 (18.4-21.3)	5.5 (4.8-6.2)	4.0 (3.3-4.8)
Critical care/operating room/catheterization lab	3.4 (3.1-3.8)	0.6 (0.5-0.8)	0.5 (0.3-0.6)

CI, confidence interval *Includes computed tomography, magnetic resonance imaging, or ultrasound.

Hispanic black race, have Medicaid or no insurance (self-pay), and less likely to have Medicare. Non-urgent visits were less likely to have arrived by ambulance and less likely to have a length of stay over 3 hours. Non-urgent visits were more common in hospitals located in non-urban areas and less common in the West. Time of day and day of the week were similar across triage acuity categories.

Most (87.8%) non-urgent visits had at least one intervention in the ED including imaging, diagnostic or screening services, a procedure performed, or medication administered (Table 2). Radiologic imaging was performed in 52.9% of immediate, emergent, or urgent (IEU) visits and 29.8% of non-urgent visits and 7.3% of non-urgent visits had cross-sectional imaging. Procedures were performed more frequently in IEU visits compared to non-urgent visits (56.3% versus 34.1%). Medication administration was similar between the 2 groups (80.6% versus 76.3%). Four percent of non-urgent visits were admitted to the hospital and 0.5% of visits were admitted to a critical care unit, operating room, or catheterization lab.

The characteristics of non-urgent visits requiring hospital admission compared to those not admitted are presented in Table 3. Among non-urgent visits, hospital admission was more likely among older, non-Hispanic white, Medicare-insured visits, as well as those who arrived by ambulance and less likely among Medicaid and self-pay visits. Nearly all (96.8%) non-urgent visits resulting in hospitalization had some intervention in the ED.

The ED visits with missing triage level (12.3% of weighted total ED visits) were compared to the visit and hospital characteristics of the study population (Table 4). Those visits with missing triage levels were less likely to have any imaging performed, less likely to have advanced imaging, less likely to have a procedure preformed, and less likely to have a medication ordered. Additionally they were less likely to have a length of stay greater than 3 hours and less likely to be admitted.

DISCUSSION

Our findings demonstrate that most ED visits categorized as non-urgent had some diagnostic or therapeutic intervention performed during the visit. Previous studies have found a lower rate of resource utilization for non-urgent patients;[13-15] however, our analysis shows a high rate of interventions for even the lowest acuity visits. This suggests that healthcare services are needed even for the lowest acuity visit and calls into question the designation of a non-urgent ED visits as being "unnecessary." We would argue that categorizing an ED visit as "unnecessary" depends not only on patient acuity but also the appropriateness of the site of service and availability of alternate sources of acute, unscheduled care.[7] The ED may in fact be an appropriate site of service for a non-urgent presentation or complaint if there are no other available sites to provide timely care to the patient.

It is possible that some of these non-urgent patients could have had their medical needs met at a different site of service. Furthermore, clinical practice differences might lead to fewer interventions by primary care providers than are typically obtained in the ED. However, many barriers to accessing timely outpatient care have been associated with increased ED utilization.[16,17] One study found that up to 32% of non-urgent ED patients attempted to access primary care but were unsuccessful.[18] Of patients who described the ED as their usual source of care, over two thirds (68%) desired to obtain a primary care physician and nearly half (48%) tried to get one.[19]

We found that non-urgent ED visits were higher among Medicaid and self-pay visits. Not surprisingly, these are also the patients who have the most difficulty obtaining access to a primary care provider. Indeed, just over a quarter (25.5%) of primary physicians surveyed were not accepting new Medicaid patients and 22.8% were not accepting new patients without insurance.[20] In comparison, only 5.1% of primary physicians were not accepting patients with private insurance.[20] Collectively, these data suggest that although a patient may have a non-urgent condition that could be

Table 3. Comparison of non-urgent emergency department (ED) visits that did and did not result in hospital admission.

Characteristics	Not Admitted % (95% CI)	Admission % (95% CI)
Total	96.0 (95.2-96.7)	4.0 (3.3-4.8)
Patient characteristics		
Age, years, median (IQR)	28 (15-45)	48 (32-69)
0-17	28.4 (26.4-30.5)	11.6 (7.7-17.0)
18-44	47.5 (45.8-49.3)	32.5 (27.3-38.3)
45-64	16.9 (15.9-17.9)	25.9 (20.7-31.8)
≥65	7.2 (6.3-8.2)	30.0 (24.8-35.8)
Female sex	52.7 (51.5-53.9)	59.0 (53.2-64.6)
Race/ethnicity		
Non-Hispanic White	56.3 (51.8-60.7)	66.5 (60.2-72.2)
Non-Hispanic Black	28.4 (24.0-33.4)	22.6 (17.0-29.4)
Hispanic	12.9 (10.5-15.8)	9.8 (6.0-15.5)
Other	2.4 (1.9-2.9)	1.1 (0.5-2.7)
Insurance		
Private	31.4 (29.0-33.9)	23.7 (18.9-29.4)
Medicaid	29.5 (27.4-31.6)	19.3 (15.2-24.1)
Medicare	9.2 (8.2-10.4)	38.2 (31.9-44.8)
Self-pay	19.0 (17.3-20.9)	13.1 (9.6-17.6)
Other/unknown	10.9 (8.9-13.2)	5.8 (3.5-9.4)
Visit characteristics		
Any imaging, diagnostic test, procedure, or medication	87.5 (85.9-88.9)	96.8 (94.2-98.2)
Any imaging	28.2 (26.3-30.1)	68.4 (63.4-73.0)
Cross-sectional imaging*	6.5 (5.5-7.6)	28.4 (23.7-33.6)
Any diagnostic or screening service	51.7 (48.6-54.9)	94.1 (90.1-96.5)
Any procedures performed	32.6 (30.4-34.8)	70.8 (65.1-75.8)
Any medication ordered	76.0 (74.4-77.6)	81.6 (74.9-86.8)
Arrival by ambulance	5.5 (4.6-6.5)	30.9 (25.3-37.0)
ED length of stay, hours, median (IQR)	1.9 (1.1-3.2)	5.0 (3.1-7.8)
<1	20.7 (18.2-23.4)	2.9 (1.5-5.3)
1-1.9	31.7 (29.6-33.9)	5.6 (3.4-9.0)
2-2.9	19.9 (18.4-21.5)	14.6 (10.3-20.2)
≥3	27.8 (24.1-31.8)	77.0 (70.3-82.5)
Hospital characteristics		
United States region		
Northeast	20.7 (16.5-25.6)	18.3 (12.7-25.6)
Midwest	24.0 (18.6-30.4)	28.3 (19.1-39.7)
South	43.2 (36.8-49.9)	42.3 (31.6-53.7)
West	12.1 (9.1-15.9)	11.2 (7.2-17.1)
Non-urban location	20.3 (11.8-32.7)	16.7 (8.5-30.1)
Hospital ownership		
Non-profit	77.3 (70.6-82.8)	77.8 (66.5-86.0)
Government (non-federal)	12.9 (8.9-18.2)	15.4 (8.2-26.9)
Private/for profit	9.9 (6.2-15.3)	6.9 (3.2-14.0)

CI, confidence interval; *IQR*, interquartile range *Includes computed tomography, magnetic resonance imaging, or ultrasound.

Table 4. Comparison of emergency department visits with triage acuity documented and missing.

Characteristics	Documented % (95% CI)	Missing % (95% CI)
Total	87.7 (85.6-89.6)	12.3 (10.4-14.4)
Patient characteristics		
Age, years, median (IQR)	34 (19-53)	32 (17-51)
0-17	22.6 (21.4-23.7)	26.6 (22.4-31.2)
18-44	42.2 (41.4-43.1)	41.2 (38.6-43.8)
45-64	20.2 (19.7-20.6)	18.5 (17.1-20.0)
≥65	15.1 (14.5-15.7)	13.7 (12.4-15.2)
Female sex	54.5 (53.9-55.0)	54.0 (52.9-55.2)
Race/ethnicity		
Non-Hispanic White	60.7 (58.0-63.4)	59.7 (54.6-64.6)
Non-Hispanic Black	23.0 (20.3-25.9)	20.1 (16.2-24.6)
Hispanic	12.7 (11.0-14.6)	16.0 (12.4-20.6)
Other	3.6 (3.0-4.3)	4.2 (3.0-5.9)
Insurance		
Private	33.8 (32.6-35.1)	32.8 (29.8-35.9)
Medicaid	24.9 (23.6-26.3)	23.0 (20.7-25.4)
Medicare	16.4 (15.7-17.2)	15.0 (13.6-16.5)
Self-pay	15.2 (14.3-16.2)	15.8 (13.7-18.1)
Other/unknown	9.7 (8.3-11.2)	13.4 (9.3-18.9)
Visit characteristics		
Any imaging, diagnostic test, procedure, or medication	93.0 (92.3-93.7)	88.3 (86.3-90.1)
Any imaging	46.2 (45.1-47.3)	37.6 (35.2-40.0)
Cross-sectional imaging*	17.0 (16.1-17.9)	12.7 (11.5-14.0)
Any diagnostic or screening service	72.2 (70.6-73.6)	64.4 (61.4-67.3)
Any procedures performed	49.0 (46.7-51.4)	41.6 (38.7-44.5)
Any medication ordered	78.0 (79.0-80.9)	74.7 (71.7-77.4)
Arrival by ambulance	16.8 (16.0-17.7)	14.1 (12.6-15.7)
ED length of stay, hours, median (IQR)	158 (92-258)	142 (79-250)
<1	11.7 (10.7-12.7)	16.4 (14.2-18.9)
1-1.9	24.7 (23.7-25.8)	26.7 (25.1-28.4)
2-2.9	21.0 (20.5-21.5)	20.8 (19.6-22.1)
≥3	42.6 (40.6-44.7)	36.1 (32.7-39.6)
Hospital admission	14.1 (13.2-15.1)	11.0 (9.6-12.7)
Hospital characteristics		
United States region		
Northeast	19.0 (16.8-21.4)	16.4 (10.9-24.0)
Midwest	21.0 (16.8-25.9)	30.3 (23.0-38.8)
South	41.7 (37.0-46.6)	32.7 (25.0-41.5)
West	18.4 (15.1-22.2)	20.6 (12.9-31.1)
Non-urban location	16.4 (9.6-26.4)	15.7 (8.1-28.3)
Hospital ownership		
Non-profit	76.2 (71.3-80.6)	70.3 (61.2-78.0)
Government (non-federal)	13.4 (10.3-17.1)	15.3 (9.5-23.8)
Private/for profit	10.4 (7.4-14.6)	14.4 (8.8-22.7)

CI, confidence interval; *IQR*, interquartile range *Includes computed tomography, magnetic resonance imaging, or ultrasound.

evaluated in up to 24 hours, barriers to care may predispose them to use the ED for non-urgent care.

Our analysis showed a similar rate of non-urgent visits across times of day and days of the week, with no surge of visits in off hours or on weekends. Furthermore, our results demonstrate that non-urgent ED visits occur even at times when health care clinics are open. Patients who present with non-urgent conditions often do so because they perceive a need for immediate medical attention, have been referred by their primary physician, or simply because the ED provides easier accessibility.[18,21,22] Of patients who report having a primary physician, 47% noted the ease of obtaining unscheduled care in the ED as a reason for their choice of site of service.[21] The barriers to obtaining timely care are also noted among primary physicians, 73.4% of whom stated that a lack of timely reports from other physicians or labs limited their ability to provide high quality care.[20] Many diagnostic interventions are not easily available in the outpatient setting. The ED offers a unique set of services and diagnostic capabilities in a time-efficient manner, which can expedite medical management for some patients. While the appropriateness of this clinical practice is debatable, it reflects the reality for many patient populations.

Some policymakers have advocated for the reduction of "unnecessary" ED visits as a means to generate significant savings in the healthcare system.[4] However, the estimates of potential costs associated with treatment of non-urgent visits in the ED as opposed to other sites of care are variable and the true cost-savings from a reduction in non-urgent ED visits may only be modest.[9] Some have reported that ED costs for minor health problems or non-urgent visits are as much as two to three times higher than care provided in other sites of service.[23] Yet others have found the cost for providing non-urgent care in the ED are relatively comparable to that provided in the outpatient settings.[8] Furthermore, previous studies comparing ED and outpatient costs of care only consider a single visit and do not include ancillary services in cost-value calculations,[8,24] which limit the interpretability of the comparison. In addition, the relative use of diagnostic tests, procedures, and medications in the outpatient setting, compared to the ED setting, for a comparable presentation is unknown. Thus, the high resource utilization in non-urgent ED visits reported in our study should prompt further analysis and comparison of the true costs associated with ED and outpatient care.

A small, but not insignificant number of non-urgent visits were admitted, sometimes in critical care settings. Prior single-center studies have reported admission rates up to 6.2% in non-urgent ED populations.[18,25,26] Similarly, we found an overall admission rate of 4.0% for non-urgent ED visits nationally. This highlights the limitations and difficulty with using triage acuity systems as a reliable surrogate marker to predict patient acuity and disposition including hospitalization.

LIMITATIONS

Data from the NHAMCS are subject to the limitations of general survey research, with possible errors in data collection and coding. In particular, data abstractors may have recorded incorrect or incomplete data on triage acuity levels, the type of ED services provided, and patient disposition. A recent NHAMCS study on the disposition of intubated patients in the ED has highlighted errors in data coding[27] and suggests that this may result in undercounting of ED interventions.[12] However, NHAMCS data have been used widely to report the epidemiology of a variety of characteristics and conditions, using rigorous methodology.[28]

We did find that a moderate number of charts had missing data, which can be attributed to multiple factors including the lack of nursing triage systems at some hospitals, as well as general errors in coding. We found that the characteristics of the missing visits were generally similar to those charts that were included in analysis. There was a lower rate of resource utilization and a lower proportion of admissions among the visits with missing triage acuity. It is possible that these could represent more lower acuity visits, which if included in primary analysis would actually decrease the resource utilization for non-urgent visits. However, there is no explicit reason to suspect those charts with missing triage acuity would preferentially be from less acute visits. Therefore, all triage categories would be affected similarly and the missing charts are unlikely to represent a major source of bias.

Finally, this analysis relies on triage classification of acuity, which may be subject to interpretation and the expertise of the classifying practitioner and is not standardized across hospital EDs. There are multiple different methodologies for classifying level of acuity but there is no clear evidence the level would be skewed in one direction and therefore should not markedly influence the results.

CONCLUSION

Most non-urgent ED visits had some diagnostic or therapeutic intervention. Relatively low, but notable, proportions of non-urgent ED visits had advanced imaging or were admitted to the hospital, sometimes to a critical care setting. These results call into question non-urgent ED visits being broadly classified as "unnecessary," particularly in the setting of limited access to timely primary care for acute illness or injury.

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Time to Focus on Improving Emergency Department Value Rather Than Discouraging Emergency Department Visits

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Recently policymakers, payers, and the media have focused attention on avoiding 'inappropriate' or 'unnecessary' emergency department visits.[1] Some states and payers have tried to institute co-pays or deny coverage for visits deemed to be non urgent with the goal of decreasing unnecessary emergency department (ED) visits.[2,3] The discussion is predicated upon the 'common knowledge' that by diverting unnecessary ED visits, substantial healthcare spending will be avoided. This 'common knowledge' is wrong.

Many of the frequently used methodologies to classify ED visits are based on the NYU ED algorithm, developed in the late 1990s to classify ED use.[4] Using expert opinion, charts were reviewed to determine if a particular visit was urgent. The algorithm was constructed to generate a probability that a particular discharge diagnosis results from a non-emergent visit. According to NYU, the algorithm was "not intended as a triage tool or a mechanism to determine whether ED use in a specific case is 'appropriate.'" Since the ultimate discharge diagnosis is not known at the time the patient makes the decision to visit the ED, classification based on the discharge diagnosis cannot be used to guide patients' decision as to whether or not to use the ED.

Raven et al[2] analyzed data from the 2009 National Hospital Ambulatory Medical Care Survey (NHAMCS) using a modified NYU ED algorithm. They modified the algorithm to predict non-emergent visits based upon chief complaint. They constructed the modification to increase the likelihood that the "classification system would identify only nonemergency ED visits." Only 6.3% of ED visits were categorized as non-emergent, with 304 chief complaints identified as markers for primary-care treatable visits. But even with their conservative algorithm, these same chief complaints accounted for 89% of all visits, including patients with critical illnesses. Their analysis shows it is not possible to identify patients based on chief complaint because identical chief complaints lead to different discharge diagnoses, some of which get categorized preventable and some emergent.

Even assuming it is possible to prospectively identify and divert non-urgent patients from the ED, achieving substantial system savings is unlikely, as care is still required. In this issue, Honigman et al[1] analyzed another approach to classify ED visits. They analyzed the interventions and ancillary testing patients required based upon triage classification. A level 5 triage classification is considered non-urgent and means the triage nurse assesses that a care delay of up to 24 hours will not have adverse medical consequences. Using NHAMCS data from 2006-2009, Honigman et al found that 10.1% were triaged as non-urgent. However, these non-urgent patients had a high rate of ancillary testing and interventions suggesting "that healthcare services are needed even for the lowest acuity visit and calls into question the designation of a non-urgent ED visits as being 'unnecessary.'" Fortunately, the marginal cost of an additional non-urgent ED visit is quite low. In 1996, Williams[5] found the marginal cost of a non-urgent ED visit was $24, as compared to an average non-urgent cost of $124 and an average cost for all visits of $383.

The United States government reports that only 3.8% of healthcare spending is in the ED.[6] Completely eliminating the costs associated with the 10.1% of non-urgent visits in the NHAMCS 2006-2009 data set could at best save a fraction of a percent of the healthcare dollar. But Honigman et al demonstrate that these patients do require testing and treatments. So diverting them from the ED simply shifts the cost elsewhere, rather than achieving system savings. Some argue that costs are higher in the ED than in the office. But patients presenting in the ED are more likely to have higher acuity and more serious ultimate diagnoses than office patients with identical chief complaints. For example, the patient with chest pain caused by a myocardial infarction is more likely to present to the ED, and the patient with musculoskeletal chest pain is more likely to present to an office.[7] Office based practitioners commonly refer higher risk patients to the ED for an expedited evaluation, especially after hours.[8] For these reasons, comparing ED costs to office costs is not valid. Patients with identical

chief complaints and identical diagnoses treated in EDs are not equivalent to those treated in offices and are reasonably expected to require more expensive evaluations. Nevertheless, improving access to alternative sites of care allows patients self identifying as lower acuity to visit clinics without risking diverting patients from needed care.

So what can emergency physicians (EPs) do to save the healthcare system money? Smolowitz et al[8] suggest that instead of focusing on the relatively low savings that could be achieved by diverting non-urgent patients from the ED, greater savings can be achieved by avoiding admissions and improved care coordination. For example, they estimate that "it would require diverting more than 80 patients with pharyngitis to save the money equivalent to a single avoided hospitalization." A recent Rand report[9] found that EPs determine the need for admission about 50% of the time. Since inpatient costs comprise 31% of all health spending, even small decreases in admission costs will have substantial impact. EPs, by directing efficient care during the ED stay, can prevent or shorten hospital admissions. Rand reports "early evidence" that "EDs are already having a positive impact by constraining the growth of admissions" for preventable admissions.

Focusing on non-admitted patient visits also holds promise. An example are the practice guidelines Washington EPs developed when faced with threatened Medicaid denial of payment for visits retrospectively deemed non-emergent based upon discharge diagnosis.[3,10] Washington EPs and EDs successfully developed and implemented a program projected to save $31 million in the first year by improving care coordination and better access to care, especially for frequent ED users. This project demonstrates the effectiveness of broad implementation of practice guidelines, coordinating care with alternative sites of care for frequent ED users.

It is time for emergency care providers and healthcare systems to develop and implement further strategies to improve the value of the care EDs provide to our communities. Techniques to achieve and measure this value are challenging given the complex interactions within the healthcare system. Fortunately, EPs are expert at making quick decisions with incomplete information, and we must use those skills to adjust our practices. By improving the value of the care delivered in the ED, there will be less motivation for policymakers and payers to adopt dangerous and ineffective policies diverting patients away from the ED.

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New Drugs and Devices from 2011 – 2012 That Might Change Your Practice

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To be honest, I thought this would be a lost cause. Even after skipping a New Drugs and Devices essay in 2012, I figured that I would have to search long and hard to find 10 new things that emergency practitioners needed to know about. Although there were no true blockbuster medications for emergency physicians, I nonetheless found 10 medicines that we probably should know, along with a new device that may change the way we work up patients with palpitations, and a clever new delivery system for subcutaneous epinephrine. [West J Emerg Med. 2013;14(6):619–628.]

XARELTO® (RIVAROXABAN)

This one you're going to hear about. Rivaroxaban is an oral anticoagulant that inhibits both free and bound Factor Xa. It is highly selective for this factor and has a rapid onset of action, reaching therapeutic levels in less than 4 hours. By inhibiting Factor Xa, both intrinsic and extrinsic pathways of the blood coagulation cascade are affected; thus, thrombin formation is blocked and clots are less likely to develop. It does not however inhibit thrombin (activated Factor II), and has no effects on platelets. Rivaroxaban has a flat dose response across an eightfold dose range (5–40 mg), so it theoretically allows predictable anticoagulation without dose adjustments and coagulation monitoring. Its half-life requires it to be taken twice daily to be effective.

Early in 2011, the United States (U.S.) Food and Drug Administration (FDA) approved rivaroxaban for prophylaxis of deep vein thrombosis (DVT), which may lead to pulmonary embolism (PE) in adults undergoing hip and knee replacement surgery; later in the year, the FDA approved it for stroke prophylaxis in patients with non-valvular atrial fibrillation (AF). Then on November 2, 2012, rivaroxaban was approved for the treatment of patients with DVT and PE and for long-term treatment to prevent recurrence. In other words, we now have an oral agent we can start in the emergency department (ED) to treat stable outpatients diagnosed with venous thromboembolic disease (VTE); as a bonus, it requires no bridging with heparin and no long-term monitoring.

While we will not be prescribing rivaroxaban for its first 2 indications, we will definitely be encouraged to use it for this most recent indication. Already, full-color 8-page glossy ads are showing up in our journals and monthly specialty-specific newspapers. Let's admit it – the prospect of treating a stable patient with VTE as an outpatient simply by writing a prescription is difficult to ignore.

Does it work? Yes, it is at least as effective as the routine regimen of low molecular weight heparin (LMWH) and warfarin. The EINSTEIN-DVT study for treatment and secondary prevention of VTE was an unblinded, randomized, noninferiority study comparing oral rivaroxaban alone (15 mg twice daily for 3 weeks, followed by 20 mg once daily) with subcutaneous enoxaparin followed by a vitamin K antagonist (usually warfarin) for 3, 6, or 12 months in patients with acute, symptomatic DVT. As so often happens in real life, the INR was in the therapeutic range (2.0 to 3.0) for only 57.7% of the time. The number of recurrent clots was similar in both groups and the principal safety outcome of major bleedings was not different.

In the EINSTEIN–Pulmonary Embolism Study rivaroxaban was also noninferior to usual care (LMWH and warfarin) as far as recurrent VTE and bleeding in patients with symptomatic PE .

While warfarin is dirt cheap, rivaroxaban costs $8-9 a day...compared to $25 to $50 a day for generic enoxaparin. Somehow, somewhere, someone will determine that this is "cost effective."

One big downside: As with dabigatran (Pradaxa®), there is no specific antidote for rivaroxaban in an exsanguinating patient. An antidote is, however, in development. Rivaroxaban's half-life is only 5-13 hours, so withholding it may be enough. One study used Prothrombin Complex

Table 1. ARISTOTLE[11]

	Stroke or systemic embolism per 100 patient-years of follow-up		Relative risk reduction (RRR)	Absolute risk reduction (ARR)	Number needed to treat (NNT)
	apixaban	warfarin			
Prior stroke or TIA n = 3,436 (19%)	2.46	3.24	24%	0.78	128
No prior stroke or TIA n = 14,865 (81%)	1.01	1.23	18%	0.22	455

TIA = transient ischemic attack

Concentrates (PCC) (50 IU/kg) in 12 healthy patients and showed reversal of the prolonged prothrombin time. However this may not correlate with hemostasis or patient-centered improved outcomes. Recall the excitement generated in studies using Recombinant Factor VIIa to limit the size of hemorrhage in cerebral bleeding, but which had no effect on patient-oriented outcomes, such as survival. Nonetheless, a trial of PCC is warranted in the exsanguinating patient anticoagulated with rivaroxaban. Because of its high protein binding, dialysis will not help. Protamine and vitamin K would not be expected to help.

Rivaroxaban is just the first drug of the xaban category to be approved for outpatient therapy of VTE. Many more will soon follow: apixaban (Eliquis®) is now also available and has been used in Europe since May 2012. Betrixaban, edoxaban, and otamixaban are all in various stages of human trials.

ELIQUIS® (APIXABAN)

Apixaban is another direct factor Xa inhibitor that has been available in Europe since May 2012. It barely made it under the wire for 2012, being approved by the FDA on 28 December for reducing the risk of stroke and systemic embolism in patients with AF that is not caused by a heart valve problem.

ARISTOTLE was a head-to-head study of apixaban 5 mg twice daily versus warfarin in patients with AF involving 18,201 patients in 1,034 clinical sites in 39 countries. The primary efficacy outcome was stroke or systemic embolism, analyzed by intention to treat. The primary safety outcome was major bleeding in the on-treatment population. Apixaban was not inferior to warfarin in the primary endpoint, and was superior in avoiding major bleeding (a key secondary endpoint). Time within the therapeutic range was mean 62%. See Table 1 for results.

The downside of apixaban is the same as for rivaroxaban. No reversal agent is available for the exsanguinating patient. A trial scheduled to be evaluated in March 2013 (Efficacy and Safety Study of Apixaban for the Treatment of Deep Vein Thrombosis or Pulmonary Embolism) will give us information about whether apixaban can be used for outpatient treatment of VTE. Then, of course, we will need to see a head-to-head trial of rivaroxaban versus apixaban versus warfarin.

Table 2. Risk factors for inclusion in platelet inhibition and patient outcomes.

- Age 60 years or older
- Previous heart attack or Coronary Artery Bypass Graft
- 50% or greater stenosis of two or more coronary arteries
- 50% or greater carotid stenosis
- Diabetes
- Peripheral artery disease
- History of ischemic stroke, transient ischemic attack, or cerebral revascularization
- Creatinine clearance <60 mL/min/1.73 m^2 body surface area

BRILINTA® (TICAGRELOR)

Ticagrelor reversibly inhibits the platelet 2Y12 adenosine diphosphate receptor. It is a cyclopentyltriazolopyrimidine, similar to the antiplatelet thienopyridines clopidogrel (Plavix) and prasugrel (Effient), both of which bind irreversibly to the P2Y12 receptor. All 3 drugs are used for secondary prevention of stent thrombosis, cardiovascular death, and heart attack in patients with acute coronary syndrome (ACS).

Ticagrelor was approved by the FDA based on the Platelet Inhibition and Patient Outcomes (PLATO) study, which looked at 18,624 patients with ACS from 862 centers in 43 countries who had symptom onset within.

Define CrCl, CABG and PLATO as footnote of table 2 the previous 24 hours. Unlike CURE and PCI-CURE, the two major studies evaluating clopidogrel, PLATO included patients with ST elevation myocardial infarctions (MIs). Patients without ST-segment elevation had to have 2 of the following for study inclusion: ST segment changes indicative of ischemia; a biomarker indicative of myocardial necrosis; or a "risk factor" (Table 2). Patients with ST-segment elevation had to have persistent ST-segment elevation of at least 0.1 mV in at least 2 contiguous leads or a new left bundle-branch block, plus planned primary percutaneous coronary intervention (PCI).

Exclusion criteria included high risk of bradycardia, contraindication to clopidogrel, fibrinolytic administration within 24 hours of randomization, use of a strong CYP3A4 inhibitor or inducer, and oral anticoagulant that could not be discontinued.

Table 3. Platelet Inhibition and Patient Outcomes.

18,624 patients admitted with acute coronary syndrome, with or without STEMI	clopidogrel# + aspirin (n=9291)	ticagrelor* + aspirin (n=9333)	*p*-value	Number Needed to Treat
1º outcome: cardiovascular death OR stroke OR MI at 12 months	11.7%	9.8%	<0.001	53
1º outcome: North America only (n = 1814)	9.6%	11.9%		
2º outcome: death from vascular cause	5.1%	4.0%	<0.001	91
2º outcome: death from any cause	5.9%	4.5%	<0.001	71
2º outcome: myocardial infarction	6.9%	5.8%	0.005	91
2º outcome: stent thrombosis	3.8%	2.9%	0.01	111
2º outcome: death from stroke	1.5%	1.3%	0.22	500
Major bleeding	11.3%	11.6%	0.43	333
Premature discontinuation of drug	21.5%	23.4%		53

#Clopidogrel-treated patients received a 300 mg loading dose following by 75 mg once daily
#Ticagrelor-treated patients received a 180 mg loading dose followed by 90 mg twice daily

In PLATO, patients were randomized to ticagrelor or clopidogrel. Patients who had not been taking aspirin received a loading dose of 325 mg, followed by 75 to 100 mg once daily, or 325 mg once daily for 6 months after stent placement.

While follow-up occurred at 1, 3, 6, 9, 12, and 13 months, the primary outcome measure was a composite endpoint at 12 months of cardiovascular death, MI, or stroke (similar to the CURE trial: PCI-CURE added recurrent angina into the composite). Results are shown in Table 3.

So for every 1,000 patients treated for up to 1 year with ticagrelor instead of clopidogrel, 11 fewer will suffer cardiovascular death, 11 fewer will have a heart attack, and 9 fewer will experience stent thromboses. The 1.9% absolute reduction (NNT=53) is being touted by AstraZeneca as a "16% reduction in death, stroke, or MI," but that, of course, is a relative reduction.

In a strange finding, efficacy was lost for patients enrolled in North America (n=1814); in fact, clopidogrel proved superior to ticagrelor in reaching the primary endpoint (11.9% vs 9.6% - see Table 4). The reasons for this are unclear, but most North American patients were from the United States. U.S. patients were heavier, had more frequent co-morbidities and were more likely to undergo PCI or CABG.

In addition, the median aspirin dose was higher in the U.S. – 325 mg versus 100 mg. Does this mean there is a drug interaction between aspirin and ticagrelor, or is it just that different aspirin doses reflect differences in patient populations. A post-hoc subgroup analysis suggested that aspirin dose, not geography, is to blame for the disparate results. Ticagrelor was approved with a requirement by AstraZeneca that they conduct educational outreach to physicians to alert them to the risk of using maintenance doses of aspirin over 100 mg daily, and there is a "black box" warning in the prescribing information about appropriate aspirin dosing.

In addition to bleeding, other adverse events included dyspnea (13.8% of patients) and, in those attached to a Holter monitor, ventricular pauses of more than 3 seconds (2%). Ticagrelor is a direct-acting oral antagonist of the adenosine diphosphate receptor, and some components of the molecular structure of ticagrelor are almost identical to those of adenosine; hence it is conceivable that metabolites of ticagrelor activate adenosine receptors. We know that adenosine induces dyspnea by bronchoconstriction, depresses the atrioventricular node, and causes deterioration in renal function by arteriolar constriction. These adverse events were generally self-limiting, but ticagrelor was discontinued because of adverse events more frequently than clopidogrel. Since less than 6% of the study patients had chronic renal disease, congestive heart failure, or obstructive pulmonary disease, we do not have good information on how these patients will fare taking ticagrelor.

Table 4: Primary efficacy outcome, US vs non-US.

Aspirin dosage	US, Hazard Ratio (95% CI)	Non-US, Hazard Ratio (95% CI)
>300 mg	1.62 (0.99-2.64)	1.23 (0.71-2.14)
>100 to <300 mg	*	1.00 (0.71-1.42)
<100 mg	0.73 (0.40-1.33)	0.78 (0.69-0.87)

*Not enough data available

Table 5. Some new anticoagulant /antiplatelet drugs.

Drug	Action	Dose	Cost / 30 days
Dabigatran (Pradaxa)	Direct thrombin inhibitor	150 mg bid	$231.82
Rivaroxaban (Xarelto)	Direct factor Xa inhibitor	10, 15, or 20 mg once daily	$231.60
Ticagrelor (Brilinta)	Blocks platelet ADP P2Y12 receptor	90 mg bid	$230.36

Ticagrelor does not have to be metabolized to become active and thus has a faster onset than clopidogrel or prasugrel. In addition, it binds reversibly to the platelet, theoretically making it an attractive option in patients requiring surgery; nonetheless, the manufacturer recommends stopping the drug 5 days before major surgery, similar to clopidogrel.

In a striking coincidence, the average wholesale cost of the three most recent anticoagulant / antiplatelet drugs are similar (Table 5).

ABTHRAX® (RAXIBACUMAB)

Raxibacumab is a newly approved drug for treatment of inhalational anthrax. It has the lumbering chemical formula C6320H9794N1702O1998S42. Like all monoclonal antibodies, the source and purpose are in the name. The last syllable (-mab) tells you that it is a monoclonal antibody. The antepenultimate syllable (-u-) tells you the source of the DNA is human (mouse DNA is designated by -o- and chimeric DNA by -xu-). And the preceding syllable (-bac-) tells you that it is an antibacterial agent.

Unlike antibiotics, which eradicate the *Bacillus anthracis* bacterium itself, raxibacumab targets the toxins produced by *B. anthracis*. These toxins are the cause of death in most human inhalational anthrax disease cases, including those in the 2001 attacks. As you may recall, as many as 68 victims were infected with inhalational anthrax delivered through the U.S. postal system, and 5 of them died despite aggressive antibiotic therapy.

More than 20,000 doses of raxibacumab have been in the Strategic National Stockpile since 2009. The stockpile includes other vaccines, antibiotics, and antitoxins that target anthrax and other agents of biological, nuclear and chemical warfare. Like raxibacumab, not all of these products are licensed.

Because naturally occurring inhalational anthrax infection in humans is rare (and studies deliberately exposing humans to the pathogen would be unethical), efficacy studies of raxibacumab were conducted in animals under the FDA's Animal Rule. It is the first monoclonal antibody approved under this rule. Established in 2002, the Animal Rule allows developers to seek approval for the marketing of drugs or biologics based on efficacy data from animal studies, provided certain criteria are met. Safety data can be collected from humans, however, as was done with raxibacumab. Raxibacumab is administered in a single 40 mg/kg dose delivered intravenously over 2.25 hours. The instructions recommend premedication with diphenhydramine 1 hour before infusion.

Dividing anthrax bacilli produces protective antigen (PA), lethal factor (LF) and edema factor (EF). PA facilitates binding of LF and EF to anthrax toxin receptor (ATR) on mammalian cell surfaces, resulting in a protein-receptor complex that enables LF and EF to enter cells. These toxins inhibit normal immune system functioning, interfere with signal transduction pathways, and ultimately cause cell death. Antibiotics help control the bacterial infection, but they fail to clear toxins from the bloodstream. Vaccines can be effective over time, but they are slow acting initially and require booster doses to maintain immunity. By binding protective antigens, raxibacumab prevents LF and EF from entering cells, preventing progression of the disease.

Raxibacumab-treated animals had improved survival over control in 2 relevant animal models both in combination with antibiotics and alone. It is strictly for treating inhalational symptoms: Raxibacumab does not cross the blood-brain barrier and does not prevent or treat meningitis. Whether the drug will be dispensed solely by the U.S. government is unclear. I cannot find a charge for individual doses, but medicines supplied by the Strategic National Stockpile are free.

TUDORZA® (ACLIDINIUM BROMIDE)

We've known for many years that inhaled anti-cholinergic agents work as bronchodilators, and they are recommended as an option with beta-agonist therapy in most treatment algorithms for chronic obstructive pulmonary disease (COPD) and emphysema. Ipratropium bromide (Atrovent®), a short-acting quaternary ammonium compound, was standard therapy for many years, but its 4-time-daily dosing had fallen out of favor recently with the addition of once-daily tiotropium (Spiriva®) to the armamentarium. At first, aclidinium bromide (Tudorza®) seems like a step backward with its twice-daily dosing schedule.

There have been several published placebo-controlled trials of aclidinium, but very few head-to-head trials of aclidinium and another inhaled anticholinergic. The studies looked at data-oriented results – for instance, a 10% increase in FEV1 30 minutes after treatment; this improvement was noted in 49.5% treated with aclidinium, 51.8% treated with tiotropium, and 13.8% treated with placebo. Interestingly, a COPD symptom score was improved at night in users of the twice-daily aclidinium. This was thought due to the second, night-time dose. No attempt was made to compare twice-daily aclidinium to twice-daily tiotropium.

Many users of the tiotropium HandiHaler find it cumbersome, as it involves placing an intact capsule in a chamber, piercing it, and inhaling the contents. Aclidinium is a breath-actuated multi-dose dry powder inhaler, similar to the familiar Advair® Discus.

Lower cost is not an issue, as aclidinium costs $220 per monthly inhaler compared to $240 per month for tiotropium. Perhaps patients without dexterity to manage the somewhat tedious task of placing a capsule in the tiotropium dispenser would benefit with a switch to aclidinium, but there is no other clear reason for someone to switch.

SKLICE® (IVERMECTIN)

Pediculus capitis is a worldwide concern that affects persons of all socioeconomic backgrounds and ages, but it is most prevalent in children aged 3–13 years old. Since lice

cannot fly or jump, transmission occurs through direct head-to-head contact, and possibly through the sharing of combs, hair brushes, or hats (although this is controversial). First-line treatments currently recommended by the American Academy of Pediatrics are the over-the-counter products, 1% permethrin or pyrethrins.

Permethrin (Nix®) has low toxicity, can be used in children as young as 2 months of age, and does not have cross-sensitivity with plant allergies (a theoretical risk with pyrethrins, which are derived from chrysanthemum flowers) However, resistance to permethrin is well documented and may limit its usefulness in certain areas of the country.

Pyrethrins (A-200, Licide, Pronto, RID, others) are neurotoxic to lice, but have little toxicity in humans. They can only be used in children 2 years of age and older and may cause an allergic reaction in patients with ragweed sensitivity. Neither permethrin nor pyrethrins are 100% ovicidal, since newly laid eggs do not have a nervous system for several days. Each costs about $20 for pediculocidal doses.

Product labeling of permethrin and pyrethrins recommends a second application at least 7 to 10 days after the initial application. Under average conditions, an egg or nit will hatch in approximately 8.5 days. Based on this time to hatch, a second treatment at 7 days will not be effective; some experts recommend the second treatment should we withheld until 9 to 10 days.

Lindane is no longer considered a first-line agent, as there are many reports of resistance, and it may have central nervous system side effects in humans. It should only be considered if head lice are unresponsive to other therapies, and then only in patients who weigh at least 50 kg. Its use has been banned in California.[34]

Malathion (Ovide®) is effective, but costs about $160. It is ovicidal, but the high alcohol content makes risk of accidental ingestion and flammability a concern. It is only approved for use in children 6 years of age and older, but resistance has not yet been proven in the U.S. (Malathion-resistance to lice is common in England.)

Benzyl alcohol lotion (Ulesfia®, which costs about $160, depending on hair length) is a suffocation-based therapy for head lice. It avoids pesticide or neurotoxin use, and resistance is not a problem, since it suffocates the lice. It can be used in children as young as 6 months of age, but kills only lice, and not the nits, so a second application is necessary 10 days after the initial application.

In the 12 years I have been doing this drug review, this will be the third unique product that I have reviewed for head lice. Topical ivermectin (Sklice®) is the newest product to be approved in the U.S. Ivermectin binds to glutamate chloride channels in nerve and muscle cells of lice, leading to an increased permeability to chloride ions resulting in paralysis and death. Based on this mechanism, it would appear that ivermectin is not ovicidal. But in vitro studies show that all lice hatched from eggs exposed to ivermectin died without the need for a second treatment. In addition, many of these lice were unable to suck blood, indicating that ivermectin somehow affected their ability to feed. One treatment costs approximately $260.

Table 6. Pharmacokinetics of Centruroides Immune $F(ab')_2$.

	Mean ± SD
Half life (hours)	159 ± 57
Volume of distribution (L)	13.6 ± 5.4
Area under the curve (ug x hr/mL)	706 ± 352

ANASCORP® (CENTRUROIDES IMMUNE F(AB')2 [EQUINE])

Scorpions are predatory arthropods in the class Arachnida. They have 8 legs and are easily recognized by the pair of grasping claws and the narrow, segmented tail, often carried in a characteristic forward curve over the back, ending with a venomous stinger. They range in size from 9 mm to 21 cm and are widely distributed over all continents, except Antarctica. There are 1,752 described species of scorpions, with 13 families recognized. Scorpions are known to fluoresce when exposed to certain wavelengths of ultraviolet light, such as that produced by a black light, due to the presence of fluorescent chemicals in the cuticle.

Scorpion venom has a fearful reputation, and about 25 species are known to have venom capable of killing a human being.

Anascorp® is an antivenin indicated for treatment of scorpion envenomations, but only if symptoms develop, such as loss of muscle control, roving or abnormal eye movements, slurred speech, respiratory distress, difficulty with swallowing, excessive secretions or any symptoms that may increase risk for aspiration or compromised airway. It is available in the U.S. in some hospitals in Arizona and Nevada, where the dangerous bark scorpion is found.

Centruroides immune F(ab')2 equine has a mechanism of action similar to that of other available antivenin products. It is composed of F(ab')2 fragments specific to the toxic venom of Centruroides scorpions. These fragments target, bind, and neutralize the toxic venom. This promotes elimination and redistribution of the toxin from body tissues.

Centruroides immune F(ab')2 equine is dosed by the whole number of vials until symptoms are resolved. The approved dosage is t3 vials as soon as possible after symptoms are observed, but an additional vial may be administered every 30 to 60 minutes if symptoms remain. Pharmacokinetic properties are shown in Table 6.

The 6 clinical trials of Centruroides immune F(ab')2 equine show resolution of clinically important signs of envenomation when compared to placebo/supportive care. Only one controlled trial of Centruroides immune F(ab')2 equine has been conducted consisting of 15 pediatric patients

Table 7. Analogs of fentanyl.

- Alfentanil (Alfenta®): ultra-short-acting (5 to 10 minutes)
- Sufentanil (Sufenta®): 5 to 10 times more potent than fentanyl. Its binding affinity is high enough to theoretically break through a buprenorphine blockade to offer pain relief from acute trauma in patients who are taking high-dose buprenorphine.
- Remifentanil (Ultiva®): shortest-acting opioid with rapid offset, even after prolonged infusions.
- Carfentanil (Wildnil®): analgesic potency 10,000 times that of morphine, used in veterinary practice to immobilize large animals such as elephants.

that presented for treatment within 5 hours of scorpion envenomation. This trial demonstrated a significant reduction of blood venom levels and full resolution of clinical symptoms by 4 hours post dose versus supportive care with midazolam.

As per the manufacturer, the shelf life of the product is 2 years. The average number of vials required to complete treatment is 3.59. Average treatment cost is $7,820.40 for 3 vials and $10,427.20 for 4 vials.

SUBSYS® (FENTANYL SUBLINGUAL SPRAY FORMULATION FOR BREAKTHROUGH CANCER PAIN)

Fentanyl is, of course, an opioid agonist with many indications for pain treatment. It is approximately 100 times more potent than morphine, with 100 micrograms of fentanyl approximately equivalent to 10 mg of morphine in analgesic activity. It is highly lipophilic and easily penetrates the blood-brain barrier. This sublingual spray formulation is indicated only for the management of breakthrough pain in cancer patients 18 years of age and older who are already receiving and who are tolerant to opioid therapy for their underlying persistent cancer pain.

Fentanyl was derived from metabolites of meperidine (pethidine) in 1960 by Paul Adriaan Jan, Baron Janssen, founder of Janssen Pharmaceutica. The highly prolific baron also discovered haloperidol (1958), droperidol, and etomidate, as well as diphenoxylate, the primary ingredient in the anti-diarrheal medication, Lomotil.

Fentanyl has been used for widespread palliative use since the 1990s. First on the market was the transdermal Duragesic® patch, followed by first quick-acting fentanyl formations in a transmucosal formulation, the Actiq® lollipop and Fentora® buccal tablets. Even the U.S. military is looking at transmucosal fentanyl for battlefield treatment of pain. Sublingual spray is a logical extension of these other delivery systems. Derivatives of fentanyl have also been developed for specific purposes: there is a summary of these derivatives in Table 7.

Fentanyl is currently considered one of the safest opioids on the market, and the least physically harmful to the body, especially with long-term or life-term use. Its therapeutic index is 270:1. Fentanyl's major side effects (>10% of patients) include diarrhea, nausea, constipation, dry mouth, somnolence, confusion, weakness, and sweating. Despite it being a more potent analgesic, fentanyl tends to induce less nausea and less histamine-mediated itching in relation to morphine.

Healthcare professionals who prescribe Subsys® on an outpatient basis must first enroll in the Transmucosal Immediate Release Fentanyl Risk Evaluation and Mitigation Strategy TIRF REMS ACCESS program (see https://www.tirfremsaccess.com/TirfUI/rems/home.action) and comply with the requirements of the REMS to ensure safe use of SUBSYS. As with all opioids, the safety of patients using such products is dependent on healthcare professionals prescribing them in strict conformity with their approved labeling with respect to patient selection, dosing, and proper conditions for use. While you will probably not prescribe Subsys®, you will almost certainly see patients who take it.

DIFICID® (FIDAXOMICIN)

Clostridium difficile is the most common cause of infectious diarrhea in hospitalized patients in North America and Europe, where both the incidence and severity of the disease have increased alarmingly since 2000. In most patients with this infection, there is a history of antibiotic or antineoplastic use within the prior 8 weeks. Its outcome can be anything from mild diarrhea to potentially-fatal pseudomembranous colitis. When identified, cessation of antibiotic is sufficient for cure in ~25% of victims.

Oral metronidazole and oral vancomycin (whose name is derived from the term "vanquish") have similar efficacy for mild to moderate *C. difficile* infection. Metronidazole is preferred due to concerns about cost and the potential for vancomycin resistance. For severe infections, response rates to oral vancomycin are significantly better than with oral metronidazole (response rates 97% versus 76% and 85% versus 65% for vancomycin and metronidazole, respectively in 2 studies).

Fidaxomicin shows similar efficacy to vancomycin and may be a therapeutic option in mild to moderate cases of *C. difficile* diarrhea, but a 10-day course costs approximately $2,800, significantly higher than a 10-day course of oral vancomycin (~$1300). If you reconstitute injectable vancomycin with sterile water and dilute it to a concentration of 50 mg/mL, then direct that it be used orally, possibly with flavoring syrup, the cost of a course of therapy is $60 or less.

The cheapest and apparently most effective treatment for infection with *C. difficile* appears to be fecal transplant, shown in several small series to completely correct the condition. This esthetically-disturbing treatment,described as early as 1958, is being used more and more frequently. It is also called fecal microbiota transplantation, or FMT. The procedure usually involves an infusion of bacterial fecal flora harvested from a healthy donor. The stool can be given by enema or colonoscopy, or through a nasogastric or nasoduodenal tube. Most patients recover clinically and have *C. difficile* eradicated after just 1

treatment. Donors should be tested for a wide array of bacterial and parasitic infections, including occult *C. difficile*.

Perhaps we should be encouraged to keep a healthy specimen of our own stool in refrigeration, as Autologous Restoration of Gastrointestinal Flora (ARGF) has also been recommended. Should you develop *C. difficile*, your stool flora are extracted with saline and filtered, then freeze-dried and placed in enteric-coated capsules, which you can take orally to restore your original colonic flora.

RECTIV® (NITROGLYCERIN OINTMENT 0.4%)

Most anal fissures are caused by stretching of the anal mucosa beyond its capability; in adults, this includes constipation, the passing of large, hard stools, prolonged diarrhea, or anal sex. Sometimes they cause bright red blood on the toilet paper, occasionally in the toilet. When acute they cause pain after defecation; chronic fissures cause pain less frequently. Anal fissures typically extend from the anal opening and are usually posteriorly in the midline, probably because of the relatively unsupported nature and poor perfusion of the anal wall in that location. Fissures can be superficial or extend down to the underlying sphincter muscle. The incidence of anal fissures is around 1 in 350 adults, equally common in men and women, and most frequent in young adults aged 15 to 40.

First-line management of anal fissure generally includes increasing fluid and fiber intake, stool softeners, topical analgesics (e.g., 1% lidocaine) or anti-inflammatories (e.g., 1% hydrocortisone), and sitz baths.

Nitroglycerin is a vasodilator and causes smooth muscle relaxation. It was first used by William Murrell to treat anginal attacks in 1878. As a topical agent, it is applied as a 0.2% to 0.4% ointment. When applied topically to the anus, it increases local blood flow, relaxes anal sphincter tone, and reduces anal pressure. The literature is mixed, but according to pooled data, topical nitroglycerin appears to be associated with healing in at least 50% of treated chronic fissures and is associated with a significant decrease in pain.

The recommended dosage is 1 inch of ointment (375 mg of ointment equivalent to 1.5 mg of nitroglycerin) applied intra-anally every 12 hours for up to 3 weeks. As with all nitrates, Rectiv® is contraindicated within a few days of using PDE5 inhibitors such as sildenafil, tadalafil, and vardenafil due to potentiating hypotensive effects. After treatment with topical nitroglycerin, recurrence of anal fissures occurs in about one-third of the patients over the following 18 months.

Topical calcium channel blockers such as diltiazem and nifedipine inhibit calcium ion entry through voltage-sensitive areas of vascular smooth muscle and also cause muscle relaxation and vascular dilatation. By relaxing the internal anal sphincter, calcium channel blockers also lower the resting anal pressure. In fact there is evidence that topical calcium channel blockers may be as effective as topical nitroglycerin, but with fewer side effects, such as headache. Diltiazem and nifedipine are not available in topical ointment or gel form and must be compounded by a pharmacist. The typical strengths used for anal fissure are diltiazem 2% and nifedipine 0.2% to 0.5%. The usual dosing is a pea-sized amount applied rectally 2 to 4 times daily.

Considering the ubiquity of nitroglycerin, the cost for a 30-gram tube is staggeringly expensive: US$386.

AUVI-Q®

This is a crossbreed between a drug, which is very old, and a device which is very new. First of all, do you call the drug adrenaline (or adrenalin) or epinephrine (or epinephrin)? It was in 1893 that George Oliver, a Harrogate physician, and Edward Schäfer, professor of physiology at University College London, demonstrated that the adrenal (or suprarenal) glands contained a substance with dramatic pharmacological effects. American physician John Abel named the crude adrenal extracts he prepared in 1897, calling them epinephrin, thinking that epinephris was the best name for the suprarenal capsule.

But none of Abel's epinephrin extracts behaved physiologically like adrenaline does. Jokichi Takamine visited Abel in 1901; afterward, he prepared a pure extract of the active principle from the adrenal gland and patented it. When Parke, Davis & Co marketed his extract, they used the proprietary name Adrenalin. Thus, epinephrine became the generic name in America.

For patients with a history of anaphylaxis and severe allergy, auto-injectors containing a dose of epinephrine between 300 and 500 μg at a 1:1000 concentration (commercial names EpiPen, Twinject, Adrenaclick, Anapen, Jext, and Allerject) have been available for decades. They are somewhat cumbersome to carry because of their size and shape. In times of great stress, such as after having a potential allergic exposure, the patient often forgets the instructions given at the time of distribution.

Auvi-Q® is an epinephrine auto-injector that is amere 3.5 inches tall by 2 inches wide and as thick as a cell phone. This makes it easy to carry in the pants back pocket or shirt pocket. As an advantage, it "talks" to you when you remove the cover, walking you through the process of injection and counting down the number of seconds to leave the device in place. The cost is about the same as other commercially-available devices. Thus, I do not know that it offers any advantage over other auto-injectors, which generally retail for $255 for 2 devices. A common complaint about the older devices is that they expire so quickly without being used, and users may be tempted to squeeze another year or two out of them. A study done in 2000 shows that they actually do lose efficacy over time.

ZIO-PATCH®

In 1946, a physicist / chemist named Norman Jefferis "Jeff" Holter returned to his home of Helena, Montana, to establish a research lab after serving in the U.S. Navy Bureau of Ships and researching the behavior of waves. One of his early inventions was a device that still bears his name: the

Holter monitor. In those pre-transistor days, the device was the size of a very large backpack and weighed about 85 pounds. The size of recorder varies among manufacturers, but the average dimensions of today's Holter monitors are about 110x70x30 mm. Most of them operate with two AA batteries and record a continuous period of 24 to 48 hours. The first report of Holter monitoring in humans appeared in 1954 by MacInnis. If you go to PUBMED now and search "Holter monitor," you will find more than 11,000 references.

The Zio® Patch is a single-use, noninvasive, waterproof, long-term continuous monitoring patch worn on the chest that provides continuous monitoring for up to 14 days. Theoretically by providing a longer time period of continuous recording, the Zio® Patch improves the likelihood of capturing arrhythmias and provides for an equal or higher diagnostic yield versus other devices on the market. Thus far there is very little literature on this device, but initial investigators gave it glowing reviews. While the authors acknowledged receiving a restricted research grant from the manufacturer iRhythm, they stated there were no conflicts of interest.

In their study they compared the Zio® Patch to a 24-hour Holter monitor in 74 consecutive patients with paroxysmal atrial fibrillation referred for Holter monitoring for detection of arrhythmias. The Zio® Patch allowed a mean monitoring period of 10.8 ± 2.8 days (range 4–14 days). Over a 24-hour period, there was excellent agreement between the Zio® Patch and Holter for identifying atrial fibrillation events and estimating atrial fibrillation burden. Atrial fibrillation events were identified in 18 additional individuals in the Zio® Patch group, prompting therapy change. Other clinically relevant cardiac events recorded on the Zio® Patch after the first 24 hours of monitoring included symptomatic ventricular pauses, which prompted referrals for pacemaker placement or changes in medications.

The patient can remove the patch after the observation time and mail it back to the physician. Cost is about $150 per patch, considerably less than the cost of Holter monitoring. I predict that when these become freely available, emergency physicians will jump at the opportunity to use them. Think about the number of patients we see complaining of palpitations or similar symptoms and how difficult it is to arrange a Holter monitor from the ED. With the Zio® Patch, we take a Band-Aid®-sized device out of its package and slap it on the patient's chest and give them instructions about what to watch for and who to follow up with.

On the other hand, as with any innovative new device I worry about the "technological imperative," also known as "the inevitability thesis." Simply stated, "whatever can be done will be done," or, to put it more bluntly, "once you are handed a hammer, everything starts to look like a nail." Will we save lives with this device, or will we pick up "incidentalomas" that condemn patients to a lifetime of medication or, worse yet, internal defibrillators and pacemakers because now we can identify trivial problems that may never cause a symptom. Will we make our patients VOMIT (Victims Of Medical Investigational Technology)? We'll have to see.

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Effectiveness of a Drill-assisted Intraosseous Catheter versus Manual Intraosseous Catheter by Resident Physicians in a Swine Model

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Introduction: Our objective was to compare the effectiveness, speed, and complication rate of the traditional manually placed intraosseous (IO) catheter to a mechanical drill-assisted IO catheter by emergency medicine (EM) resident physicians in a training environment.

Methods: Twenty-one EM residents participated in a randomized prospective crossover experiment placing 2 intraosseous needles (Cook® Intraosseous Needle, Cook Medical, Bloomington, IN; and EZ-IO® Infusion System, Vidacare, San Antonio, TX). IO needles were placed in anesthetized mixed breed swine (mass range: 25 kg to 27.2 kg). The order of IO placement and puncture location (proximal tibia or distal femur) were randomly assigned. IO placement time was recorded from skin puncture until the operator felt they had achieved successful placement. We used 3 verification criteria: aspiration of marrow blood, easy infusion of 10 mL saline mixed with methylene blue, and lack of stained soft tissue extravasation. Successful placement was defined as meeting 2 out of the 3 predetermined criteria. We surveyed participants regarding previous IO experience, device preferences, and comfort levels using multiple choice, Likert scale, and visual analog scale (VAS) questions. IO completion times, VAS, and mean Likert scales were compared using Student's t-test and success rates were compared using Fisher's exact test with $p<0.05$ considered significant.

Results: Drill-assisted IO needle placement was faster than manually placed IO needle placement (3.66 versus 33.57 seconds; $p=0.01$). Success rates were 100% with the drill-assisted IO needle and 76.2% with the manual IO needle ($p=0.04$). The most common complication of the manual IO insertion was a bent needle (33.3% of attempts). Participants surveyed preferred the drill-assisted IO insertion more than the manual IO insertion ($p<0.0001$) and felt the drill-assisted IO was easier to place ($p<0.0001$).

Conclusion: In an experimental swine model, drill-assisted IO needle placement was faster and had less failures than manual IO needle placement by inexperienced resident physicians. EM resident physician participants preferred the drill-assisted IO needle. [West J Emerg Med. 2013;14(6):629–632.]

INTRODUCTION

Peripheral intravenous (IV) catheter placement is the most commonly used procedure to gain vascular access in the emergency department (ED), with over 25 million placements each year.[1] However, when peripheral access is difficult or unsuccessful, intraosseous (IO) infusion is an alternative for life-saving vascular access.[2-5] An IO needle can be placed within the medulla of bones, providing a non-collapsible venous sinus able to accommodate rapid fluid administration. Most medications or fluid support given through the IV route can also be given intraosseously.[4] Traditionally, IO infusion was mostly used in pediatric cases, but adult IO infusion has become increasingly common.[3-9,11]

Current instruments used to obtain IO access include the standard Cook® IO needle (Cook Medical Co., Bloomington, IN), the drill-assisted EZ-IO® device (Vidacare Co., San Antonio, TX), the Jamshidi® needle (CareFusion Co., San Diego, CA), and the FAST1® IO infusion system (PYNG Medical Co., Richmond, BC). The Cook®, Jamshidi®, and FAST1® needles have been compared previously.[6,12,13] The EZ-IO® catheter has been shown to be comparatively more effective than the FAST1® system in a prehospital system setting.[14,15] The EZ-IO® catheter also demonstrated a high success rate (94-97%) in prospective observational studies with trained EMS personnel.[16,17] To our knowledge this is the first study to compare the effectiveness, speed, and complication rate of the traditional manual intraosseous catheter (Cook®) to the mechanical drill-assisted intraosseous catheter (EZ-IO®) by emergency medicine resident physician trainees with limited IO placement experience, in a live swine model.

METHODS

Protocol approval was obtained from the local Institutional Review Board and Institutional Animal Care and Use Committee prior to experimentation. Twenty-one emergency medicine (EM) resident physicians participated in the study during an EM technical and procedural skills laboratory session. The procedural skills laboratory provides them opportunities to practice lifesaving procedures on a live swine model. The EM residency program consists of 10 residents per class (PGY1-PGY3). The program is based in a Midwestern University and associated academic ED, with an annual patient volume of 74,000. No extramural or industry funding was received for this study or the procedural skills laboratory.

Laboratory sessions began with a short lecture on the use of the drill-assisted and manual IO catheters. The lecture followed the manufacturer's standard instructions on insertion of the Cook® and EZ IO® needles, as well as the clinical indications, contraindications, and possible adverse effects associated with the devices. For the Cook® IO, participants were instructed to use a smooth, controlled, to twisting motion with moderate pressure until there was a loss of resistance and the needle stood on its own, while for the EZ IO®, participants were instructed to squeeze the driver trigger and apply gentle, steady pressure until a "give" or "pop" was felt, indicating entry into medullary space. Faculty demonstrated the insertion of each device prior to the experiment initiation.

A randomization scheme assigned each resident to the needle insertion order, as well as the location of each needle (proximal tibia/distal femur). Mixed breed swine in good health were anesthetized using a combination of intramuscular injections ketamine (10 mg/kg) along with an inhalation aesthetic (isoflurane 4%). Each resident physician placed both a manual (Cook® 16 gauge x 30 mm intraosseus needle with a standard trochar tip design) and a drill-assisted needle (EZ IO® 15 gauge x 25 mm training intraosseus needle with 4 asymmetrical bevels on the stylet and 2 cutting tips on the catheter, and the 9050 Power Driver®) in a clean, but non-sterile technique. The time required for insertion was recorded beginning with puncture of the skin until the verbal end-mark given by the resident upon insertion. We evaluated successful placement using 3 criteria: aspiration of marrow blood, successful infusion of 10 mL methylene blue saline solution, and absence of extravasation of the stained saline solution. Successful IO insertion was defined as meeting two out of three criteria. Complications were defined as any event that would prevent successful placement in subsequent attempts with the same needle.

Participating residents were asked to complete a short survey after completion of the experiment. The administered questionnaire gauged prior experience using a modified Likert scale (1=strongly disagree, 5=strongly agree) and 10 cm Visual Analog Scale (VAS); 0 cm=most easy, 10 cm=most difficult). Participants were also asked to provide comments concerning the catheters and the study. IO completion times, VAS, and mean Likert scales were compared using Student's t-test, and success rates were compared using Fisher's exact test with $p<0.05$ considered significant.

RESULTS

Of the 21 resident participants, 14 were male (66.7%) and 7 were female (33.3%). Nine were first-year residents (42.9%), 7 were second-year residents (33.3%), and 5 were third-year residents (23.8%). Six residents (28.6%) had prior experience using the drill-assisted IO needle, and 12 residents (57.1%) had prior experience with the manual needle.

The average time to insertion for the drill-assisted IO needle was 3.66 seconds, compared to 33.57 seconds for the manual IO needle. The placement of the drill-assisted IO needles were successfully accomplished in 100% (21/21) compared to only 76.2% (16/21) of the manual IO needles (Table). There were no significant statistical relationships between anatomic sites (proximal or distal tibia) or among residents' gender, experience, or post-graduate year level for number of attempts or placement time.

Establishing intraosseous access using the manually placed IO needle was associated with technical complications, such as bending or breaking an infusion needle such that subsequent intraosseous infusion was impossible. Thirty-three percent of the manually placed IO needles in our study were bent compared to none of the drill-assisted IO needles (Table). No other technical complications were observed.

Based on survey results using a modified Likert scale, resident physicians would prefer to use the drill-assisted IO needle over the standard manual IO needle (4.52 versus 1.57, respectively; $p<0.0001$) and feel more confident using the drill-assisted IO than the manual IO needle in a clinical situation (4.48 versus 3.62, respectively; $p<0.0001$). Using a VAS (1 easiest and 10 most difficult), EM resident physicians also felt the drill-assisted IO needle was easier to place than the manual IO needle (0.98 cm versus 4.59 cm, respectively; $p<0.0001$).

Table. Intraosseous (IO) placement outcomes.

	Drill-assisted IO (21 attempts)	Manual IO (21 attempts)	p-value
Valid insertion	100.0% (21/21)	76.2% (16/21)	0.048
Aspiration	100.0% (21/21)	66.6% (14/21)	0.001
Successful infusion	90.5 % (19/21)	85.7% (18/21)	1.00
Extravasation	4.8% (1/21)	4.8% (1/21)	1.00
Upright needle	100.0% (21/21)	81.0% (17/21)	0.107
Bent needle	0.0% (0/21)	33.3% (7/21)	0.009
Multiple attempts needed	0%	33%	0.015

DISCUSSION

This study compared two methods of intraosseous insertion, the drill-assisted IO needle and the manual IO needle. Our study provided inexperienced resident physicians the opportunity to train with both needles on a live swine model. In acute emergent patient care scenarios, obtaining prompt intravenous or intraosseous access is often required. Clinicians in these situations require devices that are rapidly and can be readily placed. The results of our prospective randomized experimental trial indicate that the drill-assisted IO needle outperformed the manual IO needle with a higher success rate, faster insertion time, and fewer complications. The drill-assisted IO needle was the preferred device for emergency medicine resident physicians based upon survey data.

The reliability of intraosseous placement is imperative in emergency scenarios where medication, fluid, or blood administration is required and intravenous catheter placement is difficult to obtain or has been unsuccessful. Successful placement in our study was defined by meeting 2 of 3 criteria: aspiration of marrow blood, successful infusion of 10 mL methylene blue saline solution, and absence of extravasation of the stained saline solution. The rate of successful insertion of the drill-assisted IO needle compared to the manual IO needle demonstrates that the drill-assisted IO is the more reliable device in novice users. In comparison to a similar study published by Brenner et al[12], the placement of the drill-assisted IO needle in adult human cadavers had a success rate of 97.8% (44/45), while the manual IO needle had a success rate of 79.5% (31/39). These other studies help support our findings that the drill-assisted IO needle is a more reliable device than the manual IO needle.[11,14,17,18]

Much of the reason for the decreased success of the manual IO needle can be attributed to the higher rate of complications. Both needles are 15G and are similar in size. It is possible that participants in our study may have placed increased force when trying to place the manual IO needle, causing them to bend. This could be due to their lack of experience with the device or the overall nature of the manual insertion.

The drill-assisted needle can also be placed in less time, allowing faster fluid and medication administration to the patient. In a recent study of pediatric ED patients, the time for placement of a drill-assisted IO in 73/95 (77%) patients was less than 10 seconds.[18] This is consistent with our findings for drill-assisted IO insertion times. Other studies have shown comparable time lengths of 30 seconds for placement of both needles.[3,12] Regardless of the device used, intraosseous puncture can be performed quickly with the novice user and should not be delayed when IV access cannot be obtained. In clinical practice, parameters such as the cost of device, local practice patterns, and provider training and comfort levels may also have an impact on clinicians' decisions concerning the IO type utilized.

Resident responses in our survey show that the drill-assisted IO device is preferred over manual insertion in novice users. Residents also feel more confident with the drill-assisted IO needle and find it less difficult to use than the manual IO needle. These responses help solidify the drill-assisted IO needle as the better choice in inexperienced users.

LIMITATIONS

Our results must be interpreted in light of certain limitations. Participants were given the same in-service demonstration on the proper use of the devices. However, a certain degree of observational learning may have occurred with bystanders. Results may also be different in prehospital and clinical settings. The use of the swine model may serve as an explanation for the complications seen with the manual IO insertions, as swine are generally considered to have a thicker bone cortex than humans and in particular children. With more experienced users, different intraosseous devices may provide higher reliability and faster infusion. Further studies are needed to compare the rate of complications in novice users to that of experienced users in the prehospital or clinical setting.

CONCLUSION

The faster and more reliable placement of the drill-assisted IO needle in our anesthetized swine model makes it superior to the traditional manually placed IO needle in newly trained resident physician users. Future studies are needed to follow up and further evaluate our findings, particularly among children and in the prehospital setting.

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Integrated Model of Palliative Care in the Emergency Department

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An integrated model of palliative care in the emergency department (ED) of an inner city academic teaching center utilized existing hospital resources to reduce hospital length of stay (LOS) and reduce overall cost. Benefits related to resuscitation rates, intensity of care, and patient satisfaction are attributed to the ED-based palliative team's ability to provide real time consults, and utilize InterQual criteria to admit to a less costly level of care or transfer directly to home or hospice. [West J Emerg Med. 2013;14(6):633–636.]

Hospice and palliative medicine is the newest subspecialty of emergency medicine (EM), which concentrates on life-threatening illnesses whether they are curable or not. The illnesses may include terminal illness, organ failure, and/or frailty. Palliative medicine represents "the physician component of the interdisciplinary practice of palliative care."[1]

Published work on palliative care in the emergency department (ED) is limited yet promising. Research supports the use of palliative care interventions early in the disease trajectory to promote quality of life, as well as reduce costs associated with treatments.[2-5] The ability to change the existing paradigm of care for chronic diseases, such as cardiac or respiratory diseases, stroke, cancer and diabetes, is an opportunity for palliative medicine - specifically palliative care in the ED - to alter the trajectory of care. Many ED palliative care delivery systems have emerged as providers design programs to meet the needs of diverse stakeholders resulting in three recurring models of palliative medicine/care which are ED-palliative care partnerships; ED palliative care champions; and ED hospice partnerships [6]

The purpose of this article is to describe one hospital's approach in expanding the role of the ED staff into palliative and end-of-life care. St. Joseph's Regional Medical Center (SJRMC) in Paterson, New Jersey, developed a program, Life Sustaining Management and Alternatives (LSMA), to provide palliative consults in their urban ED, using the ED palliative care champion model.

Palliative Care Initiative

SJRMC is a major academic tertiary medical center and state-designated Level 2 trauma center with 651 beds and an annual ED volume of over 135,000 visits. The LSMA program was started by the chair of emergency medicine, boarded in EM and palliative medicine, who championed the palliative care initiative. The primary goal of the LSMA program was to identify those patients who might benefit from palliative care interventions upon entry into the healthcare system. The use of a trigger sheet (Figure 1) assists the staff in identifying patients for real-time palliative consults in the ED.

Early in the LSMA program, it was recognized that a distinction was needed between palliative care and end of life as both terms were used interchangeably. This same phenomenon has been noted in the literature, representing a barrier to research striving to improve care and support during this time of life.[7-9] The LSMA program defines palliative care as "providing palliative treatment while curative treatment is continued and is inclusive of end of life care." The inclusion of curative treatment is an important distinction that is in contrast to the stereotypical image of palliative care's association with comfort and death. Palliative care is not to be confused with hospice care in which patients have less than a 6-month life expectancy. Palliative care focuses on the disease trajectories of terminal illness (e.g. cancer), organ failure (e.g. congestive heart failure), and frailty (e.g. Parkinson's disease).

The LSMA program adheres closely to the World Health Organization's (WHO) definition and principles for palliative care, intervening as early as possible in the disease process to identify a plan of care that prolongs life while prioritizing the individual patient's goals.[10] End-of-life care, a component of the palliative care program, is defined as the care provided

during the last likely hospitalization. It is impossible to know when a person is dying, hence the difficulty in defining end of life. This leaves the concept to regulatory interpretation rather than scientific evidence.[9] However, end-of-life care usually encompasses a chronic disease with a progressive downward trajectory.[9]

The LSMA Program

The chair of the ED and a nurse coordinator initiated the LSMA program within an informal framework, identifying patients for palliative consults when they were working in the ED. While the ED staff had been responsive to multiple initiatives, such as the geriatric ED, resuscitation center, and the toxicology referral center, which have developed into successful programs, there was minimal interest in a palliative care program. Barriers to palliative care in the ED have been well documented and include staff resistance due to the stereotypical association with death, as well as financial barriers from insurance companies.[6,11,12]

In response, the LSMA program at SJRMC evolved slowly, using each patient's unique situation to help build the necessary foundation for the acceptance, transition and success of the ED palliative care program. The ED chair set out to expand the role of the ED by identifying patients who would benefit from palliative care, allowing the trajectory of care to be decided at the front end of the hospital stay. It has been recognized that it is beneficial to all for palliative care to start early – preferably on the first day of admission, which may mean starting in the ED itself.[1,13]

The LSMA program officially started in 2010 when the first ED palliative consult resulted in a male patient being discharged from the ED with home hospice in place. The following month, there were 6 consults in the ED resulting in 5 admissions to medical/surgical units, and 1 discharge from the ED with home hospice in place. As interest in the program grew, any ED staff member could ask for a palliative care consult, resulting in 131 LSMA consults over 16 months between March 2010 and July 2011. Additional consults were performed in-house at the request of the medical staff.

The LSMA program includes a core team of one emergency physician and one master's prepared nurse coordinator for the initial consult. Additional member involvement from the interdisciplinary team is determined by the plan of care. Other key members include nurses, nutritionists, chaplains, psychologists, social workers, physical therapists, occupational therapists, and other disciplines as required meeting the needs of each patient and family. Distinguishing itself from most other ED palliative programs, the LSMA program is open to all ages, including children. SJRMC has a pediatric ED with vast resources available to this population with a special focus on cancer trajectories.

Initial consultations range from a general introduction to in-depth communications regarding advanced directives and treatment plans. Consultations average 15 to 30 minutes or longer depending upon the patient/family circumstances. During the week, Monday through Friday from 7AM to 6PM, consultations are within 30 minutes. Telephone consultation is available 24/7; the patient is seen the following morning if further follow up is needed.

Arriving at the emergency department:

- From Long Term Care/Skilled Nursing Facility with Do Not Resuscitate status established or requested.
- Actively dying in pain and discomfort.
- Currently enrolled in a hospice program.
- Previously discharged from this hospital inpatient palliative care program.
- Two or more hospital admission within three months with same symptoms consistent with a terminal or degenerative chronic medical condition.
- Advanced disease with frequent infections.
- Nutritional complications with albumin of less than 2.5 mg/dl.
- Primarily bed bound with advanced dementia process.
- Advanced disease with enteral feeding in place.
- Disease triggers:
  - Aspiration pneumonia
  - Bone metastasis
  - Chronic obstructive pulmonary disease
  - Heart failure
  - Hemorrhagic stroke
  - Malignant neoplasm
  - Renal failure
  - Septicemia
  - Trauma

Figure 1. Triggers for emergency department palliative care consult.

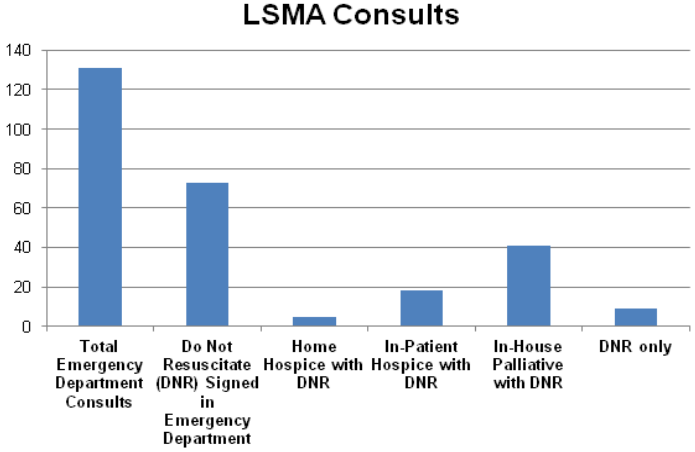
Of utmost importance is the determination of the patient goals as early as possible, including discussions of "do not resuscitate" (DNR) status as appropriate to the individual patient.[13] Most hospital settings, including SJRMC, continue to use DNR terminology even as competing terms, such as "do not attempt resuscitation" (DNAR) and "allow natural death" (AND), receive endorsement from the American Heart Association and the American Nurses Association.[14,15] Regardless of the specific terminology chosen by an institution or provider, the patient's resuscitation goals and choices need to be clearly understood by the patient, his family, and healthcare providers.[14] The LSMA consults resulted in 73 of 131 (56%) patients initiating DNR orders in the ED (Figure 2). The LSMA program has not had an impact on the number of inpatient consultations for the inpatient palliative care service at SJRMC. This may suggest that the implementation of the LSMA program has identified a new subset of patients reflecting similar experiences noted in the literature.[16]

Benefits of the LSMA program have been numerous, extending beyond the patient and their families to the ED and hospital staff. First and foremost, the patient's wishes are supported and carried out throughout the plan of care.

The interdisciplinary team focuses on open communication to attain symptom management, choice of interventions and the treatment plan. General benefits include reducing hospital length of stay (LOS) and reduction of overall cost, which is well documented in the literature.[17,18]

Specifically, the LSMA program has provided benefits related to resuscitation rates, intensity of care and patient satisfaction. Some patients with "end of life" diagnoses have chosen not to have cardiac resuscitation if needed since it did not support their goals of care, thereby impacting overall resuscitation rates in the hospital. There are cost savings as a benefit of providing the appropriate level of service for the palliative patient in terms of level of care, support of disease trajectory and patient/family choices. ICU costs are associated with approximately 20% of overall hospital costs.[5] InterQual level of care criteria for acute care was used to evaluate intensity of service and best location of care for patient consults in the LSMA program. InterQual is a medical necessity-screening tool used to determine if a hospital admission is medically necessary by correlating a patient's severity of illness with intensity of care.[19,20] Over one-half (57%) of all LSMA consult patients who were admitted to medical surgical units (lowest level of hospital inpatient care) met criteria for a higher level of care, either critical care or step-down. Of those LSMA patients discharged from the ED, 62% met admission criteria, with 50% of this cohort meeting critical care admission criteria. The decision to discharge or admit to a lower level of care was in accordance with the patient's stated goals of care and advanced directives. All told, 48 of 131 (37%) LSMA patients were cared for at a lower level (presumably lower cost), than would likely have resulted without the LSMA program.

Billing for the consultation service varies on insurer and contracts. The coding and billing can be done using ED visit codes or initial hospital codes – whichever is more appropriate based on the patient's disposition. Revenue for the service varies, but based on volume of consultations this service potentially can be self-sustaining.



LSMA, Life Sustaining Management and Alternatives

Figure 2. Emergency department palliative care consults March 2010 to July 2011 (n = 131).

Lessons Learned

The LSMA program grew from existing hospital resources. Currently, the program continues with the chair and nurse coordinator providing ED and in-house consults. These two positions (chair and nurse coordinator) are considered critical to the development of any ED-based program. It is essential to know the staff and community as well as nuances of the hospital in terms of leadership, internal politics and resources before designing an ED-based palliative care program. It is recommended that any ED-based program provide real-time consults, which has been a large part of the success of the LSMA program. As noted in the literature, contact with the patient and family on the first date of service provides the best opportunity to impact the plan of care.[21]

Education and certification of staff is an ongoing necessity including continual review of the literature. The development and maintenance of a data log are required to provide statistical evidence for over-site review, board and committee updates and to identify quality indicators for monitoring. The data log includes: date of service, medical record number, age, and gender. Quality indicators include: Reason for ED visit, reason for palliative consult, hospice referral, DNR status, and admission or discharge status.

Lastly and most importantly, an advocate of the palliative care program is needed (preferably an ED physician) who possesses the ability to work behind the scenes educating, recruiting, addressing barriers and promoting inclusion and continuity of the program within the individual hospital structure. The advocate becomes critical to the success and growth of the program. The LSMA program has survived the construction of a new 88-bed ED, as well as various personnel changes including the departure of the primary nurse coordinator. Implementing the LSMA program has met a variety of challenges in developing transition of care plans between the ED, inpatient and outpatient for multiple medical services while remaining responsive to the needs of this patient cohort and changing paradigm of care.

Future Directions

The LSMA focus has been on identifying patients for the palliative care program, providing both end-of-life and palliative consults. In the future, the emphasis will be on the transition of care and continuity throughout the hospital stay and patient discharge. This involves identifying a mechanism to follow-up with each ED palliative consult in 48 hours to define the plan of care. Currently, the LSMA team is strictly ED based and is working with hospital staff in establishing the continuity of care regardless of the patient's disposition. Continuity of care and the role of the ED-based palliative program needs to be integrated with in-house and out-of-house patient transitions.

The staff will assist in identifying the main reason for ED visits for those in palliative care, which studies suggest are related to symptoms of pain, nausea, vomiting,

constipation and shortness of breath.[22] Emergency medical service protocols, time trial therapy and heart failure patients specifically will be monitored.

Above all, each palliative care team member is an advocate for this vulnerable population, reaching out to discover innovations and advancements in this growing specialty of care. Change is a slow process and the growth of any new program is arduous. However the LSMA program is impacting the delivery of care one medical resident at a time, one patient at a time, one person at a time.

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Visualization of Cardiac Thrombus by Bedside Ultrasound

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A 85-year-old man with sudden onset of dyspnea and chest pain with an history of immobilization due to right tibia plateau fracture after traffic accident 2 months ago was admitted to our emergency department. He was hypotensive (70/50 mmHg), tachycardic (166 beats/minute), tachypneic (26/minute) on admission. A 12-lead electrocardiogram showed atrial fibrillation with rapid ventricular response, arterial blood gas analysis revealed a hypoxic and hypocarbic profile together with an increased alveolar arterial oxygen. His physical examination was unremarkable except cold extremities, delayed capillary refilling time and bilateral decreased breath sounds with rhoncus, abdominal respiration and increased in diameter of right calf 3 cm more than left. Focused cardiac ultrasonography (FOCUS) performed by the emergency physician (EP) using a Mindray M7® model ultrasound machine with a 3.6 mHz microconvex transducer (M7, Mindray Bio-medical Electronics CO., Shenzen, China) revealed enlarged right ventricle (RV), hypokinetic lateral wall and hyperkinetic apex of RV (McConnell's sign)[1] and also a large, mobile serpentine thrombus in the right atrium. The thrombus also extended into the inferior vena cava and protruded into the RV through the tricuspid valve during diastole (Video). Computerized tomography angiography of the thorax revealed filling defects in both main pulmonary arteries (Figure). The patient received alteplase treatment with a dose of 100 mg over 2 hours in the intensive care unit. The patient was discharged from the intensive care unit with oral anticoagulation after three days with symptomatic relief.

Pulmonary emboli (PE) is one of the crucial considerations in the differential diagnosis of acute dyspnea and hypotension. Multiple prospective studies reveal a low sensitivity (41-70%) of FOCUS for specifically identifying PE.[2,3] As experience with emergency ultrasound grows, EPs will be expected to fully understand and exploit the power of FOCUS to meet the evolving standards of care in emergency medicine.

Video. Focused cardiac sonography shows dilated right ventricle and also a mobile thrombus in the right atrium.

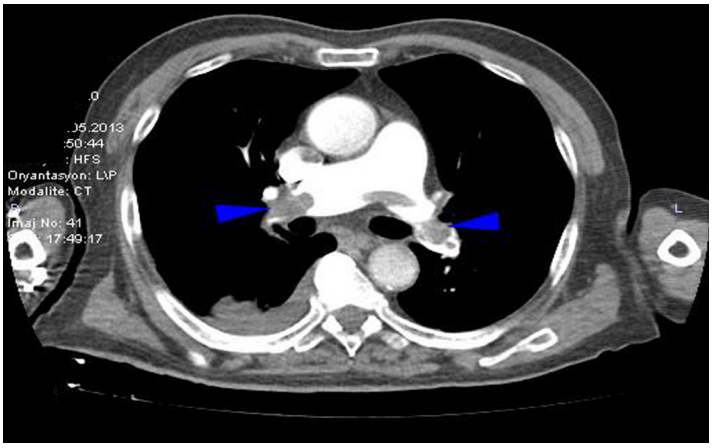

Figure. Blue arrow heads show filling defects in both main pulmonary arteries in computerized tomographic angiography of the thorax.

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Uncommon Etiology of Chest Pain: Pulmonary Sequestration

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Chest pain is a common presenting symptom in the emergency department. After ruling out emergent causes, emergency physicians need to identify and manage less commonly encountered conditions. Pulmonary sequestration (PS) is a rare congenital condition involving pulmonary parenchyma. In PS, a portion of non-functional lung tissue receives systemic blood supply from an anomalous artery. While most individuals with PS present in early life with symptoms of difficulty feeding, cyanosis, and dyspnea, some present later with recurrent pneumonia, hemoptysis, or productive cough. In this report, we present a case of PS in an adult with acute onset pleuritic chest pain. [West J Emerg Med. 2013;14(6):638–639.]

CASE PRESENTATION

A previously healthy 26 year old male presented to the emergency department (ED) with chest pain for 1 hour. The patient stated the substernal pain was 10/10 in severity, non-radiating and worse with deep inspiration. He experienced intermittent left arm numbness that started after the onset of the chest pain but denied heart palpitations, diaphoresis, shortness of breath, hemoptysis, cough or recent fevers. On physical exam, vital signs were unremarkable, and he was cooperative and able to speak in full sentences. Chest auscultation did not detect any abnormalities. An electrocardiogram was read as normal. A chest radiograph revealed a lung lesion in the left lower lobe. A computed tomography (CT) of the chest showed a 11 cm x 9 cm x 10.5 cm round, well-defined, heterogeneous mass consistent in location with the lesion noted on the chest radiograph. The patient's chest pain was well controlled on oral analgesics, and after consultation with the surgical service he was scheduled for an outpatient appointment for follow up and treatment. The patient was discharged and prescribed acetaminophen-hydrocodone 500 mg-5 mg oral tablets to be taken as needed for pain 1-2 tablets every 4-6 hours with a maximum of 8 tablets per day. He was advised to return to the ED if symptoms persisted or worsened.

The patient returned to the ED 1 day later with recurrent chest pain that was now more localized around his left lower ribs and rated as 8 out of 10 in severity. His vital signs remained within normal limits and his physical exam was unchanged from discharge. A repeat chest CT showed no changes. His pain management therapy was changed to acetaminophen-oxycodone 325 mg-7.5 mg oral tablets to be taken as needed for pain 1 tablet every 4 hours with a maximum of 6 tablets per day. This adjustment resulted in symptomatic relief of his chest pain. With improved

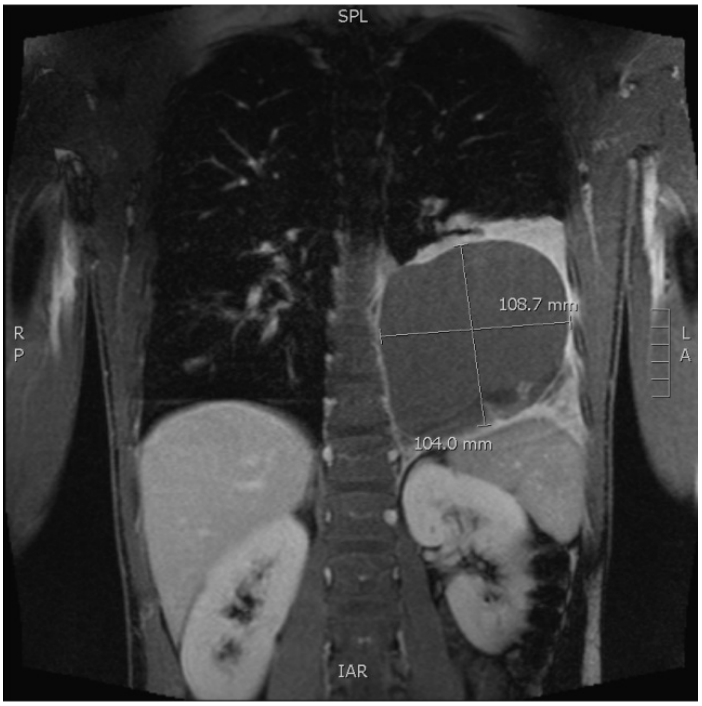

Figure. Chest magnetic resonance angiogram with contrast showing the extralobular pulmonary sequestration as a cystic lesion in the right lower lung field.

symptoms and unchanged imaging, he was discharged with strict follow-up instructions.

The patient returned 3 days later for his scheduled outpatient appointment. The surgical service obtained a chest magnetic resonance angiogram with contrast that revealed a cystic lesion measuring 108.7 mm by 104.0 mm (Figure). A thoracotomy with resection of an extralobar pulmonary sequestration (PS) was completed without intraoperative or post-operative complications. The non-communicating lung parenchyma was being supplied by an artery arising from the abdominal aorta. The patient was discharged home on post-operative day 4.

At a follow-up outpatient appointment 1 week after discharge, the patient remained asymptomatic, and a repeat chest radiograph showed resolution of the PS. The patient did not require further outpatient follow-up.

DISCUSSION

PS is a rare congenital pulmonary malformation involving lung parenchyma that lacks communication with the tracheobronchial tree. Arterial blood supply in most cases of PS is provided by the thoracic or abdominal aorta, and venous drainage is usually accomplished by pulmonary veins.[1] Most cases are diagnosed and treated in childhood with diagnosis possible antenatally by ultrasound as early as 18-19 weeks of gestation.[3] In the rare instances that PS presents in adulthood, symptoms like recurrent pneumonia, productive cough and hemoptysis are usually present.[4] As our case demonstrates, patients may also present with chest pain and other nonspecific symptoms.

When PS is incidentally found in asymptomatic individuals, observation with close monitoring may be sufficient. Recently some authors have argued for resection in asymptomatic patients due to risk of infections, the low rate of natural regression, and to exclude other pathology.[5]

In cases of symptomatic patients, such as the one presented here, management strategy is directed at confirming diagnosis, alleviating symptoms and then removal of the abnormal lung tissue. Diagnosis involves the identification of the aberrant arterial vessel supplying the non-functional lung parenchyma. Since it is not possible to exclude malignant etiologies from PS based on imaging alone, surgical intervention and histological examination are required to confirm the diagnosis.[7] Thus, PS requires a high index of suspicion once an aberrant artery is visualized on CT angiography. In the case presented, a repeat chest CT was ordered on the second ED admission due to worsening symptoms and the uncertainty of diagnosis. This was necessary to rule out progression or rupture of the lung lesion.

It is not possible to diagnose PS in adults based on physical exam and history alone. Although recurrent pneumonia may increase suspicion of PS, due to the rarity of the condition and variety of presenting symptoms, the task is formidable. In a retrospective study reviewing 2,625 PS cases from the Chinese National Knowledge Infrastructure, authors of the report were able to identify symptoms of cough or expectoration in over half of the cases followed by fever and hemoptysis.[6] These non-specific findings highlight the difficulty a clinician faces when attempting to diagnose PS based on history and physical exam findings.

Surgical resection is favored as the most effective method of treatment. In certain cases an embolization of the aberrant artery preformed preoperatively can facilitate surgical resection.[5] This technique is more valuable when removing intralobar PS, which are more challenging to distinguish compared to extralobar PS. In our case, embolization was not used or necessary in the resection of the extralobar PS.

Once life-threatening conditions and other etiologies of chest pain are eliminated, PS must remain on the differential diagnosis when lung lesions with anomalous arterial supply are seen on imaging. In the acute care setting, emergency physicians should tailor treatment for patients with PS with symptom relief until surgical resection can be preformed.

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Total Collapse of the Heart

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An approximately 30 year-old Ugandan male was found unresponsive on an American base in Iraq. The patient was altered and combative with no signs of trauma. A chest x-ray was performed showing an enlarged cardiac silhouette and pulmonary edema. The patient required intubation during which a large amount of edema fluid was produced. A computed tomography (CT) (Figure) showed severe calcifications of both the aortic and mitral valves.

Shortly after CT the patient went into cardiac arrest. The patient had a bedside echocardiogram showing severe bi-valvular heart failure and died shortly thereafter. The diagnosis of rheumatic heart disease with severe cardiomyopathy was considered the most likely cause of his presentation.

Rheumatic heart disease is a major cause of cardiovascular death in developing countries and affects between 15 and 20 million people worldwide.[1] The disease is a sequella of one or more episodes of acute rheumatic fever with subsequent valvular calcification and damage. The pathophysiology is felt to be an aberrant immune response to certain strains of *Streptococcus pyogenes* infection. The mitral valve is most commonly affected, but aortic valve involvement is also seen as the disease progresses. Patients may not recall any preceding events and present with shortness of breath between ages 20 and 50.[1] Diagnosis of rheumatic disease is often made by echocardiogram when the diagnosis is suspected. Without intervention, the disease progresses to severe valvular disease with heart failure.

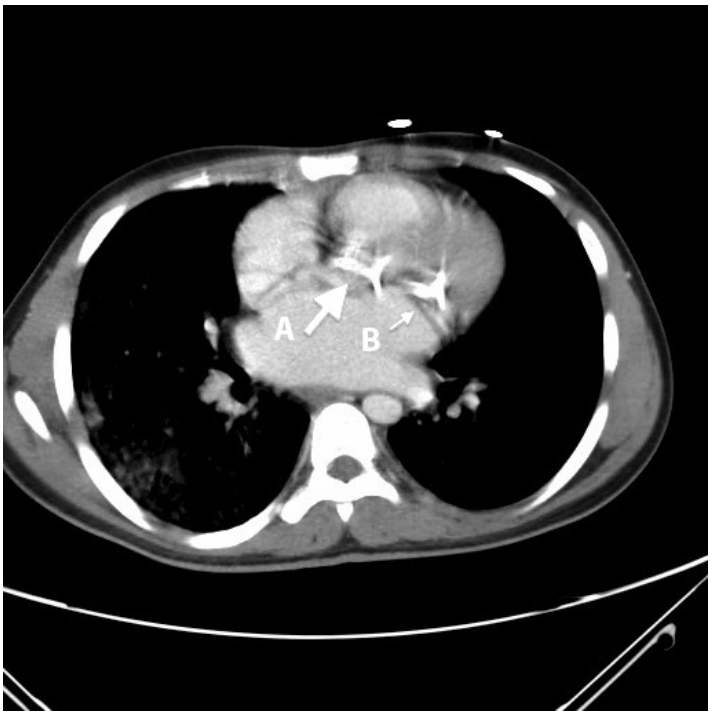

Figure. Intravenous contrast enhanced computed tomography of the chest showing severe calcifications (arrows) of both aortic (A) and mitral (B) valves.

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Ultrasound Diagnosis of Bilateral Tubo-ovarian Abscesses in the Emergency Department

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CASE REPORT

A previously healthy 30-year-old woman (gravida 1 para 1) presented to the emergency department (ED) with 5 days of lower abdominal pain, fever, and nausea. On examination, she had a temperature of 37.6° Celsius, pulse 116 beats/minute, blood pressure 123/65 mmHg, respiratory rate 18 breaths/minute, and oxygen saturation 98% on room air. On bimanual examination, the patient exhibited bilateral adnexal tenderness, but no cervical motion tenderness. Relevant laboratory studies included negative urine beta-hCG, white blood cell count $17.4x10^3/\mu L$ and lactate 2.4 mmol/L.

A bedside transabdominal pelvic ultrasound demonstrated bilateral complex adnexal masses suspicious for tubo-ovarian abscesses (Video). The patient received intravenous piperacillin/tazobactam, doxycycline, and clindamycin and was admitted to the gynecology service. Surgery was initially deferred and she was managed conservatively with intravenous antibiotics. By the third day of hospitalization, her symptoms had not resolved and an exploratory laparotomy demonstrated purulent ascites and necrotic uterus, ovaries, and fallopian tubes, necessitating a total abdominal hysterectomy and bilateral salpingo-oophorectomy. The patient was discharged home 3 days following the surgery without further complications.

DISCUSSION

Tubo-ovarian abscess (TOA) is the most common form of intra-abdominal abscess in premenopausal women,[1,2] occurring in up to 30% of women hospitalized with pelvic inflammatory disease.[3,4] Ultrasound is the preferred diagnostic study for TOA, with moderate sensitivity (56–93%) and high specificity (86–98%) among radiology-performed studies.[5,6] The increasing availability of ultrasound in the ED can aid in the early diagnosis of this common and potentially life-threatening condition.[7] Ultrasound findings suggestive of TOA include loss of tissue boundaries between pelvic organs; thick, dilated fallopian tubes; and complex adnexal masses with irregular margins.[7,8] TOAs should be treated with intravenous broad-spectrum antibiotics.[9] Surgery should be considered in patients with signs of rupture, abscess >9 cm, and who do not improve with antibiotics.[10]

Video. Transverse transabdominal ultrasound of the pelvis performed with a 5-2MHz curvilinear probe demonstrates bilateral complex septated adnexal masses.

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Evolution of a Round Pneumonia

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A previously healthy 14-year-old male presented to the emergency department (ED) complaining of 2 days of subacute onset, right-anterior pleuritic chest pain. He reported an associated dry cough, but denied fever, sputum, hemoptysis, shortness of breath, orthopnea, leg swelling, weight loss or night sweats. The patient had no known sick contacts, and had no identifiable cardiac or thromboembolic risk factors. We obtained a 2-view chest radiograph, which revealed an indeterminate 1.3 cm focal density in the right upper lobe (Figure 1). The patient was discharged on oral analgesics with a plan for follow-up imaging.

Six days after symptom onset the patient returned to the ED with worsening pain despite oral analgesics, a low-grade fever and a worsening dry cough. On physical examination the patient was well appearing and in no apparent distress. His temperature was 99.8 °F; his blood pressure was 105/72; his heart rate was 95 beats/minute; and his oxygen saturation on room air was 99%. A previously planted PPD was read as negative. We obtained a repeat chest radiograph, which revealed a wedge-shaped consolidation in the inferior segment of the right upper lobe (Figure 2). The patient was treated with an oral cephalosporin as an outpatient with complete resolution of his symptoms.

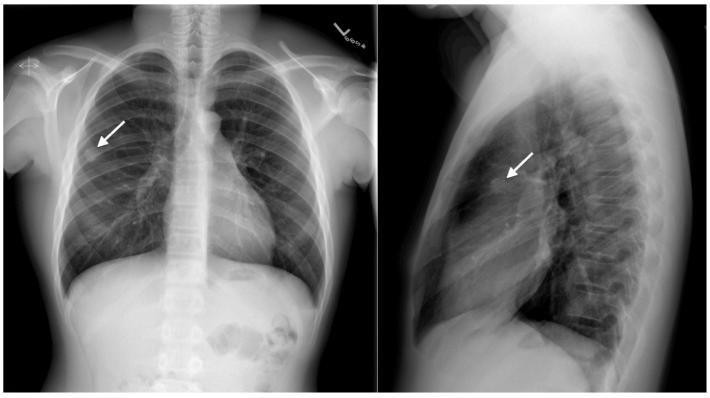

Figure 1. Anterior-Posterior chest radiograph on index visit showing a 1.3 cm right upper lobe density (arrows).

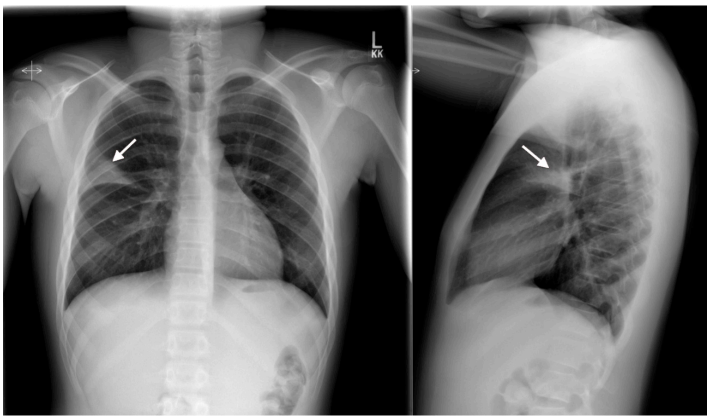

Figure 2. Anterior-Posterior chest radiograph on day 6 showing consolidation of the inferior segment of the right upper lobe (arrows).

Round pneumonia is primarily seen in children and adolescents. In one study, 75% of patients were under 8 years of age, and 90% under 12.[1] It is postulated that round pneumonias occurs more often in children as they have poorly developed pathways of collateral ventilation, more closely apposed lung connective tissue septa and smaller alveoli, when compared to adults. These factors combine to form more compact areas of infiltrate, which can appear as round lesions on chest radiography.[2] Round pneumonias are most often caused by *Streptococcus pneumoniae*, and resolution after treatment, rather than progression to lobar pneumonia, is the rule.[1,3] In addition to infection, the differential diagnosis of a round lesion on a pediatric chest radiograph includes primary lung neoplasm, congenital bronchogenic consolidation, and Wilms tumor.[2] The majority of round lesions in children, however, are non-neoplastic, and advanced imaging with computed tomography or magnetic resonance imaging is not typically indicated unless symptoms suggest an alternative diagnosis.[4]

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A Painful, Blistering Rash

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CASE

A 67-year-old man presented with painful oral and skin lesions developing over the last 2 months. The lesions initially formed in his mouth and lips, and slowly spread to his torso, groin, and extremities (Figure 1). The lesions began as blisters that broke easily and were exquisitely painful to light touch. In the past few days, he also developed painful lesions on his eyes that were associated with redness and photophobia. The patient saw his primary care doctor at the onset of illness and failed to improve with courses of azithromycin, ciprofloxacin, and tetracycline. He was no longer able to tolerate anything by mouth because of pain and he had lost a significant amount of weight. His skin exam was notable for Nikolsky's sign.

DIAGNOSIS

Pemphigus vulgaris is an autoimmune blistering disorder mediated by auto-antibodies against epidermal cell antigens.[1] It has an incidence of approximately 1 in 100,000, and the usual age of onset is 40-60 years of age.[2] Patients present with painful, flaccid bullae that rupture and form erosions (Figure). Shearing stress on skin can lead to development of new erosions (Nikolsky's sign). Oral lesions are the initial symptom in 50-60% patients and may precede cutaneous lesions by months. Diagnosis is confirmed by histology and direct immunofluorescence of peri-lesional skin. Mortality is 70% if untreated, and primarily results from sepsis, fluid loss and malnutrition from oral lesions.[3]

Our patient was admitted for fluid resuscitation and intravenous steroids, and had a skin biopsy consistent with pemphigus vulgaris.

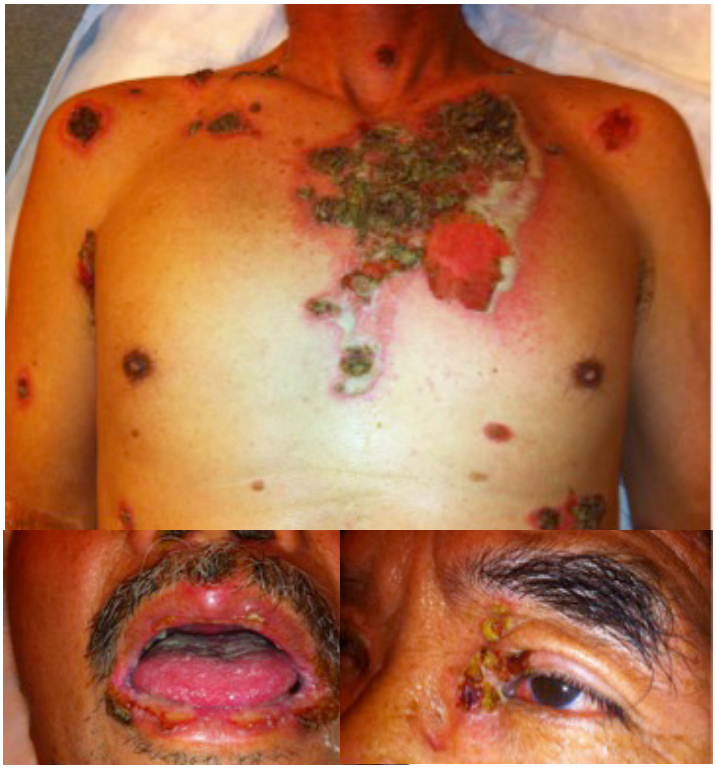

Figure. Extensive erosions and flaccid bullae associated with autoimmune blistering disorder.

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Sedative Dosing of Propofol for Treatment of Migraine Headache in the Emergency Department: A Case Series

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Introduction: Migraine headaches requiring an emergency department visit due to failed outpatient rescue therapy present a significant challenge in terms of length of stay (LOS) and financial costs. Propofol therapy may be effective at pain reduction and reduce that length of stay given its pharmacokinetic properties as a short acting intravenous sedative anesthetic and pharmacodynamics on GABA mediated chloride flux.

Methods: Case series of 4 patients presenting to an urban academic medical center with migraine headache failing outpatient therapy. Each patient was given a sedation dose (1 mg/kg) of propofol under standard procedural sedation precautions.

Results: Each of the 4 patients experienced dramatic reductions or complete resolution of headache severity. LOS for 3 of the 4 patients was 50% less than the average LOS for patients with similar chief complaints to our emergency department. 1 patient required further treatment with standard therapy but had a significant reduction in pain and a shorter LOS. There were no episodes of hypotension, hypoxia, or apnea during the sedations.

Conclusion: In this small case series, sedation dose propofol appears to be effective and safe for the treatment of refractory migraines, and may result in a reduced LOS. [West J Emerg Med. 2013;14(6):646–649.]

INTRODUCTION

Acute migraine headache accounts for approximately 2.1 million emergency department (ED) visits and incurs over $600 million in annual healthcare costs.[1,2] Common ED treatments for migraine headache include various pharmacologic agents, oxygen and/or rehydration.[2] While these treatments are usually ultimately effective, they often have the patient occupying a treatment space for extended periods. This potentially slows patient flow in already burdened ED's. A series of small studies and case reports have shown rapid relief of both chronic headache and acute migraine headache using propofol, a lipid soluble short-acting intravenous anesthetic.[3-9] The majority reported occurred as outpatient procedures or in a monitored pre-anesthesia care unit.[3,4] Only 1 small series was performed in adult ED patients at sub-sedation doses of 10 mg every 5 minutes.[10] Propofol is an ultra short-acting anesthetic that increases GABA mediated chloride flux, exerting an inhibitory effect on synaptic transmission, cerebral blood flow and metabolic rate, and central serotonergic neurons in the raphe nuclei.[11-16] We therefore postulated that propofol could safely be used in an ED setting not only with efficacy but also a substantial reduction in ED length of stay (LOS). Based upon the aforementioned studies, we used sedation dose propofol in a convenience sample of migraine patients presenting to the authors in the ED having failed their usual outpatient treatments. We report a case series of four patients safely and rapidly treated for migraine headache in the ED using sedative dosing of propofol, which we hope will form the basis for a research protocol to evaluate this therapy on a more rigorous basis.

CASE REPORTS

Patient 1

A 51-year-old male with past medical history of migraines, hypertension and depression presented with headache for the previous 24 hours. The pattern was typical of his migraine headaches. Initial vital signs were heart rate 97, blood pressure 135/93, respiratory rate 16 and pain scale of 9/10. His migraine had not responded to his home medications. Prior migraines requiring ED visits were treated with: prochlorperazine, diphenhydramine, acetaminophen, droperidol, ibuprofen, morphine, and normal saline. Physical exam was unremarkable for any focal neurologic findings other than photophobia.

The patient was consented for procedural sedation and treated with 1 mg/kg of propofol. Thirteen minutes after medication the patient was arousable. The patient was observed for an additional 1 hour and 9 minutes during which the headache decreased to 2/10 and then complete resolution with no further pharmacologic intervention. He was reassessed and discharged home with a total LOS of 2 hours. Discharge vital signs were heart rate 77, blood pressure 137/94, respiratory rate 16.

Patient 2

A 51-year-old woman with past medical history of hypertension and migraines presented with 12 hours of 9/10 headache typical of her past migraines. Repeated doses of her home sumatriptan (100 mg) had failed. Initial vital signs were heart rate 60, blood pressure 193/105, respiratory rate 14. A full neurologic examination found no focal deficits. Initial treatment with compazine 10 mg intravenous (IV) and IV hydration with 1 L of normal saline was attempted with a pain score remaining 9/10. The patient was then consented and treated with 1 mg/kg propofol. A complete resolution of symptoms was achieved with a LOS of 2.75 hours. Discharge vital signs were heart rate 48, blood pressure 134/97, respiratory rate 18.

Patient 3

A 62-year-old woman with a history of complex migraine presents with 5 days of 9/10 headache, with no relief from her home regimen of ibuprofen and rizatriptan. Past medical history was significant for irritable bowel syndrome, hepatitis C, and arthritis. She also complained of photophobia, left-sided facial paresthesias, and nausea, all of which were consistent with past migraine episodes. Initial vital signs were heart rate 73, blood pressure 151/84, and respiratory rate 18. Physical exam was remarkable only for decreased sensation on the left side of the face, in all 3 dermatomes. The patient was consented and treated with 1 mg/kg propofol. After five minutes she reported marked improvement with her pain score reduced to 3/10. On repeat evaluation she requested further treatment and was given intravenous compazine 10 mg IV, diphenhydramine 50 mg IV, and ketorolac 30 mg IV with 2 L intravenous saline. At discharge she reported full resolution of headache symptoms. Her total LOS was 4.8 hours. Discharge vital signs were heart rate 61, blood pressure 137/71, and respiratory rate 18.

Patient 4

A 59 year old man with past medical history significant for migraines, insomnia, and hypothyroidism presented with four hours of 8/10 right-sided headache and photophobia. Symptoms were consistent with his typical migraine. Home treatment with naproxen and gabapentin had failed to improve his symptoms. Previous migraines requiring ED admission were treated with prochlorperazine 10 mg IV, diphenhydramine 50 mg IV, ketorolac 30 mg IV, morphine 6 mg IV, and promethazine 12.5 mg IV. Initial vital signs were heart rate 79, blood pressure 116/78, and respiratory rate 18. Neurologic examination revealed no focal deficits. The patient was then consented and treated with 1 mg/kg propofol. After 5 minutes the patient reported near complete resolution of symptoms with a pain score of 1/10. He was able to ambulate, tolerate oral intake, and was discharged shortly thereafter. His ED LOS was 2.8 hours. Discharge vital signs were heart rate 80, blood pressure 104/66, and respiratory rate 16.

DISCUSSION

All 4 reported patients carried a prior diagnosis of migraine headache and had failed their standard home rescue therapy. Due to the unconventional nature of the off-label use of propofol therapy for migraines in the ED, patients were only considered a candidate by 1 of the authors if they carried a diagnosis of migraines as documented in the patient record, no suspicion of alternate diagnosis, and had unsuccessfully tried the outpatient rescue medication. Patients were not considered if they had fever, altered mental status, history of trauma or suspicion of alternate diagnosis. If the physician felt the patient was a good candidate, they were offered the therapy and all patients were consented for procedural sedation after careful explanation of the risks and benefits of this unconventional therapy. For comparison purposes, we obtained LOS for all 465 patients who were treated and released with a primary diagnosis code for migraine (ICD-9 codes 346-346.9) in fiscal year 2011 (July 1, 2010-June 30, 2011). The mean length of stay at this urban academic emergency department for these patients was 6.5 hours (standard deviation [SD] 3.76 hours, 95% confidence interval [CI] 6.16-6.84). Patients in the case series were seen and treated during this same time interval. LOS for patients included in the case series was verified using nursing documentation of the time the patient was placed in an examination room and the time of discharge from the Emergency Department. When available, we also calculated an average LOS for these patients with previous ED visits for migraine headache. Patients receiving propofol therapy were

Table. Pain score and length of stay.

	Initial pain score	Discharge pain score	Propofol dose (mg/kg)	Length of stay (LOS) (hours)	Average LOS prior 3 visits (hours)
Patient 1	9	0	1	2.00	4.4 (SD 0.75, 95% CI 3.5-5.2)
Patient 2	9	0	1	2.75	NA
Patient 3	9	0	1	4.80	NA
Patient 4	8	1	1	2.80	4.3 (SD 0.8, 95% CI 3.4-5.2)

LOS, length of stay; *SD,* standard deviation; *CI,* confidence interval, *NA,* not available

placed on a cardiac monitor, supplemental oxygen by nasal cannula, end-tidal CO_2 monitor, and had one:one nursing care during the sedation, as is standard practice for all procedural sedations performed in our emergency department. The drug was administered as a slow infusion over 1 minute through a peripheral IV with a 10 mL syringe until the patient fell asleep without a rise in end-tidal CO_2 or a decrease in respiratory rate or oxygen saturation. The maximum dose of propofol allowed was 1 mg/kg and was stopped short if the desired effect was achieved with a smaller dose. The patient was allowed to sleep until they woke up on his or her own. See table for summary of dose given, length of stay, and pain score of each patient.

The patients reported in this series had an average LOS of 3.1 hours (SD 1.2 hours, 95% CI 1.92-4.28). All patients reported a substantial decrease in symptoms. Two of the patients were also treated with standard migraine therapy, 1 after propofol treatment and 1 before. These patients still had shorter LOS than the average patient with migraine headache in our urban academic medical center. There were no periods of apnea or hypotension with the propofol administration, and there were no other complications reported. One patient in this series was discharged with a short course of hydrocodone/APAP while the other three did not receive narcotics in the emergency department nor were they given prescriptions for outpatient use.

Two patients had been seen multiple times in the previous 12 months with similar presentations. The most recent 3 visits were analyzed. For both patients the LOS was markedly reduced when they were treated with propofol (Table).

This series shows a promising reduction in headache symptoms using sedative dosing of propofol. Reducing emergency department LOS while safely assessing and treating patients is one of the greatest challenges facing emergency physicians today. Headache is a common presenting complaint that can often be treated symptomatically without extensive diagnostic testing. Alleviating headache symptoms rapidly could improve ED patient flow and have a possible positive effect on patient satisfaction with treatment. One concern, however, is developing a propofol dependency[17,18] much like the widespread narcotic dependence that is seen widely by EDs throughout the country. Schneider and colleagues have reported the only known case of lay-person propofol dependence[17], and despite the high abuse potential[18], no other data exists regarding this phenomenon. None of the patients reported in this series have returned for repeat therapy.

CONCLUSION

Based upon this limited experience, propofol shows promise for the treatment of ED patients who present with migraine symptoms refractory to their outpatient rescue therapy. Future research should more formally evaluate the safety, effectiveness, and cost effectiveness of sedation dosing of propofol for refractory migraines.

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Needle Decompression in Appalachia Do Obese Patients Need Longer Needles?

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Introduction: Needle decompression of a tension pneumothorax can be a lifesaving procedure. It requires an adequate needle length to reach the chest wall to rapidly remove air. With adult obesity exceeding one third of the United States population in 2010, we sought to evaluate the proper catheter length that may result in a successful needle decompression procedure. Advance Trauma Life Support (ATLS) currently recommends a 51 millimeter (mm) needle, while the needles stocked in our emergency department are 46 mm. Given the obesity rates of our patient population, we hypothesize these needles would not have a tolerable success rate of 90%.

Methods: We retrospectively reviewed 91 patient records that had computed tomography of the chest and measured the chest wall depth at the second intercostal space bilaterally.

Results: We found that 46 mm needles would only be successful in 52.7% of our patient population, yet the ATLS recommended length of 51 mm has a success rate of 64.8%. Therefore, using a 64 mm needle would be successful in 79% percent of our patient population.

Conclusion: Use of longer length needles for needle thoracostomy is essential given the extent of the nation's adult obesity population. [West J Emerg Med. 2013;14(6):650–652.]

INTRODUCTION

Tension pneumothorax is a devastating and fatal injury pattern that requires the rapid removal of air via needle decompression of the thoracic cavity as an essential lifesaving technique.[1] The current American College of Surgeons Advanced Trauma Life Support (ATLS) guidelines advocate the use of a 51 mm (2 inch) needle for needle decompression for tension pneumothoraces.[1] The United States is experiencing an increasing problem with obesity, Inaba et al[2] discussed alternate sites for decompression based on computed tomography (CT) and postulated a change in site of needle decompression. Air collects anteriorly in the supine patient in addition to scar tissue, breast tissue, hemothorax. Placement of the needle in the abdominal cavity, a solid organ, or the heart, would limit the use of a change of site for this blind technique. Two other studies were published with similar hypotheses and design in Canada and Japan, both of which have a smaller percentage of adult populations suffering from obesity.[3,4] All 3 of these studies focused on trauma populations that are predominately young males with primarily penetrating injuries. As a result of sampling bias away from the general population, these studies' assertions relating to medical causes of pneumothorax are limited.[2-4] Our rural patient population has a preponderance of obese patients exceeding Ohio's average of 29%.[5] If an insufficient needle length were used to access the thoracic cavity the patient wound could not be temporized for definitive treatment of a tension pneumothorax, which could result in increased fatalities. Based on a review of the literature and clinical experience,

our hypothesis was that the ATLS recommended needle length of 51 mm would not be sufficient in 90% of our patients.[6-9]

METHODS

With local institutional review board approval as an exempt study, we queried a retrospective database of 100 sequential patients from November 1, 2010 to November 19, 2010 who had chest CTs in a 180-bed community hospital in Appalachia. Statistical power analysis suggested a sample size of at least 70 complete records to detect moderate differences between the chest wall depth and the needle lengths as significant with 80% power. We reviewed the 100 records to ensure that the study was not statistically powered in case there were incomplete records. Inclusion criteria were adult patients (18 years or older) requiring a chest CT. Only the first CT in the date range selected was used (if the patient received more than 1 CT during the time period). Exclusion criteria involved those under the age of 18, subsequent chest CTs of the same patient, marked subcutaneous emphysema, and those with a chest wall tumor. We measured the average chest wall depth at the anterior second intercostal space at the mid clavicular line bilaterally. Three abstractors, comprised of 2 resident physicians and 1 college student, obtained the measurements. Questions of exclusion were handled by quorum of the 2 resident physicians and the attending research advisor. The variables were well defined and the abstractor group was very small; hence, no measure of inter-rater reliability was tested. We recorded chest wall depth measurements of 91 subjects who met inclusion criteria in Microsoft Excel and then analyzed the data using PASW 18 software (SPSS Inc., Chicago, IL) to the various needle lengths (46, 51, and 64 mm) using a combination of statistical methods, including the one-sample t-test, simple linear egression, and ANOVA. Statistical significance was set at $p \leq 0.05$.

RESULTS

A 46 mm needle reached the pleural space in 52.7% of our patient sample. This was not statistically different from the patient average chest wall depth of 45.98 mm. (p=0.996, 95% confidence interval [CI]: -4.31 to 4.29). Current ATLS guidelines recommend a 51 mm (2 in) needle, which would reach the pleural space in only 64.8% of our population.[1] This was significantly different from the combined average chest wall depth of 45.98 mm (p=0.023, 95% CI: -9.32 to -0.71). Furthermore, it was found that using a 64 mm needle would reach the pleural space in 79% of our patients. Indeed, the 64 mm is statistically significantly higher than the combined average chest wall depth 45.98 mm in our patient sample (p=0.000, 95% CI:-22.31 to -13.70). A comparison of success rates based on needle length is shown in the figure. The table provides summary measures such as the mean and standard deviation of the patient population for height in feet, weight in kilograms, body mass index and chest wall depths in millimeters.

DISCUSSION

We failed to reject our study hypothesis based on the statistical significance between the ATLS- recommended

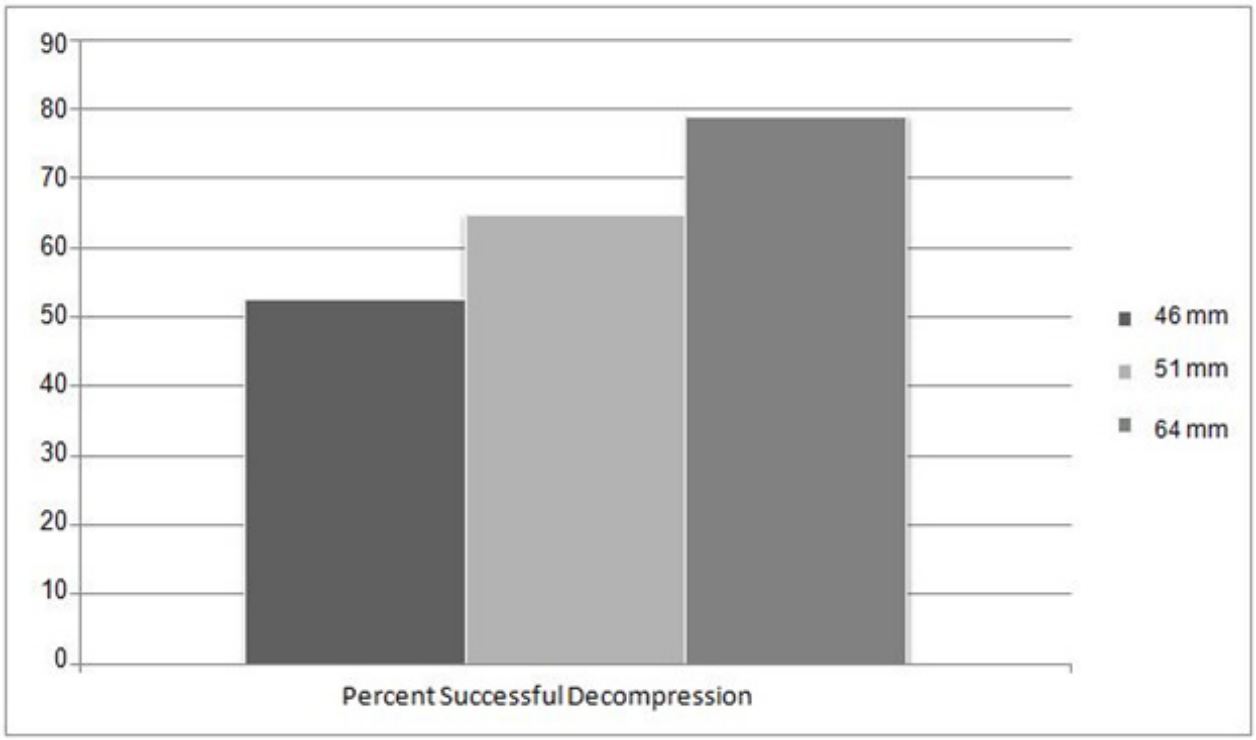

Figure. Depicts the success rates with different lengths of needles used for decompression of tension pneumothroax.

Table. Describes study population by height, weight, body mass index (BMI), and average chest wall depth by minimum (Min), maximum (Max), mean with standard deviation.

	Min	Max	Mean	Standard deviation
Height (ft)	4.1	6.5	5.47	0.46
Weight (kg)	41.0	169.0	83.98	27.82
BMI	13.2	70.4	30.25	9.71
Average chest wall depth (mm)	9.8	99.4	45.98	20.67

needle length of 51 mm and our patient average chest wall depth of 45.98 mm. However, the non-significance between the currently-stocked 46 mm needle and the chest depth wall of 45.98 mm indicated that the stocked needles are not comparatively adequate in reaching the pleural space in our patient population. These results suggest that our current equipment is not sufficient for success in 90% of our patient population.[2,7,9,10] The results indicate that a 64 mm needle will offer success in the majority of our patient population however a success rate of 79% is unlikely to be acceptable for the majority of emergency physicians as well as emergency medicine technicians. Given the current obesity epidemic consideration, modifications of many procedural approaches should be considered.

LIMITATIONS

This study is limited by its small sample size and the fact that the geographical region of study is noted for its high obesity rates.[5] Elasticity and compressibility of the anterior chest wall with this procedure may lead to higher success rates than static measurements may imply. This error may be negated by movement of the patient, most notably when related to chest compressions for cardiopulmonary resuscitation. The study sample itself could have been changed to review CTs of patients with pneumothorax; however, this is against accepted management of pneumothorax and may be fatal in tension pneumothorax.[1] Routine variation in equipment and technique are not addressed. Specifically, the use of a vascular access catheter-based aspiration further shortens the reach of the needle due to the coupling for attaching tubing found on simple catheters and the catheter may collapse or deform more easily when the needle is removed to allow evacuation of air.

CONCLUSION

Using a longer needle will lead to a higher rate of successful needle thoracostomy in our population. Further studies will be needed to validate these findings in a more diverse patient population using a multicenter approach or derivation of a clinical decision rule. Interim changes in technique are needed. Techniques based on aspiration of pleural-based air or ultrasound guidance for reduction of tension pneumothorax to assure successful decompression and reduce potential lung injury will be essential while using longer needles. The current static recommendation of 51 mm needle by the American College of Surgeons ATLS guidelines must increase or be based on the individual patient.[1] Advocacy for longer needle lengths for needle thoracostomy is essential until significant reductions in obesity rates are obtained.

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Olivier Syndrome: Traumatic Asphyxia

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A 51 year-old woman was found confused while crawling across a field. She had marked facial cyanosis and edema with cutaneous petechiae, subconjuctival hemorrhages, and echymosis across her anterior neck (image 1). Mild cerebral edema and a non-displaced thyroid cartilage fracture were found on computed tomography (CT) . The patient recovered full neuro-cognitive function within 24 hours and reported that she had been assaulted and choked by the throat. Her airway remained stable and the laryngeal injury was treated conservatively; she was discharged home after three days.

Olivier described this syndrome over 150 years ago after thoraco-abdominal crush injuries. It is essentially a prolonged valsalva maneuver that results in increased venous pressure and stasis above the level of the compressive force.[1,2] The consequent findings on the chest, neck and face are startling but of no prognostic significance, and the majority of patients have a favorable outcome.[2,3]

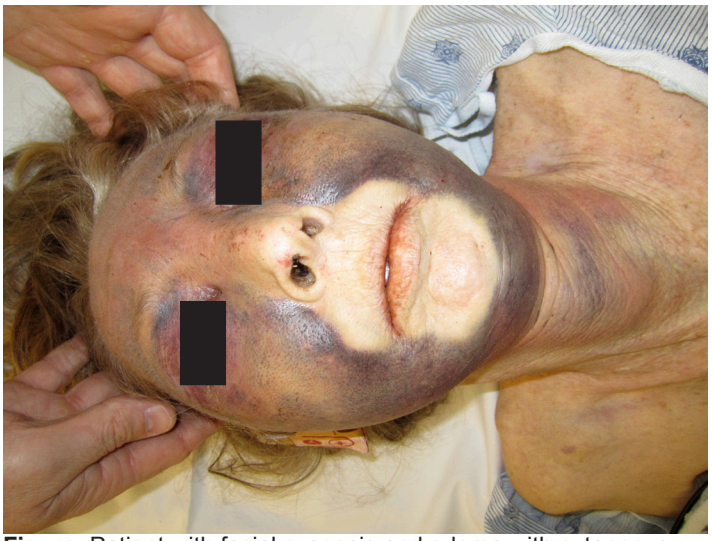

Figure. Patient with facial cyanosis and edema with cutaneous petechiae, subconjuctival hemmorhages, and echymosis across the anterior neck.

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A Survey of Graduating Emergency Medicine Residents' Experience with Cricothyrotomy

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Introduction: The Emergency Medicine (EM) Residency Review Committee stipulates that residents perform 3 cricothyrotomies in training but does not distinguish between those done on patients or via other training methods. This study was designed to determine how many cricothyrotomies residents have performed on living patients, the breadth and prevalence of alternative methods of instruction, and residents' degree of comfort with performing the procedure unassisted.

Methods: We utilized a web-based tool to survey EM residents nearing graduation and gathered data regarding the number of cricothyrotomies performed on living and deceased patients, animals, and models/simulators. Residents indicating experience with the procedure were asked additional questions as to the indication, supervision, and outcome of their most recent cricothyrotomy. We also collected data regarding experience with rescue airway devices, observation of cricothyrotomy, and comfort ("0-10" scale with "10" representing complete confidence) regarding the procedure.

Results: Of 296 residents surveyed, 22.0% performed a cricothyrotomy on a living patient, and 51.6% had witnessed at least one performed. Those who completed a single cricothyrotomy reported a significantly greater level of confidence, 6.3 (95% confidence interval [CI] 5.7-7.0), than those who did none, 4.4 (95% CI 4.1-4.7), $p<<0.001$. Most respondents, 68.1%, had used the recently deceased to practice the technique, and those who had done so more than once reported higher confidence, 5.5 (95% 5.1-5.9), than those who had never done so, 4.1 (95% CI 3.7-4.5), $p<<0.001$. Residents who practiced cricothyrotomy on both simulators and the recently deceased expressed more confidence, 5.4 (95% CI 5.0-5.8), than those who used only simulators, 4.0 (95% CI 3.6-4.5), $p<<0.001$. Neither utilization of models, simulators, or animals, nor observance of others' performance of the procedure independently affected reported confidence among residents.

Conclusion: While prevalence of cricothyrotomy and reported comfort with the procedure remain low, performing the procedure on living or deceased patients increased residents' confidence in undertaking an unassisted cricothyrotomy upon graduation in the population surveyed. There is evidence to show that multiple methods of instruction may yield the highest benefit, but further study is needed. [West J Emerg Med. 2013;14(6):654–661.]

INTRODUCTION

While the vast majority of patients requiring emergent airway management in the emergency department (ED) can be intubated endotracheally, those who cannot often require cricothyrotomy to provide a secure airway when other routes fail. The incidence of failed airway has been reported to be as low as 0.5%, but there exist patients who simply are unable to be intubated due to severe head or neck trauma, angioedema, or other anatomic obstacles.[1,2] The development of adjunct airway devices such as gum elastic bougies, intubating laryngeal mask airways (ILMAs), and video-assisted devices has rescued many potential airway failures, but each

device has its limitations. Resident education has evolved to incorporate use of these "rescue devices," and a 2004 survey of emergency medicine (EM) program directors (PDs) revealed that 90% of programs had at least 3 different devices available in the ED. While a multitude of different adjuncts were in use, cricothyrotomy was by far the most prevalent alternative technique reported, with 86.4% of PDs indicating use in their programs.[3]

Most adjunct devices possess the advantage that residents can use them during routine endotracheal intubations to gain proficiency in their use. This has the benefit of allowing trainees to better appreciate the subtleties of each instrument, its indications, and its drawbacks under more controlled circumstances. Cricothyrotomy is unique in that not only is it performed rarely, but it cannot be practiced as part of routine airway management.[3,4] This has left educators with a need to find unique ways to teach a procedure that is essential to know but seldom performed. While the advent of models and simulators has afforded residents opportunities to hone their skills in the lab, even high fidelity models cannot reproduce the tissue consistency, bleeding, and anatomic variation that exist in human models.[3,5] Canine labs have been used, but anatomic differences between dogs and humans, expense, and concern over sacrifice of the animal are significant drawbacks.[6,7,8] Using the recently deceased to teach cricothyrotomy has been advocated by many as a way to provide residents with more realistic training experiences, but this approach raises concerns regarding the best means to respect the deceased and next of kin and the necessity of and method by which consent may be obtained.[9,10,11]

Despite these challenges, cricothyrotomy is still taught in residency programs, and graduates are expected to be able to perform the procedure regardless of whether or not they have performed any in training.[1,2,3] Surgical airway remains the final step in the American Society of Anesthesiologist's Practice Guidelines for Management of the Difficult Airway, and emergency physicians have faced litigation for failing to perform a cricothyrotomy when intubation and rescue devices have failed.[12,13,14] The Residency Review Committee (RRC) for EM stipulates that a resident shall complete at least 3 cricothyrotomies by graduation, but procedure logs do not distinguish among those performed on models/simulators, animals, the deceased, or living patients.[15] Thus, the actual number of cricothyrotomies being performed by residents on living patients remains unknown.

This purpose of this study is to develop a better understanding of how residents are instructed to perform cricothyrotomy (cric), the frequency with which they observe and perform the procedure, and their degree of comfort in undertaking the procedure unassisted upon graduation.

METHODS

We surveyed EM residents scheduled to graduate in 2011 from Accreditation Council for Graduate Medical Education (ACGME) approved residencies regarding their experience with cricothyrotomy using a web-based application. This study was approved by the hospital institutional review board and deemed to be exempt from formal informed consent. The survey was piloted using a cohort of PGY1 and PGY2 residents who were not part of the population to be studied, and we used their responses and feedback to generate the final instrument.

We identified PDs via contact information on the ACGME website and e-mailed them a description of the study, a hyperlink to view a sample survey, and an e-mail to forward to their residents requesting their participation. PDs who failed to indicate whether or not they had forwarded the request to their residents were e-mailed a second time in June. We excluded only programs not graduating residents in 2011. Data collection began on May 17 and ended on June 30, 2011.

Previous research and mathematical modeling suggest that given a total population of 1,500, alpha=0.01, and margin of error=0.03, approximately 185 surveys would need to be returned to yield data on which reliable conclusions could be drawn.[16] Nevertheless, oversampling was employed to increase homogeneity and to minimize effects of geography, PD participation, and other potential sampling errors upon results.

We briefed potential subjects electronically on the mechanics of data collection and the enrollment process before they began the survey. No identifying data regarding the respondent's name, program, geographic location, or patient names were gathered. All residents answered questions regarding their level of training, opportunities to observe the procedure, and use of adjunct airway devices. Further questions asked respondents to identify the total number of cricothyrotomies they had performed personally on living and deceased humans, models/simulators, and animals, and to rate their level of comfort ("0-10" with "10" indicating complete comfort) in performing an emergent cricothyrotomy unassisted by another physician. Those who had indicated they had performed at least one cricothyrotomy on a living patient were shown additional questions regarding the circumstances and supervision of their most recent cricothyrotomy and asked to identify their level of training and previous surgical airway experience at the time the procedure occurred. Where appropriate, we included free-text response boxes to capture any additional comments respondents wished to make. No incentives, financial or otherwise, were offered to residents or PDs in exchange for participation. A portion of the survey is reproduced in Table 1.

Data were compiled electronically, extracted, and analyzed via SPSS (Version 18). We used one-way analyses to compare reported levels of comfort among groups. Post hoc comparisons using the Tukey HSD test were used to determine differences among pair wise groups. We considered statistically significant results with p values of 0.05 or less.

Table 1. Responses to selected survey questions related to performance of cricothyrotomy in the emergency department.

Question		N	Percent
What is your current level of training?	PGY 3	199	67.2
	PGY 4	92	31.1
	PGY 5	5	1.7
In patients who you or your faculty were unable to endotracheally intubate, which rescue devices have you personally utilized? (Check all that apply.)	LMA/ILMA	183	62.5
	King LT or similar device	48	16.4
	Bougie	265	90.4
	Fiberoptic scope	87	29.7
	Video assisted device	271	92.5
	Needle cricothyrotomy	28	9.6
	Retrograde intubation	14	4.8
	Nasotracheal intubation	41	14.0
How many cricothyrotomies have you performed (not assisted) on a living patient?	0	231	78.0
	1	43	14.5
	2	13	4.4
	3	3	1.0
	4	1	0.3
	5	2	0.7
	More than 5	3	1.0
*What was your level of training at the time the procedure was performed?	PGY 1	4	6.3
	PGY 2	15	23.4
	PGY 3	24	37.5
	PGY 4	20	31.3
	Other	1	1.6
*Who physically assisted or supervised the procedure as YOU were performing it?	EM Attending	38	59.4
	EM Resident	1	1.6
	Trauma/Surgical Attending	10	15.6
	Trauma Resident	3	4.7
	Multiple Providers	7	10.9
	No one	5	7.8
*Which technique did you use?	Surgical cricothyrotomy	54	84.4
	Melker	10	15.6
	Other	0	0
*What was the indication for performing the procedure?	Severe head or neck trauma	24	37.5
	Angioedema/distorted anatomy	31	48.4
	Other	9	14.1
*Did the patient survive the procedure long enough to get to the operating room or intensive care unit?	Yes	39	61.0
	No	25	39.0
How many cricothyrotomies have you personally seen performed (but not performed yourself)?	0	139	48.1
	1	63	21.9
	2	47	16.3
	3	25	8.7
	4	7	2.4
	5	1	0.3
	More than 5	6	2.1

PGY, post-graduate year; *LMA/ILMA,* intubating laryngeal mask airways; *EM,* emergency medicine
*Asked only of those who performed a cricothyrotomy on a living person.

RESULTS

Contact information for 137 of the 138 directors of programs scheduled to graduate residents in 2011 was available on the ACGME website. Thirty-eight PDs (28%) responded to the participation request and all but one of them agreed to forward the e-mail to residents. A total of 296 graduating residents participated in the survey. According to the ACGME website, 1,498 trainees were expected to complete EM training programs in 2011, yielding a response rate of approximately 20%.[15] All 296 participants completed the questions regarding their training, instruction, and previous experience with cricothyrotomy, but 3 failed to rate their comfort with the procedure and 7 did not complete the last question regarding the number of crics they had witnessed. This yielded a survey completion rate of 97.6%.

Video-assisted devices and gum elastic bougies were the

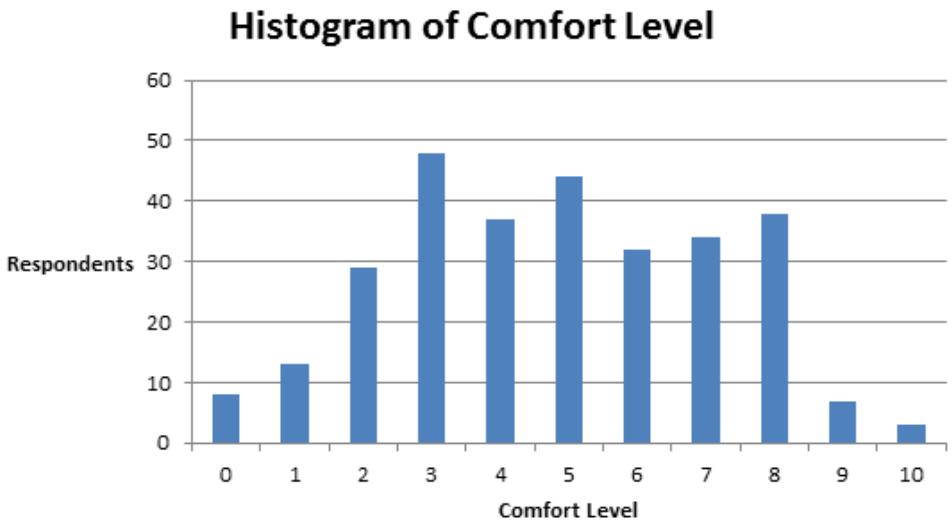

Figure 1. Histogram of EM residents' reported comfort with performing a cricothyrotomy unassisted by another practitioner upon graduation; "10" represents complete confidence.

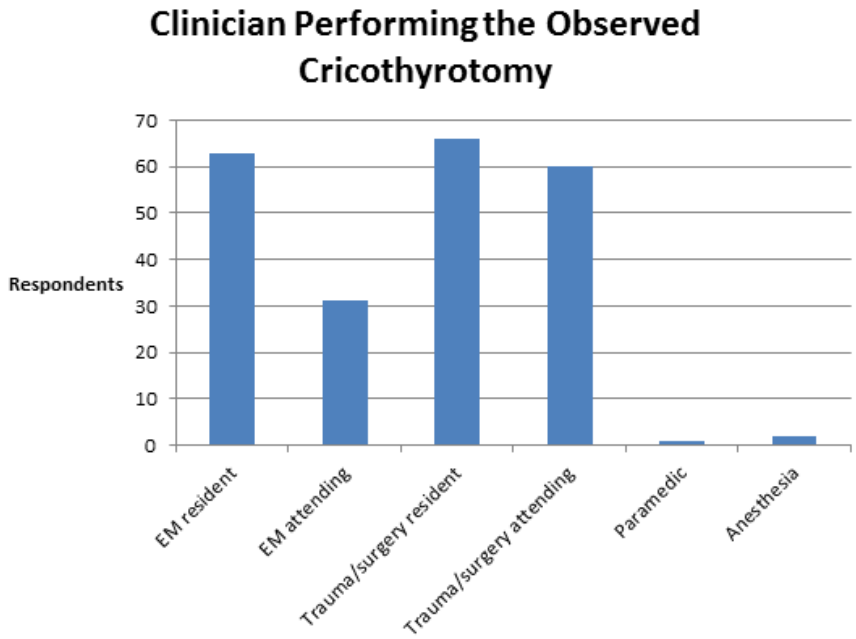

Figure 2. Background of clinicians who performed cricothyrotomies that residents observed but did not perform themselves.

most commonly used rescue devices, and a breakdown of residents' frequency of adjunct device use is available in Table 1. The average degree of comfort, with "10" representing complete comfort, in performing a cricothyrotomy unassisted by another physician was 4.8 (95% CI 4.5- 5.1) and the statistical mode was 3. A histogram of responses can be found in Figure 1.

Models and simulators were the most commonly used methods of instruction with 83.1% of residents having practiced at least one cric on a model. A majority of trainees, 61.8%, had also practiced the procedure on recently deceased humans, and 46.6% had done so more than once. Animal models were used by 55.7% of respondents, and 3% reported having used "other" methods of instruction, but the nature of these alternative methods remains unknown. Table 2 illustrates the relative frequencies of cricothyrotomies on living patients, the deceased, animals, and models/simulators.

Roughly half the participants, 51.6%, had witnessed at least one cric and 29.8% had seen more than one. Watching others perform the procedure was not shown to affect confidence, though there was a trend toward increased comfort among those who witnessed more than one procedure versus those who did not witness any, p=0.09. (Table 3) The clinician performing the procedure was most likely to be a trauma or general surgery resident, and a chart depicting the number of crics trainees witnessed other clinicians perform can be found

Table 2. Emergency medicine resident experience with cricothyrotomy (crics).

Number of crics performed	On recently deceased	On model/ simulator	On animals
0	113	50	131
1	45	39	36
2	48	52	26
3	38	57	46
4	8	25	24
5	16	17	10
>5	28	56	23

in Figure 2. Rehearsing the procedure any number of times on animals was not found to affect reported confidence.

Sixty-five respondents (22%) reported having performed at least one cricothyrotomy on a living person, and 64 of the 65 completed additional questions about the most recent procedure undertaken. EM attendings provided supervision the majority of the time, and in 7.8% of cases the procedure was unsupervised. (Table 1) Those who undertook a single cricothyrotomy on a living person reported a higher level of comfort with performing the procedure unassisted post-graduation than those who had done zero, and the difference was significant, $p<<0.001$. No difference in comfort was found between those having performed one cric and those who performed more than one. (Table 3)

A surgical technique was used in the overwhelming majority of cases. Angioedema/distorted anatomy and severe head or neck trauma were the most common reasons for failed airways. Inability to open the jaw, inability to ventilate, tissue edema, and Ludwig's Angina were included as open responses by the remaining 14.1%. (Table 1)

Twenty-seven percent of patients on whom trainees had performed their most recent cricothyrotomies suffered complications. Six attempts were complicated by massive bleeding, 3 by vomiting/aspiration, and 2 by bradycardia. Six attempts involved either incorrect placement of the airway, incorrect location of the incision, or failure to pass the airway. Esophageal injury and "other trauma" were each listed as complications on one patient. Some respondents indicated more than one complication occurred in the same attempt. Sixty-one percent of patients survived the procedure long enough to get to the ICU or operating suite, and survival among trauma patients was 54% versus 65% among those who underwent surgical airway for non-traumatic indications.

As shown in Table 1, most trainees performed their most recent cricothyrotomy as a PGY 3 or PGY 4. Four respondents had experience with cricothyrotomy prior to residency–2 as a paramedic, one in combat while serving after internship, and one during a previous general surgery residency. It was unclear if the former surgical resident performed any additional crics during EM training, but the other 3 respondents did not. Regardless, all responses were included and analyzed in an intent-to-treat fashion.

Table 3. Reported comfort level based on number of cricothyrotomies (crics) performed.

Comfort level measured	N	Mean	95% confidence interval
Population mean	293	4.8	4.5-5.1
Zero crics on living patients	230	4.4	4.1-4.7
1 cric on a living patient	43	6.3	5.7-7.0
>1 cric on living patients	20	6.7	5.6-7.7
Witnessed zero crics	139	4.7	4.3-5.1
Witnessed 1 cric	63	4.5	3.9-5.1
Witnessed >1 cric	84	5.3	4.8-5.9
Zero crics on deceased	113	4.1	3.7-4.5
1 cric on deceased	45	4.5	3.9-5.2
>1 cric on deceased	135	5.5	5.1-5.9
Zero crics on model	49	4.6	4.0-5.2
1 cric on model	39	3.5	2.8-4.2
>1 cric on model	205	5.1	4.8-5.4
Zero crics on animals	128	4.6	4.2-5.0
1 cric on animal	36	5.2	4.4-5.9
>1 cric on animal	129	5.0	4.5-5.4

Those having practiced more than one cric on the newly dead reported a higher degree of confidence with the procedure than those who did none, $p<< 0.001$. Performing the procedure only once did not result in a significant increase in confidence. While there was no significant difference in comfort levels regardless of the number of crics trainees performed on models or simulators, there was a trend toward decreased confidence among those who rehearsed the procedure only once versus those had not done so at all, $p=0.06$. (Table 3) When comparing these 2 groups, it was found that both performed the same number of total crics (by any means), and the same proportion of each group had experience with living patients (16%) and with animal labs. The subset that had never used a simulator, however, had performed more crics on the recently deceased. Graduates who reported practicing on models as well as the recently deceased also reported more confidence with the procedure,

5.4 (95% CI 5.0-5.8), than whose who used only models/simulators, 4.0 (95% 3.6-4.5), p<<0.001.

The vast majority of cricothyrotomies were performed by third- and fourth-year residents. A t-test (2-tailed distribution, equal variances assumed) also showed a trend toward a higher level of confidence among PGY 4/5s, 5.1 (95% CI 4.7-5.7) versus PGY 3s, 4.7 (95% CI 4.3-5.0), p=0.08, regardless of the number of cricothyrotomies performed. Pearson chi-squared analyses showed no effect of post-graduate year or previous cricothyrotomy experience with either living or deceased patients on patient survival.

DISCUSSION

Over the last several decades, improvements in rapid sequence intubation, changes in airway management in patients with suspected c-spine fractures, and the introduction of adjunct devices have reduced the frequency with which cricothyrotomy is performed.[1,5,17] The use of adjuncts was highly prevalent in the population surveyed, but there will always be patients who, for one reason or another, cannot be intubated and will require a surgical airway. For this reason, the RRC for EM requires each resident to complete at least 3 cricothyrotomies prior to graduation to demonstrate proficiency.

Yet, this is the first published study attempting to clarify how many cricothyrotomies residents are performing on living patients requiring emergent airways, dog or other animal labs, models/simulators, and the recently deceased. The use of each of these methods of instruction is well documented in the literature, but their use relative to each other and residents' ultimate degree of comfort with respect to cricothyrotomy were previously unknown.[7,12,18]

Previously reported rates of cricothyrotomy due to failed airway are quite low.[1,4,19] Thus, it was somewhat surprising to find that 22% of graduating residents indicated they had performed a cricothyrotomy, though a portion of these had done so exclusively outside their EM training programs. Since cricothyrotomy is rare and because the nature of the study was clearly stated in the survey's title and description, residents who have performed the procedure may have been those more likely to respond, overestimating the prevalence of cricothyrotomy among upcoming graduates. If this is true, then creating sufficient learning opportunities for trainees to gain proficiency becomes all the more important.

Not surprisingly, residents who had performed a cric on a living person rated their comfort with performing the procedure unassisted significantly higher than those who did not. Of the 223 crics observed, 129 were performed by non-ED staff. The fact that watching others perform the procedure failed to significantly raise residents' reported comfort underscores the importance of ensuring EM trainees have a role in difficult airway management in the ED.[3,17] Particularly in non-teaching institutions, it is usually impractical to await the arrival of a consultant before securing a surgical airway when one is needed.

Models and simulators, while being the most frequently reported method of instruction, did not clearly increase residents' reported comfort. There was a trend toward decreased comfort among those who attempted only one procedure on a model versus those who attempted none. These 2 cohorts had performed the same total number of crics, and no difference between them could be found other than the group who had never used a simulator had performed a greater number of crics on the newly dead. Thus, the statistical trend observed is more likely to be a function of the more confident cohort having had more use of the recently deceased than less experience with simulators, since overall instruction on the recently deceased was found to increase residents' comfort and instruction on models was not.

More than half of residents reported using animals in their training programs, but their use was not found to affect reported confidence. This survey did not ascertain what other procedures were performed on the animal, and a more dedicated study of the pooled benefit from all procedures done would need to be done to better assess the worthiness of sacrificing the animal for the sake of resident education.

The use of the recently deceased to teach residents how to perform rare procedures has long been an area of controversy.[8,10,11,20,21] A 1994 survey of adult and pediatric critical care and EM PDs found that EM teaching programs were the most likely to use the recently deceased. Sixty-three percent of those programs reported use of the deceased, and in this study, 62% of residents reported practicing the procedure on the newly dead.[11] Proponents of this practice cite the inability of models to simulate tissue layering and texture, the profuse bleeding often encountered, or the structural differences present that may impede passage of an airway.[6,8,22] Indeed, a study of EMS personnel trained exclusively on mannequins showed less success in emergency intubation than those trained on people and animals.[22] A separate but inherently related ethical issue is whether or not consent should be obtained prior to any such interventions, and several papers have demonstrated the feasibility of obtaining permission from next of kin.[9,21-24] Residents in this study who practiced cricothyrotomy on the recently deceased reported higher degrees of comfort than those who did not. In addition, those using models as well as the newly dead reported greater comfort than those who used models alone. It is certainly possible that as higher fidelity simulators and virtual reality become available, training on non-humans may become more effective. Until that time, however, there is evidence that use of the newly dead offers residents the next best option in obtaining proficiency with cricothyrotomy.

Studies of largely elective cricothyrotomies found complication rates of 6-11%, and a 2010 meta-analysis of prehospital surgical crics found an overall success rate of 90.5%.[25,26] In 1987, Erlandson reported a survival rate of 54% and complication rate of 23%, but more than half the patients in their data set were in cardiac arrest prior to cric.[25] The

mortality rate among trauma patients in this study is similar to that found in the literature, but residents reported a greater than expected number of complications during performance of their most recent cricothyrotomy.[27] This may indicate that a sicker population was sampled, that too much time was spent using adjunct devices before resorting to a cric, that physicians' clinical skills have deteriorated as experience with cricothyrotomy has declined, that the procedure is being done as a peri-mortem event for teaching purposes, or that other non-quantifiable factors are present.[8,12] Further study regarding the nature and causes of complications is needed.

LIMITATIONS

The nature of this study contained several important limitations. First and foremost, permission to contact residents directly via e-mail distribution lists could not be obtained from any organization. Of the 137 PDs contacted, 37 responded indicating that the survey had been forwarded to residents. It remains unknown how many other PDs forwarded the e-mail without notifying the primary investigator of the decision to do so. Second, because not all graduates could be reached, it is possible that surveying a larger proportion of them may have altered the results, particularly regarding those data that showed trends toward significance but did not achieve it. However, previous research regarding appropriate sampling of populations indicates that the number of surveys returned was well above the minimum needed given a total population of 1,500.[16]

Third, surveying residents regarding a rare procedure will likely capture more who have done the procedure than who have not, thereby over-estimating the incidence of cricothyrotomy on living patients. Fourth, despite the anonymity of the electronic tool used to gather the data, some respondents may have been disinclined to admit using the recently deceased or animals to rehearse the procedure if they believe the act to be morally dubious. Fifth, data on long-term survival or neurologic outcome of patients was not gathered and thus the ultimate "success" of the crics done on living patients cannot be determined.

Lastly, the majority of residents had trained using models, animals, as well as the deceased, and it is not possible to evaluate adequately and independently each teaching method with regard to resident confidence or ability to perform the procedure quickly, successfully, and unsupervised as is required upon graduation. Further study with a larger population focusing on single methods of instruction may better clarify this question.

CONCLUSIONS

The vast majority of the graduating EM residents surveyed have never performed a cricothyrotomy on a living patient during training and do not rate their comfort with performing the procedure unassisted very highly. Undertaking cricothyrotomies on living as well as on recently deceased patients significantly increased reported levels of confidence, whereas instruction involving either models or animals, or watching others perform the procedure failed to do so. Given the rarity of cricothyrotomy in contemporary practice, a multi-faceted approach that increases resident involvement in surgical airways and expands training beyond use of models and simulators alone seems prudent.

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Gender-specific medicine is the "science of how normal human biology differs between men and women and how the manifestations, mechanisms and treatment of disease vary as a function of gender." While gender-specific medicine incorporates advances in reproductive health issues, the AEM consensus conference will focus on broad disease-specific EM issues that are relevant to both women and men. The key domains of the conference are cardiovascular/resuscitation, cerebrovascular, pain, trauma/injury/violence, diagnostic imaging, mental health and substance abuse.

Consensus Goal:
The goal of the 2014 AEM Consensus Conference is to stimulate EM researchers to methodically recognize, investigate and translate the impact of gender on their clinical research outcomes. The conference proposes to build a foundation upon which researchers can build interdisciplinary scholarship, networks of expertise, discussion forums, multicenter collaborations, evidence-based publications, and improved education. The overarching themes of the conference have been guided and informed by NIH research priorities on gender medicine and include study of the lifespan, sex/gender distinctions, health disparities/differences and diversity and interdisciplinary research.

Consensus Objectives:
1) Summarize and consolidate existing data and create a blueprint that furthers gender-specific research in the prevention, diagnosis and management of acute diseases

2) Discuss the conceptual models for designing studies and analysis that incorporate gender as an independent variable.

3) Build a multinational interdisciplinary consortium to study gender medicine for acute conditions.

Accepted manuscripts will describe relevant research concepts in gender-specific areas with priority placed on differential disease risk, vulnerability, progression and outcomes. They may include work in clinical/translational, health systems, policy or basic sciences research. Descriptions of specific research, projects, or collaborations may be used for illustrative purposes but should not comprise the core of the submission. Original contributions describing relevant research or concepts on these or similar topics will be considered, and original high-quality research may also be submitted alone or in conjunction with concept papers. Papers will be considered for publication in the December 2014 issue of *Academic Emergency Medicine* if received by Monday, March 11, 2014. All submissions will undergo peer review and publication cannot be guaranteed.

For queries, please contact Marna Rayl Greenberg, DO, MPH (Marna.Greenberg@lvh.com) or Basmah Safdar, MD (basmah.safdar@yale.edu) the 2014 Consensus Conference Co-Chairs.

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Minimum qualifications:
Required doctoral degree in epidemiology, public health, or safety research, with a focus on injury, alcohol, or mental health research.

Other considerations:
1. Strong analytic skills and outstanding individual initiative.
2. Strong skills in data management and analysis, including experience using standard statistical packages.
3. Excellent scientific writing and spoken English skills.
4. Preference is given to applicants whose training and research interests align with the CTIPR.

Anticipated salary range:
http://www.som.uci.edu/academic-affairs/docs/postdoc.pdf

Applications are accepted until the position is filled.

Submit letter of interest, resume, research interests, and three references to:
Shahram Lotfipour, MD MPH (SHL@uci.edu, 714-456-2326) and Bharath Chakravarthy MD MPH (bchakrav@uci.edu, 714-456-6986).

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JOB ANNOUNCEMENT

INSTRUCTOR, ASSISTANT OR ASSOCIATE PROFESSOR POSITIONS IN THE DEPARTMENT OF EMERGENCY MEDICINE AMERICAN UNIVERSITY OF BEIRUT, FACULTY OF MEDICINE AND MEDICAL CENTER BEIRUT, LEBANON

The Department of Emergency Medicine is recruiting for full-time academic positions at the Instructor, Assistant or Associate Professor levels. Candidates must be experienced Emergency Medicine Physicians, graduates of nationally recognized Emergency Medicine residency training programs or board-certified or -eligible in Emergency Medicine by the American Board of Emergency Medicine or the American Board of Osteopathic Emergency Medicine, and must be fluent in English and, preferably, Arabic though the latter is not a requirement. Excellent opportunities exist for faculty development, research and teaching. The compensation is competitive and the positions offer excellent benefits.

Applicants should submit electronically: curriculum vitae, the names and addresses of four references, a summary of their accomplishments in the areas of clinical scholarly activities, teaching and research; and future plans. All requested documents should be forwarded to Dr. Eveline Hitti, Interim Chairperson of Department of Emergency Medicine, at the following e-mail address eh16@aub.edu.lb

Eveline Hitti, MD.
Assistant Professor of Clinical Emergency Medicine
Department of Emergency Medicine
American University of Beirut
P.O. Box 11-0236 - Riad El Solh 1107 2020
Beirut - Lebanon

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December 12-13

4th Annual *National Update on Behavioral Emergencies*

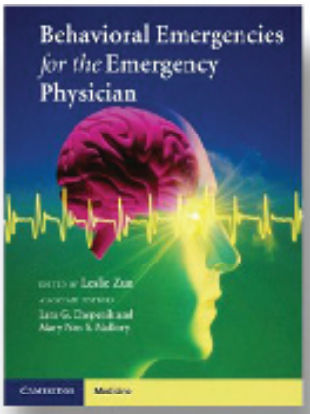
Tentative Agenda (Day 1-Dec 12)

- Introduction
- Medical Clearance Debate
- Suicide Assessment
- Deadly Disorders in Psychiatric Patients
- Cues to Deceptive Drug Seeking and Addictive
- Rare Behavioral Emergencies
- Excited Delirium
- Pediatric Psychiatric Illness
- Trauma Informed Care
- Intellectually and Developmentally Disabled
- Behavior Related to TBI
- Motivational Interviewing and SBIRT
- Ketamine Treatment
- New Treatments for Agitation
- Who can go home
- Psychiatric Boarders

Tentative Agenda (Day 2-Dec 13)

- Reduction of Frequent Users
- Danger to Others
- Patient and Family Perception
- Dealing with Difficult Patients
- Caring for the Care Givers
- Community Resources
- Patient Safety and Liability Concerns
- Accountable Care Organizations
- Informed Consent and Civil Commitment
- Billing and Reimbursement and ICD 10
- EMTALA
- Scientific Session
- Peer Involvement

Every registrant receives a copy of the textbook



Invited Speakers

Jon Berlin
Rebecca Brendel
Arjun Chenmugam
Lara Chepenik
Glenn Currier
John Draper
Barry Feldman
Laura Ginett
Roberta Glick
Rachel Glick
Robert Greenberg
Greg Larkin
Mary Nan Mallory
Kim Nordstrom
Divy Ravindranath
Sheri Richardt
Jack Rozel
Richard Shih
Robert Tarver
Ken Thompson
Gary Vilke
Chuck Weiss
Richard Wild
Michael Wilson
Scott Zeller
Leslie Zun

Pre-conference seminar on December 11 sponsored by IBHI

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For more information on the *IBHI Full Day Pre-Conference Seminar* contact:

Peter Brown at (518) 732-7176 or Peter@ibhi.net

www.ibhi.net/ibhi-seminar-dec-11-2013-in-orlando

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Trena Burke, MPA Conference Manager
Phone: 777-257-6589
E-mail:Burtr@sinai.org

Endorsements

Sinai Health System
The Chicago Medical School
American Association of Emergency Psychiatry

www.behavioralemergencies.com

AMERICAN ACADEMY OF
EMERGENCY MEDICINE

20th Annual Scientific Assembly

February 11-15, 2014
New York Hilton Midtown
New York City, NY