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Unsuspected Pulmonary Embolism in Observation Unit Patients

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Objective: Many emergency department (ED) patients with cardiopulmonary symptoms such as chest pain or dyspnea are placed in observation units but do not undergo specific diagnostic testing for pulmonary embolism (PE). The role of observation units in the diagnosis of PE has not been studied. We hypothesized that there was a small but significant rate of unsuspected PE in our observation unit population.

Methods: We performed a retrospective chart review at an urban academic hospital of all ED patients with an International Classification of Diseases, Ninth Revision diagnosis of PE between January 2005 and July 2006. The number of such patients assigned to observation at any point in their stay was recorded, in addition to events leading to diagnosis and subsequent in-hospital outcomes.

Results: Thirteen of the 190 ED patients diagnosed with PE were placed in the observation unit. Six of these either had a known recent diagnosis of PE or had testing for PE initiated prior to placement in the observation unit. Two of the remaining seven patients with undiagnosed PE were placed in observation for undifferentiated chest pain, accounting for 0.09% of the 2190 patients under the chest pain protocol. Twelve of 13 PE patients (92%) were admitted with an average stay of 4.3 days. Of the 13 patients, five were ultimately determined after admission to not have PE, leaving a rate of confirmed PE in the observation unit population of 0.12% (8/6182), with five of eight being classified as unsuspected prior to assignment to observation (0.08% rate).

Conclusion: We identified a small number of patients assigned to observation with unsuspected PE. The high rate of hospital admission and prolonged hospital stay suggests that patients with PE are inappropriate for observation status. Given the low incidence of unsuspected PE, there may be a need for a specific approach to screening for PE in observation unit patients.
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INTRODUCTION

Evaluation for acute coronary syndrome accounts for over five million emergency department (ED) visits.[1-6] Observation units have been demonstrated to reduce costs and increase efficiency for symptoms suggestive of acute coronary syndrome and thus have become widespread.[7-14] While the differential diagnosis for such symptoms also includes pulmonary embolism (PE), many patients do not receive formal evaluation for PE.

PE is a potentially fatal condition with a wide variety of presentations. Many of these overlap symptoms for which patients are placed in observation.[15-21] It has been demonstrated that the risk of mortality from PE can be reduced by early diagnosis.[22-25] Therefore, determining which patients need diagnostic evaluation prior to placement in an observation unit remains an important challenge for emergency physicians (EP). Placing patients with undiagnosed PE in observation could lead to preventable morbidity and even mortality. Despite anecdotes of patients with unsuspected PE being assigned to observation units, to our knowledge the rate of PE in this population has not been reported.

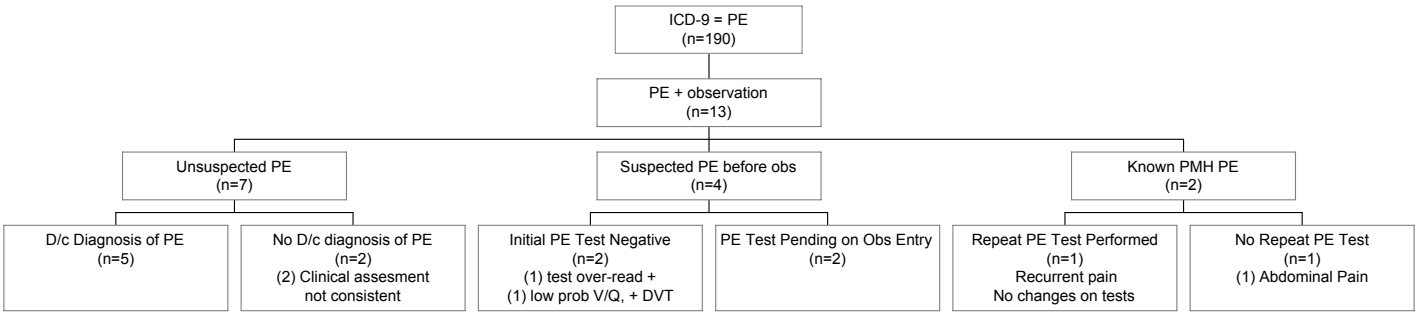

Figure. Overview of patients with PE in the observation unit

We sought to determine the rate of unsuspected PE diagnosed in the observation unit. We hypothesized that the rate of patients being diagnosed with unsuspected PE while under observation is significant. If so, routine diagnostic testing might be considered prior to placement in an observation unit. Additionally, if such PE patients were found to have short hospital courses, observation unit protocols could be developed to facilitate their care.

METHODS

We performed a retrospective chart review of all patients with an International Classification of Diseases, Ninth Revision (ICD-9) diagnosis of PE seen in the ED of an urban academic medical center between January 2005 and July 2006. During this time period our observation unit had no standardized approach to the evaluation of PE. Thus, all diagnoses of PE made there were made based on changes in patient condition or a re-evaluation. Using a hospital billing database, we identified 190 patients with primary or secondary ICD-9 diagnosis of PE, who accounted for 209 ED visits. Two reviewers independently ascertained from each electronic chart whether or not the patient had been assigned to the observation unit at any point in the ED visit, as well as what their diagnoses were on discharge from the hospital. Given the low number of patients and relatively simple data point measurement, we determined no need for reviewer training or monitoring. Reviewers had 100% agreement that all patients identified were indeed placed in the observation unit. We noted relevant clinical data such as reason for observation, method by which patient was diagnosed with PE, need for hospital admission, and length of stay. Wells criteria were noted with the exception of whether there was an alternative diagnosis more likely than PE, as this could not always be ascertained from the chart. We also recorded any adverse outcomes, such as intensive care unit admission, intubation, need for vasopressors, and death. This study met criteria for exemption from local institutional review committee.

We sub-categorized some patients with PE diagnoses as being unsuspected and some as confirmed. We considered a PE to be unsuspected if no laboratory testing such as D-dimer or radiology diagnostic testing, such as ventilation perfusion scan, computed tomography angiogram of the chest, or pulmonary angiography, was ordered prior to observation unit assignment. A patient had a confirmed PE if this was their discharge diagnosis. We used simple proportions with 95% confidence intervals.

RESULTS

Thirteen of the 190 (7%) ED patients diagnosed with PE were placed in the observation unit (Figure). Twelve of 13 PE patients (92%) were admitted with an average length of stay of 4.3 days. None of the patients died, required intensive care unit admission, or invasive interventions for complications.

Eleven of 13 patients (85%) had not been diagnosed with PE prior to observation unit. Of these, seven patients did not have any testing for PE prior to observation and were classified as unsuspected. Five (38%) of the 13 patients were discharged without the diagnosis of PE despite the initial ED ICD-9 code (Table). The inpatient team's evaluation of these patients was thought to be inconsistent with PE, despite suggestive testing in the ED.

During this time 6,182 patients were placed in observation. Including only the eight with a confirmed PE at hospital discharge, we found a 0.12% rate (8/6182, 95% CI 0.03-0.20%) of PE diagnosed in our observation unit. Since three of these had PE testing initiated prior to observation, we calculate a 0.08% rate (5/6182, 95% CI 0.01-0.15%) of unsuspected, confirmed PE.

Two were placed in observation for chest pain, leaving a diagnosis rate of 0.09% in 2,190 chest pain patients. By comparison, 14% of chest pain patients ruled in for acute coronary syndrome (ACS). Two with unsuspected PE were entered under the deep venous thrombosis (DVT) protocol and one under the chronic obstructive pulmonary disease (COPD) protocol representing 2.7% (2/73) and 1.0% (1/97), respectively, of the patients under these observation protocols.

DISCUSSION

Given the low rate of coronary disease in observation unit patients, it is possible that other etiologies are responsible for their symptoms. One such possibility is PE. It has been recently demonstrated that patients with PE diagnosed in the ED have

Table. Characteristics of patients with PE in the observation unit

No.	Wells Score	Protocol *	Method of Diagnosis **	Anti-coagulation ***	LOS (days)	Discharge Diagnosis of PE	Comment
1	4.5	DVT	CT	1	7	Y	Pulse oximetry decreased to 84% and blood pressure decreased to 90 systolic.
2	0.0	CP	VQ	0	1	N	Re-evaluated by 2nd physician, V/Q ordered, intermediate probability. Admitting team decided no PE due to lack of risk factors and negative lower extremity US.
3	3.0	COPD	DD, CT	2	10	N	Remote PMH PE, but thought to be COPD flare. Patient failed to improve in observation, CT + but with motion artifact. Admitting team decided no PE due to equivocal CT findings.
4	3.0	DVT	CT	1	4	Y	Developed chest pain, shortness of breath.
5	3.0	CHI	CT	2	5	Y	Developed tachypnea, tachycardia, and pulse oximetry decrease to 64% while in observation for fall.
6	0.0	CP	DD, VQ, CT	0	2	Y	Patient continued to have pain, on reassessment PE workup was begun.
7	1.5	CP	CT	0	3	Y	Reassessed by observation unit provider.
8	4.5	ABD/ SYNC	VQ, CL	1	3	N	Patient diagnosed with DVT, VQ low probability but plan to observe was changed by new ED physician. Admitting team decided symptoms not due to PE.
9	1.5	CP	DD, CT	0	4	N	Patient placed in observation with CT results pending. Later, had very low probability VQ.
10	1.5	PNA	VQ	0	3	N	Initial low probability V/Q report was modified to intermediate probability after patient placed in observation. Admitting team decided no PE due to a negative D-dimer, ABG, echo, and clinical improvement, .
11	1.5	CP	CT	1	3	Y	Patient placed in observation pending an allergy preparation for the CT scan.
12	2.5	ABD	CL	1	7	Y	Patient with a previous diagnosis of PE with unrelated abdominal pain.
13	2.5	COPD	CT	1	34 hours	Y	Patient diagnosed with PE 28 days earlier with no change in repeat test for PE

* *CP,* chest pain; *DVT,* deep venous thrombosis; *CHI,* closed head injury; *COPD,* chronic obstructive pulmonary disease; *PNA,* pneumonia; *ABD,* abdominal pain; *SYNC,* syncope
** *DD,* D-dimer; *VQ,* ventilation-perfusion scan; *CT,* computed tomography; *CL,* clinical judgement
****0,* no anticoagulation given; *1,* anticoagulated in the emergency department; *2,* patient on anticoagulation upon presentation to the emergency department.

fewer complications than those in whom the diagnosis is delayed.[25] Therefore, such patients in the observation unit may be at significant risk for a preventable poor outcome.

To our knowledge, this is the first report on the rate of PE diagnosed in an ED observation unit. A previous multicenter prospective effort failed to identify any patients placed in the observation unit for chest pain with subsequent diagnosis of PE or aortic dissection.[26] Other authors have reported on significant adverse events in the observation unit. Mace reviewed all observation unit patients requiring resuscitation over a 25- month time period. Of 10,245 patients, only nine (0.09%) required resuscitation as defined by chest compressions, defibrillation, assisted ventilation, or advanced cardiac life support medications. None of these nine were reported to have PE as the cause of their decompensation.[27] In a large Taiwanese study of 7,028 observation unit patients over six months, 175 initially stable patients decompensated to critical conditions requiring resuscitation. The critical conditions identified included respiratory distress, apnea, shock, dysrhythmia, gastrointestinal bleeding, altered mental status and seizure. None of them were noted to have PE identified as the cause of their decompensation.[28]

It is worth noting that the few patients in our study with unsuspected PE were diagnosed due to changes in clinical condition or re-evaluation by another clinician. This highlights the difficulty in diagnosis. Previous research has sought to define an ideal algorithmic approach.[15, 29-39] Although it was not specifically designed to address this question, our findings suggest that routine D-dimer screening prior to observation unit assignment would be a low-yield strategy. Furthermore, the rate of clinical risk factors in our low-risk observation unit population is lower than what might be expected. Thus, the standard clinical

stratification systems may not be as valuable in these patients. Complicating matters further, a number of our patients diagnosed with PE by objective testing in the ED were judged to not have PE on further workup in an inpatient setting. This demonstrates even further the often subjective nature of this diagnosis.

Given that DVT and PE share a similar pathophysiology it is not surprising to find patients in our DVT protocol developing PE. One interesting finding was the percentage of patients in the COPD protocol with PE. Previous authors who have attempted to identify whether the presence of COPD obscures the diagnosis of PE found a similar rate of PE and similar pre-test characteristics compared to patients without COPD.[40] Although our data is limited by a relatively low event rate, the relatively high proportion of patients with primary symptoms other than chest pain reflects the diversity of presentations of PE and again suggests that EPs keep a high level of vigilance.

Recent data has suggested that even PE with less severe clinical symptoms is associated with worse outcomes with delayed diagnosis.[25] Therefore, even PE patients with a subclinical initial course might still be at risk. None of the observation unit patients in our study with initially undiagnosed PE died or had a serious adverse outcome. However, most were hospitalized with a prolonged average length of stay. Therefore, it is arguable whether these cases should be viewed as an unheralded benefit of observation (the prolonged observation period made the diagnosis possible) or narrowly averted mistakes in patient management. In either case, our findings suggest the need for continued reassessment of patients under observation status. Observation unit staffing models need to accommodate this need.

LIMITATIONS

We don't know how many patients had diagnostic workup for PE before being assigned to observation during this time period. In a separate analysis of a different set of chest pain observation patients at this center, 21% had diagnostic workup for PE before being assigned to observation. Thus, it is likely that a significant portion of the observation unit patients in this study had already had an evaluation for PE, making the likelihood of finding those with unsuspected PE even less.

Our study was also limited by its retrospective methodology. Our results are thus dependent on the accuracy of the ICD-9 data. Furthermore, only patients diagnosed in the ED were included. Because we do not have follow-up on the many patients evaluated in our observation unit it is possible that there were some PE patients diagnosed after observation unit evaluation or diagnosed on a subsequent ED visit. Thus, there may have been patients with PE who are not captured in this study. Our data do not allow us to calculate a true incidence of unsuspected PE in the observation unit, merely the rate at which the diagnosis was made.

Furthermore, we did not catalog the diagnostic testing of patients admitted from observation after being diagnosed with PE. Thus, we cannot comment on the appropriateness of such admissions, whether the length of stay was appropriate, or whether such patients truly could have remained in an observation unit setting.

CONCLUSIONS

We identified a small but significant number of observation unit patients with unsuspected PE. This rate appears low enough that routine diagnostic screening would not likely be of benefit. Because these patients are not easily characterized, EPs need to be vigilant for the diagnosis prior to observation unit assignment. This study also highlights the need for adequate staffing and re-evaluation of observation patients. Future research should focus on developing better ways to identify which should have diagnostic testing prior to observation unit assignment, or incorporate such testing within the observation unit protocol.

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International Perspective from Turkey on "Unsuspected Pulmonary Embolism in Observation Unit Patients"

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Pulmonary embolism (PE) is a challenging diagnosis for emergency physicians because of its non-specific clinical presentation. Although "chest pain" is one of the major symptoms of PE,[1] it can be part of other serious diagnoses, such as aortic dissection, acute coronary syndrome (ACS), pneumothorax, or even pneumonia. New guidelines recommend using revised Geneva and Wells scores to predict probability of PE.[2] However, predictive accuracy of these scores in the emergency department (ED) or inpatient setting is still imperfect.[3]

In these circumstances, avoiding potentially deadly misdiagnosis of PE is not easy. In general, unstable patients should be admitted to intensive care units (ICUs), even without certain diagnosis; however, undiagnosed stable patients with serious chief complaints like chest pain can be candidates for observation units in the ED.

Turkey has approximately1200 hospital EDs. Those in cities see a large volume of patients, with university hospital annual volumes from 75,000-120,000 patients. Public and state education hospitals are even busier with 120,000-180,000. Today, Turkey has 75 academic EDs, with 25 of these in state education hospitals. Insufficient hospital-bed capacity, coupled with ineffective management of inpatient beds, increases the waiting time of patients in the ED to admit wards.

The model described in this paper, where patients are continuously observed and evaluated to differentiate between those with and without ACS, or other serious causes of chest pain, could benefit Turkish emergency medicine. However, observation units in state education hospital EDs are not used to differentiate potential serious diagnoses like PE. Instead, they are used primarily to give longer term treatments, or pain relief. Patients with potentially serious diagnoses, even if unconfirmed, are admitted to the hospital or transferred to tertiary care facilities. Consequently, observation units in Turkey are not called "Chest Pain Units;" therefore, ED observation for this purpose is not effective as discussed here.

The evaluation of PE in the Turkish ED is similar to U.S. EDs. Because new technologies are available in academic EDs, 64-slice multi-detector computed tomography is the major tool for PE evaluation in most centers. We no longer use V/Q scintigraphy, but Doppler ultrasound is available almost 24 hours per day in most centers. D-dimer and Well's or Geneva Criteria are the major clinical tools to risk-stratify for PE in Turkey as well.

For ruling out ACS, we have generally not established appropriate connections for stress testing in stable, low-risk patients while in the ED observation unit. The description of ACS rule out contained in this paper could benefit our patients; however, with our existing ED observation units filled with admitted patients, we have no room to implement such a protocol. Our observation units sometimes turn into ICUs. Long-term ventilators and invasive monitoring are becoming commonplace because in some centers patients stay for days. There, patients are given thrombolytics for stroke, and they spend their entire care in observation units because of no bed upstairs.

This turns the ED practice into long-term intensive and intermediate care in some centers. Fortunately, a regulation forthcoming this year will limit ED observation to no more than 24 hours. Such a limit is actually not new, with regulations some 30 years ago stating, "All emergency cases should be admitted to the appropriate ward if necessary, until the last bed of hospital is used," or "emergency cases should be directly admitted to an empty inpatient bed." Most hospitals simply ignore the old policies. As a result, some hospitals do not admit observation unit cases from the ED to their empty beds because they are sparing them for private patients or outpatient cases. Although this is an issue mostly in university hospitals, it seems that hospital politics and finances also drive inpatient and ED bed utilization decisions in Turkey as they do in the U.S.

As the authors mentioned in their report, utilization of diagnostic tools for pulmonary embolism in the ED Chest Pain Unit is insufficient. While we know ED observations units are more cost effective than in-

hospital observation units,[4] it does not mean that it should restrict investigations of other pathologies. In the study, unsuspected pulmonary embolism was diagnosed in 0.08% of patients. To my knowledge, this is a first report of "unsuspected" pulmonary embolism rate in ED observation units. Although it is a retrospective study, which may overlook the magnitude of the problem, the study still includes an important message: observation units are our chance to evaluate PE as we do for acute coronary syndromes.

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Linear Correlation of Endotracheal Tube Cuff Pressure and Volume

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Objectives: Endotracheal tube cuff (ETTc) inflation by standard methods may result in excessive ETTc pressure. Previous studies have indicated that methods of cuff inflation most frequently used to inflate ETTcs include palpation of the tension in the pilot balloon or injection of a predetermined volume of air to inflate the pilot balloon. If a logarithmic relationship exists between ETTc volume and ETTc pressure, small volumes of additional air will result in dramatic pressure increases after a volume threshold is reached. Our goal was to determine whether the relationship between ETTc volume and ETTc pressure is linear or non-linear.

Methods: In this Institutional Animal Care and Use Committee-approved study, we recorded ETTc volume and pressure in four anesthetized and mechanically-ventilated canines ranging between 30-40 pounds (mean 34.7lb, SD 3.8lb) that were endotracheally intubated with a 7.0 mm ETT. The varying cuff pressures associated with a distribution of 28 progressively increasing volumes of air in the ETTc were recorded. Spearman correlation was performed to determine if a linear or non-linear relationship existed between these variables.

Results: The Spearman rho coefficient of correlation between ETTc volume and ETTc pressure was 0.969, or approximately 97%, suggesting near-perfect linear relationship between ETTc volume and ETTc pressure over the range of volumes and pressures tested.

Conclusions: Over the range of volumes and pressures tested a linear relationship between volume and pressure results in no precipitous increase in slope of the pressure:volume curve as volume increases. [*West*JEM. 2009;10:137-139.]

INTRODUCTION

Endotracheal intubation can be a lifesaving procedure. Endotracheal tube cuffs help prevent air leak around the tube and aspiration of upper airway secretions.[1] Risks associated with placement of an endotracheal tube (ETT) include esophageal intubation, aspiration, and cardiac dysrhythmias.[2] Excessive or prolonged pressure of the ETTc may cause acute catastrophic airway injury, such as tracheal rupture, or may cause subacute or chronic injury, such as tracheal necrosis, tracheal stenosis, tracheoesophageal fistula, or laryrngeal nerve palsy.

Endotracheal cuffs in the 1960s were made of rubber and classified as high pressure-low volume systems. They commonly required pressures of greater than 100 cm H_2O to be inflated. Since these tubes would inflate in a non-circular fashion, they would present with additional complications associated with higher pressures. The most problematic issue was the tip of the ETT directly contacting the trachea, leading to tracheal injury. In the late 1960s the transition to high volume-low pressure cuffs significantly reduced the incidence of tracheal complications. Although high volume-low pressure cuffs have limitations, their safety features surpass the risks involved with low volume-high pressure ETT.[3]

Various models have been compared to evaluate ETTc

pressure thresholds that have an adverse effect on tracheal circulation. A horse model using cuff pressures of 80-100 cm H_2O and 120 cm H_2O revealed signs of mucosal damage after 175 minutes of intubation. These lesions were less severe in the lower ETTc pressures.[4] In a dog model, pressure exceeding 30 cm of H_2O for 15 minutes resulted in mucosal injury.[5] However, time in excess of 15 minutes did not increase tissue damage with additional exposure. In humans, endotracheal cuff pressures at approximately 30 cm H_2O can impair tracheal mucosa perfusion, and a critical perfusion pressure is reached at 50 cm H_2O.[6] In the 1980s endoscopic studies demonstrated impaired blood flow in the tracheal mucosa at cuff-to-wall pressures of 28-34 cm H_2O and complete stoppage of blood flow at pressures greater than 50 cm H_2O.[7]

Studies assessing clinician ability to appropriately inflate an ETTc and assess ETTc pressure in endotracheally intubated patients have been published in recent years.[8,9] These are congruent in suggesting that clinicians have poor ability to properly inflate ETTc to safe pressures using standard techniques and that ETTc pressures in these patients frequently exceed safe maximum pressures.

METHODS

In this Institutional Animal Care and Use Committee-approved study, we recorded ETTc volumes and pressures in four anesthetized and mechanically-ventilated canines weighing between 30-40 pounds (mean 34.7lb, SD 3.8lb) that were endotracheally intubated with a 7.0 mm ETT (Mallinckrodt, Hazelwood, MO) . The varying cuff pressures associated with a distribution of 28 progressively increasing volumes of air in the ETTc were recorded. Endotracheal tube cuff pressure was measured using an analog manometer (Cufflator®, Posey Corporation, Pasadena, CA). This manometer measures pressures in the range of 0 cm H_2O to 120 cm H_2O in 2 cm increments. Data analysis was performed using Intercooled Stata 8.2 statistical software (Stata Corporation, College Station, TX).

The volumes of air injected were selected on the basis of 1) the minimum volume required to generate any measurable pressure in the ETTc, and 2) the volume associated with approximation of a cuff pressure of 120 cm H_2O, above which this manometer is unable to accurately measure pressure. The actual volumes of air injected into the ETTc ranged from 0.5 mL to 9.0 mL of air, and the actual pressures measured ranged from 2 cm H_2O to 120 cm H_2O.

RESULTS

Spearman rho correlation of the variables of volume and pressure was 0.969, or approximately 97% correlation between volume and pressure. These results suggest a near-perfect linear relationship between ETTc volume and ETTc pressure (Figure).

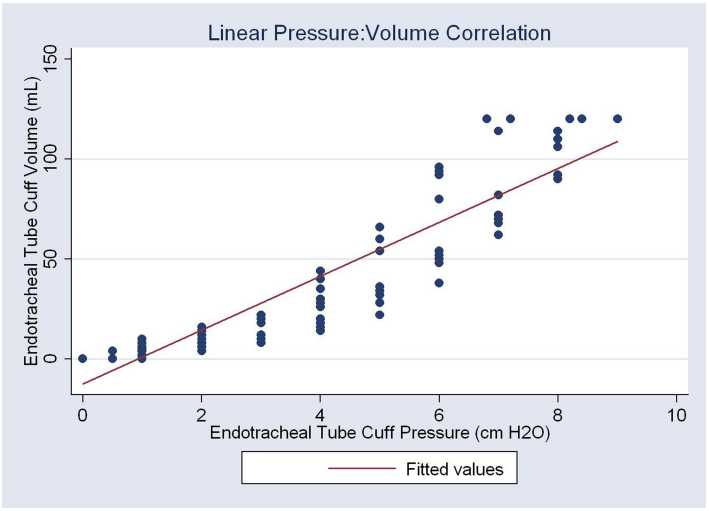

Figure. Linear correlation of endotracheal tube cuff pressure and volume

DISCUSSION

The primary findings of the present study consist of a 97 % correlation between ETTc volume and ETTc pressure in a strongly linear relationship.

Dangers associated with exponential increase of cuff pressure for a given volume of air could include severe tracheal injury. In a study by Svenson et al.[1] it was discovered that most ETTc pressures exceeded the recommended limits, and that the time spent in the ED or prehospital setting may be long enough for tracheal damage to occur. Curiel et al.[10] found that high ETTc pressure is related to post-intubation tracheal pain in patients that underwent elective surgery. However, only duration of intubation, ETTc pressure and tracheal pain were compared.

Results from our study, using four anesthetized and mechanically ventilated canines, demonstrated a near-perfect linear relationship between cuff volume and pressure. Therefore, clinicians and EMS personnel can feel assured that when inflating an ETTc at or even somewhat above appropriate cuff pressure, addition of air to the ETTc should not result in large or precipitous exponential increases in ETTc pressure. It should be noted, however, that the volume of air required to reach 50 cm H_2O is only 150% of that required for safe ETTc pressure, suggesting that the margin for error in over inflation is not large.

LIMITATIONS

Potential limitations to our study may include variability in an animal model versus human in vivo conditions, the effect of different size ETTs on the study results, as well as many less concerning variables, such as brand of ETT used, atmospheric conditions, etc. Studies using canine tracheal and upper airways as models are published,[11] but most use the tracheal tissue rather than tracheal anatomy as the basis

for the model.[12,13] Thus, the canine upper airway is not a well-established airway model. Additionally, it is possible that at higher volumes, beyond those tested here, a different relationship might exist.

CONCLUSIONS

At the volumes and pressures tested, an extraordinarily strong linear correlation was demonstrated in these canines when ETTc volume and pressure were measured. A particularly relevant point is that the correlation between volume and pressure holds at the upper limits of both volume and pressure tested. The significance of these findings is that, due to the strong linear relationship, there is not a precipitous increase in slope of the pressure:volume curve at greater volumes. Injection of additional air while at the upper end of the pressure:volume curve tested does not cause a precipitous rise in ETTc pressure. However, the volume of air required to reach 50 cm H_2O is only 150% of that required for safe ETTc pressure, suggesting that the margin for error in overinflation is not large.

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Left Ventricular Hypertrophy May Be Transient in the Emergency Department

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Background: While research has established that the bedside electrocardiogram (ECG) is an insensitive test for the presence or absence of left ventricular hypertrophy (LVH), the finding, when present, is thought to be reproducible.

Objective: To assess the reproducibility of serial ECGs done in the emergency department (ED) with regard to the presence or absence of LVH.

Method: A prospective study on consecutive patients admitted to an ED-run cardiac observation unit. A single reviewer collected and scored ECGs for the presence of LVH, using three established criteria (Cornell, Sokolow-Lyon and Romhilt-Estes). Demographic and medical history was also collected.

Results: Over a three-year time period, 295 patients were enrolled; 132 males and 163 females with a mean age of 54.4 years (range, 19-89 years). The prevalence of LVH ranged from 11-14% and the agreement among all three criteria was fair (kappa = 0.325). Using the Cornell criteria, 33 patients had ECG#1 consistent with LVH. Of the patients meeting LVH criteria on ECG #1, only 15 retained their diagnosis of LVH on ECG#2 (i.e. 55% of the LVH identified in ECG#1 was not seen in ECG#2). Additionally, nine patients developed an ECG diagnosis of LVH between ECG#1 and ECG#2. In total, 27 (nine percent of the total) had ECG measurements that changed between ECG#1 and ECG#2. We made similar findings with the Sokolow-Lyon and Romhilt-Estes criteria. The results were not modified by gender, blood pressure or medication use.

Conclusion: The finding of LVH on ECG was not very reproducible during serial measurements on the same person during a single 24-hour observation period.
[*West*JEM. 2009;10:140-143]

INTRODUCTION

The presence of left ventricular hypertrophy (LVH) has been reported to carry significant cardiovascular risk.[1-5] Although echocardiography and cardiac MRI are superior to electrocardiogram (ECG) for the diagnosis of LVH, these modalities are not readily available in the emergency department (ED).[6-9] Instead, emergency physicians (EP) rely on ECG when risk stratifying a patient who presents with acute chest pain. The need to use this rapid bedside test to make the diagnosis of LVH has led to the development of multiple tools to interpret LVH on ECG, e.g. Cornell voltage, Sokolow-Lyon and Romhilt-Estes criterion. The specificities of these tools are high (>90%), but the sensitivities are low (20-60%).[10-14] In at least one large retrospective study, the overall sensitivity of ECG diagnosis of LVH was found to be 6.9%.[15] In addition, the findings of LVH on ECG may resolve over time. A number of studies have described patients diagnosed with LVH using ECG technology only to show significant regression with appropriate anti-hypertensive treatment during subsequent years.[16-20]

If EPs are to utilize the finding of LVH on ECGs to risk

stratify individuals presenting with acute chest pain, the test should be reproducible during the course of a single ED visit. Previous authors have demonstrated that a single ECG is not a sensitive measure of LVH, but there is no published data on the reproducibility of serial ECGs in the acute setting. We undertook a prospective study using ED patients presenting with chest pain to examine the reproducibility of serial ECGs to identify LVH.

METHODS

Study Population

This was a convenience sample of patients presenting to a large, urban ED with a chief complaint of chest pain. Patients were included in the study if they had a minimum of two electrocardiograms performed to rule out a myocardial infarction in the ED and/or the adjacent ED-run chest pain unit (CPU). Participants were excluded if their electrocardiograms were unreadable due to poor technique or if the patient had bundle branch or atrio-ventricular block on ECG.

Study Design

Data was gathered prospectively as patients were admitted to the departmental CPU. We collected demographic information, clinical data and copies of standard 12-lead electrocardiograms during the ED/CPU stay. Vital signs and pertinent medications, specifically the use of digitalis, were abstracted from the medical charts. A single EP independently read and interpreted each ECG for the presence or absence of LVH using (a) the Cornell voltage criteria, (b) the Sokolow-Lyon voltage criteria, and (c) the Romhilt-Estes score. According to the Cornell voltage criteria, LVH is present if the sum of R_{aVL} and S_{V3} is greater than or equal to 28 mm in men and 20 mm in women. The Sokolow-Lyon voltage criteria identify LVH when either R_{aVL} is greater than 1.1mV or the sum of S_{V1} and R_{V5} or R_{V6} is greater than or equal to 3.5 mV. The Romhilt-Estes point score system determines LVH to be probable for four points and definite for five or more points; however, we combined those individuals with Romhilt-Estes scores of four and five into an LVH (+) classification. Previous authors have used this threshold of ≥four to ease interpretation and assess the true prevalence and cardiovascular risk associated with LVH.[21] The EP interpreting the electrocardiograms was blinded to all data except gender and the use of digitalis.

Statistical Analysis

We performed statistical analysis using STATA 9.0 software (College Station, TX), and generated a Kappa statistic to test the agreement between the Cornell voltage criteria, Sokolow-Lyon criteria, and the Romhilt-Estes score. We then used logistic regression analysis to study the associations between change in criteria determination from ECG #1 to ECG #2 and age, race, gender and the change in mean arterial pressure from ECG #1 to ECG #2.

RESULTS

Between December 2004 and May 2007, 295 patients were included in the study; 132 males and 163 females with a mean age of 54.4 years (range, 19-89 years) (Table 1). Most of the patients were Latinos (65%) and ranged from 50-69 years old (60%).

Table 1. Demographic characteristics of study participants

Variable		N (%)
Gender		
	Male	132 (44.75)
	Female	163 (55.25)
Ethnicity		
	Asian	21 (7.12)
	Black	54 (18.31)
	Hispanic	192 (65.08)
	White	19 (6.44)
	Other/Unknown	9 (3.05)
Age		
	<20 years	1 (0.34)
	20-29 years	8 (2.71)
	30-39 years	22 (7.46)
	40-49 years	61 (20.68)
	50-59 years	102 (34.58)
	60-69 years	74 (25.08)
	>70 years	26 (8.81)
	Average	**54.44**
	Range	**19 - 89**

Table 2. Percentages of LVH (+) and LVH (-) by criteria at ECG #1*

Criteria Used	LVH (+) N (%)	LVH (-) N (%)	Total
Cornell	33 (11)	262 (89)	295
Sokolow-Lyon	40 (14)	255 (86)	295
Modified Romhilt-Estes	35 (12)	260 (88)	295

*Kappa statistic testing agreement between the three criteria = 0.325

Table 3. Change in LVH status from ECG time #1 to ECG time #2 by criteria

Criteria Used	LVH (+) to LVH (-) N (%)	LVH (-) to LVH (+) N (%)
Cornell	18 (55)	9 (3)
Sokolow-Lyon	14 (35)	11 (4)
Modified Romhilt-Estes	18 (51)	5 (2)

Table 2 details the prevalence of LVH in the population for each of the three criteria used. Overall, the prevalence ranged from 11-14% in our patient population. The agreement between the three criteria was fair (kappa = 0.325). When using the Cornell criteria, 33 patients (11%) tested positive for LVH on ECG#1 and 262 had no evidence of LVH on ECG#1. Only 15 of 33 (45%) who tested positive for LVH on ECG#1 retained their original diagnosis on ECG#2. Furthermore, nine patients out of 262 (3%) who tested negative for LVH during ECG#1 subsequently tested positive during ECG#2. In total, 27 patients (9% of the total) had ECG measurements that changed between ECG#1 and ECG#2. We noted similar findings with all three criteria used, although neither the Sokolow-Lyon criteria nor the modified Romhilt-Estes criteria demonstrated such a dramatic change (Table 3).

To explain the variation seen in ECG criteria for LVH over time, we controlled for the mean arterial pressure (MAP) during analysis; however, we saw no consistent effect (data not shown). Age, gender and ethnicity also had no effect on our findings.

DISCUSSION

When evaluating an ED patient with chest pain, EPs risk-stratify patients to estimate probability of a diagnosis of acute coronary syndrome. One data point in this decision is the 12-lead ECG. Since LVH is known to be an independent predictor of future cardiovascular events and all-cause mortality, its identification on ECG implies increased risk to the patient, thus necessitating a more extensive patient work-up. Unfortunately, this logic has been challenged by recent research that suggests ECG technology provides an insensitive marker for the presence or absence of LVH.[10-14] It also appears that there is a large degree of variability from ECG to ECG within the same individual. Three previous reports describe the variability of electrocardiographic diagnosis of LVH.[22-24] These studies demonstrate inconsistent amplitude and duration of P waves, QRS complexes and ST and T wave measurements in certain leads during ECGs taken minutes to 24 hours apart on the same person. If ECG is used to risk stratify an individual with possible acute coronary syndrome, then it is important that the test be reproducible.

The presence of LVH has been shown to predict a higher rate of future cardiovascular events compared to those patients without LVH. In a sample of men, De Bacquer et al.[1] (using Sokolow-Lyon) demonstrated that ECG diagnosed LVH was significantly associated with cardiovascular disease death (RR = 3.14). In a different multicenter study of patients presenting to the ED with symptoms of acute coronary syndrome, Pope et al.[3] (using Cornell voltage) found that patients with ECG-LVH were six times as likely to have a confirmed diagnosis of congestive heart disease and three times as likely to have hypertension. In addition, they discovered the 30-day mortality among patients with ECG-LVH was 4.6%. Mansoor et al.[25] (using Sokolow-Lyon) describe rates of hypertension complications, which include stroke, hypertensive heart failure and myocardial infarction, retinopathy, and aortic aneurysm, to be two to four times higher in patients with ECG-LVH.[25] This effect has been demonstrated in multiple populations including patients with renal disease, the elderly and those with coronary artery disease.[4,7,26]

The presence of LVH has also been considered a marker of sustained hemodynamic and neurohormonal stress on the myocardium.[4] In the Health Outcomes Prevention Evaluation trial (using Sokolow-Lyon), LVH was present in 8.3% of a high-risk population undergoing treatment with ACE inhibitors. Patients had a single ECG performed at the time of randomization that was read by the local site investigator. For those patients with ECG measurements demonstrating evidence of LVH, the relative risk (RR) of sustaining a major CV event was 1.3 compared to those patients without LVH and the RR of all-cause death was 1.53.[4]

In our study of patients presenting to an ED with acute chest pain, diagnostic changes occurred in the interpretation of ECG#1 versus ECG#2 regarding LVH in approximately nine percent of patients; thus, the test was reproducible in 91% of the total patient population. However, in those patients that tested positive for LVH in ECG#1 using Cornell criteria, only 45% retained findings of LVH on ECG#2. Similarly, three percent of patients who tested negative for LVH in ECG#1 subsequently tested positive after ECG#2. We noted similar findings using Sokolow-Lyon criteria and the modified Romhilt-Estes criteria. While we did not investigate the reason for these changes, potential variables include situational stress, transient or untreated hypertension, lead placement, or underlying heart disease.

As mentioned, one possible explanation for the misdiagnosis of LVH in our patient population is lead placement. Angeli et al.[23] demonstrated the profound effect that lead placement can have on the presence of LVH by repeating electrocardiograms on hypertensive patients within 24 hours. Compared to our study, they found a similar proportion of patients changed their classification of LVH from the first to the second ECG. In 1990, Farb et al.[24] demonstrated a high variability in the measurement of LVH when serial ECG measurements were separated by eight days. Although the lead to lead variability was high in that study, only two to three percent of individuals were reclassified as having LVH or not. Therefore, one approach to minimize the type of variability would be to leave the leads in place during the entire ED/CPU visit.

LIMITATIONS

A primary limitation of this study was that we did not confirm the presence of LVH with an echocardiogram in real time; so we have no gold standard against which to judge the accuracy of the ECG in making the diagnosis of LVH. In addition, the ECGs were analyzed by one EP to limit the confusion associated with multiple reviewers; however, this introduced a possible rater bias. Lastly, the ECG leads were placed by different emergency ECG technicians, and the time period between ECGs varied during the 24-hour observation period.

CONCLUSION

Our study demonstrates that patients presenting with acute chest pain to the ED often have ECG findings of LVH that are not reproducible. Therefore, the utility of diagnosing LVH by ECG in patients with acute chest pain is yet to be determined.

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Surgeons' and Emergency Physicians' Perceptions of Trauma Management and Training

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Objective: The study objective was to determine whether surgeons and emergency medicine physicians (EMPs) have differing opinions on trauma residency training and trauma management in clinical practice.

Methods: A survey was mailed to 250 EMPs and 250 surgeons randomly selected.

Results: Fifty percent of surgeons perceived that surgery exclusively managed trauma compared to 27% of EMPs. Surgeons were more likely to feel that only surgeons should manage trauma on presentation to the ED. However, only 60% of surgeons currently felt comfortable with caring for the trauma patient, compared to 84% of EMPs. Compared to EMPs, surgeons are less likely to feel that EMPs can initially manage the trauma patient (71% of surgeons vs. 92% of EMPs).

Conclusion: EMPs are comfortable managing trauma while many surgeons do not feel comfortable with the complex trauma patient although the majority of surgeons responded that surgeons should manage the trauma.
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INTRODUCTION

Both emergency medicine (EM) and surgery residents require training in the care and management of acute trauma victims.[1-4] At times this dual requirement can result in conflict between surgery residents and attendings who feel that only surgeons should run trauma resuscitations, and emergency medicine residents and attendings who feel that they are both capable and need to be able to care for trauma patients. However, as both groups struggle for control there is little published research as to the variability of who continues to take care of trauma victims once each group leaves their residency training and what their ongoing comfort level is with caring for the acutely injured trauma patient.

The purpose of this study was to survey practicing emergency physicians (EPs) and surgeons to determine who manages trauma patients in practice. We also sought opinions from each group as to who they felt was qualified to manage the initial resuscitation of the trauma victim, what their comfort level was in treating the trauma victim, and whether they felt that their trauma training during residency was adequate for their current practice.

METHODS

A survey was mailed to 250 board-certified EPs and 250 board-certified surgeons selected at random from the American College of Emergency Physicians and the American College of Surgeons membership directories, respectively. A follow-up mailing was sent to all non-respondents one month following the initial mailing. This survey was approved by the investigational review board.

The survey requested basic demographic data and information on the types of postgraduate and specialty training that each physician completed (Appendix). The survey then asked about who manages the trauma patient at the physician's current hospital, and whether or not the physician is currently comfortable with handling the unstable trauma patient. The physicians were asked about their opinions of who should manage trauma. In the survey we did not attempt to define precisely what a "trauma patient" or a "trauma team" was. Instead, the cover letter asked respondents to consider who cared for "sick" trauma patients in their residency and who cared for these patients in their current practice (to include a multidisciplinary group of physicians on a trauma team).

Table 1: Demographics*

	Surgeons	EP	p-values
Mean age (+/-SD)	56 (13)	42 (8)	<0.05
Women	6.5%	18.7%	<0.05
Mean year training completed (+/-SD)	1976 (13)	1988 (11)	<0.05
Practice setting			
Community	49%	39%	0.1
Urban	10%	11%	0.9
Community teaching	15%	15%	0.9
Urban teaching	26%	25%	0.9
Combination of practices		10%	

* 33 emergency medicine and 20 surgery respondents returned an incomplete survey. The results from partially complete surveys were included.

Table 2: Survey questions

Survey Question	Surgeon Agree	EDP Agree	p-values
Only surgeons should manage the care given to the trauma patient that presents in the ED?	53%	4%	<0.05
Physicians who are board certified in EM can manage and stabilize trauma patients that arrive in the ED until a surgeon arrives or until the patient can be transferred.	71%	92%	<0.05
The amount of training in trauma you received as a resident was too great for the amount of trauma that you now encounter in your practice.	24%	10%	<0.05
EPs are capable of the initial management of trauma patients that present to the ED.	63%	94%	<0.05
I should have received additional training in trauma as a resident.	11%	13%	0.8
I should have received less training in trauma as a resident.	5%	3%	0.8

The initial responses were collapsed to "agree, neutral and disagree." Data was analyzed using SPSS10-Mac. Chi-square, t-tests and odds ratios were calculated to compare responses between the two groups of physicians.

RESULTS

One hundred thirty-nine of 250 EPs (56%) and 126 of 250 (50%) surgeons responded. Demographic information is in Table 1. Residency training included defined months in trauma surgery for 52% of surgeons and 72% of EPs. During their residency, 72% of surgeons stated that surgery ran their traumas, and 19% stated that a trauma team ran their traumas. Only 7% of surgeons responded that during their residency the management of the trauma patient was shared with EPs. Fifty-six percent of EPs shared the care of the trauma patient with surgery when they were in training, while 23% stated that EPs were the primary trauma care providers, and 16% of traumas were managed by the surgery attending.

At their current hospital 38% of surgeons stated that trauma was managed by an EP, 50% by surgery (29% by a surgery team, and 21% by a surgery attending). Twelve percent of surgeons gave the answer of other, in which most commented that the trauma patient was cared for by both surgery and EPs. In their current practice, EPs stated that 60% of the initial management of the trauma patient is managed initially by the EP, while 24% is managed by a trauma team, and only 3% is managed by a surgery attending.

The opinions of the two groups on the management of trauma are in Table 2. Surgeons were more likely to believe that only surgeons should manage trauma upon presentation to the ED (53% vs. 4%, Odds ratio 26.4, 95% CI 10.8-64.2). This opinion was shared regardless of where the surgeons were practicing. However, only 60% of surgeons are comfortable with caring for the complex trauma patient, compared to 84% of EPs (Odds ratio 0.28, 95% CI 0.16-0.5). Fifty-six percent of surgeons who felt that only surgeons should take care of trauma did not, themselves, feel comfortable taking care of trauma patients.

While the majority of surgeons agreed that only surgeons should manage trauma, when given the opportunity to answer a question asking their opinion about whether EPs could manage the initial resuscitation of trauma patients the majority of surgeons (71%) seemed to agree that this was acceptable. The numbers were too small to comment on whether those who shared trauma training with EM residents had a more favorable view of the ability of EPs to care for the trauma patient.

The majority of surgeons and EPs did not feel that their trauma training should change. However, 24% of surgeons compared with 10% of EPs felt that they had received too much training in trauma for the amount of trauma that they now saw in their practice (Odds ratio 2.8, 95% CI 1.4-5.6).

DISCUSSION

Many medical centers that care for trauma patients have residency programs in both surgery and emergency medicine. In caring for the trauma patient, conflicts may arise as to who is the most appropriate physician to both run the trauma as well as perform procedures. Both specialties can claim that they need to learn how to care for the trauma victim.[5] It is not uncommon for surgeons to claim that trauma is a

surgical disease and, thus, only surgeons should be involved in the care of these patients.[6] This may be particularly true at regional trauma centers where EM residents may be allowed only a marginal role in trauma resuscitation. EM residents can correctly claim that not all "Level I trauma patients" arrive at Level I centers. EPs must be competent in the management and resuscitation of the acute trauma patient when a surgeon is not immediately available. In many cases the EP is the only available physician with trauma experience at some facilities. If the patient is to survive until the surgeon arrives or until his transport to another facility, he must be managed by providers trained and skilled in the care of the trauma patients.

Moving beyond what individual practitioners may think about who should take care of the trauma patient, guidelines do exist, and in some cases may be at odds.[7] The American College of Surgeons (ACS) Committee on Trauma publishes guidelines for trauma center designation, and a Level I designation requires trauma patients to be taken care of by surgeons. Since emergency medicine residency training requires that residents have opportunities to perform invasive procedures and direct major resuscitations (including trauma resuscitations), it is possible that the educational goals and guidelines for each specialty may conflict if surgeons feel that they are the only physicians capable of managing trauma patients.[2,8]

Many surgeons do not wish to incorporate trauma into their future clinical practice and most hospitals are not Level I trauma centers. Girotti et al.[9] found that only 5% of surgeons wanted greater than 30% of their future practice to be trauma related. Richardson and Miller[10] reported that less than 20% of surgery residents wanted to provide significant trauma care in their future practice. Given these findings it seems possible that many hospitals outside of the largest centers will have surgeons staffing them that neither want to take care of these patients, and in fact, may no longer feel comfortable taking care of trauma patients once they are a few years out of residency training. We were unable to find data indicating the long-term expectations of EPs as to how much trauma that they wanted to care for in their practice. However, given the realization of most EPs about the unexpected nature of many emergencies, it seems reasonable to assume that most EPs will have some expectation that they should and will care for trauma patients in the future.

In considering the response of EPs it is not surprising that they disagree with the statement that only surgeons should manage trauma patients. They also overwhelmingly agree that trained EPs can manage the initial resuscitation and management of the trauma patient until a surgeon arrives or until the patient is transferred. Eighty-four percent of EPs were comfortable managing the complex trauma patient compared with only 60% of surgeons. Given the numbers of practicing EPs currently caring for trauma at their hospital, their degree of comfort with the care of these patients, and the fact that they generally believe that they are capable of caring for these patients, it appears that EPs are active in trauma care once they graduate from residency.

The results of this survey indicate that once surgeons have graduated from residency many do not remain comfortable taking care of the complex trauma patient because they do not continue to care for trauma patients. This is in contrast to EPs, most of whom appear to remain comfortable with this type of patient.

This study has implications for facilitating a better understanding between surgeons and EPs in order to provide the highest quality of training in the care of the trauma patient. Understanding the role in trauma management that they are likely to play in their future practice may help each group understand the needs and goals of the other specialty while still in training. Further, given that some surgeons may not be comfortable providing routine trauma care once they move out of training, this study may help them understand that EM physicians both expect to manage and feel comfortable with providing care to trauma patients. Together these two groups may improve the care and outcomes of trauma patients, particularly those that present outside of the major trauma centers.

LIMITATIONS

There are several limitations in this study. There was no way to confirm the perceptions of participants as to who is actually taking care of the trauma patient at their facility. Despite attempts to increase the number of returned surveys, the percentage of returned forms was below desired. Those who felt less opinionated may have been the ones who did not reply. These results may therefore reflect the response bias of those that feel most opinionate or passionate about this topic. It is possible that EM physicians that feel more comfortable taking care of trauma patients are over-represented by this survey and the same may be true for surgeons. Future survey research in this area may generate better response by using a combination of mailed surveys along with phone follow-up rather than a second mailing.

The difference in mean age between the two surveyed populations may suggest a bias in the responses between the surgeons and the EPs. New graduates of surgery programs who are more used to training alongside EPs may have different opinions about the ability of EPs to care for trauma patients. However, the age and sex differences between the groups reflect existing demographic status at our own institution and may be an accurate reflection of current demographic differences between these two specialties. The surgical specialty is currently older than emergency medicine and remains a male-dominated specialty.

Finally, while we were interested in the way surgeons and EM physicians are practicing compared to the way

they were trained we did not explore the way in which the perceptions of these physicians may have changed over the interval between their training and their response to this survey. Future research could explore this area in greater detail.

CONCLUSION

In conclusion, many surgeons do not feel comfortable managing the trauma patient, but they still appear to feel that the trauma patient is best managed by a surgeon. However, most recognize that the EP can adequately care for the initial trauma resuscitation. The majority of EPs feel both capable of managing the trauma patient and that the trauma patient can be managed by EPs.

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Appendix *(continued).* Survey Administered to Surgeons and Emergency Medicine Physicians

Physician Opinions on Trauma Management – Emergency Medicine

Age:_____

Sex: M F

Year you ended training: _____

1. In what type of medicine are you Board certified?
a) surgery b) medicine c) family practice d) emergency medicine e)other (specify):_____

2. In what field did you complete your residency?
a) surgery b) medicine c) family practice d) emergency medicine e)other (specify):_____

3. Did you complete any fellowship training following residency?
a) yes b) no If yes please specify:_____

4. What is your current practice?
a) community b) urban c) community teaching d) urban teaching

5. In your emergency medicine residency did you do defined month(s) of trauma surgery?
a) yes b) no

6. Who managed trauma patients in the emergency department in your residency program?
a) trauma surgeon/ surgery b) emergency medicine c) shared/alternated with surgery
d) other (specify):_____

7. Who manages trauma patients if they arrive in the emergency department at your current hospital?
a) surgery attending b) emergency medicine attending c) trauma team d)other (specify):_____

8. Do you currently feel comfortable taking care of a complex, unstable trauma patient with chest and abdominal injuries?
a) yes b) no c) no opinion

Please state your agreement with the following statements:

9. Only surgeons should manage the care given to the trauma patient that presents in the emergency department?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

10. Physicians who are board certified in emergency medicine can manage and stabilize trauma patients that arrive in the ED until a surgeon arrives or until the patient can be transferred?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

11.Tthe amount of training in trauma you received as a resident was too great for the amount of trauma that you now encounter in your practice?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

12. Emergency medicine physicians are capable of the initial management of trauma patients that present to the emergency department?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

13. I should have received additional training in trauma as a resident?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

14. I should have received less training in trauma as a resident?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

Appendix. Survey Administered to Surgeons and Emergency Medicine Physicians

Physician Opinions on Trauma Management - Trauma

Age:_____

Sex: M F

Year you ended training: _____

1. In what type of medicine are you board-certified or eligible?

a) surgery b) trauma surgery c) other (specify):_____

2. In what field did you complete your residency?
a) surgery b) other (specify):_____

3. Did you complete any fellowship training following residency?
a) yes b) no If yes please specify:_____

4. What is your current practice?
a) community b) urban c) community teaching d) urban teaching

5. In your surgery residency did you do defined month(s) of trauma surgery?
a) yes b) no

6. Who managed trauma patients in the emergency department in your residency program?
a) trauma surgeon/ surgery b) emergency medicine c) shared/alternated with surgery
d) other (specify):_____

7. Who manages trauma patients if they arrive in the emergency department at your current hospital?
a) surgery attending b) emergency medicine attending c) trauma team d)other (specify):_____

8. Do you currently feel comfortable taking care of a complex, unstable trauma patient with chest and abdominal injuries?
a) yes b) no c) no opinion

Please state your agreement with the following statements:

9. Only surgeons should manage the care given to the trauma patient that presents in the emergency department?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

10. Physicians who are board-certified in emergency medicine can manage and stabilize trauma patients that arrive in the ED until a surgeon arrives or until the patient can be transferred?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

11. The amount of training in trauma you received as a resident was too great for the amount of trauma that you now encounter in your practice?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

12. Emergency medicine physicians are capable of the initial management of trauma patients that present to the emergency department?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

13. I should have received additional training in trauma as a resident?
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

14. I should have received less training in trauma as a resident.
1 2 3 4 5
Strongly Agree Neutral Strongly Disagree

International Perspective from the United Kingdom on "Surgeons' and Emergency Physicians' Perceptions of Trauma Management and Training"

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My comments on this paper are drawn from a London-based, British National Health Sevice (NHS) perspective. The United Kingdom (UK) health care system has certain unique characteristics (as every other system). The most remarkable of these remains the fact that virtually all of the health care in UK is provided as an absolute universal and free service from 'cradle to grave' funded by tax. Therefore, the balanced operation of market forces, both professional and financial, to achieve efficiencies and quality, remains a challenge for the British government which ultimately owns and runs it through a complex and imperfect system. Operational requirements are routinely placed on the NHS to be implemented locally by the managers. Many of these are contested by the professions and are the subject of much debate and negotiation. The clinical environment in which emergency medicine (EM) is practiced here has strong similarities and dissimilarities to that in the USA where the paper was researched.

Despite the differences in the infrastructure, the practicalities of emergency medicine (EM) in several countries are remarkably comparable. Therefore, the relevance and implications of the paper to the UK and perhaps globally is of interest.

Within the British emergency departments (EDs), training to the next generation of specialists is provided under intense pressure to achieve correct disposition of all patients within four hours of arrival. This controversial practice was implemented in 2003 to address perceived shortcoming in the UK EDs. Significant new funds were made available to support the policy, and many hospitals adjusted their care pathways to achieve the four-hour targets. The scientific evidence base for selecting four hours as the upper limit of time in the ED was never made clear by the UK Department of Health where the bureaucratic responsibility for it resides. Limited clinical exceptions to the rule were allowed.

Generally, the cost and benefit of target-driven health care is the subject of heated debate without an agreed conclusion. The four-hour target continues to have an unavoidable impact on the work-up of the patients in the ED.

Numerous changes to the ED processes, including closer cooperation with the admitting teams and the establishment of diagnostic or assessment units, have been implemented with mixed results. The 'ownership' of the patient with incomplete work-up has attracted various solutions, consistent with patient safety. In the case of trauma care, typically the threshold for activating the hospital trauma team response has been recalibrated to reflect the local realities, taking into account service and training needs. For example, in some hospitals if the ED is very busy, the trauma team may be called even for patients who do not meet strict criteria.

Management of multiple injuries is along the ATLS guidelines. Attending the ATLS course is effectively an essential requirement for both the EM and surgical trainees. Depending on the size of the department, condition of the patient on arrival and local political dynamics, the initial response is derived from a combination of the following three possibilities:

1) Autonomously by EM staff, who eventually call the relevant specialties if the patient requires admission to the hospital.
2) By the hospital trauma team, incorporating the EM staff and relevant surgical specialties
3) Independently by the trauma team with minimum (if any) involvement of EM staff.

In general the patient remains the responsibility of the emergency physicians (EP) until a hand-over to the relevant admitting team has been completed according to the local practice. Serious multiple trauma is usually managed jointly by the surgical specialties, anaesthetists and the EPs through the activation of the hospital trauma response. The person leading the team (again a matter for local policy) is the senior-most clinician (often the senior surgical trainee or EP) resolves any conflicts in real time followed in due course by a review, if appropriate, by the heads of departments and/or the trauma committee.

Typically, the EM and surgical trainees work side-by-side to provide the level of care appropriate to their speciality

and interest. Most assessments, including the FAST scan, are performed by EM staff whilst procedures of relevance to on-going surgical care, such as stab wound in the neck, are managed by the surgeons. Where the territories overlap, as in the case of chest tube insertion, this is done by mutual agreement. There is a genuine acceptance of the need to provide relevant experience and to share the training opportunity with all specialties. Simulation-based training prior to live supervised practice is now well established. Usually the trainee, whether surgical or EM, will have previously identified the procedures he or she needs to learn. The most experienced clinician in the trauma team takes responsibility to teach the trainee whose requirements are best met by the patient's condition. Whilst there are instances of specialties favouring their own, eventually everyone gets a chance. The airway is similarly cared for by prior arrangement jointly by anaesthetists and EPs. Cricothyroidotomy, for example, is an extremely rare procedure and if required would probably be performed by the most experienced clinician in the trauma team, likely to be a surgeon or EP, unless a trainee is ready for supervised learning. The surgeons are usually not interested in intubating the patient, though, if requested, the anaethestists cooperate with the educational needs of other specialities.

Let me not give the impression that everything is done with absolute bonhomie between the trainees and specialities. Resentment and tensions do arise, requiring diplomatic resolution or worse! Instances of political and professional arguments over legal responsibility, resource allocation and territory-related issues are well known. Ultimately, as in most human endeavour, the differences are settled by a combination of patient's best interest and expediency, within the context of local realities. So, if a speciality cannot or will not agree to something, the buck usually passes to the one who will.

The paper provides some insight into the cause and severity of potential conflict, if any, in the role and expectation of the EM and surgical staff. It also hints at the differences in motivation of the surgeons and EPs.

It can be argued that trauma care is more deeply and universally imbedded in the work of the EP throughout their professional life, whilst for the surgeons, their involvement, relatively speaking, is a matter of some choice. The general surgeons remain at the heart of trauma teams, in close cooperation with the anaesthetists and EPs. If the patient is admitted to the ITU the care is shared between surgeons and anaesthetists. Surgical intensivists are not a well-established specialty in UK. Trauma surgeons are not separately designated or trained in Britain, but often there are those within general surgery, orthopaedics, neuro and vascular surgery who take a specialist interest in providing trauma care. With increasing sub-specialisation in each domain it is possible that new practises will evolve over the next five years. The on-call arrangements for surgeons include a commitment to attend trauma patients. But those patients that do not require urgent life-saving surgery may well be transferred to specialist centres from smaller hospitals, though a formal classification into U.S. style level 1 to 5 does not exist.

Even the presence of a surgeon in the initial response to trauma is now a matter of debate if not dispute. Only a minor percentage of injured patients require surgery. EM and intensive care specialists jointly share much of the responsibility for trauma care with surgical specialties. There is little consensus about the definitive general surgical curriculum for trauma training. Implicitly there may be territorial issues, with implications for quality assurance and continuity of care. Protocols agreed by trauma committees in many UK hospitals provide the template and benchmark for cooperation as well as a forum for conflict resolution, sometimes in an unsatisfactory manner as noted above.

In a departure from previous policy, in London three new trauma centres are planned to achieve more efficient care for the seriously injured patients. Since the demography of trauma is quite distinct in different societies, one solution, however well founded in local evidence, is unlikely to meet the global need. In London approximately 1500 to 2000 major and serious multi-trauma cases are expected to be cared for annually within the planned new trauma centres where patients will be transferred by the London Ambulance Service, by-passing the local providers. The NHS, with its state-run monopoly, is particularly suited to achieve this within a small geographic area represented by Greater London. The smaller hospitals are expected to continue serving the single limb trauma or low grade midline injuries. The exact equivalent of the American trauma system does not exist in the UK, but the hospitals are established to a population base of 250,000 to 500, 000, supported by tertiary centres of excellence for referral of cases. Patients usually access the hospital-based secondary care at the request of the primary care providers (family doctor), except in emergency. But close cooperation exists (or should do) between the hospital and the family doctors so that the right patient is treated in the right way by the right people at the right time at the right place. But as everyone knows this remains an aspiration rather than an achievement in the UK at present. Opportunities for training are available if not in abundance, at least to an adequate level and are provided by cooperation between different professions. The value of good training for the future of health case is acknowledged by most if not all concerned.

The paper provides the basis to seek more detailed and contextual understanding. It may help to conduct further studies with better response rates to look at the education benefits that surgical and EM trainees expect from Trauma Care so that their roles may be better defined.

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Procedural Skills Training During Emergency Medicine Residency: Are We Teaching the Right Things?

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Objectives: The Residency Review Committee training requirements for emergency medicine residents (EM) are defined by consensus panels, with specific topics abstracted from lists of patient complaints and diagnostic codes. The relevance of specific curricular topics to actual practice has not been studied. We compared residency graduates' self-assessed preparation during training to importance in practice for a variety of EM procedural skills.

Methods: We distributed a web-based survey to all graduates of the Denver Health Residency Program in EM over the past 10 years. The survey addressed: practice type and patient census; years of experience; additional procedural training beyond residency; and confidence, preparation, and importance in practice for 12 procedures (extensor tendon repair, transvenous pacing, lumbar puncture, applanation tonometry, arterial line placement, anoscopy, CT scan interpretation, diagnostic peritoneal lavage, slit lamp usage, ultrasonography, compartment pressure measurement and procedural sedation). For each skill, preparation and importance were measured on four-point Likert scales. We compared mean preparation and importance scores using paired sample t-tests, to identify areas of under- or over-preparation.

Results: Seventy-four residency graduates (59% of those eligible) completed the survey. There were significant discrepancies between importance in practice and preparation during residency for eight of the 12 skills. Under-preparation was significant for transvenous pacing, CT scan interpretation, slit lamp examinations and procedural sedation. Over-preparation was significant for extensor tendon repair, arterial line placement, peritoneal lavage and ultrasonography. There were strong correlations ($r>0.3$) between preparation during residency and confidence for 10 of the 12 procedural skills, suggesting a high degree of internal consistency for the survey.

Conclusions: Practicing emergency physicians may be uniquely qualified to identify areas of under- and over-preparation during residency training. There were significant discrepancies between importance in practice and preparation during residency for eight of 12 procedures. There was a strong correlation between confidence and preparation during residency for almost all procedural skills, re-enforcing the tenet that residency training is the primary locus of instruction for clinical procedures. [*West*JEM. 2009;10:152-156.]

INTRODUCTION

How do we assess what we need to teach? Experts in instructional design agree that a periodic needs assessment is a critical element when planning or revising the content of any educational endeavor.[1] For emergency medicine (EM) residencies, the Residency Review Committee follows the *2007 Model of the Clinical Practice of Emergency Medicine*.[2] This model curriculum, first released in 2001, was based on expert panel recommendations. It has undergone extensive revisions and now incorporates empirical data as well as expert review. The 2003 release notes that "the ACEP Academic Affairs Committee has used the emergency

medicine model to survey emergency medicine residency program directors and recent residency graduates to identify curricula gaps and educational needs."[3] However, this evaluation method of post-residency survey, although used in other fields, has never been applied to specific content areas in EM.[4]

Practicing emergency physicians (EP) may be in the best position to identify areas of over- and under-preparation in their residency programs. They may be uniquely qualified to compare their training with the demands of clinical practice in the "real world."[5] Therefore, we examined procedural skill training, a subset of our residency curriculum. We surveyed recent graduates to compare "preparation during residency training" and "importance in clinical practice" for 12 common procedural skills.

METHODS

The principal objective of this study was to identify areas of over- and under-preparation for commonly taught EM procedures. We distributed a web-based survey to all physicians who had graduated from the Denver Health Emergency Medicine Residency program in the past 10 years (1997-2007). The study protocol was approved by the Colorado Multiple Institutional Review Board.

Survey Design

We convened an expert panel of five senior EM clinicians from our institution. After evaluating the list of procedures from the 2007 Clinical Practice Model (Appendix 1, Procedures)[2], panel members concluded that some procedures (i.e., central line insertion and orotracheal intubation) were so clearly important and routinely performed in residency training that they should be excluded from the survey. Instead, the panel agreed to focus on 12 procedures that it judged to be "important but not emergent." These procedures included: extensor tendon repair; transvenous pacing; lumbar puncture; applanation tonometry; arterial line placement; anoscopy; CT scan interpretation; diagnostic peritoneal lavage; slit lamp usage; ultrasonography; compartment pressure measurement; and procedural sedation.

The 46-item survey included demographic information (age and gender) of graduates, years of practice since graduation, board certification and fellowship or other post-residency training. Survey questions also addressed current ED practice type (academic, military, private, urgent care or other), geographic locale (urban, suburban or rural), and census.

A principal objective of this study was to compare *preparation during residency training* and *importance in practice* for these 12 procedural skills. *Preparation during training* was ascertained by asking this question: "Thinking back to residency and keeping in mind the didactic and practical instruction you received, please rate how well your residency training program prepared you to perform each procedure, with 'four' being excellent instruction and great preparation and 'one' being poor preparation with no instruction at all." *Importance during practice* was measured by asking, "Please rate the importance of each of these procedures in your current practice currently, with 'four' being extremely important and 'one' being not important at all."

To assess the internal consistency of the survey, we also calculated "confidence" scores for each procedure, using a similar four-point Likert scale. We hypothesized that preparation during training and confidence would be linked; we tested for an association between "confidence" and "preparation during residency training," by calculating Pearson's correlation coefficients for each procedural skill. Measuring these correlations also provided a means to test the hypothesis that residency is a primary locus of instruction for procedural training.

Several EM clinicians pilot-tested the survey in order to improve the clarity of the questions and response choices and to test the electronic interface. Criterion validity was strengthened by using procedures included in the 2007 Clinical Practice Module.[2,6]

The survey was distributed by email to all 126 residency graduates from the previous 10 years. The email contained a link to a commercial survey web site (Zoomerang.com®). One reminder email was sent to all graduates, whose email addresses were valid at the time of initial survey deployment.

Statistical Analysis

The analysis of the survey data proceeded in two steps. First, we summarized demographic characteristics of participants and their survey responses using means and standard deviations or medians and ranges for continuous variables; proportions and 95 percent confidence intervals were computed for categorical variables.

Second, we performed bivariate analyses to test for differences between mean preparation and mean importance scores for each procedure. To measure the significance of the differences, paired sample t-tests and 95% confidence intervals were calculated.

The survey questions, Likert scales and statistical methods utilized in this study were based on earlier residency training evaluations.[5,6,7,8]

RESULTS

Among 126 eligible participants, 74 (59%) completed the survey. The median annual ED census was 50,000 (range 10,000 to 130,000), and the median number of years in practice was 5.0 (range 0.5 to 14). The majority (72%) were practicing in private settings; smaller proportions were in academic (23%), urgent care (3%) or military (1%) practices. Fifty-six percent of graduates described their ED practice settings as "urban;" 36% "suburban," and 8% "rural. All

Table. Preparation versus importance for 12 procedural skills

Procedure	Mean preparation	Mean importance	Mean difference (95%CI)	p-value
Over-Prepared				
Diagnostic peritoneal lavage	3.0	1.5	1.5 (1.2-1.7)	0.00
Arterial line placement	3.1	2.3	0.8 (0.5-1.1)	0.00
Extensor tendon repair	2.6	2.1	0.5 (0.2-0.8)	0.00
Ultrasound usage	3.8	3.4	0.4 (0.1-0.6)	0.00
Under-Prepared				
Slit lamp usage	2.9	3.7	-0.8 (-1.0- -0.5)	0.00
CT scan interpretation	1.6	2.3	-0.7 (-0.9- -0.4)	0.00
Procedural sedation	3.3	3.9	-0.6 (-0.8 - -0.4)	0.00
Transvenous pacing	2.0	2.3	-0.3 (-0.5 - -0.1)	0.02
Concordant Preparation				
Applanation tonometry	2.3	2.5	-0.3 (-0.6 – 0.0)	0.06
Compartment pressure measurement	2.2	2.0	0.2 (0.0 – 0.4)	0.08
Anoscopy	2.8	2.5	0.3 (-0.1 – 0.6)	0.14
Lumbar puncture	3.8	3.9	-0.1 (-0.3 – 0.0)	0.15

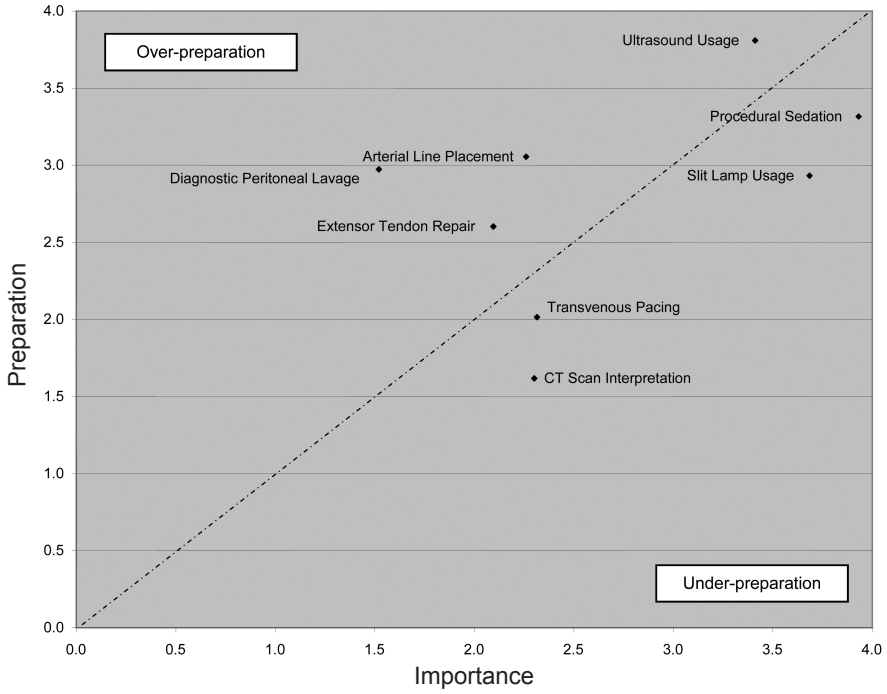

Figure. The diagonal line represents concordance between preparation during residency training and importance in current clinical practice. Preparation was significantly different from importance for these eight procedures.

participants were either board-certified or had been in practice for less than the time required for board eligibility. Five participants (7%) were fellowship trained.

Analysis of Preparation vs. Importance

When preparation and importance scores for the 12 procedures were compared, eight of the 12 procedures showed statistically significant differences (Table). Preparation exceeded importance for four procedures: extensor tendon repair; arterial line placement; diagnostic peritoneal lavage; and ultrasonography. Importance exceeded preparation in four areas: transvenous pacing; CT scan interpretation; slit lamp usage; and procedural sedation. The figure highlights these eight procedural skills for which there was significant over- or under-preparation. Four procedures (lumbar puncture, applanation tonometry, anoscopy and compartment pressure

measurement) appeared to be appropriately emphasized during training.

When survey participants were asked about their "other" sources of procedural training, 74% cited textbooks, 59% "trial and error," 30% continuing education courses, and 30% procedural training from colleagues. When asked about additional procedures that were important but not taught adequately, participants mentioned billing procedures and advanced airway techniques most frequently.

Preparation and confidence scores were significantly and strongly correlated ($r > 0.3$) for 10 of the 12 procedures, suggesting a high degree of internal consistency. The strong association between residency training and confidence also suggested that residency was a major source of procedural skill training.

There was no association between the number of years in practice and preparation, importance or confidence for any procedural skill. Physicians practicing in rural areas were more likely than their urban or suburban counterparts to rate CT scan interpretation as "important" or "very important" ($p = 0.16$); this difference was not statistically significant, perhaps due to the small number of rural emergency physicians participating in the survey.

DISCUSSION

In this study we looked to recent graduates to educate us about deficiencies in our residency training program. This technique, and the statistical methods we used to compare preparation and importance, were first suggested by Kern et al,[5] who proposed that "information from former trainees [can] provide a view of training that would be based on the demands of practice in the real world ."

These findings suggest that modest changes in our curriculum may be necessary to bring preparation more in line with the demands of practice. Of note, two procedures demonstrated marked differences in preparation and importance. Graduates reported significant under-training in CT scan interpretation; in contrast, they were over-trained in diagnostic peritoneal lavage.

Similar studies can easily be performed by other residency programs to identify areas of under- and over-training. These techniques may also prove useful in evaluating other skill and cognitive areas of the EM core curriculum, such as critical care, toxicology, orthopedics or other subspecialty disciplines.

The ACGME Outcomes project[7] warns that "[residency] programs are expected to show evidence of how they use educational outcomes data to improve individual resident and overall program performance." This study illustrates one technique that program directors can use to meet the ACGME requirements. Without gathering periodic feedback from recent graduates, it will be more difficult to effect needed curricular change.

LIMITATIONS

This study has several important limitations. First, it is based on a relatively small sample of recent graduates from a single EM residency program. Also, we only studied 12 selected procedures. Our results may not apply to other residency programs or their graduates, or to other procedural skills. The sample size also limits the precision of our results and the power to detect differences among residents, practice settings and specific procedures. Additionally, the survey response rate was 59%, which is acceptable but not ideal. We could not collect any information about graduates who did not respond to the survey; therefore, we cannot assess the direction or magnitude of any nonparticipation bias. Also, all of the data come from self-reports, and there is no assurance that response are reliable or valid. Nonetheless, our survey and analytic methods were adapted from previous residency training evaluations.[5,6,7,8]

We also acknowledge that some differences between preparation and importance scores may be statistically, but not educationally, significant. When Plauth et al.[8] studied hospitalists' perceptions of their training needs, they arbitrarily defined "meaningful differences" as those in which the difference between the mean preparation and mean importance scores were at least 1.0. Applying that standard to our study, three procedures (extensor tendon repair, CT scan interpretation and diagnostic peritoneal lavage) demonstrated "educationally meaningful differences."

We also learned in this investigation that some procedures are likely to receive higher or lower importance ratings in different EM practice settings. As noted earlier, rural practitioners assigned a higher importance rating to CT scan interpretation. Also, our graduates frequently reported that three procedures – thoracotomy, lateral canthotomy and transvenous pacing – were emphasized in training but were unimportant in their practices. It is interesting to note that although transvenous pacing was considered undertrained, it also was selected as unimportant. This result may derive from a division of respondents classifying the procedure as very important and another subset listing it as unimportant. Graduates were quick to note that if they were practicing in a different setting, these procedures might indeed be critical.

Finally, we did not measure the intensity of training or the methods of instruction for these 12 procedures. We did not review residents' procedure logs or ask them to estimate their training hours or the number of procedures they performed during residency or after graduation. Also, it is highly likely that procedural instruction varied during the 10-year study period. For example, in training and practice there was a steady decrease in attention paid to diagnostic peritoneal lavage, while there was a sharp increase in emphasis on ultrasonography, CT scanning and procedural sedation. Also, newer instructional technologies (for example, simulations) may have been introduced in recent years. In our study, we were unable to measure or adjust for these temporal trends in procedural training.

In summary, it cannot be assumed that the results of this study will apply directly to other residencies or their graduates. However, the key message is that this evaluation technique may prove useful as other program directors assess their own curricula for areas of over- and under-training, taking into account the varied settings in which graduates practice.

CONCLUSIONS

Frequently, the design and evaluation of residency training programs are guided by national surveys, consensus reports and the dissemination of model curricula. However, local, program-specific evaluations are also important and can only be provided by recent graduates, who are uniquely qualified to identify areas of under- or over-training for the "real-world" perspective. Post-graduate surveys may be an important new paradigm for residency program evaluation and reform.

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International Perspective from Saudi Arabia on "Procedural Skills Training During Emergency Medicine Residency: Are We Teaching the Right Things?"

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Commentary

This article illustrates the use of an essential post-residency survey to identify specific topic deficiencies in the emergency medicine (EM) residency curriculum. This method has been effectively used in other specialties. Lieberman et al.[1] used a post-residency survey in Canada to record opinions of 239 pediatricians for their preparedness for practice. Results showed trainees need more community and ambulatory pediatrics and less tertiary care exposure, and these were later incorporated in the curriculum. Khairy et al.[2] did a similar study to evaluate surgical residency training in Saudi Arabia. Ninety-six surgeons from different practice settings participated in the survey, which identified technical skills as the biggest training deficit. A structured skills training center for both junior and senior residents, especially outside the operating theater, was proposed.

Aksay et al.[3] describes a 14-year experience in Turkey using a similar survey to guide developing their EM programs. They used three different surveys for residents, trainers, and department heads of 20 EDs and 261 physicians. One hundred eighty-five residents, 56 trainers and 20 department heads participated in the study. Comparison of resident and trainer views regarding various aspect of EM training program was presented. Resident views differed significantly from trainer views (expressed as sufficiency percentages) in the number of practical skills (29.6% vs. 67.3%), competency in practical skills (60% vs. 78.2%), literature update (21% vs 37%), and quality of education (44.3%.vs 76.8%). Similar observations were made when theoretical knowledge and practical skills were evaluated. The residents' sufficiency level for different core content compared to trainer were as follows: cardiovascular, 74% vs. 91%; neurology, 68% vs. 86%; resuscitation, 83% vs. 98%; trauma, 76% vs. 87%; orthopedics 56% vs. 75%; pediatrics, 16% vs. 27%; and toxicology, 63% vs. 82% respectively. Resident and trainer views on practical skills were significantly different in all procedures except endotracheal intubation. For all other procedures the resident felt more under-prepared than the trainers reported. The authors concluded that while most of the departments have developed the basic components for residency training, significant gaps were identified in the curriculum taught and practical skills acquired. This important observation reminds educators of the need for post-training feedback to guide future training.

The present study used a similar survey to address preparation for "twelve common procedures taught during EM training and their importance in practice." Investigators used procedures considered important but not emergent, with the assumption that emergent procedures are routinely performed and well taught. The responses were classified in three groups: over or under-prepared and concordant. Slit lamp usage, computed tomography interpretation, transvenous pacing and procedural sedation were areas reported as under-prepared.

The study limitations included small sample size, single residency program and lack of information on methods of instruction and intensity of training. The authors did not compare these results with emergent procedures preparation, which would have allowed better understanding of the cause of this perceived under-preparation. The significant message from this study is that this evaluation can help identify program-specific deficiencies and modify the residency accordingly.

This study looks at the micro level of actual educational delivery to each resident rather than the macro view of curricular plan. Practice environments differ across the country. What may be important in one environment may not be in another setting. In the U.S., rural and community ED practices customarily have fewer on-call specialists than urban, academic ones. This, in turn, requires emergency

physicians without backup to perform procedures that specialists traditionally do.

In Saudi Arabia, standardized EM training was introduced only in 2000. Because EM-trained specialists are limited, the majority of physicians are non EM-trained and require significant support from subspecialists for specific procedures. This mitigates the need for broad procedural training to some degree. We should note that due to the annual Hajj pilgrimage, EM training in Saudi Arabia emphasizes mass gathering casualty care, disaster preparedness and ability to cope with multicultural people with no background medical knowledge. EM training programs include a National Hajj Preparation course and mandatory Hajj rotation during the residency program to prepare for this real-world challenge.

High-fidelity simulation is increasingly used in the U.S. to teach uncommon procedures and rudimentary skills prior to experience on patients. In Australia and New Zealand, the College of Anesthetists recently instituted a mandatory 2 1/2-day simulation-based course to assess competency in critical situations. This course is required of all anesthesia trainees before completion of their training. A similar initiative is in development by the Australian College of Emergency Medicine.[4] In the Middle East this concept is starting to evolve as well. Recently King Faisal Specialist Hospital in Riyadh (Saudi Arabia) identified the need for simulation labs to teach uncommon procedures. Simulation certainly improves performance in the simulated setting; however, little information is available on the translation of these skills to the actual patient care environment and their outcomes.

Studies with large sample sizes and broader assessment of both curriculum and procedural spectrum are required to more closely mirror real world needs.

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Factors Applicants Value when Selecting an Emergency Medicine Residency

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Objective: Little is known about the factors important to applicants when selecting an emergency medicine residency. We sought to identify which residency-specific criteria applicants value in selecting a training program.

Methods: We conducted an anonymous survey of emergency medicine interviewees at our residency. Applicants were asked to rate each of 18 factors on a four-point scale from 1 ("not at all important") to 4 ("very important") in their selection of a residency.

Results: Of 82 interviewees, 73 (89%) completed the survey. The factors with the top six mean scores were: how happy the residents seemed (3.9), program personality (3.8), faculty enthusiasm (3.7), geographic location (3.6), experience during interview day (3.5), and pediatrics training (3.5).

Conclusion: The top three factors deemed most important to emergency medicine applicants are primarily intangibles, while programs have no control over the fourth most important factor, location. [*West*JEM. 2009;10:159-162.]

INTRODUCTION

Emergency medicine (EM) is one of the newest medical specialties. As the field expands, so do the number of training positions in the United States. EM has become an increasingly popular career path among graduating medical students, and residencies select future cohorts of trainees from a very competitive pool of highly qualified applicants. Previous studies have shown that residencies differentiate among applicants on the basis of several factors, the most important being performance in an EM rotation, grades in clinical rotations, and letters of recommendation.[1,2] These data have been used to advise medical students facing the daunting task of applying to EM residency.

In contrast, residency selection committees have found little guidance in the literature regarding the factors that are important to applicants in selecting an EM residency. Knowing these factors could guide programs to emphasize factors that are already in place and improve those that are not strengths to attract the best candidates.

In addition to identifying factors important to applicants in selecting a residency, we were also interested in exploring whether these factors differ between male and female applicants. Women, traditionally underrepresented in the field of EM, comprised 39% of EM residents in 2007-2008.[3] In 2005-2006 the AAMC reported that women represented 49% of all graduating medical students.[4] Evidence shows that the gender representation in EM is changing. The number of female residents in EM has increased by 36% in the last five years while the number of men has remained relatively unchanged. Because the growth in applicants is mainly due to increased numbers of women choosing the specialty, any gender differences in factors important to applicants may be of interest to programs.

The primary objective of this study was to identify factors important to residency applicants in selecting an EM residency. A recent study by DeSantis and Marco[5] concluded

that the top five factors applicants consider when selecting a residency include friendliness, environment, interview experience, academics, and location. Our secondary objectives included investigating whether responses differed when respondents were stratified by gender or by whether they were involved in a committed relationship.

METHODS

Study Design

This cross-sectional study surveyed applicants interviewing at an urban, academic EM residency.

Study Setting and Population

This study was conducted at a three-year EM residency that offers nine PGY-1 positions each year. Of 653 applicants in this academic year, 114 (17%) were invited to interview, and all 82 applicants who did so during the study period were invited to participate in the survey. Geographic representation of our total pool of interviewees was 23% from the Midwest, 18% from the Northeast, 10% from the Southeast, 46% from the West, and 3% foreign medical graduates.

Study Protocol

During the orientation session on interview days, the survey was described to the applicants and the surveys and study information sheet were left in the room where they took a break during their interview day. They were able to fill out the survey privately, and the surveys were placed in a sealed box. Participation was both anonymous and voluntary. The local institutional review board granted approval for this study. Written consent was not required.

Measurements

The investigators selected aspects of an EM residency to include on the survey based on available literature and suggestions from the core education research faculty at our institution. The survey asked applicants to rate 18 factors on a four-point scale to indicate how important the factor was in their selection of an EM residency. The four options included "not at all important," "less important," "important," and "very important." Some of the terms, such as "the 'personality' of the program" and "academic rigor," were intentionally kept broad to mirror our experience in how medical students use these terms when we have served as their advisors. The survey also asked applicants to provide the following demographic information: age, gender, race, and marital status (either "single" or "married or equally committed relationship"). The survey was piloted on 20 applicants and reviewed before the study was initiated. No significant problems were identified.

Data Analysis

Mean scores were calculated for each factor by assigning a numerical value to each category (1=not at all important, 2= less important, 3=important, 4=very important).

Differences in responses by gender and relationship status were compared using the Wilcoxon rank sum test. For ease of interpretation, when the rank sum test was significant, the importance scores were collapsed into two categories of approximately equal sizes and compared using chi square tests.

RESULTS

Eighty-two applicants interviewed during the survey time frame of December 9, 2005 to January 20, 2006. Of these applicants, 73 completed the survey (89% response rate). As shown in Table 1, 60% of respondents were male, 86% were white, and 49% were in committed relationships. Sixty-four percent of males and 32% of females reported being in a committed relationship (chi-square test, p=0.01). Respondents' mean age was 28 (SD 2.6, range 25-36). Table 2 shows the applicants' ratings of the importance of each factor.

We also evaluated whether women answered differently than men. For women, the mean score for geographic location was 3.7, compared to 3.4 for men (p=0.04, rank sum test); 78% of women, compared to 52% of men, rated location as "very important" (p=0.03, chi-square). Females were also more likely to find opportunities for international electives important. The mean score for the importance of international electives was 3.1 in women, versus 2.4 in men (p<0.01), with

Table 1. Characteristics of respondents*

Gender		
	Male	44 (60%)
	Female	27 (37%)
	No response	2 (3%)
Race		
	White	63 (86%)
	Black	1 (1.5%)
	Asian	5 (7%)
	Other	1 (1.5%)
	No response	3 (4%)
Marital Status		
	Single	33 (45%)
	Married/committed relationship	36 (49%)
	No response	4 (6%)

* Percentages listed for 73 returned surveys.

Table 2. Applicants' ratings of the importance of factors in selecting an emergency medicine residency

Factor	Mean Score*	Std. Dev.
Happy residents	3.9	0.36
Program personality	3.8	0.40
Faculty enthusiasm	3.7	0.55
Location	3.6	0.60
Interview	3.5	0.55
Pediatrics training	3.5	0.60
Away rotation experience	3.4	0.85
Academic rigor	3.2	0.52
Ultrasound	3.2	0.62
Family friendly	2.9	0.94
Faculty reputation	2.9	0.81
Needs to coordinate with spouse/ partner	2.7	1.18
International opportunities	2.6	0.91
Length of program	2.6	0.78
Research infrastructure	2.6	0.69
Proximity to family	2.6	0.90
Salary and benefits	2.2	0.79
Family leave policy	2.0	0.63

* Possible range from 1 to 4, where 4 is the most important.

74% of females responding "very important" or "important" as compared with 43% of males (p =0.01). The only factor that was significantly more important to males than females was a need to coordinate with spouse/partner; the mean score in women was 2.1, versus 3.0 in men (p<0.01); However, this association decreased to a trivial magnitude and lost statistical significance after adjusting for marital status.

Considering differences between single respondents and those in a committed relationship, committed applicants were less likely to value the international elective, with mean scores of 2.4 for committed applicants versus 2.9 for single applicants (p=0.02); 42% of committed applicants versus 70% of single applicants chose "very important" or "important" (p=0.02).

Committed applicants were more likely than single ones to place importance on the need to coordinate with spouse or partner (mean scores 3.5 versus 1.8, p<0.01); 92% of committed vs. 28% of single applicants chose "very important" or "important" (p < 0.01). Committed applicants also placed greater importance on family-friendly environment (mean scores 3.4 versus 2.4); 56% of committed respondents versus 9% of single chose "very important" (p<0.01).

DISCUSSION

EM residencies compete for the strongest applicants, and each program determines which strengths to highlight during interview season. Many conduct post-match surveys of applicants to determine which factors led them to select other programs in lieu of their own. However, a prospective understanding of the factors important to applicants is helpful for residency selection committees and may help shape the interview-day experience.

This study addresses some of the limitations in DeSantis and Marco previous study,[5] which noted that their study population was limited to applicants of one Midwestern residency. By conducting our study in a markedly different geographic location, we add information about a population that may differ in important ways from that of the first study. In addition, the authors of the previous study note that their survey was conducted by mail with a response rate just over 50%. Our method of self-administered surveys completed on interview day yielded a response rate of 89% and demonstrated the feasibility of this method of survey administration.

In contrast to the previous study, which found that academics is one of the most important factors, we found that academic rigor as perceived by applicants was in the middle of the rank list for factors that applicants value (mean score 3.2). Similarly, research infrastructure was listed in the six factors ***least*** important to future residents. If, as we suspect, many programs focus on academic and research strengths during residency fairs and interview-day experiences, and if this finding holds true for other applicant pools, they may want to reconsider which strengths to emphasize when interacting with applicants. While some programs may choose to focus on other strengths to appeal to the broadest audience, others who wish to maintain or develop an academic distinction may continue to emphasize academic and research strengths to attract like-minded residents.

Our study also lends new insight into the factors that women value as compared to men. This information could be of value to programs interested in focusing recruiting efforts on talented female applicants. For example, if a program wants to foster gender equality (given the fact that women in academic EM reach achievement milestones at a rate that lags behind their male colleagues)[6] then knowing what factors are important to women could help attract strong female candidates with academic and leadership potential.

The DeSantis and Marco study found only minor gender difference in responses, with the top five factors being the same for both genders; however, rank differed slightly by gender with location ranked higher for females and environment ranked higher for males. Our study confirmed that location is indeed more important to women. One may hypothesize that women value location more because of a need to coordinate with a

spouse or partner, but we did not find a statistical difference between female and male responses about this variable (need to coordinate with spouse or partner) after adjusting for relationship status. Of note, males were twice as likely as females to be in a committed relationship. Interestingly, while females valued location more than males, as a group they are less tied to that location in the sense that they are more interested in international opportunities. Since program directors cannot change their program location, further investigations into other factors that may help recruit strong female applicants are needed.

Our findings are similar to DeSantis and Marco's in several interesting ways. We, too, found that geographic location and interview-day experience are among the most important factors to applicants in selecting a program. While location is a factor beyond the program director's control, understanding its importance to applicants may lead residency selection committees to emphasize the strengths of their geographic location. In contrast, because the interview-day experience is a dynamic factor amenable to change, it would be helpful to investigate what features of that experience are particularly attractive to residency applicants.

Similar to DeSantis and Marco's finding that friendliness and environment are important, we found that how happy the residents seem, the "personality" of the program, and the enthusiasm of faculty topped our list of factors that applicants value. While encouraging the residents and faculty to be welcoming and engaging may make some programs shine more than others, the program "personality" is likely to be subjective for each applicant and therefore a difficult factor to control. It seems that our top three factors relate to the concept of "a good fit" and one can argue that if programs strive to present an accurate self-image, then those who are drawn to the program are likely to be a better match than those who are not.

LIMITATIONS

Our candidate pool may differ from the general pool of EM applicants in several ways. For example, an interviewee at our program may not be representative of candidates who consider other areas of the country, or prefer a four-year program. In addition, this study identified which factors in a broad sense are valued by applicants, but further investigations are needed to more clearly understand how they define these factors. It is also important to note that the factors they value are likely to change over time. For example, both generational and medical system changes, such as technology advances and overcrowding, may impact future applicants' perceptions of the most important factors when selecting a residency.

CONCLUSION

Faced with finite time and resources, EM residency directors must determine how to best structure the interview-day experience to highlight program strengths that applicants value while accurately representing the character and mission of their residency. We found that when selecting an EM residency, applicants value how happy the residents seem, the personality of the program, the enthusiasm of the faculty, geographic location, and the interview-day experience. While most of these factors are subjective, their importance may prompt programs to investigate innovative ways to increase applicants' exposure to the residents, faculty, and program characteristics – especially since the most objective factor, location, cannot be altered. Areas that merit future consideration include the specific aspects of interview day that applicants value, as well as further exploration of the differences in values according to gender and relationship status.

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Balancing Potency of Platelet Inhibition with Bleeding Risk in the Early Treatment of Acute Coronary Syndrome

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Objective: To review available evidence and examine issues surrounding the use of advanced antiplatelet therapy in an effort to provide a practical guide for emergency physicians caring for patients with acute coronary syndromes (ACS).

Data Sources: American College of Cardiology/American Heart Association (ACC/AHA) 2007 guidelines for the management of patients with unstable angina (UA) and non-ST-segment elevation myocardial infarction (NSTEMI), AHA/ACC 2007 focused update for the management of patients with STEMI, selected clinical articles identified through the PubMed database (1965-February 2008), and manual searches for relevant articles identified from those retrieved.

Study Selection: English-language controlled studies and randomized clinical trials that assessed the efficacy and safety of antiplatelet therapy in treating patients with all ACS manifestations.

Data Extraction and Synthesis: Clinical data, including treatment regimens and patient demographics and outcomes, were extracted and critically analyzed from the selected studies and clinical trials. Pertinent data from relevant patient registries were also evaluated to assess current clinical practice.

Conclusions: As platelet activation and aggregation are central to ACS pathology, antiplatelet agents are critical to early treatment. A widely accepted first-line treatment is aspirin, which acts to decrease platelet activation via inhibition of thromboxane A2 synthesis. Thienopyridines, which inhibit ADP-induced platelet activation, and glycoprotein (GP) receptor antagonists, which bind to platelet GP IIb/IIIa receptors and hinder their role in platelet aggregation and thrombus formation, provide complementary mechanisms of platelet inhibition and are often employed in combination with aspirin. While the higher levels of platelet inhibition that accompany combination therapy improve protection against ischemic and peri-procedural events, the risk of bleeding is also increased. Thus, the challenge in choosing appropriate therapy in the emergency department lies in balancing the need for potent platelet inhibition with the potential for increased risk of bleeding and future interventions the patient is likely to receive during the index hospitalization.
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INTRODUCTION

Acute coronary syndrome (ACS) describes a spectrum of atherothrombosis, including unstable angina (UA), non−ST-segment elevation myocardial infarction (NSTEMI) and ST-segment elevation myocardial infarction (STEMI). As treatment decisions are driven by ACS type and severity, initial risk stratification in the emergency department (ED) is essential. In addition to historical factors and hemodynamic stability, electrocardiographic and cardiac biomarker findings play an important role in differentiating UA/NSTEMI from STEMI (Figure 1). Patients with acute STEMI are candidates for immediate reperfusion therapy

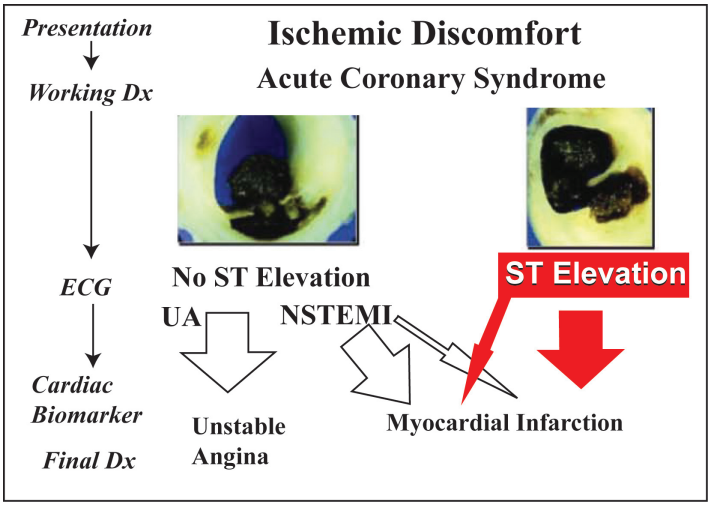

Figure 1. Spectrum of acute coronary syndromes. Adapted with permission from ©2004 American Heart Association, Inc.[63]

with adjunctive antiplatelet and antithrombotic therapy. The optimal strategy (percutaneous coronary intervention [PCI] vs. fibrinolysis) depends on the patient's clinical condition, timing of presentation, and the availability of interventional resources. In patients with UA/NSTEMI, diagnostic tools such as the 7-point Thrombolysis in Myocardial Infarction (TIMI) risk score can be used for semi-quantitative assessment of the risk of cardiac ischemic complications, where the risk of mortality or adverse cardiovascular events increases with the scale score.[1] It is recommended that high- and intermediate-risk UA/NSTEMI patients be managed with an early invasive strategy (i.e., diagnostic angiography followed by revascularization [PCI or coronary artery bypass graft (CABG)]).[2,3] The choice of optimal revascularization depends on the patient's coronary anatomy, left ventricular function, and the presence of co-morbidities such as diabetes. Lower-risk patients can receive medical management, with diagnostic angiography deferred unless deterioration occurs.[3]

Since platelet activation and aggregation are pivotal to ACS pathology, antiplatelet therapy, including aspirin, thienopyridines and glycoprotein IIb/IIIa receptor inhibitors (GPIs), is central to ACS treatment. Aspirin, which inhibits platelet activation by irreversibly binding to cyclooxygenase-1, is widely accepted as first-line treatment in ACS patients.[2] By irreversibly binding the platelet $P2Y_{12}$ receptor, thienopyridines inhibit adenosine disphosphate-mediated platelet activation. GPIs prevent activated platelets from cross-linking with fibrinogen, and ultimately decrease the trapping of red blood cells that leads to early vessel thrombus formation, obstruction, and/or distal small vessel embolization. "Dual" antiplatelet therapy (aspirin plus GPIs or aspirin plus thienopyridines) is appropriate in some patients, while in others, "triple" therapy including all three agents is suitable.

Emergency physicians (EPs) must choose appropriate antiplatelet therapy based on the underlying risk of ischemic complications and the anticipated course of treatment, i.e. medical vs. interventional management.[4] Ideally, evidence-based, predetermined ACS protocols should be in place so that optimal antiplatelet therapy can occur concurrently with maximum protection against bleeding complications. Ongoing collaboration among EPs, cardiologists, hospitalists and cardiovascular surgeons will undoubtedly improve care for ACS patients. Data from CRUSADE, a national health quality improvement initiative, showed significant improvement in adherence to guideline recommendations for ACS management in the acute setting, as participating hospitals developed more thorough cross-disciplinary pathways and protocols.[5] It is through such institutional-level collaboration that EPs can be empowered to initiate early, appropriate anti-ischemic therapy rather than being dependent on the individual, often varied, preferences of on-call specialists.

In addition to disease-related ischemia and necrosis, high-risk patients who undergo angiography face the potential added burden of periprocedural ischemia. It is hypothesized that microvascular embolization downstream of the target vessel plays a predominant role in the development of periprocedural infarction risk.[6] Hence, it is important to recognize the adjuvant role of pre-catheterization ("upstream") antiplatelet agents and anticoagulation during coronary intervention to offer protection against both disease-related and periprocedural ischemic insults. Appropriate therapy must balance the need for potent platelet inhibition with the potential for increased bleeding.

This review aims to examine issues and barriers surrounding antiplatelet therapy use and to provide a practical guide for EPs regarding their optimal use in ACS patients. While not a purely systematic review, we sought to identify relevant controlled studies and randomized clinical trials that assessed the efficacy and safety of antiplatelet therapy in treating patients with all ACS manifestations. Other data sources included 1) the 2007 American College of Cardiology/American Heart Association (ACC/AHA) ACS treatment guidelines, 2) relevant clinical data extracted from patient registries, and 3) selected clinical articles identified through the PubMed database (1965-February 2008) using appropriate search terms (e.g. acute coronary syndrome, antiplatelet agents, atherosclerosis, blood platelets, myocardial infarction, thrombosis).

Variability of platelet response

Available secondary prevention therapies do not provide cures. They decrease associated risks. Despite receiving "adequate" antiplatelet therapy, approximately 8-10% of patients experience recurrent cardiovascular ischemic events after ACS.[7-9] This phenomenon is loosely referred to as "resistance" without a clear, consensus definition.[10,11] In most

Table 1. Factors affecting inter-individual variability in response to antiplatelet therapy.

Adherence
Intestinal absorption[31]
Genetic polymorphism resulting in variable cytochrome P450-dependent enzyme activity [14,15,17]
Pretreatment platelet reactivity[72]
Drug resistance[72]

instances, what is described as resistance is actually either hyporesponsiveness to therapy, which falls under platelet response variability, or patient non-adherence, which may or may not be obvious.[12,13] There are many potential reasons for platelet response variability, including adherence, non-absorption, and genetic polymorphisms (Table 1).

True pharmacological resistance is probably uncommon and likely the result of genetic polymorphism. Some evidence suggests that variability in cytochrome P450-dependent enzyme activity due to genetic polymorphism may contribute to inter-patient variation in aspirin and clopidogrel response.[14,15] ACS patients are likely to be taking multiple medications for co-morbid conditions, including statins and/or calcium-channel blockers, that are metabolized by cytochrome P3A4 (CYP 3A4). Non-dihydropyridines such as verapamil and diltiazen are known to inhibit CYP 3A4, and most statins, with the exception of pravastatin, compete with clopidogrel for binding to CYP 3A4; this could lead to reduced metabolism or clearance of one or both of the drugs involved.[16] Conversely, a study conducted in healthy volunteers showed that St. John's Wort amplified the effects of clopidogrel, turning non-responders into responders.[17] Recently, the FDA reported that additional studies would be conducted to better characterize the impact of genetic factors and concomitant administration of other drugs on the efficacy of clopidogrel.[18]

Laboratory platelet aggregation tests, traditionally used to evaluate bleeding disorders, have recently been employed to correlate *ex vivo* results of antiplatelet therapy with clinical outcomes. However, using these inhibition of platelet activity (IPA) results is problematic and currently clinically non-interpretable, partly due to the lack of a standard test for IPA. For each given test, there is considerable variation among laboratories as the methodology is difficult to standardize. Further, results of these tests are temporally variable for any given patient. More importantly, there have been no data definitively linking IPA with clinical outcomes. In studies of patients presenting to the ED with acute chest pain or ACS, the success of platelet function testing in predicting the severity of MI or other adverse cardiac events has been variable.[19,20] In particular, results of IPA tests suggest 'resistance' upwards of 35%; in reality, however, only 8%-10% of patients show clinical signs of hyporesponsiveness or resistance.[21] Clearly, platelet response variability to antiplatelet therapy is a controversial and widely debated topic that requires more research to discern its true clinical impact and whether any practice changes are necessary. Such changes are likely to occur first in the chronic management of coronary artery disease, but at some point in the future may impact ED decision-making as well.

Loading Dose

Rapid inhibition of platelet aggregation is often accomplished by administering a loading dose of an antiplatelet agent. As shown in the CURE,[8,22] CREDO,[7] and CLARITY[23,24] trials, as well as a meta-analysis thereof ,[24] addition of a 300-mg clopidogrel loading dose resulted in significant relative risk reductions in endpoints among all ACS patients, regardless of their intervention strategy (Table 2). The optimal loading dose of clopidogrel necessary to safely achieve rapid platelet inhibition has been an area of investigation. Compared to the standard 300-mg loading dose, a 600-mg dose has been shown to inhibit platelet aggregation more rapidly, reducing the time required to achieve maximum platelet inhibition from six to two hours.[25-31]

Although a higher clopidogrel loading dose more rapidly inhibits platelet aggregation, it is unclear whether this translates into improved clinical outcomes. In the ARMYDA-2 study of UA/NSTEMI patients undergoing PCI, a 600-mg clopidogrel loading dose reduced the risk of periprocedural events by 50% compared to a 300-mg loading dose without increasing the risk of bleeding (Table 2).[30] In the CLEAR PLATELETS and ISAR-REACT 2 studies, addition of a GPI following a 600 mg clopidogrel loading dose further reduced the risk of adverse events and myocardial necrosis without significantly increasing the risk of bleeding.[9,25] However, the added clinical benefits relative to the safety (bleeding risk) of higher loading doses remain to be fully established. This is being evaluated in the ongoing CURRENT OASIS-7 trial.

Current U.S. guidelines reflect the uncertainty of the optimal clopidogrel loading dose. Both the PCI and UA/NSTEMI guidelines specifically mention this uncertainty.[2,32] The UA/NSTEMI guidelines don't make a specific recommendation, while the PCI guidelines recommend a 600-mg loading dose.[2,32] The STEMI guidelines maintain a recommendation of 300 mg for patients receiving fibrinolysis or no reperfusion.[33]

Loading doses of the recently approved antiplatelet agent, prasugrel, have also been assessed. In PRINCIPLE, a 60-mg prasugrel loading dose resulted in greater platelet inhibition compared to a 600-mg clopidogrel loading dose as early as 30 minutes after intake.[34] Although PRINCIPLE was not powered to detect clinical outcomes, hemorrhagic adverse events were more common in patients taking prasugrel. The excess

Table 2. Selected clinical trials and meta-analyses of relevant antiplatelet therapies. The trials are presented according to the antiplatelet therapy and ACS type investigated.

	Study	Treatment	Duration	Relative Risk Reduction	Safety outcomes
Antiplatelet Therapy vs. Placebo					
Acute MI	Antithrombotic Trialists' Collaboration[73]	Dependent on trial and antiplatelet therapy used	Mean = 1 month	38 fewer vascular events (SE=5) per 1,000 patients treated	1-2 additional extracranial bleeds
Clopidogrel + Aspirin vs. Aspirin alone					
NSTEMI	CURE[8]	300 mg loading dose clopi + 75 mg/day clopi + 75-325 mg/day ASA vs. 75-325 mg/day ASA + Placebo	Mean = 9 months Range = 3-12 months	20% (95% CI, 0.72-0.90; P<0.001) in CV death, IS, or non-fatal reinfarction at 12 months	1% excess of major bleeding (3.7% vs. 2.7%; RR, 1.38; P=0.001) and 0.3% excess of life-threatening bleeding (2.1% vs. 1.8%; P=0.13) with dual therapy vs. ASA alone
PCI	PCI-CURE[22]	300 mg loading dose clopi + 75 mg/day clopi + 75-325 mg/day ASA vs. 75-325 mg/day ASA + Placebo	Mean = 8 months Range = 3-12 months	30% (95% CI, 0.50-0.97; p=0.03) for CV death, MI or urgent TVR within 30 days	No excess of any bleeding between PCI and 30 days, but a 1.4% excess of minor bleeding (RR, 1.68; 95% CI, 1.06-2.68; p=0.03) after 30 days with dual therapy vs. ASA alone
	CREDO[7]	300 mg clopi loading dose + 75 mg/day clopi + 75-325 mg/day ASA vs. 75-325 mg/day ASA + Placebo	12 months	27% (95% CI, 3.9-44.4%; P=0.02) for CV death, MI, or IS at 12 months	2.1% (8.8% vs. 6.7%; P=0.07) increase in the risk of major bleeding at 12 months with dual therapy vs. ASA alone
STEMI	CLARITY[23]	300 mg clopi loading dose + 75 mg/day clopi + 75-162 mg ASA vs. 75-162 mg ASA + Placebo	30 days	36% (95% CI, 24-47%; P<0.001) for an occluded infarct-related artery upon angiography or death or recurrent MI prior to angiography; 20% (OR, 0.80; 95% CI, 0.65-0.97; P=0.03) for CV death, recurrent MI, or urgent TVR within 30 days	0.2% increase (1.3% vs. 1.1%; P=0.64) in the risk of major bleeding through 30 days
	COMMIT[74]	75 mg/day clopi + 162 mg/day ASA vs. 162 mg/day ASA + Placebo	Mean = 15 days Max = 28 days Quartiles = 9, 14, and 21 days	9% (OR, 0.91; 95% CI, 0.86-0.97; p=.002) for death, recurrent MI, or stroke during hospitalization; 7% (OR, 0.93; 95% CI, 0.87-0.99; p=0.03) for all-cause death during hospitalization	0.03% (0.58% vs. 0.55%; p=0.59) excess of major bleeding 0.5% (3.6% vs. 3.1%; p=0.005) excess of minor bleeding
600 mg clopidogrel loading dose vs. 300 mg clopidogrel loading dose					
PCI	ARMYDA-2[30]	600 mg clopi loading dose + 75 mg/day clopi + 100 mg/day ASA vs. 300 mg clopi loading dose + 75 mg/day clopi + 100 mg/day ASA	30 days	50% (OR, 0.48; 95% CI, 0.15-0.97; P=0.044) for periprocedural MI with 600 mg vs. 300 mg clopi loading dose	No excess bleeding of any type
Prasugrel + Aspirin vs. clopidogrel + Aspirin					
PCI	TRITON-TIMI 38[75]	60 mg prasugrel loading dose + 10 mg/day prasugrel + 75-162 mg/day ASA vs. 300 mg clopi loading dose + 75 mg/day clopi + 75-162 mg/day ASA	Median = 14.5 months	29% (HR, 0.81; 95% CI, 0.73-0.90; P<0.001) for cardiovascular death, non-fatal MI, or non-fatal stroke	Excess non-CABG-related TIMI major (2.4% vs. 1.8%; P=0.03), life-threatening (1.4% vs. 0.9%; P=0.01), major or minor (5.0% vs. 3.8%; P=0.002) and CABG-related TIMI major (13.4% vs. 3.2%; P<0.001) bleeding

GP IIb/IIIa Inhibitor + ASA vs. ASA alone					
NSTEMI	Meta-analysis[56]	Dependent on trial	Dependent on trial	9% (OR, 0.91; 95% CI, 0.84-0.98; p=0.015) in death or MI at 30 days	1% (2.4% vs. 1.4%; p<0.0001) excess of major bleeding
PCI	Meta-analysis[76]	Dependent on trial	Dependent on trial	31% (RR, 0.69; 95% CI, 0.53-0.90) 21% (RR, 0.79; 95% CI, 0.64-0.97) in death at 30 days and 6 months, respectively	Excess major bleeding only when heparin continued after PCI (RR, 1.70; 95% CI, 1.36-2.40 vs. RR, 1.02; 95% CI, 0.85-1.24)
GP IIb/IIIa Inhibitor + Fibrinolytic vs. Fibrinolytic alone					
STEMI	INTEGRITI[77]	180 mcg/kg bolus eptifibatide + 2 mcg/kg/min infusion + 180 mcg/kg bolus eptifibatide 10 minutes later + 0.27 mg/kg TNK +ASA vs. 0.54 mg/kg TNK + ASA + Placebo	60 minutes	10% (59% vs. 49%; p=0.15) increase in TIMI grade 3 flow at 60 minutes	5.1% (7.6% vs. 2.5%; p=0.14) excess of major hemorrhage 9.2% (13.4% vs. 4.2%; p=0.02) excess of transfusions
	SPEED[78]	0.25 mg/kg bolus abciximab + 12 hour 0.125 mg/kg/min abciximab infusion + 2 5U boluses of reteplase + ASA vs. 2 10 U boluses of reteplase + ASA + Placebo	12 hours	7% (54% vs. 47%; p=0.39) increase in TIMI grade 3 flow at 60-90 minutes	6.1% (9.8% vs. 3.7%; p=0.11) excess of major bleeding

ARMYDA-2, Antiplatelet Therapy for Reduction of Myocardial Damage During Angioplasty; *ASA*, aspirin; clopi, clopidogrel; *CLARITY*, Clopidogrel as Adjunctive Reperfusion Therapy; *COMMIT*, Clopidogrel and Metoprolol in Myocardial Infarction Trial; *CREDO*, Clopidogrel for the Reduction of Events During Observation; *CURE*, Clopidogrel in Unstable Angina to Prevent Recurrent Events; *CV*, cardiovascular; *GP*, glycoprotein; *INTEGRITI*, Integrilin and Tenecteplase in Acute Myocardial Infarction; *IS*, ischemic stroke; *MI*, myocardial infarction; *NSTEMI*, non-ST elevation myocardial infarction; *OR*, odds ratio; *PCI*, percutaneous coronary intervention; *RR*, relative risk; *SE*, standard error; *SPEED*, Strategies for Patency Enhancement in the Emergency Department; *STEMI*, ST elevation myocardial infarction; *TIMI*, thrombolysis in myocardial infarction; *TRITON*, Trial to Assess Improvement in Therapeutic Outcomes by Optimizing Platelet Inhibition with Prasugrel; *TVR*, target vessel revascularization.

bleeding associated with prasugrel was more pronounced in TRITON, in which efficacy and safety were compared in PCI patients receiving prasugrel or clopidogrel (standard 300-mg dose); in this study, all classes of TIMI bleeding were significantly greater in patients taking prasugrel.[35] In light of these findings, the U.S. prescribing information for prasugrel includes a black box warning highlighting its associated bleeding risks. Specifically, prasugrel is contraindicated in patients with active pathological bleeding or a history of stroke or TIA, should not be given to patients likely to undergo CABG, and is generally not recommended for patients aged ≥75 years.

CABG

In ACS patients who undergo CABG, the addition of clopidogrel to aspirin increases bleeding risk if surgery is performed within five days after discontinuation.[8] A dilemma thus arises, as it is difficult to predict prior to diagnostic angiography which patients will require urgent, early CABG.[8,36] The EP can take one of two approaches to starting clopidogrel: 1) Initiate clopidogrel in the ED in all high-risk UA/NSTEMI patients, with a view to withdraw before emergency CABG or five to seven days before semi-elective or elective CABG; or 2) defer clopidogrel treatment until after angiography, therefore avoiding treatment in patients who require emergency CABG. The first strategy, recommended by the European Society of Cardiology (ESC),[37] offers the advantages of reducing early ischemic events (relative risk reduction of 20%) and optimal timing for pre-PCI administration, but at the cost of increased peri-operative bleeding for patients who undergo early CABG.[36,38] The second strategy offers the advantage of avoiding excess bleeding during early CABG, but at the cost of ischemic events and loss of pre-treatment benefit in PCI patients.[8,39]

It is important to remember the CRUSADE data, where only 12% of UA/NSTEMI patients underwent

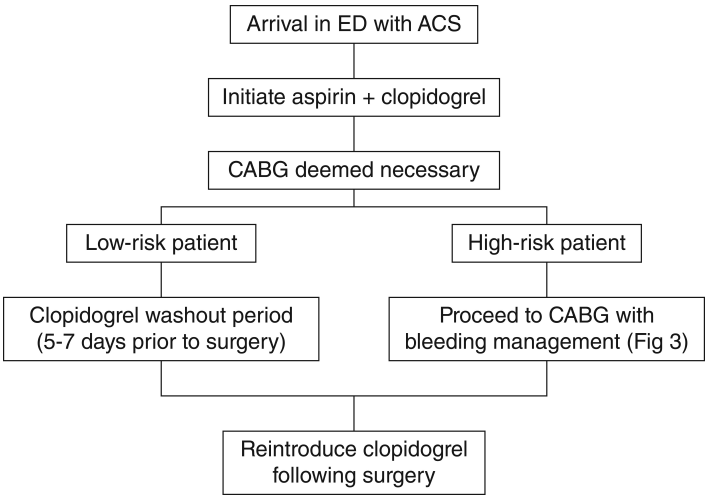

Figure 2. Suggested antiplatelet therapy management algorithm for patients presenting to the ED with ACS and requiring CABG. *Consider withholding antiplatelet therapy in patients at a high risk of CABG (e.g., those with cardiogenic shock, mitral regurgitation, impaired left ventricular function). *ACS*, acute coronary syndrome; *CABG*, coronary artery bypass grafting; *ED*, emergency department.

CABG during their index hospitalization.[40] Other studies estimate rates of CABG between 8% and 25% during index hospitalization.[8,41-44] Emergency CABG rates are seemingly lower, from 0.3% to 0.6%.[45] Since the majority of patients are suitable for PCI or medical management, most high-risk ACS patients would thus benefit from early dual antiplatelet inhibition. Furthermore, among patients in CURE who underwent CABG, lower ischemic event rates were observed with clopidogrel treatment before CABG.[36] Taking these considerations into account, it has been suggested that most patients requiring CABG will benefit from initiating clopidogrel and aspirin on admission (i.e. in the ED) and then stopping clopidogrel five days before surgery to minimize bleeding risk (Figure 2).[36,46] Even if urgent CABG is required, evidence indicates that an experienced surgeon can perform CABG within five days of clopidogrel washout via judicious use of a bleeding management algorithm.[47] One study found that CABG performed within five days of clopidogrel washout resulted in postoperative mortality rates similar to patients who were not exposed to clopidogrel within five days before CABG.[47]

Patients with hemodynamic instability (cardiogenic shock), mechanical complications (acute mitral regurgitation), diabetes, impaired left ventricular function, concomitant vascular disease, and multivessel disease are at higher risk for urgent CABG.[2,48] As shown in the Bypass Angioplasty Revascularization Investigation study of patients with diabetes,[49] such patients may have improved survival with CABG compared to PCI. It would therefore be prudent to withhold clopidogrel in these patients. For patients for whom clopidogrel pre-treatment is withheld pending angiography, data from ISAR-REACT 2 suggest that GPIs be administered upstream of the catheterization lab in troponin-positive patients [9]

Based on an analysis of NSTEMI patients from the TACTICS-TIMI-18 trials, Sadanandan et al.[50] developed a predictive risk score to identify patients who are likely to require CABG during index hospitalization. Mehta et al.[51] have also developed a multivariate model, based on CRUSADE data, identifying 13 presenting clinical characteristics significantly associated with undergoing CABG during initial hospital stay. However, identification in the ED of patients likely to need urgent CABG remains problematic as these prediction scores are often unreliable prior to diagnostic angiography. Because of the difficulty in predicting which ACS patients will require emergency CABG, it is essential that emergency physicians, cardiologists, cardiovascular surgeons, and hospitalists develop clear, institution-specific indications for clopidogrel and GPI administration. Such collaboration decreases reliance on personal preferences and empowers emergency physicians to initiate care and gain ischemia-related reductions while simultaneously maximizing patient safety.

Safety Considerations

The risk of bleeding is the most important safety consideration when initiating antiplatelet therapy. This risk must be weighed against observed clinical benefits in all ACS patients. As might be expected based on higher levels of platelet inhibition, bleeding risk is increased by combining antiplatelet agents (Table 2). Among ACS patients, adding clopidogrel to aspirin is associated with an absolute 0.2% to 1.0% increase in major bleeding.[52] However, the statistical significance of this increased bleeding varied among the trials. This may be partly due to the definition used to classify bleeding events. For example, the excess bleeding in CURE was significant when the OASIS scale was used but insignificant using the TIMI and GUSTO scales.[8] Importantly, even using the stringent OASIS scale, life-threatening bleeding was not significantly greater among dual aspirin and clopidogrel recipients in CURE.

In contrast to the well-established safety and efficacy data of dual treatment with aspirin and clopidogrel, data related to dual therapy with aspirin and prasugrel are only emerging, and their overall clinical significance is yet unknown. In TRITON, the superior efficacy of prasugrel and aspirin was accompanied by significant excesses of non-CABG-related TIMI major and minor bleeding, life-threatening and fatal bleeding, bleeding requiring transfusion, and CABG-related TIMI major bleeding (Table 2).[35] The risk of bleeding was particularly prominent in patients with a history of stroke or TIA and those aged ≥75 years or with a body weight <60

kg. The resultant unfavorable net benefit in these patient subgroups led to the inclusion of the aforementioned black box warning in the prasugrel prescribing information. Additional data are required to fully establish the net benefit of dual therapy with aspirin and prasugrel.

The safety profiles of AZD6140 and cangrelor, two emerging antiplatelet agents which are reversible inhibitors of the $P2Y_{12}$ receptor, also remain to be determined. In early trials, AZD6140 induced hypotension and dyspnea, potentially problematic side effects that may mimic symptoms of recurrent atherothrombotic events.[53] Additionally, AZD610 has a higher IPA than clopidogrel and may lead to an increased risk of bleeding in certain patient populations.[53] While cangrelor did not show significant excess bleeding in early trials,[54,55] more data are needed.

GPI inhibition is associated with a small, significant increased incidence of bleeding, most commonly at the vascular access site (Table 2). In a meta-analysis, GPI use in UA/NSTEMI patients was associated with a significant excess of major bleeding complications (2.4% vs. 1.4%, p<0.0001), though intracranial bleeding was not increased significantly.[56] It is important to note, however, that this increased bleeding risk was offset by significant reductions in death and MI, particularly in high-risk patients. Among STEMI patients treated by fibrinolysis, GPI therapy is not associated with a net clinical benefit as major bleeding is significantly increased in the absence of any mortality reductions (Table 3).[57,58] In contrast, the ADMIRAL[59] and CADILLAC[60] studies showed that benefits from upstream GPI therapy in PCI patients were not compromised by any important increased bleeding risk. In the ACUITY trial,[61] which investigated an early invasive strategy in UA/NSTEMI patients, the combination of bivalirudin, a direct thrombin inhibitor, with GPI therapy was associated with comparable clinical outcomes and a lower bleeding risk compared with heparin plus GPI therapy.

Overall, a large body of evidence supports an acceptable safety profile for dual antiplatelet therapy with aspirin and clopidogrel in all ACS patients, a differential safety profile with GPIs, and an unclear safety profile for the novel agents prasugrel, AZD6140, and cangrelor.

Evidence-based, practical solutions for antiplatelet therapy

The 2007 ACC/AHA guidelines recommend that all ACS patients receive aspirin and clopidogrel (loading dose followed by a maintenance dose) as soon as possible regardless of reperfusion strategy (Table 3).[2] Antiplatelet therapy should not be withheld prior to catheterization. If the patient has already received clopidogrel and elective CABG is deemed necessary, clopidogrel should be discontinued for five to seven days prior to surgery in order to balance antiplatelet efficacy with bleeding risk. The addition of a GPI depends on the management strategy and risk level of the patient.[2] In UA/NSTEMI patients, a GPI should be given upstream

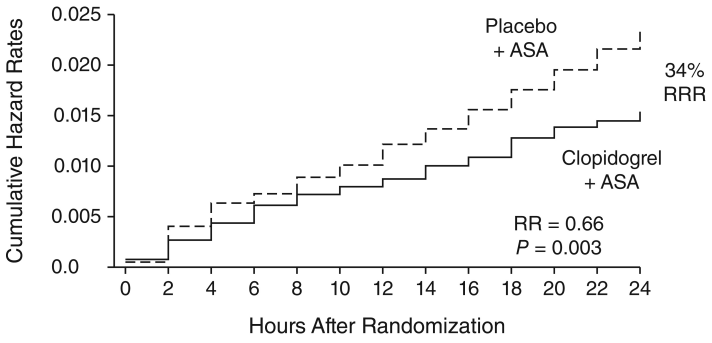

Figure 3. Cardiovascular death, myocardial infarction, stroke and severe ischemia within the first 24 hours after randomization to aspirin plus placebo or aspirin plus clopidogrel in the CURE study. With permission. Yusuf et al. Early and Late Effects of Clopidogrel in Patients with Acute Coronary Syndromes. *Circulation*. 2003;107:966-72.[80]

of, or immediately prior to, PCI. The guidelines advocate GPI administration as early as possible in STEMI patients undergoing PCI,[32,33,62,63] which supports initiating treatment in the ED.

Results from various studies supporting these guidelines are of particular interest to EPs. One example is the finding from CURE supporting *early* initiation of dual antiplatelet inhibition in UA/NSTEMI patients. A statistically significant benefit of dual antiplatelet therapy over aspirin alone in reducing ischemic events was evident as early as 24 hours after randomization, with the curves separating qualitatively at 12 hours (Figure 3).[8] Other evidence supports pretreatment with a clopidogrel loading dose prior to PCI.[7,22] Among UA/NSTEMI patients in CREDO and those undergoing PCI in CURE, adding a clopidogrel loading dose resulted in significant relative risk reductions in endpoints (Table 2).[22] The CLARITY and COMMIT trials, which evaluated clopidogrel treatment in conjunction with fibrinolytics, aspirin and heparin in STEMI patients, reported significant cardiovascular event reductions in patients pretreated with clopidogrel (Table 2).[23]

CREDO also raised the issue of timing in UA/NSTEMI patients, suggesting that longer intervals between dosing and PCI might show greater benefit, ostensibly by allowing clopidogrel to achieve maximum platelet inhibition.[7] It should be emphasized that one of the most compelling reasons to initiate clopidogrel therapy as early as possible is to decrease periprocedural ischemia.[30] In the ARMYDA-2 trial, patients were randomized to loading doses of either 600-mg or the conventional 300-mg 4-8 hours prior to angiography.[30] The primary endpoint was the 30-day occurrence of death, MI, or target vessel revascularization. The primary endpoint occurred in 4% of patients in the high-loading dose group versus 12% of those in the conventional-loading dose group (P=0.041) and was due entirely to periprocedural MI. However, in a small study of patients with ACS undergoing stent implantation, no difference was found with three days of clopidogrel pretreatment compared with standard post-procedural

Table 3. Current antiplatelet therapy recommendations and adverse effects. The data is presented according to class of antiplatelet therapy and ACS condition. Recommendations were compiled from references 2, 32, 33, 63 and 79.

Antiplatelet	Condition	Recommendation	Adverse Effects	Comments
Thromboxane A_2 Inhibitors				
Aspirin	NSTEMI, PCI, and STEMI	Daily consumption initiated immediately following symptom onset and continued indefinitely by all patients with a history of CAD or ACS and without aspirin allergy	1. Increased risk of bleeding complications; 2. Monotherapy associated with high risk of stent thrombosis after PCI	1. The most studied and well-established of the antiplatelet therapies; 2. Efficacious; 3. Good safety profile; 4. Low cost; 5. Aspirin resistance may occur
Thienopyridine Inhibitors				
Clopidogrel	NSTEMI, PCI, and STEMI	An alternative in secondary prevention if aspirin is contraindicated		1. 10 years of experience; 2. Well-established efficacy in preventing adverse events following revascularization when used with aspirin; 3. Clopidogrel resistance is a documented phenomenon
	NSTEMI	1. A loading dose followed by daily maintenance for at least 1 month and ideally up to 1 year as part of early conservative management; 2. Withhold in the 5-7 days prior to CABG	1. Increased risk of bleeding when used in combination with aspirin; 2. Increased risk of bleeding when used in the 5-7 days prior to CABG	
	PCI	A loading dose initiated prior to PCI, followed by maintenance dose daily for at least 1 month, and ideally up to 1 year, following BMS implantation and at least 12 months following DES implantation	Increased risk of bleeding when used in combination with aspirin	
	STEMI	1. A loading dose followed by daily maintenance for at least 14 days; 2. Withhold in the 5-7 days prior to CABG	Increased risk of bleeding when used <5 days prior to CABG	
Prasugrel	NSTEMI	None		Under assessment
	PCI	None	Increased risk of bleeding, especially in patients with a history of stroke or TIA, those aged ≥75 years, and those with a body weight <60 kg	1. Higher IPA than clopidogrel, which could mean greater risk of bleeding; 2. No statistically powered evidence showing superiority over clopidogrel
	STEMI	None		Under assessment

treatment in troponin I or creatinine kinase-MB serum levels up to 24 hours after PCI.[64]

Although it is important for EPs to appreciate the added periprocedural protection that upstream administration of advanced antiplatelet therapy affords their ACS patients, the ideal timing of clopidogrel initiation is uncertain. The guidelines recommend administration as soon as possible, and as the time from administration to PCI increases, so does the periprocedural protection. The ARMYDA-2 trial gave a loading dose 4-6 hours prior to PCI, but the EP is often dealing with a 90-minute treatment window, making the ARMYDA-2 results relevant primarily to those ACS patients not going emergently for PCI.

Similarly, the optimal timing for GPI initiation prior to PCI is unclear.[4] In PURSUIT, the reduction in death and MI was inversely associated with the time from symptom onset to GPI initiation;[4] however, data from PRISM and NRMI 4 suggest no difference in outcomes as long as the drug was initiated within 24 hours of symptom onset.[65,66] In the absence of clear evidence, ED physicians must carefully weigh each individual patient's characteristics and clinical symptoms when making a decision concerning GPI initiation.

The adjunctive use of GPIs in STEMI patients depends on the planned treatment course. In the setting of PCI, the ADMIRAL study showed a significant reduction in death/reinfarction/urgent revascularization at both 30 days and six months when adjunctive abciximab was administered prior to the procedure.[59] The CADILLAC study confirmed the protective effect of abciximab in the short term (35% relative risk reduction for death, MI, target vessel revascularization or stroke at 30 days), although this benefit

GP IIb/IIIa Inhibitors				
Abciximab	NSTEMI	Not recommended		No benefit
	PCI	1. Initiate as soon as possible as ancillary therapy in high risk patients undergoing PCI only if there is no appreciable delay to angiography; otherwise, eptifibatide or tirofiban is preferred; 2. Early initiation to improve pre-procedural TIMI grade 3 flow	1. Insignificant excess risk of bleeding; 2. Significantly increased risk of disabling stroke	1. Abciximab has not been shown to reduce the risk of target vessel reocclusion; 2. Combination abciximab and reteplase or tenecteplase should not be given to patients aged >75 years due to an increase risk of ICH
	STEMI	May be considered for reperfusion in combination with half-dose reteplase or tenecteplase in high-risk patients	Increased risk of ICH in patients aged ≥75 years	Treatment does not translate to survival advantage at 30 days or 1 year
Eptifibatide	NSTEMI	May be considered in high-risk patients undergoing early conservative management	Increased risk of bleeding	Benefits seem to be restricted to high-risk patients
	PCI	Initiate as soon as possible as ancillary therapy	Increased risk of minor bleeding	Benefits seem to be restricted to high-risk patients
	STEMI	None		
Tirofiban	NSTEMI	May be considered in high-risk patients undergoing early conservative management	Increased risk of bleeding	Benefits seem to be restricted to high-risk patients
	PCI	Initiate as soon as possible as ancillary therapy	1. Increased risk of death, MI, stroke, and target vessel failure at 30 days when used with paclitaxel-eluting stents; 2. Insignificant risk of major bleeding when used in combination with heparin	Benefits seem to be restricted to high-risk patients
	STEMI	None		
Non-thienopyridine P_2Y_{12} Inhibitors				
AZD6140	NSTEMI	None	1. Bleeding risk similar to clopidogrel; 2. Higher rates of dyspnea, hypotension, and nausea compared to clopidogrel	1. Higher IPA, which could mean greater risk of bleeding in other patient populations; 2. Short half-life; 3. No published evidence showing superiority over clopidogrel
	PCI	None		Assessment underway
	STEMI	None		Assessment underway
Cangrelor	NSTEMI	None	Insignificant excess risk of bleeding	1. Does not require liver metabolism to produce active compound and can therefore be used IV; 2. High IPA
	PCI	None		Assessment underway
	STEMI	None		Assessment underway

ACS, acute coronary syndrome; *BMS*, bare metal stent; *CABG*, coronary artery bypass grafting; *CAD*, coronary artery disease; *DES*, drug-eluting stent; *GP*, glycoprotein; *ICH*, intracranial hemorrhage; *MI*, myocardial infarction; *NSTEMI*, non-ST elevation myocardial infarction; *PCI*, percutaneous coronary intervention; *STEMI*, ST elevation myocardial infarction; *TIMI*, thrombolysis in myocardial infarction

was no longer apparent at one year.[60] Data from ADMIRAL and CADILLAC, conducted in the PCI setting, show that the protective benefits of pre-procedural abciximab are not compromised by any important increase in bleeding risk. In contrast, the ASSENT-3 and GUSTO V trials demonstrated that the combination of a GPI with half-dose thrombolytic reduced ischemic events but increased bleeding; furthermore, there was no short- or long-term survival benefit.[67-71] These findings suggest that adding a GPI is not justified during fibrinolytic treatment of STEMI.

Table 4. Summary of the Class I recommendations of the American College of Cardiology/American Heart Association (ACC/AHA) guidelines for antiplatelet therapy in UA/NSTEMI,[2] STEMI,[33,63] and PCI[32] patients.

UA/STEMI	STEMI	PCI
• Initiate aspirin as soon as possible after hospital presentation and continue indefinitely; substitute clopidogrel in patients who have aspirin intolerance	• Initiate aspirin as soon as possible after hospital presentation and continue indefinitely, substitute clopidogrel for aspirin in cases of intolerance	• Patients already taking preventative aspirin should take 75 mg-325 mg prior to PCI. Patients not currently taking aspirin should receive 300 mg -325 mg at least 2, preferably 24, hours prior to PCI
• Add clopidogrel (loading dose followed by maintenance dose) to aspirin therapy as soon as possible after admission if an early non-invasive strategy is planned and continue clopidogrel for at least 1 month and ideally for 1 year	• Add clopidogrel (loading dose followed by maintenance dose) to aspirin therapy regardless of the planned reperfusion strategy and continue for at least 14 days in all patients and ≥1 month but ≤9 months in patients undergoing PCI.	• Add 600 mg loading dose of clopidogrel before or at the time of PCI. If fibrinolytic therapy was received in the previous 12-24 hours, a 300 mg loading dose may be considered.
• Add clopidogrel (loading dose followed by maintenance dose) or an intravenous GP IIB/IIIa inhibitor (abciximab if there is no delay to angiography and PCI is likely; otherwise, eptifibatide or tirofiban are preferred) to aspirin if an initial invasive strategy is planned	• If elective CABG surgery is planned, withhold clopidogrel for 5-7 days beforehand	
• If elective CABG surgery is planned, withhold clopidogrel for 5-7 days beforehand		

UA/STEMI, unstable angina ST elevation myocardial infarction; *STEMI*, ST elevation myocardial infarction; *PCI*, percutaneous coronary intervention.

CONCLUSION

The EP's role in treating ACS patients is to provide rapid, accurate diagnosis and institute timely, risk-directed treatment. Increasing the potency of platelet inhibition by adding a thienopyridine or GPI to standard therapy early in the treatment course improves protection against ischemic and periprocedural events but must be balanced against any unjustifiable increase in bleeding risk. Clopidogrel plus aspirin is a safe and effective therapy recommended by national guidelines for use in ACS patients, regardless of treatment strategy (Table 4).

Choice and timing of antiplatelet therapy in the ED must also take into consideration future interventions the patients may receive during their hospital course. In addition to standard aspirin therapy, early initiation of clopidogrel in the ED is often justified in ACS patients, regardless of their subsequent treatment strategy (medical or interventional). However, care should be taken regarding patients who are highly likely to require early CABG. Early administration of a GPI is also often justified in ACS patients in the PCI setting and in high-risk UA/NSTEMI patients in whom medical management is planned. Results from the ASSENT-3 and GUSTO-V trials do not support a favorable balance of benefit over bleeding risk for GP inhibition in STEMI patients undergoing fibrinolysis. This finding illustrates the complexity of balancing increased antiplatelet potency with bleeding risk.

Emerging investigational antiplatelet agents may show promise in ACS treatment; however, use of these agents should be approached with caution. Although touting increased IPA, it should be recalled that traditionally this has been a measure of bleeding, not potency. Therefore, long-term risks for bleeding and compliance may become issues. As the science of emergency cardiology care continues to mature and evolve at a rapid pace, continuous, evidence-based, multidisciplinary collaboration is paramount for delivering optimal and safe care for ACS patients. Given the variability in treatment preferences and awareness of guideline recommendations, there is an important need for developing institutional protocols and order sheets in order to improve adherence to treatment guidelines.

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Violent Hiccups: An Infrequent Cause of Bradyarrhythmias

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A hiccup, or singultus, results from a sudden, simultaneous, vigorous contraction of the diaphragm and inspiratory muscles, accompanied by closure of the glottis. Hiccups can be associated with bradyarrhythmias. The mechanism of this phenomenon is likely hiccup-induced Valsalva maneuver and increased parasympathetic tone. We present a case of a patient with violent hiccups producing a bradyarrhythmia.
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CASE

A 76-year-old male with no prior cardiac history was hospitalized after chest wall and pelvic trauma following a fall from a ladder. On the third hospital day, a pause lasting 2.6 seconds was seen on telemetry while the patient was awake (Figure 1). Progressive PR prolongation is visible in the first two cardiac cycles. The T wave of the second cycle is deformed suggesting a superimposed premature atrial contraction with atrioventricular block. A junctional beat is visible 2.6 seconds after the preceding QRS, followed by a sinus beat with a prolonged PR interval and another junctional beat. There was no associated lightheadedness, presyncope, or syncope. Interestingly, the patient reported having a violent bout of hiccups (which he described as being the worst of his life) during the time the bradyarrhythmia was recorded on telemetry.

The patient was normotensive and his pulse rate was noted to be in the sixties. The cardiac examination was normal. Patient's medications included metoprolol 50 mg orally twice daily (started during this hospitalization for episodes of atrial tachycardia) and morphine sulfate intravenously as needed for pain control. Laboratory data demonstrated no electrolytes disturbances and a normal thyroid stimulating hormone level. Transthoracic echocardiogram was performed, which showed normal left ventricular function, no significant valvular abnormality, normal aortic root, and no evidence of cardiac contusion. Based on these findings, the etiology of the atrial tachycardia was likely from an increased catecholamine state from his recent trauma. Of note, the patient last received metoprolol 12 hours prior to the pause and morphine sulfate three hours prior.

Increased vagal tone/parasympathetic activity can be associated with hiccups, and hiccups have been reported to cause bradyarrhythmias. Due to the transient nature of the patient's hiccups and the absence of bradycardic symptoms a permanent pacemaker was not indicated or offered to the patient. The metoprolol dose was continued at the same dose and the patient experienced no further bradyarrhythmias or hiccups for the remainder of the hospitalization. An outpatient Holter monitor did not reveal any recurrence of the bradyarrhythmias and the patient remains asymptomatic.

DISCUSSION

Bradyarrhythmias in hospitalized patients can occur from a multitude of causes, including intrinsic conduction system disease, medications, and maneuvers that increase parasympathetic activity (e.g. tracheal suctioning, bowel movements, cough). A comprehensive history is essential in the evaluation of a patient with a bradyarrhythmia.

Our patient initially presented with chest and pelvic trauma. There was no evidence of blunt myocardial injury (BMI) by transthoracic echocardiogram. Ventricular arrhythmias are common with BMI while atrial arrhythmias and bradyarrhythmias are less frequent. The patient was given two medications (metoprolol and morphine) that can contribute to bradyarrhythmias. However, both of these medications were continued after the bradycardic event,

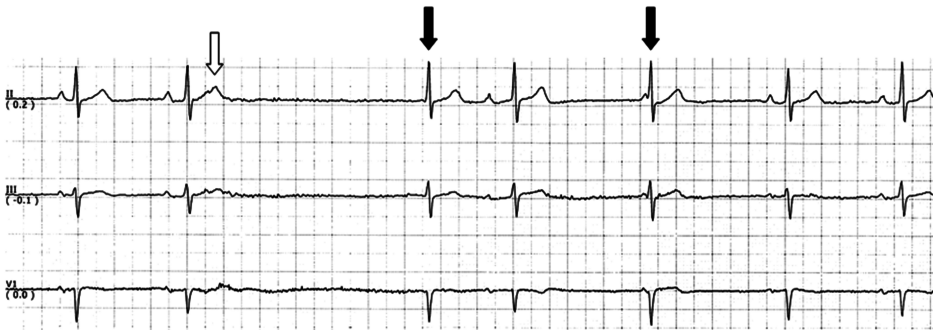

Figure 1. A rhythm strip demonstrating a 2.6 second pause. White arrow indicates a blocked premature atrial contraction. PR interval prolongation and junctional beats (black arrows) are also visible.

and no recurrences of bradyarrhythmia were seen. The simultaneous occurrence of violent hiccups during the bradyarrhythmia makes the hiccups the likely cause of the pause.

A hiccup, or singultus, results from a complex motor event consisting of a sudden, simultaneous, vigorous contraction of the diaphragm and inspiratory muscles, accompanied by closure of the glottis. The rush of air colliding with the closed glottis produces the hiccup sound. Hiccups are often rhythmic in nature, and synchronous with cardiac (mid-systole) and respiratory cycles (mid-inspiration).[1] They are usually benign; however, they rarely can be associated with pathology or have serious consequences.

Hiccup-induced heart block was first described by Harrington in 1969, and others have confirmed the association between hiccups and bradyarrhythmias.[2-4] Transient bradyarrhythmias have been described following vagal stimulation (deep breathing, Valsalva maneuver, carotid massage, coughing, and nausea/vomiting), and increased vagal tone/parasympathetic activity is the most likely mechanism of how hiccups induce bradyarrhythmias. Hiccups can increase parasympathetic activity in several ways. Increased activity from atrial mechanoreceptors and respiratory stretch receptors can modulate parasympathetic tone. The fact that hiccups are synchronous with cardiac and respiratory cycles suggests that neural mechanisms exist between the heart, lungs, and the hiccup generator.[1] In addition, hiccups mimic the Valsalva maneuver, and this is likely the mechanism that has the most influence on cardiac rhythm.[4]

Hiccups are usually transient in nature. Since our patient had no further bradyarrhythmias once his hiccups resolved a permanent pacemaker was not required. A careful history in this case made the diagnosis, and the patient was spared an unnecessary procedure.

CONCLUSION

Hiccups are an infrequent cause of bradyarrhythmias. Hiccup-induced Valsalva maneuver and increased parasympathetic tone is the most likely explanation for this phenomenon and the likely cause of bradyarrhythmia in this patient. When evaluating a patient with bradyarrhythmias in the hospital, the physician should be aware of this clinical entity and be diligent in evaluating for all causes of bradyarrhythmias.

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Reimbursement for Emergency Department Electrocardiography and Radiograph Interpretations: What Is It Worth for the Emergency Physician

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Background: Physician reimbursement laws for diagnostic interpretive services require that only those services provided contemporaneously and /or contribute directly to patient care can be billed for. Despite these regulations, cardiologists and radiologists in many hospitals continue to bill for ECG and plain film diagnostic services performed in the emergency department (ED). The reimbursement value of this care, which is disconnected in time and place from the ED patient encounter, is unknown. In a California community ED with a 32,000 annual census, the emergency physicians (EPs) alone, by contract, bill for all ECG readings and plain film interpretations when the radiologists are not available to provide contemporaneous readings.

Objectives: To determine the impact of this billing practice on actual EP reimbursement we undertook an analysis that allows calculation of physician reimbursement from billing data.

Methods: An IRB-approved analysis of 12 months of billing data cleansed of all patient identifiers was undertaken for 2003. From the data we created a descriptive study with itemized breakdown of reimbursement for radiograph and ECG interpretive services (procedures) and the gross resultant physician income.

Results: In 2003 EPs at this hospital treated patients during 32,690 ED visits. Total group income in 2003 for radiographs was $173,555 and $91,025 for ECGs, or $19/EP hour and $6/EP hour respectively. For the average full-time EP, the combined total is $2537/month or $30,444 per annum, per EP. This is $8/ED visit (averaged across all patients).

Conclusion: As EP-reimbursement is challenged by rising malpractice premiums, uninsured patients, HMO contracts, unfunded government mandates and state budgetary shortfalls, EPs are seeking to preserve their patient services and resultant income. They should also be reimbursed for those services and the liability that they incur. The reimbursement value of ECGs and plain film interpretations to the practicing EP is substantial. In the ED studied, it represents $30,444 gross income per full-time EP annually. Plain film interpretation services produce three times the hourly revenue of ECG reading at the hospital studied. [*West*JEM. 2009;10:178-183.]

INTRODUCTION

ECGs and radiographs are fundamental diagnostic tools in the emergency department (ED); however, reimbursement for emergency physicians' (EP) interpretations of these studies has long been a controversial issue. Most of the healthcare dollars for interpretative services went to cardiology and radiology specialists because they respectively interpreted and subsequently billed for ECG and radiograph interpretations

performed in EDs, regardless of its immediate relevance to the patient care in question.[1,2] The Health Care Financing Administration's policy (HCFA), now known as Centers for Medicare and Medicaid Services (CMS), assumed that the cardiology and radiology overread constituted patient care and has traditionally paid the first claim submitted. Previously, Medicare would consider the EP's interpretation to be part of the attending physician's overall workup and treatment of the patient in the ED, and this service would not be considered under a separate charge.[3]

The current study attempts to determine the financial impact of misdirected revenue from EPs for diagnostic studies, such as radiographs and ECG interpretations in the ED.[4-6] We examined the billing records of a 32,000 annual census community ED located in Chino Valley, California, and were able to extrapolate this data to the National Hospital Ambulatory Medical Care Survey (NHAMCS) data from 2005, which estimated 115 million ED visits in the country. We performed calculations, estimating the average annual revenue for EPs, based on billing and reimbursement data at this community hospital.

METHODS

We conducted a retrospective, descriptive study of consecutive ED visits for one year. The hospital's Institutional Review Board approved the study to analyze 12 months of the ED's billing data, cleansed of all confidential patient identifiers. The study was exempt from obtaining a written informed consent form due to the noninvasive, nonclinical nature of the analysis. This particular billing company has successfully withstood multiple outside audits to verify the validity of these billing and coding practices. Additionally, in a 2005 audit performed by National Health Information Center (NHIC), the Medicare carrier for California conducted a statewide audit of coding and documentation practices of EPs. The billing company successfully defended coding in all reviewed charts and confirmed that their approach to coding and billing for plain film and ECG interpretation met industry standards.

RESULTS

To generate an average reimbursement fee per interpretation we compiled and summated itemized lists of reimbursement fees for both the radiograph and ECG interpretations for the 12-month period. The payor mix, as shown in Table 1 – Medicare, 14%; MediCal, 28%; fee for service, 28%; contracted HMO, 8%; occupational medicine, 2%; and self-pay, 19% – is similar to national data from the NHAMCS 2005 survey. We recorded plain film radiograph billing only during ED hours without immediately available radiology interpretative services. There were 40 hours per day of EP coverage, with double coverage 16 hours daily. Radiology's schedule of plain film coverage in 2003 left 9,048 hours "uncovered," during which time the EPs billed for plain film interpretive services. This schedule included 15.5 hours each weekday, and 20 hours on Saturdays, and all day Sunday. Advanced studies, such as CT scans, angiograms, and formal ultrasounds, continued to be interpreted by radiologists off site. Since EPs read all ECGs, we recorded ECG billing for a total of 40 hours per day of EP coverage (due to 16-hours daily double coverage). This totaled 14,600 hours annually.

Table. Emergency department payor mix and percentage of visits: Chino Valley vs. NHAMCS*

	Chino Valley	National Data*
Total number of visits	32,690	115,300,000
Private insurance	36%	40%
HMO	8%	
Fee for service	28%	
Medicare	14%	16.6%
Medical	28%	25%
Self-pay	19%	16%
Occupational medicine	2%	1.7%

*National Hospital Ambulatory Medical Care Survey: 2005 Emergency Department Summary

Actual revenue amounts in 2003 for ECGs and radiograph were $91,025 and $173,555 respectively. Using physician coverage data, these figures resulted in revenue of $19 per hour for radiograph interpretation and $6 for ECG interpretation per hour for each physician. For the average full-time EP, the combined total is $2,537 per month and $30,444 per annum for each individual physician.

DISCUSSION

With the growth of the specialty of emergency medicine, the first-line physician treating patients in the ED is usually a residency-trained EP. The interpretation of diagnostic tests is considered a critical skill in the armamentarium of their competencies, and in fact is part of the core content of the specialty.[7] Furthermore, the credentialing process at many hospitals specifically includes these interpretive services for EPs. Ultimately, the EPs use these ancillary test interpretations to direct immediate patient management and treatment decisions. ECG and radiograph interpretations generally occur at the same time as patient care. Because of frequent unavailability, cardiologists and radiologists often interpret radiographs and ECGs hours to days after the patients' departure from the ED; therefore, their interpretations often do not directly affect the patients' ED visit and real-time medical decisions. Many hospitals that contract with teleradiology groups after hours often limit interpretation services to CT scan and MRI images.

Specialists have challenged EP billing for these services,

arguing that because they have greater qualifications to interpret these studies patient care would suffer without their involvement. Several studies, however, report strong concordance rates of ECG interpretation between cardiologists and EPs and even challenge the concept that the "specialist" interpretation is the "gold standard."[8] The largest study, conducted with 400 patients by the University of California, Los Angeles Department of Medicine, concluded that a cardiologist's review of ED ECGs interpreted by the EP in fact contributed little additional clinically relevant information.[9]. Twenty-five of 289 tracings, or 8.6%, had potentially significant ECG abnormalities for which the ED physician and cardiologists reads differed. In 2.7% of these cases, it was the ED physician who detected an abnormality that the cardiologist missed. In a review of the 2.7% of cases that differed, no cases were found to have been inappropriately managed. In conclusion, ECG interpretation by a cardiologist did not alter patient care. Other studies have found that using cardiologist interpretation as "the gold standard" is problematic as they have found that interpretations even between cardiologists reading the same ECG often vary substantially.[10]

The accuracy of EPs' interpretations of plain radiography studies is also well documented in the literature. Concordance rates of radiographic readings between EPs and radiologists were generally quite high. Rates of disagreement between EPs and radiologists in the interpretation of radiographs have traditionally ranged from 8-11% with an alteration in treatment required in 0.1-3% of these patients.[11-17] The significance of these numbers must be interpreted in light of other studies that have found inter-radiologist disagreement rates between 4-8%.[18] A review of over 15,000 films in a community teaching hospital revealed 99% were correctly interpreted. Of the remaining 1% of EP "misreads," less than half were deemed clinically significant.[19] A George Washington University Medical Center study that reviewed 23,500 radiographs over a one- year period and evaluated patient care outcomes in those instances where post-discharge radiology interpretations differed from the EPs' interpretation found an overall error rate of 1.8%. However, no adverse patient care outcomes resulted. Undesirable outcomes included permanent loss of function, suboptimal restoration, or prolonged recovery identified by delayed radiological diagnosis.[20]

Interdisciplinary concordance and interpretive skill discussions, while relevant, fail to address the central issue that only interpretation contemporaneous to care represents a service to patients in the ED. These studies and their interpretations result in real-time patient care decisions and management. Interpretation occurring at a later time can only serve a medical-legal or quality assurance purpose and should not be billed by specialists as a service to the patient.

Perhaps the most relevant and important study to date was conducted by the Office of Inspector General (OIG), a branch of the Department of Health and Human Service that detects fraud, waste, abuse and mismanagement. The study, which examined 356 medical records and telephone interviews with ED and radiology department directors at 18 hospitals in nine states, found that 44 percent of radiology interpretations were performed at least one day after the patient was discharged from the ED.[21] Only 6.2% were interpreted and made immediately available to the treating EP prior to patient discharge. The remainder had no documentation of the time of interpretation or whether it was available to the treating EP. In no cases, did the radiologists' reinterpretation require alterations in the initial treatment plan. As a result of this study, OIG findings concluded that a radiologist's reinterpretations: 1) did not constitute patient care, 2) did not result in recall of patients, and 3) did not affect initial treatment. Consequently, OIG recommended to HCFA, "Pay for reinterpretations of radiographs only when attending physicians specifically request a second physician's interpretation in order to render appropriate medical care before the patient is discharged. Any other reinterpretation of the attending physician's original interpretation should be treated and reimbursed as part of the hospital's quality assurance program. HCFA should implement this recommendation through either regulation or by seeking legislation as appropriate." OIG projected that a minimum of $20.4 million was paid for these reinterpretations in 1990.[5,6,21]

Prior to 1996, reimbursement and billing occurred sporadically for the EP interpreting ECGs and plain radiographs with potentially thousands to millions of dollars of lost revenue. Per HCFA guidelines at that time interpretation of a radiograph or ECG given to an ED patient by a radiologist or cardiologist generally constituted an element of Part B service covered by the carrier. Often this meant that the cardiologist and radiologist submitted claims first and were reimbursed, even if their interpretation was performed subsequent to the EP's interpretation, which ultimately dictated the patients' disposition and management.

The 1996 Medicare rulings favored the reimbursement of ECG and radiograph for EPs. HCFA ruled in the Federal Register that reimbursement would occur only for the radiograph and ECG interpretation that directly and immediately contributes to the diagnosis or treatment of the patient.[22] Only one radiograph and/or ECG interpretation will be reimbursed, except under unusual circumstances. Exceptions to this rule include a provision for a second read when the physician performing the initial interpretation believes that another physician's expertise is required to examine a questionable finding. The second interpretation would be considered a quality assurance measure, unless the second interpretation changes the diagnosis. If a new diagnosis is reached, then CMS policy dictates that payment be provided for the second interpretation. Furthermore,

any interpretation (per current Medicare policy) that is not performed contemporaneously is not medically necessary. A non-contemporaneous read can be made as a quality assurance function, but must not be billed to Medicare Part B. A 1995 Medicare Final Rule states: "Advise hospitals that the Medicare carrier may determine that the hospital's official interpretation is for quality control and liability purposes only and is a service to the hospital rather than to an individual beneficiary."[22]

For ECG and plain radiograph interpretations to be considered as a separate payment, specific conditions must be met. A distinction between an interpretation and a review of the findings must be made. A review of diagnostic tests is already included in the ED visit payment.[22] Proper documentation of an ECG and radiograph interpretation as a billable procedure includes providing a complete written interpretation within the ED treatment records.[2,6] A separate document of the EP's interpretation is not necessary for billing purposes.

For radiograph interpretations, simply stating "normal" or "no acute disease" are inadequate. Comment must be made as to who provided the initial interpretation, the type of views/ projection, specific description of anatomic location, pertinent positives, and a conclusion.[2] For ECGs, the interpretation must include three of the following six elements: 1). Rhythm or rate, 2) axis, 3) intervals, 4) segments, 5) notation of a comparison with a prior ECG if one was available, and 6) summary of clinical condition.

While overreads performed by radiologists are a valuable resource to the hospital for quality assurance, they rarely alter a patient's treatment plan.[4] Billing for non-contemporaneous interpretations, which is often the practice of radiologists and cardiologists, is not considered patient care and would constitute fraud and abuse of the Medicare program,[1] subject to penalties and False Claims laws.

Despite the clarity of these laws for EP reimbursements, many third parties still do not reimburse for these interpretations. Many argue that since hospital bylaws and the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) regulations require an "official interpretation," it is the radiologists and cardiologists who are responsible for all radiographs and ECGs respectively performed in the hospital. They contend that these specialists have had more extensive training specific to these diagnostic studies and should ultimately be compensated for their expertise. In many hospitals the contractual arrangement for cardiology and radiology services specifically directs billing activities to the specialists and away from the EPs. These hospital arrangements should be considered fraudulent given the clarity of the language surrounding interpretive services. In effect, directing ECG and plain film interpretive fees to specialists who do not provide contemporaneous care is a form of fee splitting.

Two of the most important types of malpractice claims against EPs derive from "missed myocardial infarctions" and "missed fractures" where failure to diagnose is the tort. "Missed myocardial infarction" represents the most expensive claims while "missed fracture" represents one of the most frequent claims. These two diagnoses rely primarily on the accurate real-time interpretation of ECGs and radiographs. Since litigation of these in medical malpractice suits is so heavily reliant on EP interpretations, logic would dictate that it is the EPs who should be reimbursed for the interpretations since they assume the greatest liability for the interpretation.

The American College of Emergency Physicians (ACEP) has issued a policy statement regarding this topic, originally issued in 1996, reaffirmed in 2000, and revised and approved in 2006:

1. Interpretation of diagnostic studies ordered for the immediate evaluation and management of an ED patient should be done contemporaneously with the ED visit. A contemporaneous interpretation may be done by the emergency physician or by another specialist within the limits of training, experience and competence of that physician

2. The interpretation of the diagnostic studies, both preliminary reading and final reports, must be documented in writing, available contemporaneously with the patient's evaluation, and filed in the patient's medical record.

3. The emergency physician providing contemporaneous interpretation of a diagnostic study is entitled to reimbursement for such interpretation even if the study is reviewed subsequently as part of the quality control process of the institution in which the physician practices.[23]

As noted above, the OIG projected that $20.4 million was paid for ECG and plain film interpretations. The current study data suggests this is may be a substantial underestimate. In 2005 The CDC National Hospital Ambulatory Medical Care Survey (NAAMC), which measures ED utilization across the country, found that an estimated 115.3 million visits were made to hospital EDs, or about 39.6 visits per 100 persons.[24] Diagnostic and screening services were provided at 71% of visits, including 40.7 million visits (35%) receiving radiographs and 18.9 million visits receiving ECGs (16%). Extrapolating these figures from ED utilization data from this study and the estimated revenue generated at our community hospital, U.S. ED visits would generate approximately $779 million dollars for radiographs and $114 million for ECGs, for a grand total of $890 million dollars of revenue. The payor mix at the study site closely mimics the NHAMC

national database. Even if the ECGs are deleted, using the assumption that many EPs do in fact bill for this service, the radiograph component is still $779 million, or 39-fold greater than the OIG estimate.

LIMITATIONS

Although continuous quality improvement data and management of patient callbacks are maintained at this hospital site for discrepancies between radiologists and EPs, as well as cardiologists and EPs, we did not report this data in the current study; therefore, the discrepancy data is not available. Additionally as mentioned above, although our hospital payor demographics reflect the majority of all hospitals in the U.S., based on the NHAMC national database, we caution the generalization of the study results to individual hospitals. In addition, in extrapolating the NHAMC data for ED visits, we are assuming that the vast majority of providers for those visits are EPs qualified in radiograph and ECG interpretation. This may vary widely again based on geographic location.

CONCLUSION

The potential revenue derived annually from the interpretation of radiograph and ECG interpretive services is substantial. At this community hospital, the average full-time EP receives $30,444 for these services each year. Depending on yearly income and geographic location, this could mean up to 10-20% of their annual income. If we assume these funds are largely untapped, or are misdirected to those who are billing for these studies (that are not interpreted contemporaneously to patient care) in other hospitals, then EPs currently are losing a large portion of their revenue. The payor mix represented by the study-site hospital reflects the demographics of many EDs in the country. However, because reimbursement rates vary widely in different regions, caution should be used in generalizing this data to other hospitals.

Non-contemporaneous interpretation of radiographs and ECGs are not medically necessary, do not contribute to patient care, and consequently should be considered a submission of a false claim and carry severe consequences. Attempts by hospitals and specialists to circumvent Medicare rules should be deemed as fraudulent activity. EPs are entitled to be reimbursed for their interpretive services that affect the patients' emergency treatment and disposition.

Value is provided both to the patient and the EP when ECG and radiograph interpretations are delivered in a timely manner that is cost effective and supported by quality assurance measures. The additional time needed to document an appropriate radiograph and ECG interpretation is well worth the reimbursement value for the EPs' practice, as the results of this study indicate. Patients also benefit from these immediate findings and appropriate management based on these interpretations in a timely and meaningful fashion, thus maximizing the quality of ED care.

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Overcoming Barriers to the Use of Osteopathic Manipulation Techniques in the Emergency Department

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Background: Osteopathic Manipulation Techniques (OMT) have been shown to be effective therapeutic modalities in various clinical settings, but appear to be underutilized in the emergency department (ED) setting.

Objective: To examine barriers to the use of OMT in the ED and provide suggestions to ameliorate these barriers.

Methods: Literature review

Results: While the medical literature cites numerous obstacles to the use of OMT in the ED setting, most can be positively addressed through education, careful planning, and ongoing research into use of these techniques. Recent prospective clinical trials of OMT have demonstrated the utility of these modalities.

Conclusion: Osteopathic Manipulation Techniques are useful therapeutic modalities that could be utilized to a greater degree in the ED. As the number of osteopathic emergency physicians increases, the opportunity to employ these techniques should increase.
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INTRODUCTION

Osteopathic Manipulation Techniques (OMT) are therapeutic maneuvers (Table 1) employed by osteopathic physicians to treat somatic dysfunction (defined as impaired or altered function of related components of the somatic system, including skeletal, arthrodial, and myofascial structures, as well as related vascular, lymphatic and neural elements).[1-3] Recent prospective studies have demonstrated statistically significant improvement in outcomes for the treatment of neck pain and ankle sprains with the use of OMT in the emergency department (ED).[4,5] Further, the Agency for Health Care Policy and Research of the U.S. Public Health Service has previously suggested that the use of spinal manipulation is one of the safest methods for relief of spinal discomfort in adults presenting with acute low back pain[6] and often meets with positive results.[7]

In 1999, 2,559 osteopathic physicians were practicing emergency medicine, accounting for 8% of the emergency physician workforce.[8] Increases in class sizes and the opening of seven more osteopathic medical schools in the interim (two new osteopathic medical schools and five new campuses of existing osteopathic medical schools) suggest that the number of osteopathic emergency physicians (OEP) will increase, as will, ostensibly, the opportunity to employ OMT in the ED. The increased use is also potentially enhanced by the finding that a significant proportion of ED patients is open to, and utilizes, alternative medical therapies.[9] With greater than 110 million ED patient visits annually in the U.S., this amounts to potentially nine million patients cared for by OEP each year.[10] Despite the wider opportunities for use of OMT in the emergency setting, recent data indicate that perhaps only 55% of OEP utilize OMT in their practice and a minority (28%) report daily or weekly usage.[11] A number of impediments to OMT use have been cited in the literature (Table 2). This article will review some cited obstacles to OMT utilization in the ED and explore amelioration strategies.[11,12]

Table 1. Major categories of Osteopathic Manipulation Techniques[1,2]

1. High-velocity-low-amplitude techniques* (also called thrust or mobilization with impulse) – involves a quick thrust over a short distance to restore joint play or a desirable gap between articulating surfaces that permits free translational or gliding motion in addition to the usual angular motion.
2. Muscle energy techniques* – patient directs muscle energy from a precise position in a direction against counterforce applied by the physician, thereby creating isometric contraction that results in joint mobilization and lengthening of contracted muscles.
3. Soft tissue technique*– rhythmic stretching, deep pressure and traction commonly applied to the musculature surrounding the spine to remove edema and to relax hypertonic muscles and myofascial layers.
4. Counterstrain techniques – the patient is moved passively away from the restricted motion towards the position of greatest comfort (usually a position where the muscle is at its shortest length), where the position is held for 90 seconds and the joint is slowly and passively returned to the neutral position.
5. Myofascial release techniques – similar to deep massage, the goal is to stretch muscles and fascia to reduce tension by applying a constant force traction to the long axis of the muscles until muscle release occurs.
6. Lymphatic pump techniques – designed to promote circulation of the lymphatic fluids by physical measures such as pectoral traction, postural drainage, effleurage, thoracic expansion, and rhythmic passive dorsiflexion of the feet in an attempt to enhance lymphatic return either by influencing negative intrathoracic pressure or mechanically assisting return of lymph from the lower extremities.
7. Craniosacral therapy – based on the supposition that (barely perceptible) oscillatory motions of the cranial bones and sacrum exist, the amplitude and rate are thought to provide information about the patient's health and to be influenced by the application of gentle pressure over specific areas of the cranium and sacrum.

* techniques most frequently used in the emergency department[7]

Table 2. Some perceived impediments to the use of Osteopathic Manipulative Techniques (OMT) in Emergency Departments[13,14]

- Time constraints
- Unproven benefit in emergency care
- Reimbursement issues
- Physician insecurity about OMT skills
- Physician disinterest
- Lack of familiarity with contraindications to OMT use
- Patients' unfamiliarity with OMT
- Hospital privilege issues
- Liability concerns
- Breach of the standard of care

Time Constraints

OEPs utilize OMT significantly less than family practice osteopathic physicians.[13] Lack of time has been cited as the primary reason.[11,12] Because the number of EDs in the U.S. has decreased 14% since 1993, greater average patient numbers at remaining sites without concomitant increases in staff means less time per patient.[14] In addition, fewer procedures are being performed in the ED, in part because of increased documentation requirements.[15] The average estimated time needed for the actual performance of OMT in the ED ranges from as little as 2 – 6 minutes to 10 – 20 minutes, depending on the procedure and the practitioner's skills.[4,12] If one accepts both the suggested guidelines that the optimal number of patients seen by EPs should not exceed 2.5 patients/hour[16] and the stated performance time estimates for OMT, it is possible that in select cases OMT could be utilized in a timely fashion in most ED settings. While performance times could be enhanced by the development of teaching programs in osteopathic medical schools that focus on OMT use in the ED clinical setting to maximize efficiency and time management, ,such programs are in short supply.[11] OMT that can be performed efficiently and offer the most immediately-apparent results (i.e., soft tissue treatment, high-velocity/low amplitude treatment, muscle energy treatment) should be employed.[11] Triage protocols could be established to identify patients who would potentially agree to its use and who could benefit most from OMT (e.g., torticollis, low back pain, etc.), and an ED room could be designated specifically for OMT.[11]

Unproven Benefit in Emergency Care

Recent data has shown that 13.8% of patients coming to an ED in the U.S. have complaints referable to the musculoskeletal system.[10] Despite the commonplace use of OMT in the medical community (it is estimated that there are hundreds of millions of such treatments per year in the U.S.)[17] and the great numbers and variety of patient encounters amenable to use of OMT,[11,12] only two randomized, controlled studies from EDs attest to their efficacy in the treatment of musculoskeletal dysfunction.[18-21] Both demonstrated benefit from OMT use for acute musculoskeletal disorders.[4,5] One ED study found that the use of OMT for the treatment of acute ankle sprains was associated with a statistically significant improvement in edema and pain and a trend toward increased range-of-motion immediately following intervention.[4] In the second ED study, which compared OMT to intramuscular ketorolac for the treatment of acute neck pain, OMT proved just as efficacious in providing pain relief, but was significantly better in reducing pain intensity. Possible reasons for the dearth of evidence-based studies in osteopathic medicine include concentration on clinic services and obtaining practice rights, and improving the profession's standing.[22] However, with the ever-increasing emphasis on evidence-based medicine, it is incumbent upon OEPs to institute well-designed, randomized ED studies

that will address the utility of OMT in terms of safety, efficacy, and cost-effectiveness.[23] If such studies continue to corroborate their efficacy, OMT use should increase in the ED. Currently six prospective, randomized studies are being carried out under the auspices of osteopathic medical schools and the American Osteopathic Association, but none are ED trials.[24] A recent editorial[22] highlighted this issue of evidence-based osteopathic medicine by calling for the osteopathic medical profession to make a dedicated effort to develop research that can test OMT mechanisms and define their effectiveness. Thus, the ultimate role of OMT in the ED therapeutic armamentarium can only fully be defined through well-conducted, prospective clinical trials that will weigh its efficacy, or lack thereof, for specific disorders.

Physician Insecurity with OMT Skills

Proficiency in OMT requires constant practice and application, and insecurity may reflect limitations in training and/or clinical experience. Classroom instruction is carried out during four years of osteopathic medical school, and competence must be demonstrated on the Certification of Osteopathic Medicine Licensure Examination (COMLEX) required for medical licensure in the U.S. OMT training continues in osteopathic internship and osteopathic residency training, and studies have shown that the use of OMT correlates closely with OMT interest and training during internship and residency.[13,25] Osteopathic physicians who undertake osteopathic residency training use OMT significantly more than those osteopaths who pursue training in allopathic residencies.[26] However, more than 50% of osteopaths currently enter allopathic residency training programs each year where they are generally not exposed to OMT.[27] This lack of supplementary OMT training, coupled with the lack of OMT role models in allopathic programs, inhibits OMT skills development of osteopathic resident physicians.[28] Therefore, it seems that the key to overcoming physician insecurity of OMT skills is ensuring that appropriate skills learned in osteopathic medical school will continue to be honed during the postdoctoral clinical training period. An increase in the number of osteopathic residency programs has been suggested as one measure to ensure that adequate numbers of osteopathic physicians continue to learn OMT skills.[28] The incorporation of OMT training for osteopathic physicians in allopathic residencies also continues the learning process, and such programs have shown the added benefit of spurring interest in OMT by allopathic physicians.[27,29] One survey reported that 90% of allopathic family medicine resident physicians believe that OMT is effective for treating somatic dysfunction.[27] For physicians who have been in private practice for a number of years with limited OMT exposure, refresher courses are available.[30]

Reimbursement

Third-party payers [e.g., governmental (Medicare, Medicaid, etc.), and private insurers (insurance companies, health management organizations, preferred provider organizations, etc.)] are the primary sources of income for healthcare institutions and providers. The types of procedures that can be billed for by OEPs include any service listed in the American Medical Association's Current Procedural Terminology (CPT) codes.[31] Five CPT codes (98925, 98926, 98927, 98928, 98929), referring to different body regions [i.e., head region, cervical region, thoracic region, lumbar region, sacral region, pelvic region, lower extremities, upper extremities, rib cage region, abdomen, and viscera region] are identified for OMT. Although procedures such as OMT are legitimately billable and reimbursable, some third-party payer practices may result in non-payment or decreased payment. Specifically, insurers may attempt to "bundle" services (i.e., combining the payment of one service into another to reduce payment) or utilize capitation of services, as occurs frequently within the framework of managed care contracts.[32,33] Use of a modifier will allow OMT to be billed separately, in some situations, if it is designated as a separate and distinct service rendered during an ED visit. The most commonly-employed modifier is modifier-25 that indicates a significant, separately identifiable evaluation and management service by the same physician on the same day of the procedure or other service provided.[32] The combination of EP inexperience with billing and recent data have demonstrated that a significant number of EPs are naïve regarding OMT billing in their practices and that only a small minority of hospital EDs (16.8%) bill for OMT.[11] Therefore, it is imperative that OEPs be familiar with the types of service arrangements they have with insurers and they should work closely with their billing providers to remain current regarding reimbursement issues to ensure appropriate reimbursements for OMT. In these days of declining healthcare institution revenues, the additional revenue generated from OMT performed in the ED can be substantial for the practitioner and the institution.[12]

Physician Disinterest

The reported lack of interest in using OMT by osteopathic physicians may be related to a number of issues.[12] It has been suggested that unsuccessful applicants to medical schools who subsequently are accepted to osteopathic medical school may place limited importance on OMT and thus be less likely to utilize this modality.[34] Also, as more osteopathic physicians compete for residency training in non-primary care specialties, the emphasis on OMT diminishes.[35] Similarly, the growth in the number of osteopathic physicians who graduate each year has increased the number of these individuals who enroll in allopathic training programs where there is no exposure to OMT. Interestingly, there appears to be increasing interest in OMT among allopathic physicians.[28] One study noted that approximately two-thirds of allopathic physicians in family practice residencies expressed interest in learning OMT and supported the concept of certification by the American

Osteopathic Association (AOA) of allopathic physicians who demonstrate proficiency in OMT.[27] Other allopathic programs (i.e., physical medicine and rehabilitation medicine) are increasingly recognizing the need for OMT.[36] Since it has been shown that interest in OMT correlates with the emphasis placed on it during postgraduate training, an increase in the number of osteopathic residency programs, or an emphasis on combining elements of osteopathic medicine into allopathic programs, might serve to spur increased interest and usage of OMT.[28,29] CME programs in OMT increase interest and expertise among osteopathic physicians, as well as allopathic physicians. The greater the number of allopathic physicians who use OMT, the greater likelihood of continued interest by osteopathic physicians. Disinterest is usually overcome as the benefits of OMT are consistently realized by the practitioner.[12]

Lack of Knowledge of Contraindications to OMT Use

Practicing physicians must be aware of the contraindications to any procedure, and OMT is no exception. Development of formal guidelines their use in the ED have been proposed that would serve to diminish inappropriate use.[11] Thrust techniques have the greatest number of absolute contraindications, including: malignancy, osteoporosis, severe rheumatoid arthritis, carotid or vertebrobasilar vascular disease, fracture, history of a pathological fracture, connective tissue disease, aneurysm, and anticoagulant therapy.[1,36] The appropriateness of the use of thrust techniques for lumbar radiculopathy is unresolved.[37] Soft tissue, muscle energy, and myofascial release techniques have few contraindications.[37] A checklist of contraindications can be placed in the ED chart of patients being considered for OMT to reinforce precautions against inappropriate use.[12]

Patient Unfamiliarity with OMT

A significant proportion of Americans are not familiar with osteopathic medicine. However, the 44 million ambulatory care visits made annually to osteopathic physicians suggest that familiarity with osteopathic medicine and (by extension) OMT is increasing.[1] In addition, a sizable proportion of ED patients utilize alternative therapies, including OMT.[3,9] One survey noted that 23% of ED patients had previously utilized manipulation-type therapy (chiropractic).[38] This suggests that many ED patients would be amenable to considering the use of OMT. As with any medical procedure, a thorough explanation of the procedure beforehand will ensure patient understanding and cooperation. This should include a discussion of alternatives, risks/benefits, and assessment of the patient's understanding and preference.[39]

Hospital Privilege Issues

Physician credentialing is the process of gathering information regarding a physician's qualifications for appointment to the medical staff, whereas delineation of clinical privileges denotes approval to provide specific services or perform specific procedures by a physician.[40] The specific process for physician credentialing and delineation of clinical privileges must be defined by medical staff and department bylaws, policy, rules, or regulations. Hospital privileges are not owned by any specific department and are granted by the hospital board on the basis of the practitioner's documented training, experience and current clinical practice.[41] OEPs wishing to use OMT in the ED must include OMT in their request for clinical privileges, as do physicians from other specialties who wish to use these techniques in hospital-based settings (e.g., family medicine practitioners, internists), and need to be able to document appropriate training and experience. Since competence in OMT is part of the COMLEX examination for medical licensure in osteopathic medicine, passage indicates appropriate knowledge and experience in OMT. Graduates of an allopathic family medicine residency program that offers a one-month course in OMT have obtained hospital privileges for OMT with receipt of a letter from their program documenting completion of such study.[42]

Liability Concerns

While liability concerns are ever present given the current surge in malpractice litigation in the U.S., few therapeutic modalities possess as safe a track record as OMT. A review encompassing six decades of use in the U.S. (several hundred million treatments performed annually) noted only 185 reports of injury, although there are concerns about underreporting.[17] Similarly, no treatment-related complications were noted in a study of 346 pediatric patients undergoing OMT.[43] Some reported injuries following manipulation techniques (including OMT) have included stroke secondary to vertebral artery or vertebrobasilar artery injury, Wallenberg syndrome, visual defects, hearing loss, balance defects, phrenic nerve injury, cauda equine syndrome, disc herniations, fractures, dislocations, but few of these were attributable to osteopathic physicians.[44-46] The key to good outcomes in OMT, as with most therapeutic procedures, is appropriate training and a thorough patient history and physical examination prior to manipulation.[17] Thorough knowledge of contraindications to OMT is also requisite.[12] Documentation of informed consent before a medical procedure is a prudent undertaking and may be more important in the ED because EPs are less likely to have an ongoing relationship with their patients than other physicians.[47]

Breach of the Standard of Care

In legal terms, the standard of care is the level at which the average, prudent provider in a given community would practice. It is how similarly qualified practitioners would have managed the patient's care under the same or similar circumstances. The standard of care is established in liability cases through the use of expert witnesses, and the medical malpractice plaintiff must

establish that it has been breached. Osteopathic physicians are trained in OMT and must demonstrate their competence in OMT on their medical licensure examination (COMLEX). Numerous well-designed studies have demonstrated that OMT is comparable to other therapeutic modalities with respect to numerous disorders (e.g., neck pain, back pain, ankle sprain, etc.),[4,23-25] thereby validating OMT as an acceptable therapeutic modality. The estimated use of OMT hundreds of millions of times per year in the this country with few reports of complications attests to its safety, an issue that is paramount in defining the standard of care.[17]

CONCLUSION

While OMT are safe, effective therapeutic modalities that have practical application in the ED evaluation and treatment of musculoskeletal disorders, these techniques are currently underused. Cited impediments to its use in the ED by OMT-credentialed physicians can be overcome by guidelines-directed use, and education of ED staff, hospital administration and patients as to its potential benefits. More randomized ED clinical trials of OMT are needed to delineate positive or negative aspects of these therapies as they relate to specific disorders. Studies that show benefit in the ED setting will enhance its application.

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Iatrogenic Digital Compromise with Tubular Dressings

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Objective: This case report describes a digit amputation resulting from an improperly applied tubular dressing. The safe application of digital tubular dressings, and the rationale behind it, is detailed to raise emergency physician (EP) awareness.

Methods: We present a case report of a recent iatrogenic-induced digit ischemia caused by improperly applied tube gauze. We review the literature on the subject and the likely sources of poor outcomes presented. The proper application of tubular gauze dressings is then outlined.

Conclusion: EPs and emergency department personnel must be educated on the safe application of tubular gauze dressings to avoid dire outcomes associated with improper applications. [*West*JEM. 2009;10:190-192.]

INTRODUCTION

Since their introduction in the mid-1950s**,** tubular gauze dressings have been commonly applied to the digits in emergency departments (ED), urgent care, office and other surgical settings. The dressing, also available online for purchase by the public, is placed over a metal or plastic cage and then slipped over the digit in successive layers. Package inserts offer incomplete details on the proper application. The use of tubular gauze dressings is safe when applied methodically and properly. However, the potential for disaster exists when they are improperly placed. This paper presents a case report of iatrogenic digital compromise resulting in amputation, reviews the literature on this topic, and presents the proper application of tube gauze and the anticipated dangers associated with its improper use.

CASE

A 10-year-old girl reached into a compact car parked on a grade. As she removed her right hand, the door closed under the pull of gravity and caught her left fifth digit. She presented to the emergency department (ED) with a superficial non-suturable laceration over the dorsal distal inter-phalangeal joint. Neuro-vascular-motor-tendon functions were normal, capillary refill was under three seconds, and x-rays were negative. The wound was prepped and Spandage® (Medi-Tech International Corporation, Brooklyn, NY) tubular finger gauze was applied. Although the child experienced increased pain after the dressing application, the exact manner of application was unknown. The discharge diagnosis was "5th digit superficial laceration."

Follow up within 72 hours was instructed. At that time, digit ischemia was noted and plastic surgery was consulted. The zone of ischemia was allowed to demarcate over several weeks and the digit was eventually amputated at the proximal inter-phalangeal joint (PIP). The child had no underlying co-morbidity that would make her more susceptible to ischemia from an improperly applied dressing.

DISCUSSION

In 1975 four cases of digital ischemia associated with the use of digital tubular gauze were reported in the literature.[1] Each involved a superficial injury to a different digit and was dressed with a Surgifix® (BSN Medical) tubular plastic net bandage in place of the "older" dressing material, Tubgauz® (Scholl). Three of the dressings were found to be "constrictive" at the base of digits on follow-up. One required amputation, while the other three recovered completely. The constriction at the base of two of the digits was relegated to a "twist" in the bandage in that area during dressing application. The authors hypothesized that Surgifix® is more elastic and coarser than the fine meshed Tubegauz® and becomes a constrictive

tourniquet when twisted in multilayers.

In 1982 a 16-year-old boy amputated half of his distal phalanx.[2] After repair the remaining finger was dressed in multiple layers with an elastic net bandage. Four days post-op the patient had unexpected pain in the injured digit and the rest of the finger required amputation. The author measured the amount of pressure exerted by multiple layers of an elastic net bandage as compared to the cotton tube gauze. Each layer of elastic net produced increasing tension in the next layer and this effect was dramatic, cumulative, and potentially constrictive. This was not the case with the cotton tube gauze.

In 1986 a case report documented a 21-year-old with a severe crush injury to the distal tip of his right middle finger associated with a comminuted distal tuft fracture.[3] Neurovascular-tendon function was intact. The nail was removed and lacerations were repaired followed by seven layers of an elastic tubular dressing. The patient's finger became severely painful and the tubular bandage was noted to be "tight." The finger was eventually amputated. The author concluded that more than two layers of dressing should be avoided, especially when the elasticized bandages are used. Twisting of the proximal end of the dressing should either be avoided or limited to less than 90-degree arc. Every patient should be cautioned to remove the dressing and return if severe, throbbing pain develops or if the digit swells despite elevation.

In 1995 a 54-year-old underwent the elective excision of a benign cyst from the nail fold of a digit. A tubular gauze dressing was applied in three layers, each with a 90-degree twist over a thin contact dressing. A non-circumferential adhesive tape was applied proximally to secure the dressing. The patient returned for a wound check 18 hours later and, although the dressing was noted to be "unusually tight," the patient was asymptomatic and the digit "appeared normal." The patient was re-examined three hours later due to pain. The digit was found to be cyanotic under the dressing. Gradual, full recovery occurred. The investigators measured the effects of different types of tubular gauze applications and found that the following techniques produced increasing pressure and constriction in the following order: three layers, 90-degree twist < three layers, 540 degree twist < rolled proximal edge < excess longitudinal traction < five layers, 90-degree twist. Twisting and traction referred to maneuvers undertaken during on-the-digit application. The absence of pain immediately after the dressing application was not reassuring.

In 2005 an afebrile 74-year-old woman smoker, with hypertension, type II diabetes, and hyperlipidemia presented to the ED with a finger paronychia.[4] Incision and drainage was followed by tube gauze applied in "standard fashion." The gauze used appeared to be of the elastic Spandage® variety. She was discharged on Keflex® which she started two days late. She returned to the ED on day 5 and the dressing was noted to be tight. The finger was found to be discolored, dusky and indurated from the PIP forward and required eventual amputation.

In the current case we present, the overwhelming likelihood is that the tubular dressing was misapplied and produced ischemia and the dire surgical result. The mechanism and force of injury were relatively minor and could not reasonably be expected to account for the final consequence. As well, the injury forces were applied to the anterior and posterior aspects of the distal digit, not bi-laterally where the vessels lie. Properly applied tubular gauze is likely very safe: cotton gauze loaded onto a cage inserted over the digit and unloaded onto the digit as the cage is moved proximally to distally in two layers or less. However, any misapplied tubular dressing, be it by twisting and/or axial traction of the dressing on the digit, and/or multi-layers, is a set up for profound morbidity. When twisted, the normal mesh, which usually serves to evenly distribute minor pressure with minimal to no constriction, becomes rope-like and can act as a tourniquet. When axial or longitudinal traction is applied, significant constriction may occur, but over a much wider area. These constrictive forces are mechanically intuitive and borne out in the literature.

Substituting coarser and more elastic materials in place of the intended cotton finger tubular gauze further increases the potential for danger. Indeed, one elastic manufacturer currently cautions in its application procedures and directions that one should never apply more than two layers to any dressed appendage.[5] Likewise, tubular gauze dressings should be avoided if possible in those with co-morbidities that result in underlying vascular compromise. The table outlines our recommended proper use of tube gauze to avoid constrictive dressings and bad outcomes on digits.

CONCLUSION

The dangers of improper applications of various types of tubular gauze to digits have been known for at least three

Table. Guidelines for the safe use of tubular digital gauze dressings

1.	Do not use when simpler dressings are adequate.
2.	Do not place if not trained in the proper application and possible pitfalls.
3.	Do not twist while the cage is anywhere over the digit v. beyond the digit.
4.	Do not apply with axial / longitudinal traction.
5.	Do not use more than two layers.
6.	Do not roll proximal edges when applying.
7.	Avoid using any tubular material other than the fine meshed, cotton gauze type specifically manufactured and designated for digits alone.
8.	Avoid using in patients at risk with co-morbidities such as COPD, diabetes, peripheral vascular disease, hyperlipidemia, mixed connective tissue disorders.

decades. Yet the contemporary case report presented here details a severe and unacceptable consequence to tubular gauze application.

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Frequent Users of the Emergency Department: Risky Business

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Frequent users of the emergency department (ED), recently defined as having four or more visits per year, are a diverse group of patients that provide a challenge to emergency physicians (EPs).[1-3] These so-called "frequent flyers" have been shown to have more psychiatric, psychosocial, and substance abuse issues than the general population and tend to be complex to manage. [1-10]

One issue yet to be addressed is that ED frequent users may be doing themselves a disservice by choosing emergency care rather than seeking consistent care from a single physician. The ED, designed and staffed for emergent illness, usually lacks the resources and personnel for the long-term management of chronic or recurrent conditions. Furthermore, ED physicians tend to lack the training and information necessary for the management of such conditions. Instead they focus on ruling out acute disease.[4,6,9,11]

Repeated ED care can be detrimental to patients seeking care for a chronic condition, such as chronic pain,[7,11,12] migraines,[13] and opiate addiction,[8,11,14] whose symptoms or complications can be quickly managed by the ED. For the busy EP, chronic pain patients in need of medication may appear to be a simple patient encounter. However, a quick fix with a pain shot or narcotic script is likely hurtful to these patients in the long run. Pain literature has demonstrated that opioid therapy can lead to conditions of hyperalgesia, altered perceptions of pain, and abnormal functioning of pain receptors and signaling pathways. Chronic pain is best managed by a single provider who is in a position to reassess a treatment plan, for example, because he is aware of increased needs or usage. [12] While the ED can treat acute pain symptoms, chronic pain patients often feel worse after short-term medications wear off. This can result in worsening pain with repeat ED visits for pain control.[11,12,15] Patients may prefer the convenience and ready availability of the ED, but the seemingly simple ED narcotic treatment is not an ideal plan of care for these patients.

Another group of frequent ED patients for whom emergency care is less than ideal include those whose psychological stress or psychiatric illness produces somatic pain or symptoms. For example, it has been estimated that 30% of patients with chest pain and no evidence of coronary artery disease suffer from panic disorder.[9] Perpetually in a rush, EPs are unable to engage in a long conversation about psychosocial stressors or anxiety and may overlook the underlying cause of the patient's disease. Additionally, the fear of missing serious illness leads EPs to avoid attributing somatic symptoms to psychiatric or psychosocial causes. As a result, many of these psychosocial issues are not explored, and patients are often discharged with the cause of their symptoms unaddressed. Consequently, the symptoms will likely recur leading the patient to return to the ED yet again.

Finally, the extensive workup that ED patients receive in trying to rule out acute causes of symptoms is a source of potential harm to those frequently seeking emergency care. EPs have become increasingly dependent on radiological diagnostics to rule out acute disease and avoid missing occult illness.[16,17] Recent evidence has shown that 0.4% of all cancers in the U.S. between 1991 and 1996 were possibly attributable to radiation from computed tomography (CT) studies. Extrapolation of this data puts estimates of the prevalence of cancer from CT scans in the near future at almost 2%.[18] Consider a patient with chronic abdominal pain related to underlying anxiety disorder. Each time he or she presents to the ED, the treating physician is concerned about acute abdominal pathology and may not be aware of the patient's anxiety or history of recurrent abdominal pain. For what appears to be an acute abdominal process the physician may utilize radiologic studies, such as radiograph or CT scans, to aid in diagnosis. Should the underlying condition continue, the patient may receive numerous radiological studies, and incur the risks associated with radiation exposure.

Recent work on managing frequent users on a more individual basis through consistent outpatient services has been shown to both reduce ED use and improve symptoms of

the chronic conditions that bring the patient to the ED[12,19,20]. Efforts such as these are much needed for the ED frequent user, as they can help improve quality of care while reducing potential risks incurred by seeking emergency care for chronic conditions. In the meantime, a prudent EP should keep in mind the potential risks to the ED frequent user when treating this group of patients.

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Counter-Point: Frequent Users of the Emergency Department: Meeting Society's Needs

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Internal medicine physicians were once known as the "physician's physician." These clinicians were consultants or specialists to the general practitioners of society. As medicine matured, their practices changed significantly. Now internists are one of the leading primary care specialties, while remaining specialists in their own right. When the specialty of emergency medicine (EM) was born, its intent was to care for patients with emergency medical conditions. However, as societal needs changed, so did the house of medicine, blurring the line between primary and episodic care. For better or worse, EM has changed to become the safety net for all of American healthcare.

"It has long been acknowledged that ED visits are frequently the result of a failure of prevention."[1] Others frequent the emergency department (ED) due to the lack of timely primary care. Yet, a significant portion of ED patients, primarily low-income and underserved, have no other place to go. The underinsured are having increasing difficulty finding healthcare providers willing to accept Medicaid reimbursement.[2,3] To compound the problem, the fully insured are turning to the ED for a variety of reasons. Open 24 hours a day/7 days a week, EDs give access to those who can't make time during regular business hours. And in this era of instant gratification, some seek ED services for the sole reason of expediency.[4] Many patients see the ED as a one-stop shop, where a physician and diagnostic and therapeutic options are available in the same facility. Very few primary care office practices can offer the same convenience. Finally, even insured patients have significant barriers to their primary medical doctor (PMD) for urgent medical needs and can only get appointments weeks or even months later. In essence, the ED has become the preferred provider of choice for some.

The EM community, although far from unanimous in proposing solutions, has at least recognized the problems associated with access to care in our current healthcare system. The Society of Academic Emergency Medicine (SAEM) developed a Public Health and Education Task Force (PHETF) to investigate the appropriateness of including primary and secondary preventive interventions in routine emergency care. Assuming sufficient resources, the PHETF found enough evidence to support alcohol screening and intervention, HIV screening and referral, hypertension screening and referral, adult pneumococcal immunizations, smoking cessation counseling, and referral of children without primary care physicians to a continuing source of care.[5] This, coupled with the belief that EM provides access to all, meets the critical needs of our most vulnerable patients and is uniquely positioned to conduct public health surveillance, makes the ED an effective site for preventive care.[1]

Impetus to broaden the scope of EM to include prevention found support in the Institute of Medicine (IOM) reports requesting that all persons coming for care to medical settings be screened for alcohol problems and in the creation of "Safe America" by the National Center for Injury Prevention and Control and the Centers for Disease Control to limit injuries.[6] Because studies have shown that up to 22% of injured patients return to the ED one or more times in the following year, many believe that identifying them initially and offering preventive services could potentially diminish patient suffering significantly.[7] To better solidify this argument, Hungerford et. al.[6] provides encouraging preliminary evidence that alcohol screening and preventive services in the ED can decrease alcohol intake, related harm, and dependence symptoms at least four months post-baseline.

Although EM training focuses on acute care, recent graduates have had significant exposure to patients with recurrent and chronic conditions, as none of the EM training programs have remained immune to ED "frequent users." The training of EM specialists is dependent on the environment. Recall that the specialty developed from a societal need for hospital-based acute care generalists in the 1960s through 1980s. In fact, EM is the first and still one of the few specialties not focused on an organ or organ system. As the

evolution of EM practice continues, by definition it embraces chronic and recurrent disease. In a sense we are what we eat! I believe that, for purists who cling to acute care of life-threatening illness or injury as the sine qua non of EM, the treatment of chronic or recurrent disease is more a dislike rather than a lack of capability. Change is generally resisted to some extent. EM's ability to deliver a full range of medical services, coupled with accessibility 24/7, truly make it the ultimate safety net for those turned away by other providers.[8]

Where is EM headed? We will always need to care for those with life or limb threats. As the needs of society change, we will have to adapt. Are we destined to be primary care physicians? For a segment of the American population, I would offer that we already are. However, ED-based public health surveillance will likely be the critical link in the future of ED-based preventive services.[9] Knowing the inevitable change, we may now have to redesign the ED so that it has the staff and systems in place to ensure some level of continuity of care and serve as the primary provider of care for many who now seem dependent upon it.[10] Lastly, we will need to push our legislators regarding distribution of resources from federal payers to enable us to fill this role. Once adequate reimbursement is available, ED physicians will be less reluctant to provide preventive services, as evidenced in the recent growth of alcohol and tobacco screening with the institution of Centers for Medicaid and Medicare Services CPT codes.

Preventive and primary care services continue to creep into the ED and have been met with a wide range of emotion, from open arms to complete disregard. With a steady increase of uninsured, the Medicaid office visit reimbursement of $27 and an overall diminished access to primary care, the frequent users of the ED are likely to increase. We have many challenges ahead: acceptance by ED staff, hindrance of clinical operations and changing the mindsets of ED physicians.[6] Fortunately, recent legislation has added reimbursement for some of these efforts to Medicaid patients in 10 states so far.[11] Grumbach et al.[12] opined some 15 years ago: "Many patients presenting to public hospital EDs may not require emergency services, but almost all have health care needs that deserve medical attention. Policies that deny patients emergency department care either explicitly, through criteria for refusing care, or implicitly, though long waiting times, without assuring patients of access to an alternative source of care are ethically and clinically unacceptable." Like internal medicine, we must adapt to the needs of our patient, who must always come first.

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Methemoglobinemia and Sulfhemoglobinemia in Two Pediatric Patients after Ingestion of Hydroxylamine Sulfate

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This case report describes two pediatric cases of immediate oxygen desaturation from methemoglobinemia and sulfhemoglobinemia after one sip from a plastic water bottle containing hydroxylamine sulfate used by a relative to clean shoes. Supplemental oxygen and two separate doses of methylene blue given to one of the patients had no effect on clinical symptoms or pulse oximetry. The patients were admitted to the pediatric Intensive Care Unit (ICU) with subsequent improvement after exchange transfusion. Endoscopy showed ulcer formation in one case and sucralafate was initiated; both patients were discharged after a one-week hospital stay. [*West*JEM. 2009;10:197-201.]

INTRODUCTION

Sulfhemoglobinemia is a rare condition that can result from exposure to any substance containing a sulfur atom with the ability to bind to hemoglobin. Cases of sulfhemoglobinemia have been reported from ingestions of phenacetin, dapsone, and sulfonamides.[1-3] Sulfhemoglobinemia should be considered in cases presenting with oxygen desaturation and cyanosis, especially if methemoglobinemia can be excluded. Unlike methemoglobinemia, which is reversible with a known antidote, methylene blue, sulfhemoglobinemia is irreversible with no known antidote. It requires early recognition, diagnosis and intervention in order to prevent end-organ damage, especially with high levels of sulfhemoglobin. The irreversibility of sulfhemoglobinemia illustrates the importance of its consideration as a diagnosis in the emergency department (ED).[3] Using PubMed and Medline search engines from the National Library of Medicine, as well as the MD Consult website, we conducted a review of all-language medical literature from January 1966 to August 2008 using the search parameters "Sulfhemoglobinemia and/or Methemoglobinemia and Hydroxylamine Sulfate." The search resulted in zero articles. We also searched using Medical Subject Headings (MeSH) terms "pediatrics" and "sulfhemoglobinemia." This generated a list of one article, a review.[4] Finally, we reviewed the bibliography of the review found in the Medline search and looked for any obvious omissions from our literature review. Based on our literature review, we believe this to be the first report of pediatric patients developing methemoglobinemia and sulfhemoglobinemia from the ingestion of hydroxylamine sulfate.

CASE 1

A three-year-old male was brought by paramedics to the ED accompanied by his mother. She stated he had immediate blue-gray discoloration of skin, increased somnolence and abdominal pain after drinking one sip from a water bottle found in his sister's room. The bottle, brought in by the paramedics, was noted to contain a colorless fluid. The patient's mother denied knowledge of any substance mixed with the water and any toxic substances or drugs in the home.

After the three-year-old drank from the bottle, he then gave it to his two-year-old cousin whose findings are discussed below. On history, the three-year-old boy pointed to his epigastrium for the location of the abdominal pain. He stated that the severity was "a little" and the quality was "sharp." There was no vomiting, diarrhea, cough, change in behavior, or loss of consciousness. The patient was not taking

Table. Laboratory results for three-year-old male with cyanosis

Complete Metabolic Panel		
Test	**Value**	**Reference Range**
Sodium	142 mmol/L	135-147 mmol/L
Potassium	3.6 mmol/L	3.5-5.5 mmol/L
Chloride	109 mmol/ L	96-108 mmol/L
Bicarbonate	22 mmol/L	22-29 mmol/L
Blood urea nitrogen	12 mg/dL	5-18 mg/dL
Creatinine	0.4 mg/dL	0.2-0.7 mg/dL
Glucose	117 mg/dL	65-99 mg/dL
Albumin	4.4 g/dL	3-5.4 g/dL
Aspartate aminotransferase	31 U/L	0-49 U/L
Alanine aminotransferase	15 U/L	0-44 U/L
Alkaline phosphatase	188 U/L	0-280 U/L
Calcium	9.8 mg/dL	8.8-10.8 mg/dL
Total bilirubin	0.5 mg/dL	0.2-1 mg/dL

Complete Blood Count		
Test	**Value**	**Reference Range**
White blood cell	18.8 K/UL	5.5-15.5 k/μL
Hemoglobin	12.5 g/dL	10.7-14.5 g/dL
Hematocrit	36.7%	22-46%
Platelets	327 K/UL	150-450 k/μL

medications, and past medical and family histories were unremarkable.

The physical exam showed an oral temperature of 36.4 degrees Celsius, heart rate of 120 beats/minute, respiratory rate of 30 breaths/min, blood pressure of 115/43 mmHg, and oxygen saturation on room air of 84% by pulse oximetry. The patient weighed 18.5 kg. He demonstrated central cyanosis. Otherwise, his general appearance was of an alert and oriented male in no apparent distress. He was not diaphoretic, his mucous membranes were moist, his bowel sounds were normal, and his neurologic exam was normal.

An arterial blood gas (ABG) while the patient was on 100% oxygen via non-rebreather face mask showed a pH of 7.53 (reference range 7.35-7.42), pCO_2 of 25.2 mmHg (36-50), pO_2 of 249 mmHg (80-100), and HCO_3 21.2 mmol/L (24-29). His calculated oxygen saturation on arterial blood gas (ABG) was 100%, whereas the finger pulse oximeter showed 84% oxygen saturation. Laboratory studies included a complete metabolic panel and complete blood count (Table).

Ethanol level was less than 10 mg/dL. A midstream clean-catch urinalysis was normal, and a rapid urine drug screen was negative for amphetamines, barbiturates, benzodiazepines, opiates, cocaines, phencyclidines, and cannabanoids. The carboxyhemoglobin, methemoglobin and sulfhemoglobin levels had to be sent to an outside hospital lab. A chest radiograph showed no evidence of acute disease.

The three-year-old patient was placed on 100% supplemental oxygen and cardiac monitor, which showed normal sinus rhythm. An intravenous line (IV) was placed. The social worker attempted to locate the patient's sister who had the bottle in her room. The Poison Control Center recommended giving a dose of methylene blue at a dose of 1mg/kg. Methylene blue had no effect. At that time the blood specimen originally sent for analysis of the methemoglobin level was noted to be hemolyzed, and a second specimen was sent to the lab. A second dose of methylene blue at 1mg/kg was administered without effect.

The patient's older sister, who then arrived at the ED, stated that she had put a substance to clean shoes into the water bottle. It was "HAS": hydroxylamine sulfate. At the same time the patient's carboxyhemoglobin level returned from the lab at 0.6% (0%-5%) and methemoglobin level was 5.4% (0.4%-1.5%). He was admitted to the pediatric ICU.

The Gastroenterology service performed endoscopy on the patient due to continued abdominal pain. Endoscopy revealed two 1.5 cm by 1.5 cm Grade II ulcers (through the mucosa and muscularis mucosa) in the upper esophagus and multiple small, superficial erosions in the mid-esophagus, none of which were circumferential. The patient was started on sucralafate and ranitidine.

The patient's methemoglobin levels improved gradually after admission, dropping to 4.5% after the two doses of methylene blue described above. At 24 hours the level was 3.1%, and by 36 hours post-ingestion hismethemoglobin level had fallen to 2.7%. At that time, Hematology was consulted due to continued low oxygen saturations despite lowering methemoglobin levels. Hematology recommended partial exchange transfusion with packed red blood cells and fresh frozen plasma. Prior to the initial exchange transfusion, the patient's oxygen saturation was 85% by pulse oximetry while receiving supplemental oxygen via a non-rebreather face mask. The exchange transfusion had to be stopped as he developed hives on his face and chin, but more than three quarters of a unit of blood and a single unit of fresh frozen plasma was administered. The resultant oxygen saturation was documented in the low 90s. On the third hospital day, packed red blood cells were transfused without exchange, and by day four, his oxygen saturation had improved to 94%. The patient was discharged home on the fifth hospital day with stable vital signs (including oxygen saturation of 97%) and without end organ damage. The initial sulfhemoglobin level, which was sent on the day of the patient's arrival, returned 10 days after patient's discharge and was noted to be 10 % (0-2%).

CASE 2

A two-year-old female accompanied the above patient. She also had blue-gray discoloration after drinking one

sip from the plastic water bottle and complained of similar abdominal pain. There was no somnolence, nausea, vomiting, change in behavior, or loss of consciousness. The past medical and family histories were unremarkable, and she was not taking any medications.

The physical exam showed an oral temperature of 36.7 degrees Celsius, heart rate 120 beats/min, respiratory rate 26 breaths/min, capillary refill of less than 2 seconds, and oxygen saturation of 84% on room air by pulse oximetry. The patient's weight was 15 kg. She was noted to be alert and oriented, in no apparent distress, speaking appropriately, with blue-gray central skin discoloration. The remainder of the physical exam was normal including clear lung sounds without stridor.

An immediate blood gas showed a pH 7.45, pCO_2 28 mmHg, pO_2 233 mmHg, HCO_3 19.5 mmol/L and oxygen saturation of 100% while the finger pulse oximeter showed an oxygen saturation of 92% on 100% supplemental oxygen via mask. Laboratory studies included a complete metabolic panel that was within normal limits. A complete blood count showed white blood cell 9.7 K/UL, hemoglobin 10 g/dL, hematocrit 29.4%, platelets 301 K/UL. Ethanol level was <10 mg/dL, and a urinalysis and urine drug screen were negative. A chest radiograph showed no evidence of acute disease.

The same management was taken as with the previous patient. After the methemoglobin level was tested to be 3.8% with a normal carboxyhemoglobin level at 1.3%, methylene blue was administered at 1mg/kg without effect prior to admitting the patient to the pediatric ICU.

Gastroenterology performed an endoscopy showing no ulcers. On the second hospital day, hematology recommended packed red blood cell transfusion due to hemoglobin falling to 9.1 g/dL due to presumed hemolysis from oxidant stress from the toxin. This improved her oxygen saturations. Exchange transfusion was not recommended, as she was asymptomatic. The patient was weaned off supplemental oxygen and discharged home on the sixth hospital day.

DISCUSSION

These cases describe patients who presented with acute oxygen desaturation via pulse oximetry and central cyanosis after drinking one sip of water mixed with hydroxylamine sulfate, which resulted in methemoglobinemia and sulfhemoglobinemia, a rare combination.

Hydroxylamine sulfate is a strong acid and powerful reducing agent. It is a white crystalline compound containing nitrogen and sulfate with the formula of $(NH_2OH)_2H_2SO_4$ that can cause irritation to the nose and throat, as well as pulmonary edema if inhaled.[4] It is also corrosive and can cause burns to skin and, if ingested, in the mouth, esophagus and stomach, as was evident in one of our patients. It is known to cause methemoglobinemia, but sulfhemoglobinemia is not a stated result of exposure in the Material Safety Data Sheet (MSDS).[5] It is usually used in photography and surface cleaning solutions.[5] Our patient's older sister obtained the product from their mother's work, which has housecleaning products. It was mixed with water in a plastic bottle, was not labeled and easily accessible.

As with all cases of acute oxygen desaturation, a search for the etiology is emergently required. After mechanical obstruction and cardiac shunting has been eliminated as a possibility, ventilation problems such as pneumothorax, pneumonia, or asthma and perfusion problems, such as pulmonary embolism, should be considered. Once these problems have been sufficiently ruled out, evaluation for abnormal blood hemoglobin is warranted.[6,7] The "oxygen saturation gap" is the difference between the calculated oxygen saturation from a standard blood gas machine and the reading from a pulse oximeter. If it is greater than 5%, the patient's hemoglobin may be abnormal, representing carbon monoxide poisoning, methemoglobinemia, or sulfhemoglobinemia. Our patients had no symptoms of mechanical obstruction, no history of reactive airway disease or cardiac abnormalities or fever, and no risk factors for pulmonary embolism. Their acute oxygen desaturation event occurred immediately after ingestion of the colorless fluid in the water bottle. Although the chemical was not known at the time, the suspicion for a toxic ingestion was high.

Methemoglobin is a product of hemoglobin in which the normal ferrous ion in the heme complex is converted by oxidation to the ferric form which does not combine with oxygen, but can convert back to hemoglobin by reducing agents such as methylene blue.[7-11] Acquired methemoglobinemia is produced by the action of oxidants.[12] This leads to a leftward shift of the oxygen dissociation curve for the remaining normal hemoglobin, resulting in diminished oxygen unloading in the tissues and predisposing to tissue hypoxia.[7-10]

Several enzymes work to decrease the amount of circulating methemoglobin molecules. Cytochrome b5 reductase is the primary enzyme that works to decrease levels of oxidized hemoglobin (such as methemoglobin) by reducing the molecule. Other enzymes include glutathione peroxidase and catalase. Cellular hypoxia can occur if an abnormally increased oxidant stress exceeds the normal source of reducing power. Methylene blue is used as an electron donor in chemical-induced methemoglobinemia, which utilizes NADPH and the hexose monophosphate pathway to reduce methemoglobin to hemoglobin. This reduction occurs quickly over several minutes. The regeneration of NADPH requires an intact pentose phosphate pathway. It is also critical to remember that in those patients with glucose-6-phosphate dehydrogenase deficiency, methylene blue has no effect and can actually induce acute hemolysis.[10,11]

Sulfhemoglobin is a stable, green-pigmented molecule, which is not normally present in the body. It is made by the oxidation of the iron in hemoglobin to a ferric state by

drugs and chemicals that contain sulfur. Sulfur can bind to the hemoglobin molecule's porphyrin ring, which forms sulfhemoglobin. Sulfhemoglobin is irreversible, lasting the lifetime of the erythrocyte, and sulfhemoglobin molecules cannot carry oxygen.[3,9,12,13] Acetanilide, phenacetin, nitrates, trinitroluene, metoclopramide, and sulfur compounds have all been linked to producing sulfhemoglobinemia. The origin of sulfur, in cases where it is not overtly apparent, has been theorized to come from hydrogen sulfide released by intestinal organisms and/or glutathione.[3,7,9,13]

The concentration of sulfhemoglobin decreases as erythrocytes are destroyed and replaced.[3] The decreased oxygen affinity of the unaffected hemoglobin results in protection of tissue oxygen delivery. Sulfhemoglobinemia is a rare cause of cyanosis, and patients present with mild to moderate clinical symptoms.[3,10,13] Dyspnea is uncommon unless the level of sulfhemoglobin is high, although cyanosis can set in at much lower concentrations. It is reported that levels of only 0.5g/dL is sufficient for cyanosis to occur.[9,10,11] Our patients denied any symptoms consistent with end-organ damage (including dyspnea), but had obvious cyanosis, which in and of itself is not an indicator of tissue hypoxia.

Reports of physiologic affects of sulfhemoglbinemia display little consistency.[6,9,14,15] While some describe sulfhemoglobin levels of 20% to 60% as benign for some patients, these lack evaluation of tissue oxygen status or of its influence on the course of patient outcome in the face of cardiac and pulmonary involvement.[6,15]

The diagnosis of true sulfhemoglobinemia can be difficult. Any time there is a significant pulse oximetry desaturation associated with a normal arterial oxygen tension (PaO2) or anytime a patient remains cyanotic without response to methylene blue, an emergency physician should consider the possibility of abnormal hemoglobin species interfering with the pulse oximeter other than methemoglobin.[3,13] Our patients illustrated this point clearly since there was no effect in oxygen saturation after methylene blue.

The knowledge of the type of co-oximeter used in the analysis of ABGs is also essential. Hemoximeters use multiple wavelengths to determine concentrations of oxyhemoglobin, deoxyhemoglobin, carboxyhemoglobin, and methemoglobin. However, different co-oximeters vary widely, with some not being able to distinguish between methemoglobin and sulfhemoglobin due to similar absorbance peaks. Gas chromatography is considered the "criterion" standard. However, to perform gas chromatography, specialized equipment, time and expertise are required.[9,16]

Some pulse oximeters use two light wavelengths (660nm and 940nm) to determine the ratio of pulse-added absorbancies. Dyshemoglobin molecules that have light absorbance peaks at 660nm or 940nm affect the ratio of light absorbancies at these wavelengths and lead to spurious pO_2 readings. Methemoglobin has significant absorbancies at both wavelengths. Sulfhemoglobin molecules share a similar peak with methemoglobin molecules at 630nm. Therefore, a reported methemoglobin level may actually be sulfhemoglobin and be inappropriately treated with methylene blue as has been described in other case reports.[9] Further complicating the clinical picture, some substances can cause both methemoglobin and sulfhemoglobin.[9,10,11] The blood gas analyzer at the outside institution for our case was able to accurately differentiate methemoglobinemia from sulfhemoglobinemia.

Sulfhemoglobinemia may be distinguished from methemoglobinemia by isoelectric focusing.[4] The laboratory measurement of sulfhemoglobin relies on an absorption peak at 630nm, which, unlike methemoglobin, persists after the addition of cyanide or dithionate.[3,7,12] Another method of differentiating sulfhemoglobin from methemoglobin involves carbon monoxide, since it binds to sulfhemoglobin but not to methemoglobin. Finally, newer generation co-oximeters that are designed to assess sulfhemoglobin and other types of hemoglobin can differentiate between the two types.[9,17,18] The sulfhemoglobin level in our case returned 10 days after initially sent and was analyzed in an outside laboratory using potassium cyanide.

There is no specific treatment for sulfhemoglobinemia. Most treatment recommendations for sulfhemoglobinemia state to remove the offending agent, and with low levels of sulfhemoglobin, no more than observation is needed, usually until they are clinically stable and it is clear that the cyanosis and/or sulfhemoglobin level is improving.[3,6,9,11,15] Lim and Lower[19] suggest exchange transfusion as a means of managing extreme sulfhemoglobinemia. Other sources state that exchange transfusion is hardly justified, since the cyanosis itself is in no way disabling.[12] Exchange transfusion and packed red blood cell transfusion improved oxygen saturations in our patients, reversed the cyanosis, and maintained normal oxygen saturation through the rest of their hospital stay. In retrospect, these interventions may not have been necessary in our patients, since low levels sulfhemoglobin will cause little if any effect. Also, exchange shares similar risks as other blood transfusion products.

CONCLUSION

Hydroxylamine sulfate, a strong acid known to cause methemoglobinemia but not sulfhemoglobinemia, was mixed in a water bottle and not appropriately labeled. The hydroxylamine sulfate was ingested by two children causing a mixed methemoglobinemia and sulfhemoglobinemia. Sulfhemoglobinemia itself is rare, difficult to distinguish from methemoglobinemia, and (at high levels) can result in end-organ damage. Our patients did not respond to methylene blue treatment, illustrating that their oxygen desaturation was mainly due to sulfhemoglobinemia. Sulfhemoglobinemia may appear identical to methemoglobinemia by co-oximeters that

cannot differentiate between the two molecules. Knowledge of the co-oximeter used at your institution can help to differentiate the abnormal hemoglobin molecules. Exchange transfusion and packed red blood cell transfusion immediately increased our patients' oxygen saturations, which may have prevented end-organ damage, illustrating the importance of early recognition and intervention. However, given the low levels of sulfhemoglobin, observation alone may have been sufficient.

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International Perspective from Singapore on "Methemoglobinemia and Sulfhemoglobinemia in Two Pediatric Patients after Ingestion of Hydroxylamine Sulfate"

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Accidental ingestional poisoning among pediatric patients is a prevalent problem. In the absence of a well-designed national injury and poisoning surveillance system, cases often go unreported. Underreporting also occurs because many pediatric ingestions are trivial and not referred to a hospital for further medical management.[1] To reduce health risks posed by common household products, emphasis and enforcement of regulations specifying child-safe packaging are required.[2]

The authors described two cases of methemoglobinemia (metHbemia) and sulfhemoglobinemia (sulfHbemia) following ingestion of hydroxylamine sulfate, which were treated with methylene blue and exchange transfusion. Drugs or chemicals that cause sulfHbemia can also cause metHbemia, although it is not understood why the same chemical causes metHbemia in one person and sulfHbemia in another.[3] Other ingestants that may cause methHbemia and sulfHbemia are dapsone, metoclopramide, phenacetin and phenazopyridine.

Emergency physicians (EP) in some developing countries may not have access to lab equipment with advanced co-oximeter capabilities to differentiate the two types of dyshemoglobinemia. In a time-pressured situation, some bedside investigation methods may be useful in guiding decisions for specific therapy like methylene blue in a cyanosed patient with suspected poisoning. One method, the filter paper test, helps to distinguish deoxyhemoglobin from dyshemoglobin as the darkly colored blood changes to bright red after blowing some oxygen over it. No changes occur with metHb or sulfHb. To distinguish metHb from sulfHb, the addition of a few drops of potassium cyanide changes the chocolate brown of metHb to bright red as cyanometHb is formed. No reaction occurs with sulfHb.[4] Therapeutic response to methylene blue will also aid in the diagnosis of underlying metHbemia. The response is usually fairly rapid, within 30 minutes to one hour.

EPs should consider several differentials for apparent metHbemia that does not respond to methylene blue treatment. These include older equipment incapable of distinguishing sulfHb from metHb due to limited co-oximeter capability; Hb M disease prone to metHb formation that resists reduction; glucose-6-phosphate dehydrogenase (G6PD) deficiency; NADPH metHb reductase deficiency; poisoning with oxidizing compounds that have enterohepatic circulation, which causes prolonged elevation of metHb; and overdosing of methylene blue itself, which is an oxidizing agent.[3,4]

Finally, G6PD deficiency, one of the most prevalent disease-causing mutations worldwide, has several variants in Asia. Patient's status will influence decision when using methylene blue as treatment for metHbemia because methylene blue itself may induce hemolysis (through development of Heinz bodies) and cause paradoxical metHbemia, especially in G6PD deficient patients.[4]

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Irritant Contact Dermatitis from Jet Fuel

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A previously healthy 31-year-old man presented to the emergency department complaining of right foot pain and a non-pruritic rash with swelling for one day. He reported spilling jet fuel on his right lower leg at work the previous evening and had worn the fuel-soaked sock for another 10 hours. Physical examination demonstrated a coalescing erythematous macular rash with mild non-pitting edema in a sock-like pattern extending from the ankle inferiorly across the dorsum of the foot (Figure 1.) The affected skin was warm to touch compared to the unaffected foot.

Irritant contact dermatitis is a nonspecific inflammation of the skin caused by the release of mediators of inflammation in response to chemical damage.[1] Some animal studies have shown that the release of chemokines and cytokines, both markers of inflammation, causes erythema, edema and hyperplasia of the skin when it is exposed to Jet propulsion fuel 8 (JP-8), but this exact mechanism is not completely understood.[2, 3] Irritant contact dermatitis is not a true pruritic allergic reaction, distinguishing it from allergic contact dermatitis. Irritant dermatitis can be caused by a wide variety of compounds including surfactants, solvents, oils, and hydrocarbons.[2, 4] JP-8 is a complex mixture of hydrocarbons used as a multipurpose fuel for commercial aircraft, as well as ground vehicles, generators, heaters and stoves. JP-8 and other kerosene-based fuels have been shown to cause skin irritation, skin sensitization and even skin tumors with repeated or prolonged contact.[2]

Treatment primarily involves removal of the offending agent by washing with a gentle soap and water. Topical corticosteroids have not been proven beneficial.[4] Oral antihistamines may be useful for treatment of any associated pruritis.

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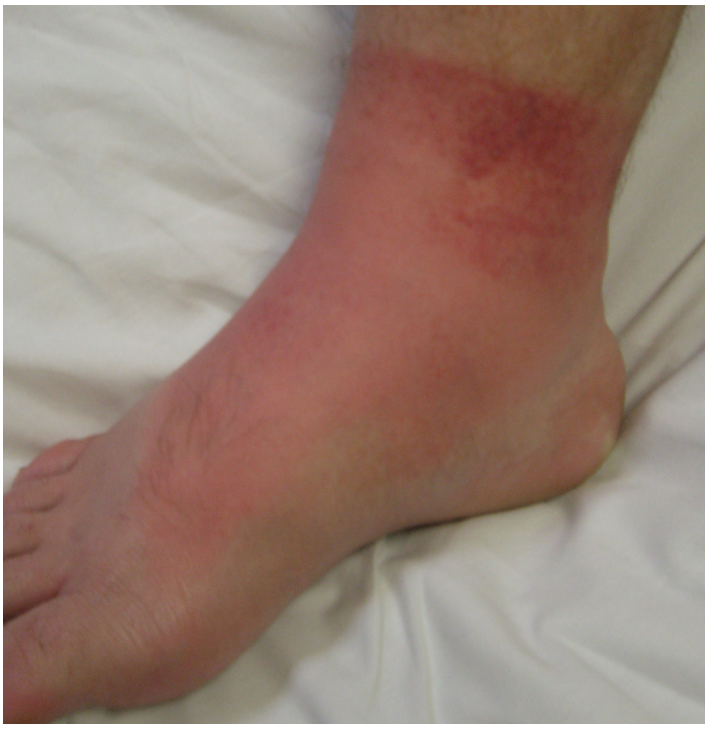

Figure 1: Medial aspect of the right foot with sock-like erythema [Color photo viewable at: http://repositories.cdlib.org/uciem/westjem/vol10/iss3/art22/].

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Sporotrichosis

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A 25-year-old healthy Hispanic male agricultural laborer presented to the emergency department with six weeks of a painless raised lesion on the proximal thumb with occasional drainage of fluid, without history of injury. Over the next several weeks, he developed painless subcutaneous nodules proximally. He denied any systemic symptoms. The patient emigrated from Mexico two years earlier, but had not traveled since. Physical examination showed an ulcerated, raised, dry, crusted lesion on the lateral surface of the left thumb, with four proximal raised, erythematous, subcutaneous nodules, without epitrochlear or axillary lymphadenopathy (Figure 1). Purulent material was aspirated from one of the nodules; gram, fungal and mycobacterial stains showed no organisms. Saturated solution of potassium iodide (SSKI) was prescribed, and the patient was referred to the Infectious Diseases clinic for follow-up. Thirty days later, the fungal culture grew *Sporothrix schenkii.* The patient was lost to follow-up.

Sporotrichosis is caused by infection with *Sporothrix schenkii*, a dimorphic fungus, found in soil, wood, and plant surfaces. The fungus is mostly found in the tropics of Central and South America, and Africa.[1] The largest U.S. outbreak occurred in 1988, involving 84 people in 15 states, and was associated with exposure to sphagnum moss.[2]

Lymphocutaneous sporotrichosis, the most common form, presents as a small, nontender, erythematous papulonodule at the site of primary injury. This lesion may be smooth or verrucous, often ulcerates, and develops raised red borders. Over days to weeks, proximal subcutaneous nodules form along the lymphatic drainage, and may ulcerate. Fungal cultures and tissue biopsies aid in the diagnosis.

The differential diagnosis of sporotrichosis includes: nocardiosis, cutaneous leishmaniasis and atypical mycobacterial infection, especially *Mycobacterium marinum*.[3] The treatment of choice for sporotrichosis is oral itraconazole for 3-6 months with SSKI as an alternative. In severe cases, intravenous amphotericin B is used.

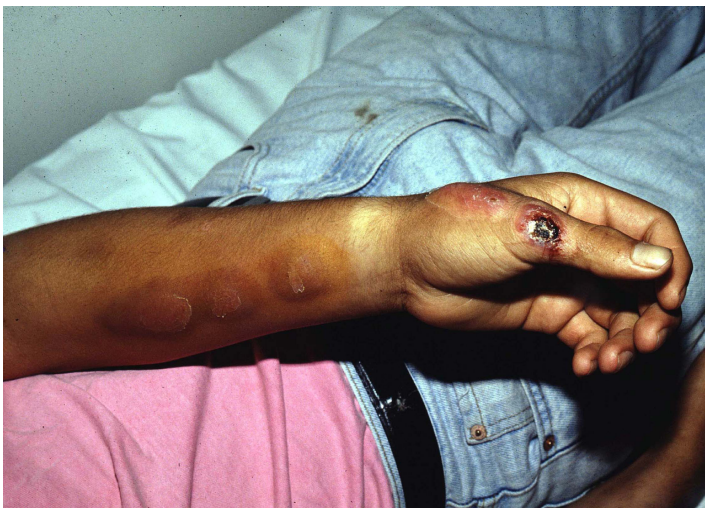

Figure 1. Lymphocutaneous sporotrichosis. [Color photo viewable at: http://repositories.cdlib.org/uciem/westjem/vol10/iss3/art23/]

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Infected Thyroglossal Duct Cyst

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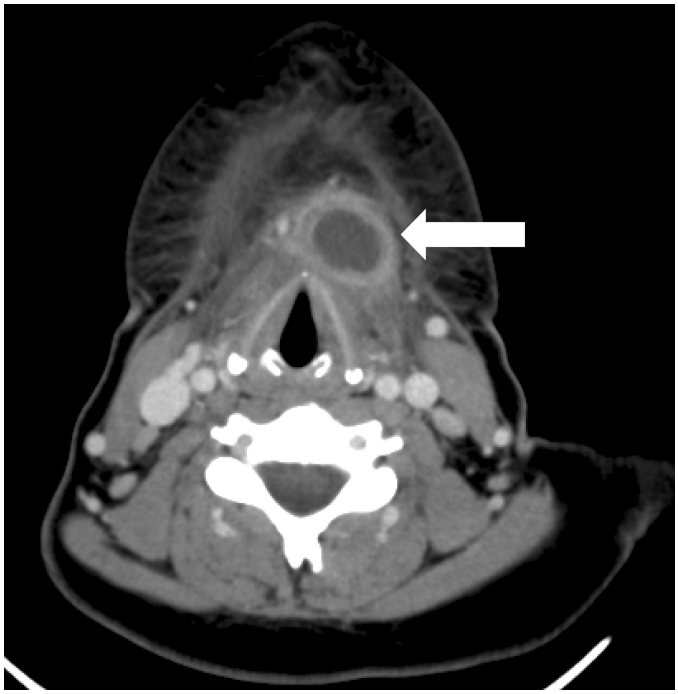

Figure. CT of the neck with contrast showing an enhancing, well-circumscribed lesion located in the anterior neck at the level of the thyroid cartilage.

A 23-year-old female presented to the emergency department (ED) with a five-day history of sore throat, body aches and 24 hours of throat swelling accompanied by globus sensation and hoarseness. The patient was afebrile with normal vital signs. Physical exam was significant for a firm, non-erythematous anterior neck mass that was exquisitely tender to palpation. The mass was noted to move slightly with swallowing. A CT scan with contrast revealed a 2 x 2.5 x 3 cm cystic lesion with a thick, enhancing rim located inferior to the hyoid bone with overlying soft tissue swelling. Given the history and radiographic appearance of the lesion, a diagnosis of infected thyroglossal duct cyst was made. The patient was started on Clindamycin in the ED and admitted to ENT for needle aspiration and 23-hour observation.

Thyroglossal duct cysts (TGDC) are the most common cause of midline neck masses.[1] TGDC are typically located inferior to the hyoid bone (65%) in the region adjacent to the thyrohyoid membrane.[2] However, these remnants can occur anywhere along the path followed by the primordial thyroid gland during descent from the base of the tongue. Frequently presenting as an asymptomatic neck mass in the pediatric population, the most common presentation in adults is underlying infection of the cyst.[1] Other common causes of midline neck masses include lymphadenopathy, dermoid cysts, and various odontogenic anomalies. Classic physical exam findings include a mobile neck mass that moves with swallowing or protrusion of the tongue. Accompanying symptoms include sore throat, pain, dysphagia, hoarseness, and globus. Serious complications involve airway obstruction precipitated by rapid enlargement of the cyst. Findings on CT include a well-circumscribed lesion with significant rim enhancement.[3]

Definitive treatment of infected TGDC involves both antibiotics and needle aspiration. Examination of the aspirate allows for identification of the involved organisms as well as cytologic analysis to rule out underlying TGDC carcinoma. The most common organisms involved include *Staphylococcus epidermis*, *Haemophilus influenza*, and *Staphylococcus aureu.*[3] Following control of the underlying infection, the patient may elect to surgically remove the cyst to prevent further recurrence.

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Cecal Diverticulitis

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A 56-year-old Hispanic male presented to the emergency department (ED) complaining of right lower quadrant abdominal pain for two days. The pain was gradual in onset with a throbbing, burning quality, and 10 out of 10 severity. He reported diarrhea but denied fever, chills, nausea or vomiting. In the ED the patient was afebrile with normal vital signs, and his abdomen was soft and mildly tender in the right lower quadrant with normal bowel sounds. Computed Tomography (CT) of the pelvis with oral and intravenous contrast showed a thickened cecal wall with radiographic findings consistent with appendicitis (Figure 1). The patient went to the operating room for laparoscopic appendectomy and was found to have right-sided colonic diverticulitis involving the cecum, as well as a normal appendix.

Right-sided colonic diverticulitis was first described in 1912 by Potier.[1] Right-sided diverticulae are true, involving all layers of the intestinal wall, in contrast to left-sided which are false, only involving the mucosa and submucosa; however, the pathological mechanism that leads to diverticulitis is the same throughout the colon.[2] In a majority of cases the underlying cause is secondary to obstruction by a faecolith.[3] This pathologic mechanism mimics appendicitis and as such, the clinical presentation of right-sided diverticulitis is identical.[4] Diverticulitis is initially managed non-operatively with antibiotics, unlike appendicitis which mandates surgical intervention. This difference underscores the importance of radiographic evidence along with a high index of suspicion for correctly identifying this uncommon diagnosis.

Despite its low incidence, right-sided colonic diverticulitis remains an important differential diagnosis to consider in the presentation of an older patient with acute right lower quadrant pain. CT for acute appendicitis is good but not perfect. A systematic review showed CT to be 94 percent sensitive and 95 percent specific.[5] Therefore, correct radiographic diagnosis, coupled with astute clinical judgment, may avoid unnecessary laparotomy.

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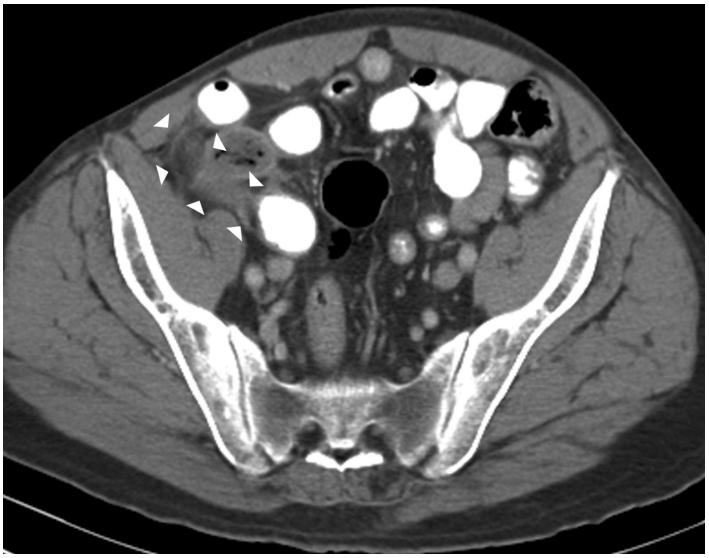

Figure 1. CT of the pelvis with oral and intravenous contrast showing inflammatory changes with a dilated 2 cm blind-ending tubular structure arising from the cecum inferior to the ileocecal valve.

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What's Hot, with Spots and Red All Over? Murine Typhus

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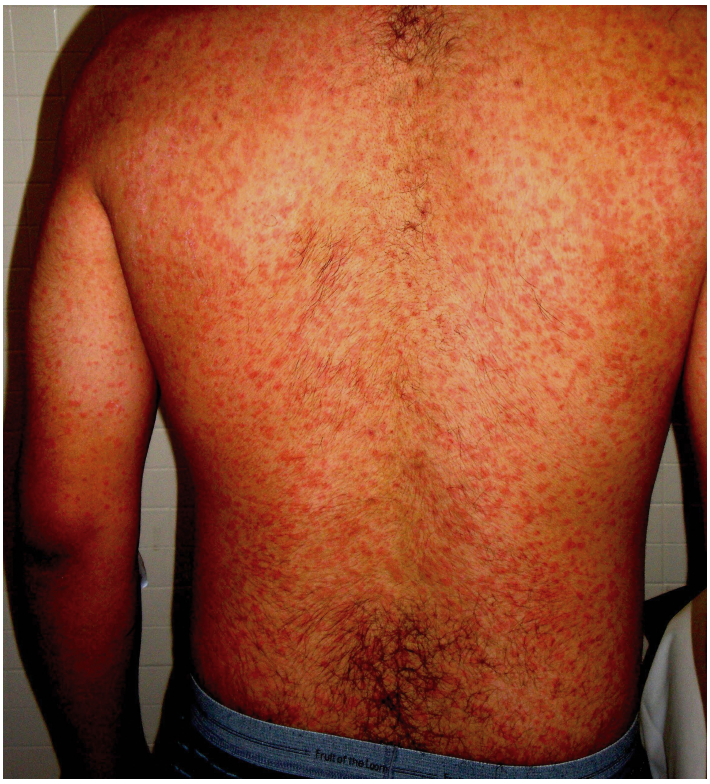

Figure. Diffuse rash consisting of multiple, small, erythematous, and confluent macules. [Color photo viewable at: http://repositories.cdlib.org/uciem/westjem/vol10/iss3/art26/]

A 17-year-old male presented to the emergency department with complaints of fever, rash that originated on the abdomen, malaise, and a cough for 10 days prior to evaluation. The patient reported an encounter with an opossum three days prior to the onset of symptoms. Vital signs were a temperature of 101.2°F, a heart rate of 129 beats per minute, 12 respirations per minute and a blood pressure of 123/76 mmHg. Dermatologic exam revealed a rash on the face, trunk, back, extremities and palms that consisted of multiple small, erythematous maculopapules. Rapid plasma reagin (RPR), monospot and brucella were negative. Rickettsial titers supported the diagnosis of murine typhus. This diagnosis may be suggested clinically by a characteristic rash, normal WBC, low platelets, and elevated liver function tests. Definitive diagnosis requires serology. We prescribed a10-day course of doxycycline, resulting in complete resolution of the rash and constitutional symptoms at three-day follow up.

Murine typhus is a flea-borne illness caused by r*ickettsia typhi*. Rickettsial infections are endemic to hot, humid, usually tropical and subtropical coastal regions.[1] Up to 50% develop a rash that is rarely puritic.[1] The rash of murine typhus presents as fine erythematous papules on the abdomen, which spreads centripetally to the trunk and extremities but often spares the face, palms, and soles. Symptoms include abrupt onset of high fever, nausea, myalgia, arthralgia and headache.[1] The differential should include other rickettsial infections, such as epidemic typhus, murine typhus, scrub typhus, rocky-mountain spotted fever, ehrlichiosis, as well as mononucleosis, borreliosis, drug allergy, meningococcemia, enterovirus infection, typhoid, leptospirosis, toxic shock syndrome, syphilis, rubella, measles, and Kawasaki's. Its intracellular predilection causes a vasculitis. The prognosis is generally good except in the very young and very old and in the immunosuppressed.[1,2] These individuals may progress to multiple organ failure. The mortality rate for treated murine typhus is 1%.[1,2] It is imperative to initiate macrolides when the diagnosis is suspected.

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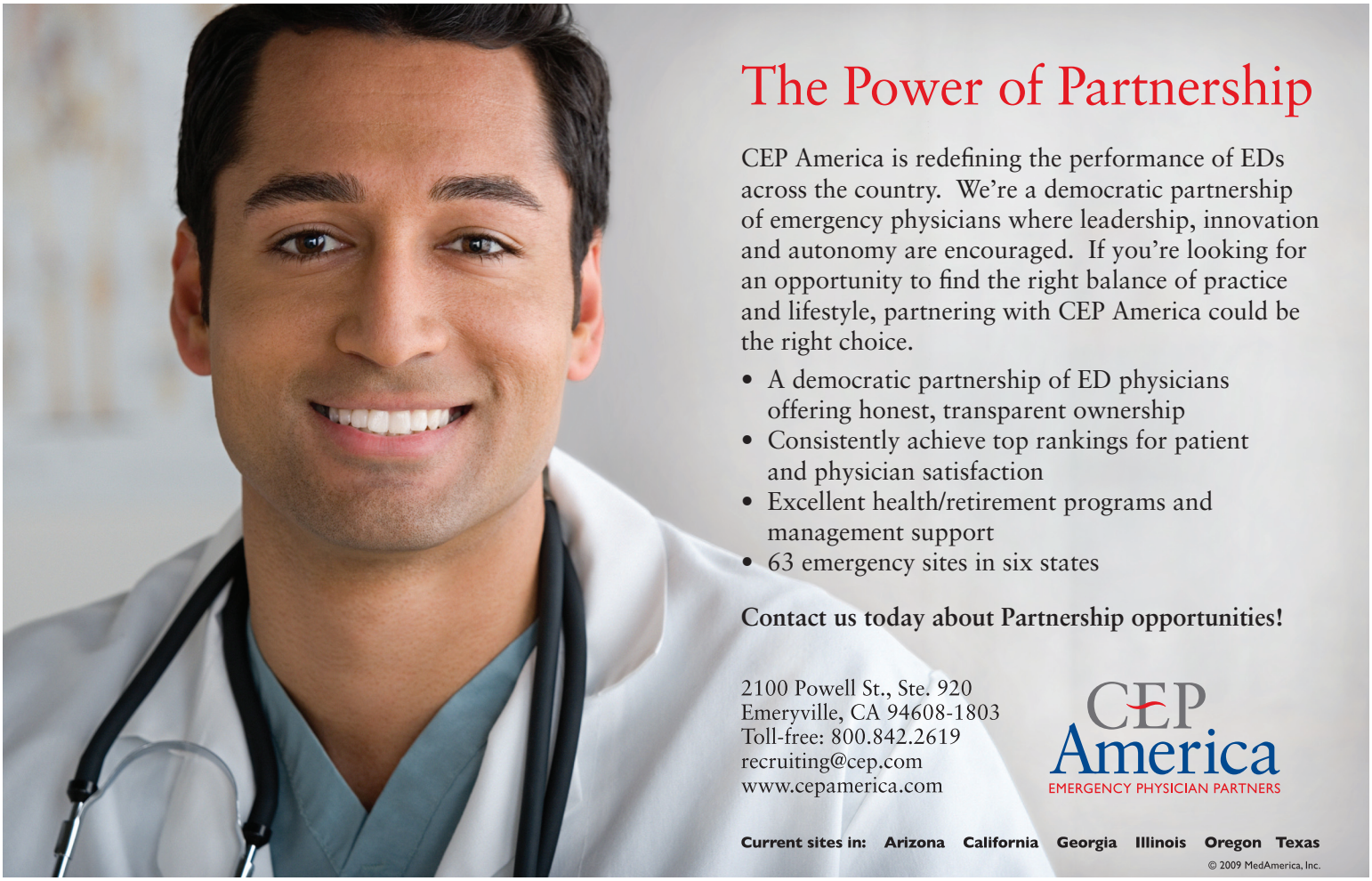

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