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

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Does Limiting Oral Contrast Decrease Emergency Department Length of Stay?

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Introduction: The purpose of this study was to examine the impact on emergency department (ED) length of stay (LOS) of a new protocol for intravenous (IV)-contrast only abdominal/pelvic computed tomography (ABCT) compared to historical controls.

Methods: This was a retrospective case-controlled study performed at a single academic medical center. Patients ≥ 18 undergoing ABCT imaging for non-traumatic abdominal pain were included in the study. We compared ED LOS between historical controls undergoing ABCT imaging with PO/IV contrast and study patients undergoing an IV-contrast-only protocol. Imaging indications were the same for both groups and included patients with clinical suspicion for appendicitis, diverticulitis, small bowel obstruction, or perforation. We identified all patients from the hospital's electronic storehouse (imaging code, ordering department, imaging times), and we abstracted ED LOS and disposition from electronic medical records.

Results: Two hundred and eleven patients who underwent PO/IV ABCT prep were compared to 184 patients undergoing IV-contrast only ABCT prep. ED LOS was shorter for patients imaged with the IV-contrast only protocol (4:35 hrs vs. 6:39 hrs, $p < 0.0001$).

Conclusion: Implementation of an IV-contrast only ABCT prep for select ED patients presenting for evaluation of acute abdominal pain significantly decreased ED LOS. [West J Emerg Med 2012;13(5):383-387.]

INTRODUCTION

Abdominal pain is one of the most common presenting complaints to United States emergency departments (ED), comprising up to 6.5% of all presenting complaints.[1] The use of computed tomography (CT) is common in the initial evaluation of patients with abdominal pain acutely presenting to the ED in order to rule out intra-abdominal pathology.

Several improvements in CT imaging technology have transpired, including more rapid image acquisition, which is now possible with helical scanning, and multi-detector CTs. The rapid image acquisition limits the artifact seen from respiratory and peristaltic motion, decreasing the amount of image degradation noted with earlier generation scanners.[2]

Due to these recent advances in imaging, there is a growing body of literature which suggests that oral contrast does not improve the accuracy of CTAB scans when evaluating patients with CT for appendicitis[2-4,5-9] or other common disorders like diverticulitis and small bowel obstruction (SBO).[10,11] The use of intravenous (IV) contrast alone is typically easier for patients to tolerate than PO contrasted exams. In addition, IV-contrast only exams do not require the protracted preparation time associated with many IV/PO contrast protocols. The use of IV contrast may increase the sensitivity for diagnosis of appendicitis and recognition of the complications of common causes of abdominal pain, such as bowel ischemia, when compared to non-contrast enhanced CTs.[12-14]

ED length of stay (LOS) times have been documented to be as much as 60 minutes shorter with alternate bowel preps (i.e. rectal),[15] and 240 minutes shorter for unenhanced CT.[16] The impact of ED LOS for IV-contrast only CT exams was examined in one study to date, which showed a median decrease of ED LOS of 30 minutes for patients with undifferentiated abdominal pain.[17]

The objective of this study was to quantify the impact of a new IV-contrast only CT protocol on ED LOS as compared to historical controls receiving both IV/PO contrasted studies for a select group of patients clinically suspected of having appendicitis, diverticulitis, SBO or intra-abdominal free air.

METHODS

This study was performed at the University of Utah Medical Center ED, an academic emergency department with an annual census of 38,000, and an emergency medicine residency training program. All attending physicians working in this department were board-certified/prepared by the American Board of Emergency Medicine during the study period. The study was approved by the hospital's institutional review board. The institution initiated a new CT protocol in which IV-contrast only exams were approved for use in ED patients with a high clinical suspicion for appendicitis, SBO, diverticulitis, or free air. Previously, the IV-contrast only study had been used solely for patients undergoing evaluation for traumatic injuries. Historically, all evaluations for non-traumatic abdominal pain had been evaluated using both PO and IV contrasted exams, unless contraindications to contrast material existed.

During the study period, abdominal scanning was performed using a 128-Multidectector CT scanner (Siemens Definition 128). Portal venous phase CT images were acquired from the diaphragm to the greater trochanters with the following parameters: slice thickness, 5 mm; reconstruction interval, 5 mm; pitch, 1.0; noise factor, 19 (Care Dose modulation); and rotation time, 1 second. The direct multiplanar reformation function was used to generate coronal reformations with a slice thickness of 3 mm and a reconstruction interval of 3 mm. All patients received 140 mL of Isovue (Optiray 300 mg I/mL, Mallinckrodt Imaging) administered via power injection through an IV cannula located in an antecubital or hand vein at a rate of 3 mL/s. A dual-syringe power injector (Stellant CT Injection System, Medrad) was used to administer a 50-mL normal saline chasing bolus immediately after the injection of IV contrast material. The saline bolus was injected at 3 mL/s. The acquisition of portal venous phase images started 70 seconds after the initiation of the injection of IV contrast material. At the study institution, oral contrast was administered for 90 minutes with barium sulfate oral contrast bowel prep (900 mL of 2.2% barium sulfate suspension [Medescan barium sulfate, Lafayette Pharmaceuticals]).

The IV-contrast only abdominal/pelvic computed tomography (ABCT) protocol, initiated in November 2008, was suggested for patients with a clinical history and physical exam suggestive of appendicitis, diverticulitis, SBO, or intra-abdominal free air. In contrast, an ABCT with IV/PO contrast was recommended for patients who did not meet the IV-only protocol indications (for example, those patients with conditions or presenting complaints of undifferentiated abdominal pain, post-operative imaging, or patients with complex underlying medical issues). We did not include imaging performed for the evaluation of traumatic injuries in the data analysis. We also excluded pregnant patients and patients under the age of 18 from the study.

The study group consisted of all consecutive IV-contrast only ABCT scans specifically performed to evaluate patients for acute appendicitis, diverticulitis, SBO, or free air (February 2009 through May 2009). We used historical controls from a period pre-dating the implementation of the new IV-contrast only CT protocol (April 2008 through September 2008). Only patients whose indications for CT were similar to the study patients (acute appendicitis, diverticulitis, SBO, or free air) were chosen for historical controls.

We identified cases using the hospital's electronic data storehouse, which records the date, patient visit number, ordering physician, ordering department, radiology study code, the order indication, and the radiology read turnaround time (TAT) for all imaging requests in the hospital. We downloaded all data into an Excel 2008 spreadsheet, version 12.2.3 (Microsoft, Redmond, CA).

Chart review was performed by an emergency medicine resident (ZF) and a trained medical student (MR) using a standardized abstraction form with standard definitions for all variables. Both were familiar with the electronic medical system, and abstractors were trained beforehand in data abstraction methods and data interpretation. The principal investigator provided regular feedback to the data abstractors regarding any errors or discrepancies in data collection. The abstractors were aware of the general aims of the study (the evaluation of pre- and post-CT protocol changes) but were not aware of the specific hypotheses to be evaluated in the study. One data abstractor performed review on all of the charts from the period prior to implementation of the protocol, while the other performed data review on all the charts from the period after the protocol implementation. Quality assurance review of the data was performed on 10% of the charts by the principal investigator (CH), with a kappa score of 0.976.

We abstracted ED length of stay (LOS) from ED charts and defined LOS as the interval between the time the patient was placed in an ED room until the time the patient was physically discharged from the ED (to home, to the operating room, to an inpatient unit, or to the ED observation unit [EDOBS]). These times were abstracted from the ED nursing flow sheet, which specifically details both of these times. The indication for exam and patient disposition (home, operating room, EDOBS, or admission) was abstracted from the ED physician electronic medical record (EMR). We identified radiology-read TAT as the interval between the time from completion of imaging to the time a preliminary read was electronically available. Radiological interpretation was abstracted from the hospital's EMR as were surgical pathology results, when available.

Table 1. Study group chracteristics.

	ABCT with IV/ PO contrast	ABCT w/ IV contrast	p-value
Total Exams	211	184	
Gender	**N (%)**	**N (%)**	0.48
Male	88 (41.7%)	84 (45.7%)	
Female	123 (58.3%)	100 (54.3%)	
	[Median (IQR)]	**[Median (IQR)]**	
Age (years)	[39 (28-56.5)]	[35 (25-49)]	0.005
Average ED visits/day	104.5 (pts/day)	107 (pts/day)	
Study Indications	**N (%)**	**N (%)**	
Appendicitis	125 (59.2%)	121 (65.8%)	0.21
Small Bowel Obstruction	44 (20.9%)	35 (19%)	0.71
Diverticulitis	35 (16.6%)	20 (10.9%)	0.11
Perforation	7 (3.3%)	8 (4.3%)	0.61
Rescans within 2 weeks	19 (9%)	16 (8.7%)	0.99

ABCT, abdominal/pelvic computed tomography; *IQR,* interquartile range

We analyzed the data using chi-square and Mann-Whitney U test (SPSS v. 15.0, SPSS Inc., Chicago, IL) to compare ED LOS, time from completion of imaging to time radiology report available to the provider, and baseline patient characteristics between the two patient groups.

RESULTS

Of the 590 ABCT exams performed during the four-month (February 2009 through May 2009) post protocol study period for the evaluation of non-traumatic abdominal pain, 348 were performed with IV and PO contrast, and 242 were performed with IV-contrast only. One hundred and eighty-four of the IV-contrast only exams were specifically performed to evaluate for acute appendicitis, diverticulitis, SBO, or free air.

A total of 467 ABCT exams were performed for non-traumatic abdominal pain during the 6 month historical control period (April 2008 to September 2008). Of these, 211 ABCTs were performed to specifically evaluate for acute appendicitis, diverticulitis, SBO, or free air.

Baseline characteristics for both groups are shown in Table 1. The patients in the IV-contrast only group were a median of 4 years younger when compared to the historical control group. Gender distribution was similar between the groups. During the study period, the average number of ED patient visits per day was, on average, 2 patients per day more for the IV-contrast only group (105 pts/day vs. 107 pts/day). Both groups had a similar distribution for the four main study indications. The rescan rate between the two groups was also similar. Prior to the implementation of the new protocol, the ABCT rate was 5.8 ABCT/100 patients. The rate post protocol implementation was 6.7 ABCT/100 patients.

The total ED LOS was significantly shorter for patients in the IV-contrast only group. The median ED LOS for those in the IV-contrast only group was 4:35 hours, while average ED LOS for the IV/PO group was 6:39 hours, ($p<0.0001$). We observed the shorter LOS in patients discharged to home, as well as in patients taken directly to the OR, or admitted to the hospital (Table 2). The radiology-read TAT was not significantly different between the two groups (Table 2). The median time from test scheduled to time the test was completed was 126 minutes for studies with PO/IV contrast and 52 minutes for studies with IV-contrast only (a difference of 74 minutes).

In the IV-contrast only group, 100 of the 184 patients (54.3%) scanned had a new abnormality by CT. Forty-three (23.4%) patients had an exam that revealed an alternative diagnosis other than the clinical indication recorded for the

Table 2. Emergency department length of stay (LOS) time measurements.

	ABCT with IV/PO contrast Median (IQR) n=211	**ABCT w/ IV contrast Median (IQR) n=184**	**95% CI of difference**	**p-value**
Total ED LOS	6:39 (5:18-8:05)	4:35 (3:29-5:53)	1:38-2:08	<0.0001
Time to admission	7:41 (6:17-9:06)	5:10 (4:15-6:43)	1:30-3:26	<0.0001
Time to OR	5:40 (4:28-6:50)	4:05 (2:53-5:17)	0:28-2:15	<0.0001
Time to discharge home	6:09 (4:55-7:42)	4:28 (3:15-5:32)	1:04-2:23	<0.0001
Radiology read time	0:30 (0:18-0:49)	0:29 (0:20-0:44)	-2.23-8.23	0.46

ABCT, abdominal/pelvic computed tomography; *IQR,* interquartile range; OR, operating room

exam, and 82 (44.6%) had exams that were normal or showed no new changes. Of the remaining patients, one had a missed appendicitis (diagnosed 2 days later), and one was diagnosed with chronic appendicitis by CT (observed in the hospital, then sent home).

In the control group (IV/PO contrast), 141 (66.8%) patients had a new abnormality by CT. Fifty-seven (27%) had an exam that revealed an alternative diagnosis other than the clinical indication recorded for the exam, and 70 patients (33.2%) had studies that were normal or showed no new changes. Three patients diagnosed with acute appendicitis by CT were observed and discharged home by surgery without going to the operating room (OR); a fourth patient with appendicitis by CT was taken to the OR and had no appendicitis by pathology.

Rescan Rate

Rescan rates were comparable between the IV-contrast only and the IV/PO groups. In the IV-contrast only group, 16 (8.7%) patients were rescanned within two weeks of their original CT imaging. Of these patients, 12 were rescanned during their inpatient hospitalization. Eight of the admitted patients had either post-operative exams (5 patients), or a follow-up inpatient exam (3 patients). One patient had repeat imaging with oral contrast the same day as their initial evaluation, which did not change the original CT finding (early appendicitis). Three patients were discharged from an inpatient hospitalization, and then re-presented to the ED and had another CT performed (none had a change in the initial diagnosis).

Four patients were discharged home from the ED and were rescanned within two weeks of discharge. Three of the 4 had no change in the original diagnosis. The last patient had an initial CT read as normal (appendix was not visualized) and had a repeat scan (with oral contrast) 2 days later that showed an acute appendicitis.

Nineteen (9.0%) patients in the control group were rescanned within two weeks of their original scan. Of these, 16 were rescanned during their inpatient hospitalization (10 patients had post-operative exams and 6 patients had follow-up inpatient exams). Three patients were discharged home from the ED and then re-scanned within two weeks of discharge. There was no change in the original diagnosis on the second scan for any of the patients.

DISCUSSION

The use of IV-contrast only for the evaluation of patients presenting to the ED with abdominal pain has been shown to have a high sensitivity and specificity for the diagnosis of common causes of acute abdominal pain, such as acute appendicitis, diverticulitis, and SBO.[7,10] One previous study showed a decreased ED LOS for those patients undergoing ABCT with IV-contrast only for undifferentiated abdominal pain, with a median ED LOS decrease of 30 minutes.[17]

In our series, the use of an IV-contrast only protocol for patients with a high clinical suspicion of appendicitis, diverticulitis, SBO or free air significantly decreased ED LOS. This held true not only for patients discharged home from the ED, but also for those requiring surgery or admission. The impact of limiting PO contrast in such patients not only decreased ED LOS, but also allowed for earlier consultation and definitive treatment for patients with identified pathology, with over 2 hours in time saved for patients requiring operative interventions. In addition, the re-scan rate for patients undergoing the IV-contrast only protocol did not change significantly when compared to historical controls.

In our study, the time test ordered to time test completed was a median of 72 minutes shorter for patients undergoing the IV-contrast only protocol. It would be expected that the decrease in ED LOS would approximate the time saved by not using oral contrast. The additional time saved may have been due to the fact that the patients selected to undergo the IV-contrast only imaging presented with a more straightforward clinical picture, and/or were younger with less complicating medical factors. It is also possible that the addition of a faster CT protocol may have reduced the threshold to order such testing, which may result in testing patients with a lower pre-test probability of disease.

LIMITATIONS

This study had several limitations. Retrospective data abstraction is limited to that which is recorded in the medical record and is subject to additional limitations due to the process of chart abstraction and data interpretation. However, an independent evaluation of 10% of the study patients revealed excellent agreement in abstracted study data (kappa = 0.97).

The patients in the IV-contrast group were, on average, five years younger than the historical control group and had less pathology detected on imaging overall. It is possible that the decreased ED LOS was not only influenced by the decreased prep time for oral contrast; additionally, this imaging may have been preferentially used in patients with straightforward clinical presentations and/or less underlying clinical pathology.

The study institution did see an increase in total ABCT ordered (approximately 1 additional scan/100 patients) post implementation of the new protocol. It is unlikely that this increased volume impacted the total ED LOS for all ED patients; however; we did not specifically measure this in the study. The addition of a faster ABCT protocol may have also lowered the threshold to image patients with a lower pre-test probability of disease.

In our study, the decision of what type of imaging to order was left to the discretion of the treating physician in the ED. Due to the retrospective nature of this study it was difficult to determine which patients may not have met the indications of the IV-contrast only protocol (protocol violations). It is possible that some of the patients who received the IV-contrast

only ABCT protocol did not receive oral contrast due to patient inability to tolerate oral contrast, time constraints, or unfamiliarity with the protocol indications.

This study was performed at a single center. Some of the patients initially evaluated and imaged at our institution could have been re-evaluated or re-imaged at another facility, thus affecting the reported re-scan rate noted in our study. No attempt was made to determine if patients went to another facility for follow-up. This limits the quality of the re-scan rates reported in this study.

CONCLUSION

Initiation of an IV-contrast only protocol for select ED patients decreased the patients overall ED LOS by approximately 2 hours.

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Value of Mandatory Screening Studies in Emergency Department Patients Cleared for Psychiatric Admission

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Introduction: Laboratory and radiographic studies are often required by psychiatric services prior to admitting emergency patients who are otherwise deemed medically stable. Such testing may represent an unnecessary expense that prolongs emergency department stays without significantly improving care. This study determines the prevalence of such testing and how often it leads to changes in care.

Methods: We prospectively tracked laboratory testing among psychiatric patients presenting to the emergency departments of two academic tertiary care facilities. For each visit we determined whether laboratory or radiographic studies were ordered, and whether the examination was conducted at the request of the emergency physician as part of a medical screening examination or requested by the psychiatry service. We then determined if this testing changed patient disposition.

Results: Our study enrolled 598 patients. Of these, emergency physicians ordered testing as a part of medical screening on 155 patients (25.9%). We found the psychiatry service ordered laboratory or radiographic studies for 191 of 434 patients (44.0%) who emergency physicians determined did not require ancillary testing for medical clearance. Of these 191 patients, only one (0.5%; 95% Confidence Interval: 0.01% - 2.9%) had an abnormal result that led to a change in disposition. Total Medicare reimbursement rates for the additional ancillary testing in this study was $37,682.

Conclusion: Ancillary testing beyond what is required for medical clearance of psychiatric emergency patients rarely alters care. Policies that require panels of testing prior to psychiatric admission are costly and appear to be unnecessary. [West J Emerg Med 2012;13(5):388-393.]

INTRODUCTION

Patients with psychiatric complaints comprised 5.4% of all visits to U.S. emergency departments (ED) in the year 2000. Emergency psychiatric visits appear to be increasing over time, and patients with psychiatric complaints are more likely to require hospitalization than non-psychiatric patients.[1]

Many of these patients undergo laboratory and radiologic testing as part of their medical screening prior to psychiatric

evaluation. Most recommendations for routine screening stem from expert opinion and case series and are often based on medical screening performed by psychiatrists, not emergency physicians (EP).[2-8] EPs are uniquely trained to evaluate a variety of patients and rapidly determine the presence of serious medical illness, even among those with limited ability to effectively communicate. In daily practice, EPs often complete their evaluations and determine patient dispositions without using laboratory or radiologic testing.

In modern practice environments, resource optimization, patient safety and throughput are increasingly important. Streamlined patient testing could improve patient care and potentially decompress overcrowded EDs. Critics of mandatory testing cite wasted money, time and the potential patient harm from false test results, while proponents think psychiatric patients represent a vulnerable population that is impossible to evaluate on the basis of history and physical examination alone.

From this perspective it is unclear whether mandatory ancillary testing of psychiatric patients is useful or beneficial. Several retrospective studies suggest that screening labs are unlikely to reveal significant medical problems once a physician has determined, based on history and physical exam, that a psychiatric patient is medically stable for admission to a psychiatric facility.[9-16] A study by Korn et al concluded that patients with a psychiatric chief complaint, normal physical exam and documented psychiatric history may be safely referred to psychiatric services without the use of ancillary ED testing.[16]

Previous work in this area has been limited to case series and retrospective analyses.[2,4,8,10,11,16] In this study, we sought to prospectively determine the effect that mandatory ancillary testing has on the disposition of psychiatric patients. We hypothesized that ancillary testing does not alter the disposition of patients with psychiatric disease who have been deemed medically stable for admission to a psychiatric facility by an EP. We hypothesized that a careful history and physical examination by an EP can determine which patients require studies *prior* to medical clearance, and which patients can be safely admitted without further testing. Our primary outcome measure was the proportion of dispositions among psychiatric patients that changed from psychiatric ward to admission elsewhere in the hospital based on screening studies.

As secondary outcomes, we collected data on the types and numbers of laboratory and radiographic studies performed. We also looked at how frequently tests were performed and the costs for these screening tests.

METHODS

Study Design

This was a multi-center, prospective observational study.

Setting

We conducted our study in the EDs of two academic tertiary centers: Ronald Reagan-University of California, Los Angeles Medical Center (UCLA) in Los Angeles, California, and Wilford Hall Medical Center (WHMC) at Lackland Air Force Base in San Antonio, Texas. Both hospitals have inpatient psychiatric wards and ED consultation by psychiatry residents available 24 hours/day. Ronald Regan-UCLA serves a diverse, urban patient population located in west Los Angeles with an annual volume of about 40,000 patients. WHMC has an annual volume of about 50,000 patients and serves a military population, which includes active duty troops from all services, activated reservists and National Guard troops, a large retiree population, family members of all ages, and civilians who either have base access or arrive via ambulance for medical or traumatic emergencies.

Selection of Participants

We conducted the study from June 15, 2008 to July 15, 2009 at UCLA and from December 17, 2008 to July 5, 2009 at WHMC. To ensure that our study achieved a power of 98%, we continuously enrolled patients until we had obtained data on 183 cases. Patients with a psychiatric chief complaint, as determined by the examining EP, were eligible for enrollment. The physician was not limited to a specific complaint list, or specific diagnostic codes, but rather instructed to enroll patients they thought had a primary psychiatric complaint as the reason for their presentation. We conducted the study using convenience sampling where all EPs (both residents and attendings) participated in data collection and enrollment at the WHMC ED, while 12 residents (under direct attending supervision) and one attending EP collected data in the UCLA ED during the course of their normal shifts.

Outcome Measures

Our primary outcome measure was the proportion of dispositions that changed as a consequence of ancillary testing in patients who had received medical clearance. We therefore tabulated the number of patients with primary psychiatric complaints who were deemed medically clear for psychiatric admission (our denominator), as well as the subset of these patients who underwent further laboratory or radiographic testing. From among patients who received further testing, we recorded the number who had their disposition changed from psychiatric service to admission under another hospital service (our numerator).

We also tabulated the types and numbers of laboratory and radiographic tests ordered on enrollees, as well as Medicare reimbursement charges for these tests (Table 1).

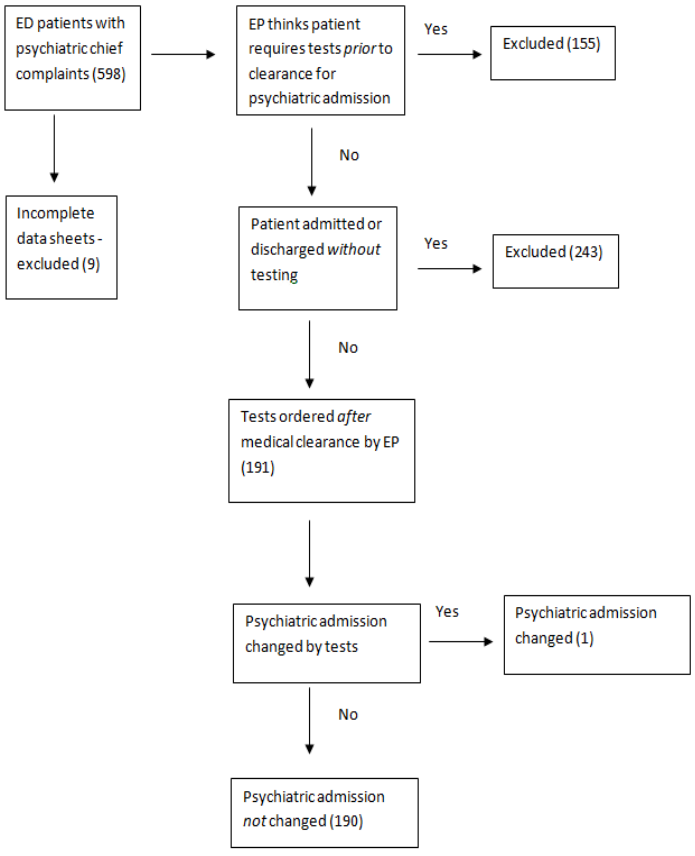
Method of Measurement and Data Collection

Physicians completed an initial history and physical examination on each patient, and based on this assessment determined whether or not laboratory or radiographic testing

Table 1. Medicare emergency reimbursement rates.

	Medicare
Complete blood count	$11.35
Basic metabolic panel	$12.68
Urine drug screening	$180
Urinalysis	$4.63
Thyroid stimulating hormone	$24.53
Chest radiograph	$29.20
Computed tomography head non-contrast	$382.53
Electrocardiogram	$29.55
Liver function test	$11.93
Lipase	$10.06
Coagulation study	$14.50
Salicylate level	$10.36
Acetaminophen level	$29.55
Ethanol level	$15.78

Figure. Selection of participants.



ED, emergency department; *EP*, emergency physician

Table 2. Numbers of laboratory/imaging test ordered on emergency department psychiatric patients.

Name of Study	Number
Complete blood count	146
Basic metabolic panel	151
Urine drug screening	141
Urinalysis	97
Thyroid stimulating hormone	85
Chest radiograph	1
Computed tomography head non-contrast	2
Electrocardiogram	48
Liver function test	52
Lipase	8
Coagulation study	6
Acetylsalicylic level	48
Acetaminophen level	52
Ethanol	53
Urine dipstick	2
Lithium level	3
Rapid plasma reagin test	13
Troponin	1
Valproic acid level	3
Erythrocyte sedimentation rate	1
Phenytoin level	2
U-Human chorionic gonadotropin	5

was indicated should the patient require inpatient psychiatric admission. We excluded all patients that the EPs thought required testing *prior* to psychiatric admission.

For patients whom the EP felt could be safely admitted without testing, the physician recorded whether or not tests were ordered, and, if so, which ones. Physicians also recorded whether the patient was admitted to a service other than psychiatry, and if so, whether laboratory or radiology studies led to this change in disposition. We excluded any incomplete data sheets from the study (Figure).

We did not collect any identifying information on enrolled patients or enrolling physicians, and our study did not require a change in usual care of any enrolled patients. Our study was reviewed and approved by the UCLA and WHMC Institutional Research Boards.

RESULTS

We collected 598 data sheets during the study (504 UCLA, 94 WHMC (Table 1). Nine patients (1.5% of the total; 6 UCLA, 3 WHMC) had incomplete forms and were excluded. EPs determined that 155 patients (134 UCLA, 21 WHMC) required laboratory or radiographic testing *prior* to admission and could not be medically cleared based on history

Table 3. Cumulative Medicare charges per test performed on emergency department psychciatric patients.

Name of Study	Medicare Charges
Complete blood count	$1657.10
Basic metabolic panel	$1914.68
Urine drug screening	$25380.00
Urinalysis	$449.11
Thyroid stimulating hormone	$2085.05
Chest radiograph	$29.20
Computed tomography head non-contrast	$765.06
Electrocardiogram	$1418.40
Liver function test	$620.36
Lipase	$80.48
Coagulation study	$87.00
Acetylsalicylic level	$497.28
Acetaminophen level	$1542.32
Ethanol	$836.34
Urine dipstick	$7.48
Lithium level	$28.95
Rapid plasma reagin test	$80.99
Troponin	$14.37
Valproic acid level	$59.34
Erythrocyte sedimentation rate	$5.00
Phenytoin level	$38.72
U-Human chorionic gonadotropin	$40.25

and physical examination alone. Laboratory or radiographic testing was obtained on 191 of the remaining 434 patients deemed medically stable for psychiatric admission (44.0%; 95% Confidence Interval (CI): 39.3% - 48.8%). Only one of these 191 patients (0.5%; 95% CI: 0.01 – 2.9%) was found to have an abnormal study that led to a change in disposition. The sole screening study that resulted in a change in admission was an abnormal acetaminophen level that prompted admission to a medical ward for N-acetylcysteine treatment.

Table 2 presents the number of laboratory and imaging studies performed on patients deemed medically clear. The most frequently ordered studies were complete blood count, blood chemistries and urine drug screens. Other frequently ordered tests included measuring specific levels for alcohol, acetaminophen, aspirin, and thyroid-stimulating hormone. Tests that were infrequently ordered included chest radiographs, computed tomography (CT) of the head, lipase, and coagulation studies. The total monetary impact of all labs, based on Medicare reimbursement rates, was $37,682. The average charge per patient for these studies was $197.29.

DISCUSSION

Psychiatric patients present unique challenges for emergency care, with one of the foremost problems involving the optimal way to assess whether these patients are suitable for admission to psychiatric facilities. Prior literature regarding this clearance process consists largely of expert opinion and retrospective analysis. Our study advances understanding in this area by providing prospective data to this body of literature, and specifically focuses on whether mandatory test panels change disposition after EPs have cleared a psychiatric patient for admission by history and physical exam.

This multi-center study overwhelmingly demonstrates that routine or mandatory studies do *not* change the disposition of psychiatric patients after EPs have cleared them for admission. Of the 191 patients evaluated in this study, only *one* (0.52%) patient's disposition was changed by additional tests.

With only 1 exception, none of the studies performed on medically cleared patients, including complete blood count and blood chemistries, alcohol levels, urine drug screens, aspirin levels, thyroid-stimulating hormone levels, electrocardiograms, urinalysis, chest radiographs, CT scans of the head, liver function tests, lipase, or coagulation studies, altered a patient's disposition. The one test that did change a disposition, a positive acetaminophen level that led to medical admission for N-acetylcysteine treatment, was a focused evaluation that addressed a specific medical question that can be difficult to assess by history or physical examination in some patients. Unlike most pathologies affecting psychiatric patients, such as salicylate toxicity, infection, or trauma, early acetaminophen overdose may present with no toxidrome—normal vitals and physical exam—and few historical clues. If the patient lies about the ingestion, acetaminophen overdose could go clinically undetected even with a diligent EP's history and physical exam. Missing an acetaminophen overdose could lead to a poor patient outcome. This suggests that one means of optimizing screening tests for psychiatric patients, and a possible future strategy, would be to mandate acetaminophen levels on suicidal patients, while eliminating other testing that is unlikely to impact disposition or management.

Our study suggests extensive routine screening studies for all psychiatric patients are likely unnecessary, and that EPs are very unlikely to change a psychiatric patient's disposition after clearing them with a history and physical examination. Future studies examining other populations could help validate this conclusion for a wider spectrum of ED environments.

Our study also reveals that mandatory testing leads to significant expense. The relatively small group of patients evaluated at two centers accounted for $37,682 in tests. The charges would be significantly larger for patients with private insurance, or patients receiving a direct bill from a hospital. Remarkably, more than $25,000 was spent on urine drug

screens (Table 3). The combination of how commonly this test was ordered and its high cost ($180) made it responsible for the highest percentage of costs attributed to one test. Furthermore, these drug screens never led to a change in patient disposition. While these tests may be useful in the overall management of specific patients, there is no reason they need to be performed in the ED.[14] It therefore appears reasonable to curtail the mandatory use of urine drug screens when evaluating ways to optimize patient testing prior to psychiatric admission.

A key assumption is that the EP conducts a thorough history and physical. If the EP feels a thorough assessment cannot be conducted, or there are high-risk features for organic illness, testing may prove useful.[4,17] Indeed, EPs thought 155 of the original 598 patients in the study required testing *prior* to medical clearance. The clinical judgment of the treating physician, rather than panels of routine tests, may more efficiently and appropriately guide this work-up.[4] Further studies could analyze the cost effectiveness and patient safety outcomes of this notion.

In summary, routine testing of patients medically cleared for psychiatric admission by an EP's history and physical rarely changes disposition. EPs and psychiatrists should work together to develop appropriate, cost-effective, testing strategies for admitting emergency psychiatric patients.

LIMITATIONS

We conducted this study at two tertiary care academic hospitals with residency programs. Consequently, our findings will be most relevant to similar institutions and may not translate directly to smaller or community EDs. Additionally, one of our sites is an Air Force hospital that treats patients of all ages, with all medical problems and levels of acuity (including Level 1 traumas), but the active duty population tends to be relatively young and healthy, which may not mirror other ED populations. These factors likely skew our results to the populations seen in these institutions, but probably have little effect on the ability of ED physicians to accurately screen psychiatric patients for underlying acute medical problems. Thus, while our population may not be representative of all institutions, we believe that our observations regarding testing on medically cleared patients are likely to be applicable to a wide variety of settings.

We used non-randomized convenience sampling to assemble our cohort. We instructed physicians to gather data on all patients meeting enrollment criteria, but we did not track compliance. It is therefore possible that some eligible patients were not enrolled in the study. It is likely that missed enrollment occurred during times when the EDs were busy and clinical demands made it difficult for physicians to complete data collection in a timely fashion. While it is possible that this limitation could result in biased selection of patients, or altered the medical assessments of psychiatric patients, there is little reason to believe this actually occurred. There is also little reason to suspect that patients who were medically cleared without laboratory testing, but not included in the study, would be more likely than enrolled patients to have abnormal results that would require changes in admission.

Our calculated financial impacts included only Medicare reimbursements. The more elusive, and likely higher, costs of time spent in the ED, and additional nursing and physician care have not been included. Additionally, these financial impacts do not reflect the charges that patients may receive from a particular hospital, which could be much higher, nor do they reflect the actual costs of the tests themselves, which could be lower.

Finally, because we conducted an observational study, we did not blind ED physicians to diagnostic test ordering or patient outcomes. This lack of blinding is unlikely to be a source of bias because the physicians who made decisions regarding testing and admission, the evaluating psychiatrists, were unaware of the study.

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Quantitative Brain Electrical Activity in the Initial Screening of Mild Traumatic Brain Injuries

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Introduction: The incidence of emergency department (ED) visits for Traumatic Brain Injury (TBI) in the United States exceeds 1,000,000 cases/year with the vast majority classified as mild (mTBI). Using existing computed tomography (CT) decision rules for selecting patients to be referred for CT, such as the New Orleans Criteria (NOC), approximately 70% of those scanned are found to have a negative CT. This study investigates the use of quantified brain electrical activity to assess its possible role in the initial screening of ED mTBI patients as compared to NOC.

Methods: We studied 119 patients who reported to the ED with mTBI and received a CT. Using a hand-held electroencephalogram (EEG) acquisition device, we collected data from frontal leads to determine the likelihood of a positive CT. The brain electrical activity was processed off-line to generate an index (TBI-Index, biomarker). This index was previously derived using an independent population, and the value found to be sensitive for significant brain dysfunction in TBI patients. We compared this performance of the TBI-Index to the NOC for accuracy in prediction of positive CT findings.

Results: Both the brain electrical activity TBI-Index and the NOC had sensitivities, at 94.7% and 92.1% respectively. The specificity of the TBI-Index was more than twice that of NOC, 49.4% and 23.5% respectively. The positive predictive value, negative predictive value and the positive likelihood ratio were better with the TBI-Index. When either the TBI-Index or the NOC are positive (combining both indices) the sensitivity to detect a positive CT increases to 97%**.**

Conclusion: The hand-held EEG device with a limited frontal montage is applicable to the ED environment and its performance was superior to that obtained using the New Orleans criteria. This study suggests a possible role for an index of brain function based on EEG to aid in the acute assessment of mTBI patients. [West J Emerg Med. 2012;13(5):394-400.]

INTRODUCTION

Traumatic brain injury accounts for over 1 million emergency department (ED) visits annually within the United States with the majority of these visits for mild injury.[1,2] This incidence is increasing at an alarming rate, rising 21% from 2002 to 2006, quadrupling the rate of population growth. This increasing rate will further tax ED resources.

The American College of Emergency Physicians' 2008 panel on mild traumatic brain injury (mTBI) raised several important issues, among them which patients with acute mTBI should have a non-contrast computed tomography (CT) in the ED. This question is particularly relevant given concerns over the increased use of CT and the long-term complications of radiation. The estimated increased cancer risk from a CT has been estimated to be 1 patient in 1000-2000.[3] In EDs the overwhelming majority of patients presenting with mTBI routinely undergo a CT. This occurs primarily because of the zero tolerance for missed intracranial lesions and because

current decision rules for the use of CT in TBI have high sensitivity at the expense of poor specificity (that is, low false negative rate and a high false positive rate).[4-6]

Quantitative electroencephalography (QEEG) has been shown to be a sensitive indicator of the presence of brain injury after mild head injury.[7] QEEG can be used to distinguish normal controls from patients with mild head injury (mTBI),[8,9] and patients with mild head injury from those with severe head injury.[10] QEEG features appear to be sensitive for post-concussion syndrome and can predict recovery of function at one-year post injury [11-13] and discriminant functions using derived features of brain electrical activity were demonstrated to be sensitive indicators of brain dysfunction after mild head injury due to blast concussion.[14] Using such methods, classification of athletes with residual brain injury subsequent to concussion was also reported.[15,] Current evidence suggests that electrophysiological abnormalities reflecting functional changes in the brain may emerge earlier than structural changes and may better detect mTBI than conventional neuroimaging techniques.[16]

Recent advances, including limited lead EEGs, improved automatic artifact detection, quantitative EEG analysis and the application of pattern recognition algorithms, have led to studies demonstrating the feasibility of using these technologies in the ED setting.[17] Further, recent publications in sports concussion using this approach have reported that an index derived from quantitative brain electrical activity (TBI Index) reflected significant persistence of brain dysfunction beyond the point of clinical recovery.[18,19]

The present study was designed to investigate whether the TBI-Index can play a role in the initial screening of mTBI patients presenting to the ED. More specifically, can it be shown to be useful in predicting which patients should be sent for further brain imaging studies such as CT for the determination of the presence of structural brain damage or which patients might be discharged without further testing? These results will be compared to those obtained using the New Orleans Criteria (NOC). To this end we used a hand-held device to collect EEG data in the ED environment. We processed this data off-line to obtain a single brain electrical activity measure (biomarker) in this independent population, using the index derived previously (unpublished data, see *EEG Data Analysis* below) in a separate mTBI ED population (n=282) and shown to be sensitive (>90%) for prediction of positive CT.

METHODS

Subjects

The study population consisted of a convenience sample of 119 ED patients who presented with acute head injury and received a CT. Patients were enrolled in the ED at 1 of the 8 study sites (the majority from Washington University, Barnes Hospital, Bellevue Hospital Center and Royal Oaks Medical Center), following a closed head injury (85% within 24 hours of injury) and meeting the inclusion/exclusion criteria described below. All sites received approval from their respective Human Research Committees. Written informed consent was obtained prior to testing of all subjects. For the purpose of this study, CTs were read as positive if they had lesions potentially due to trauma, including cerebral or cerebellar contusion, subarachnoid hemorrhage, parenchymal bleeds, petechial hemorrhages, subdural and epidural hematomas. We defined mTBI using the American Congress of Rehabilitation criteria, which requires that at least 1 of the following conditions be met: any period of loss of consciousness < 30 minutes; Glasgow Coma Scale (GCS) score of 13-15; any loss of memory for the event immediately before or after the injury, with post traumatic amnesia less than 24 hours; or any alteration in mental state at the time of the event, (dazed, disoriented or confused).

Inclusion/Exclusion Criteria

Eligible for study were patients over 18 years of age who presented to the ED after a closed head injury, met the above mTBI definition and had a CT ordered as part of their evaluation. Patient enrollment occurred during all periods when the research assistants were available; patients were not selected by referral from treating physicians. We excluded patients if clinical conditions would not allow placement of the electrodes or if they were unable (e.g., obtunded due to intoxication) or unwilling to provide informed consent. In addition, we excluded patients with chronic psychiatric disorder, chronic drug or alcohol abuse, or chronic seizure history. We also excluded developmentally delayed patients, or those who were taking central nervous system active medication that the investigator believed would interfere with the EEG testing. Finally, if the head injury was believed to be a result of a seizure, the patient was not a candidate for this study.

Design and Procedures

Evaluations were made in the ED by ED research assistants, none of whom had formal EEG experience. The evaluations were done as early as practical without hindering patient care. The mean time from injury to evaluation in the ED was <12 hours for the vast majority (~80%) of the subjects and all were tested within 72 hours. All patients' hospital records were queried after ED or hospital discharge. At the time of EEG evaluations the research assistants were also blinded to CT outcome and NOC score.

Computed Tomography

CT interpretations from final reports issued by the neuroradiologists at each institution as the final CT result for this study. The CT readings were made blinded to all other information about the patient, other than the TBI indication for the head scan. An independent investigator blinded to EEG and all other clinical results scored the CTs of the CT positive

(CT+) group using the Marshall criteria.[20] The Marshall criteria is a method for grading the severity of CT abnormality on a 6-point scale, where "I" indicates a diffuse injury with no visible pathology and "VI" indicates a non-evacuated mass lesion (>25cc).

New Orleans Criteria (NOC)

The queries that make up the NOC scores were collected by the research assistant at the time of the EEG evaluation, for scoring off site.[4] These included: headache, vomiting, age > 60 years, drug or alcohol intoxication, persistent anterograde amnesia, visible trauma above the clavicle, or seizure.[5] If the patient had any 1 of these items the NOC was considered to be positive.

EEG Acquisition

Patients underwent 10 minutes of eyes closed resting EEG recording. The EEG data were collected using self-adhesive electrodes from frontal electrode sites of the International 10/20 system, which included FP1, FP2, AFz, F7, and F8, referenced to linked ears.(Figure) All electrode impedances were below 10 kΩ. Amplifiers had a band pass filter from 0.5 to 70 Hz (3 dB points). Set-up was accomplished in all cases in less than 5 minutes.

EEG Data Analysis

The device used in this study can compute the TBI-Index in approximately "real-time;" however, to maintain the blinding and perform quality assurance, the TBI-Index was calculated off site. EEG data was subjected to automatic artifact rejection to remove any biologic and non-biologic contamination, such as that from eye movement or muscle movement. An experienced EEG technician also reviewed the selected artifact-free EEG segments for the purpose of confirming data quality for all data analyzed in this study. Previous experience has demonstrated that sufficient artifact-free data (120 seconds) can be obtained from this 10-minute recording.

The artifact-free EEG data from both the algorithm development and test groups to Fast Fourier Transform to extract QEEG features of absolute and relative (%) power, mean frequency, inter- and intra-hemispheric coherence and symmetry computed for the delta (1.5 - 3.5 Hz), theta (3.5 -7.5 Hz), alpha (7.5 to 12.5 Hz), beta (12.5 - 25 Hz) and gamma (30-45 Hz) frequency bands. These measures are described in detail elsewhere.[21] All quantitative features to obtain a Gaussian distribution and Z-transformed relative to age-expected normal values. The importance of each of these steps in enhancing the sensitivity and specificity of brain electrical activity has been described in detail elsewhere, as are the robust test-retest reliability and independent replications of the neurometric normative data of brain electrical activity.[22,23] Non-linear features of complexity of the electrical signal were also extracted and transformed in the same way.[24]

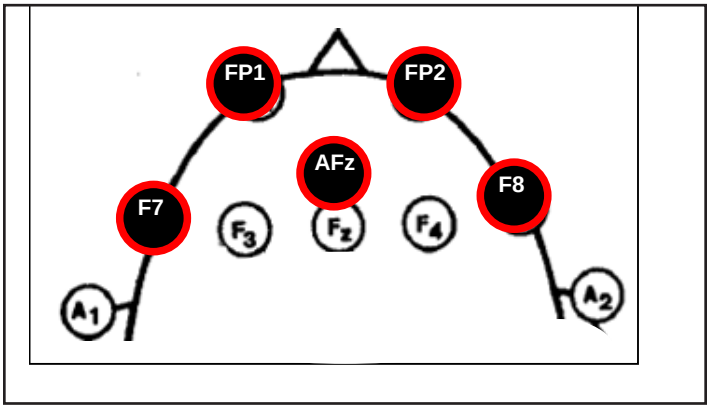

Figure. Schematic showing the location of the five frontal electrode sites of the International 10/20 system.

Classifier Function

We used the extracted EEG measures described above to develop a discriminat classifier function (biomarker) that maximally separated closed head-injured patients with GSC >8 who were CT+ from those who were CT- patients and controls. We constructed this binary discriminant classification algorithm using iterative methods and cross-validation based on features extracted from all patients in the algorithm development group (n=282).[25] Inclusion/exclusion criteria for this population was the same as for the current study as described above and patients were tested in the acute phase (within 24 hours) following injury. The algorithm consists of a multivariate weighted combination of selected linear and nonlinear features of brain electrical activity that mathematically describe the profile of traumatic brain injury statistically most resembling that seen in patients who sustain a closed head injury and are found to be CT+. The result is expressed as a TBI- Index/biomarker ranging from 0-100, where 100 is the highest probability of being CT+. Features that contributed most to this discriminant included: relative power increase in slow waves in frontal regions, relative power decrease in alpha 1 and alpha 2 in frontal regions, power asymmetries in theta and total power between lateral and midline frontal regions, incoherence in slow waves between frontopolar regions and decrease in mean frequency of the total spectrum composited across frontal regions.

Statistical Analyses

The TBI-Index was calculated for the 119 patients in the current study and were not used in the derivation of the index and therefore represents an independent replication/validation of the algorithm. We submitted the brain electrical activity data from all patients in the study to discriminant analysis and obtained a discriminant score. Patients were considered to be positive if the score obtained was greater than or equivalent to a cut-off point derived from the Receiver Operating Curve (sensitivity as a function of specificity) from the original

Table. Performance statistics for the New Orleans Criteria and the BrainScope Index.

	Sensitivity (% CI)	Specificity (% CI)	PPV (% CI)	NPV (% CI)	LR+ (CI)	LR- (CI)	Odds Ratio
NOC	92.10 (.79-.97)	23.50 (.16-.34)	36.10 (.27-.46)	34.00 (.67-.95)	1.20 (1.03-1.4)	0.34 (.11-1.07)	3.6
TBI-Index	94.70 (.83-.99)	49.40 (.40-.61)	47.40 (.37-.58)	95.30 (.85-.99)	1.92 (1.57-2.42)	0.10 (.03-.41)	18.5
TBI-Index + NOC	97.00 (.86-.99)	50.60 (.40-.61)	48.05 (.37-.59)	97.62 (.88-.99)	1.97 (1.57-2.47)	0.06 (.007-.36)	36.1

PPV, positive predictive value; *NPV,* net present value; *LR,* likelihood-ratio test; *NOC,* New Orleans Criteria; *TBI,* traumatic brain injury; *CI*, confidence interval

discriminant function. We identified a score of 65 as the point at which 95% of the CT+ population was correctly identified. We calculated the NOC for the CT+ and CT- patients and considered it to be positive if there was a total score of 1 or greater. We also calculated the NOC total score supplemented by the TBI-Index. That is, if either the TBI-Index or the NOC were positive, the classification was considered to be positive. Performance metrics, including sensitivity, specificity, positive predictive value, negative predictive value, and positive and negative likelihood values associated with the independent population in the current study, were then calculated for all measures. In addition, we computed Pearson correlations to assess the relationship between NOC and TBI-Index.

RESULTS

Patient populations

One hundred and nineteen patients met inclusion criteria and were enrolled in this study. The mean age was 48.32 (range 18-92 years) and contained 38 patients (31.9%) with CT+ and 81 (68.1%) with CT-. Distribution by gender did not differ across the 2 groups, with the CT+ group containing 57.1% males and the CT- group 60.9% males. The mean age of patients in each group differed, with mean age higher in the CT+ group than those in the CT- group (CT+ = 61.0, range of 21-92 years; and CT- = 45.0, range of 18-82 years, $p < 0.001$). It is important to point out that patient age was taken into account prior to calculation of the brain state discriminant index, since all EEG features were age-regressed prior to inclusion in discriminant analyses. The total patient population was enrolled during a 36-month time window. The most common reasons for exclusion of patients for study were acute intoxication (too obtunded to participate), co-morbid diagnosis of dementia, or a non-acute or incidental CT finding (it is estimated that this represents approximately 15%).

Using the Marshall score, 32 of 38 CT+ patients received a score of 2, 1 a score of 3, 1 a score of 4 and 4 a score of 5. CT+ findings included: 60% traumatic hemorrhages (majority being subarachnoid), 29% subdural and epidural hematomas, 8% contusions, 3% other. The majority of the CT- patients received a diagnosis of concussion.

New Orleans Criteria (NOC) Classification

CT+ and CT- patients were classified using a NOC total score of greater than or equal to 1. Using this cut point 35/38 CT+ and 62/81 CT- patients received a positive classification. This resulted in sensitivity of 92.1% (95% confidence interval (CI) = 0.79 to 0.97), and a specificity of 23.5% (CI = 0.16 to 0.34), positive predictive power (PPV) = 36.1% (CI = 0.27 to 0.46), negative predictive power (NPV) = 86.4% (CI = 0.67 to 0.95), a positive likelihood ratio (LR+) = 1.2 (CI = 1.03 to 1.40), and a negative likelihood ratio (LR+) = 0.34 (CI = 0.11 to 1.07) [Table].

TBI-Index

A TBI-Index greater than or equal to the cutoff value (a score ≥65) was used to classify each of the CT+ and CT- patients. A total of 36 of 38 CT + and 40 of 81 CT- patients had TBI-Index greater than or equal to this value. Sensitivity was 94.7% (CI= 0.83 to 0.99), specificity was 50.6% (CI= 0.40 to 0.61), PPV = 47.4% (CI = 0.37 to 0.58), NPV = 95.3% (CI = 0.85 to 0.99), LR+ was 1.92 (CI = 1.57 to 2.42), and LR- was 0.10 (CI= 0.03 to 0.41) [Table 1]. There was also evidence that the TBI-Index was sensitive to the degree of injury within our sample of mTBI patients since the Pearson correlation between the NOC total score and the TBI-Index was found to be +.33, with $p < .0001$.

New Orleans Total plus TBI-Index

We also classified all patients using the TBI-Index to supplement the NOC total score. A patient was classified as "Combined+" if the NOC total score was 1 or greater or the TBI-Index was greater than or equal to the cutoff value, with a patient classified as "Combined-" if the NOC total score was zero or the TBI-Index was less than the cutoff value. Using this algorithm, 37 of 38 CT + and 41 of 81 CT- patients were correctly classified. Thus, sensitivity was 97.4% (CI= 0.86 to 0.99), specificity was

50.6% (CI = 0.40 to 0.61), PPV = 48.0% (CI = 0.37 to 0.59), NPV = 97.6% (CI = 0.88 to 0.99), LR+ was 1.97 (CI= 1.57 to 2.47), and LR- was 0.06 (95% CI=0.007 to 0.36) [Table 1].

DISCUSSION

In this study all EEG data was collected from a limited montage, with electrodes placed over frontopolar, frontal midline and dorsolateral frontal regions on the forehead. We The rationale for these electrode locations on the published reports that after minor closed head injury the frontal and frontotemporal regions are particularly susceptible/vulnerable to injury, and more likely to be affected than other cortical regions.[26-28] This increased susceptibility of the frontal regions most likely results from direct impact of this region and subsequent disruption of the extensive connections between this region and other cortical regions.[29] The ability to focus on the frontal regions enhanced the practicality of EEG set-up and use in the ED while not compromising the ability to detect brain dysfunction following closed head injury. A recently published study demonstrated the ability to use these methods in the ED setting, with set-up completed in less than 5 minutes and data acquired in less than 10 minutes.[17] As noted above, although for purposes of this study we computed results off-site, in actuality data analysis and computation of the TBI-Index can be performed in "real-time" on the device, again supporting feasibility in the ED environment.

The QEEG-derived TBI-Index appears to be a sensitive measure of brain function that may be used in conjunction with other clinical information to determine whether or not a patient presenting to the ED has a brain injury severe enough to warrant further diagnostic evaluation and treatment. It is of note that the 2 CT+ patients with an index below the cut point (<65) each had a score of 2 on the Marshall CT-scoring criteria, and were discharged from the hospital without intervention. One CT showed a small subarachnoid bleed, (SAH) in the left frontal region without any mass effect with a TBI-Index = 34, with a positive NOC; and the second, a small SAH in the left temporal/parietal region without mass effect and a TBI-Index = 56, with a negative NOC.

The finding that the TBI-Index was greater than the cut point for 49.4% of the CT- patients may indicate that a subset of the CT- patients showed signs of disturbed brain function in the presence of normal brain structure, possibly representing the effects of concussion. Evidence for this hypothesis can be found in a recent publication that used an EEG-based index to document the presence of concussion in college and high school athletes.[18,19] These studies noted that the index remained abnormal well past the period when clinical recovery was reported. Also of importance is the finding that 50.6% of the CT- population obtained scores below the cut point, suggesting the lack of structural brain damage in this group, potentially aiding in their screening for CT. Bazarian et al.[30] reported that after concussion the presence of a normal CT does not rule out the presence of a functional brain injury due to axonal damage. Such concern extends to possible "second impact syndrome," in cases where the individual may be at risk when returned to play prematurely.[31] Derived QEEG indices may reveal signs of brain injury in concussed individuals that are missed by other less objective assessment tools and may play a role in assessing and monitoring residual brain dysfunction in mTBI patients.[32] This subset of CT- patients will more than likely warrant rapid referral for treatment and counseling as they may represent the population at risk for Post-Concussion Syndrome.

In our sample the CT+ patients were older than those in the CT- group. This almost certainly reflects the inherent increased risk of serious injuries from head trauma in this age group and emphasizes the importance placed on age in determining the severity of mTBI by the Canadian and NOC and the clinical policy statements issued by the CDC.[33] The resilience of the QEEG method described above to age effects, due to age regression (comparing the patient to age-expected normal values) further emphasizes the clinical use of the method.

In the present population the NOC score for head injury was not as useful for distinguishing the CT + from the CT- patients since specificity was only 23.5%. While 35/38 CT+ patients were identified, 62/81 CT- patients also met criteria. Similar findings to those reported here for the NOC were reported in 2 studies that compared the NOC with the Canadian CT Head Rule using very large populations of mTBI patients.[34,35] While these studies reported sensitivity for the NOC identification of a neurosurgical lesion or an intracranial injury to be high, they also reported very low specificity values for the NOC (3.0%-12.7%). Since the majority of patients in our sample had mild traumatic brain injury, as verified by subsequent scoring of their CT+ using the Marshall criteria (84.2% had a score of 2), it would appear that the TBI-Index is a more clinically useful index than the NOC within this population since sensitivity was slightly greater and specificity more than doubled. It was noted that 22 patients classified as "high risk" on the NOC were not considered so on the TBI-Index, suggesting that these patients might have been spared CT examinations. Further, it was found that adding the TBI-Index to the NOC total score resulted in increased specificity and more reliable positive and negative likelihood results.

A study of 381 mild head injury patients all of whom received a CT revealed an incidence of 38% positive scans requiring further treatment, a finding consistent with that seen in our patient sample. Age, mode of injury, loss of consciousness, seizures, ENT bleeding, and vomiting did not predict positive CT, while GCS, the presence of focal neurological signs, and the presence of a radiographic skull fracture only had moderate predictive power of a CT+.[36] While CTs are readily available in this country recent studies have highlighted the adverse effects of radiation from CT and the fact that increased use increases the individual risk for cancer

and overuse in general can increase the incidence of cancer in the population at large.[36,37] In addition, it has been proposed that objective indices of cerebral physiology are necessary to follow the course of recovery and the effectiveness of rehabilitation efforts. We would add that measures of cerebral physiology may be useful for the documentation of the extent of brain dysfunction at the time of injury. These concerns point to the need for biologic markers indicating which patients may recover. This study, if replicated, would suggest that the TBI-Index can play an important role in the ED setting in determining which patients presenting with mTBI require further evaluation.

LIMITATIONS

The sample size for this study was moderate and the authors are aware of the need for prospective independent replications of this work in larger populations with more refined scoring of CT results. Although the inclusion criteria were used to enroll a low-risk group for intracranial hemorrhage, we enrolled a rather high percentage of patients with a positive CT. This high positive CT rate may be partially due to the fact that as a study entry criterion the patient needed to undergo a CT and therefore the very low-risk group was eliminated. The most common reasons for exclusion of patients include: acute intoxication (too obtunded to participate), comorbid diagnosis of dementia, pregnancy, or a non-acute or incidental CT finding (it is estimated that this represents approximately 15%). While the exclusion criteria may limit the immediate applicability of our findings to the general ED population they were applied in order to examine the physiological consequence of mild head trauma in the absence of confounding variables. Future studies will examine how a derived EEG index is changed by these factors. The possibility of spectrum bias due to inclusion/exclusion criteria cannot be eliminated, although it is noted that this would apply to both the TBI-Index and the NOC groups. We did not acquire long-term follow up or neuropsychological testing of patients after ED discharge.In the future this may help to differentiate those patients at high risk for neurological dysfunction, neurocognitive deficits or post-concussive syndrome.

CONCLUSION

In patients presenting to the ED with mTBI, the TBI-Index used in this study had sensitivity levels equivalent to the NOC and specificity that outperformed the NOC (50.6% compared with 23.5%). Combining the index with NOC resulted in a sensitivity of 97.0% (only 1 false negative). This study demonstrates that the hand-held device measuring brain electrical activity can be used in the ED setting and suggests a role in the initial screening of mild traumatic brain-injured patients. Further validation of this TBI-Index is necessary in a consecutive ED sample with common behavioral confounders, as well as its real-time use and incorporation into clinical decisions in the ED.

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Leslie S. Prichep is a scientific consultant to BrainScope Co., Inc., who provided the funds for this research.Robert Chabot is a research consultant to BrainScope Co., Inc., and provided scientific and statistical expertise. Rosanne Naunheim discloses BrainScope Co., Inc., provides a clinical coordinator. Brian O'Neil discloses BrainScope sponsored the study covering technical costs. No other financial relationships were present.

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Urine Collection in the Emergency Department: What Really Happens in There?

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Introduction: In women with suspected urinary tract infection (UTI), a non-contaminated voided specimen is considered important for valid urinalysis and culture results. We assess whether midstream parted-labia catch (MSPC) instructions were provided by nurses, understood, and performed correctly, according to the patient.

Methods: We conducted a cross-sectional survey of English- and Spanish-speaking female patients submitting voided urine samples for urinalysis for suspected UTI. The survey was conducted in a public teaching hospital emergency department (ED) from June to December 2010, beginning 2 months after development and dissemination of a nursing MSPC instructions protocol. Research assistants administered the survey within 2 hours of urine collection. Nurses were unaware of the study purpose.

Results: Of 129 patients approached, 74 (57%) consented and were included in the analysis. Median age was 35; 44% were Latino. Regarding instructions from nurses, patients reported the following: 45 (61%; 95% CI 50-72%) received any instructions; of whom 37 (82%; 95% CI 71-93%) understood them completely. Sixteen (36%; 95% CI 22-51%) were instructed to collect midstream; and 7 (16%; 95% CI 6-29%) to part the labia. Regardless of receiving or understanding instructions, 33 (45%; 95% CI 33-57%) reported actually collecting midstream, and 11 (15%, 95% CI 8-25%) parting the labia.

Conclusion: In this ED, instructions for MSPC urine collection frequently were not given, despite a nursing protocol, and patients rarely performed the essential steps. An evidence-based approach to urine testing in the ED that considers urine collection technique, is needed. [West J Emerg Med. 2012;13(5):401-405.]

INTRODUCTION

Urinary tract infections (UTIs) are estimated to account for one million emergency department (ED) visits annually.[1] Women are especially prone to infection. Evaluation usually entails some kind of urine testing, including dipstick urinalysis, microscopic urinalysis and urine culture, most often performed on a voided specimen. To minimize false positive results, which can lead to diagnostic confusion and unnecessary antibiotic use, it is recommended that patients collect the urine in a way that minimizes contamination with vaginal material.[2,3] Parting the labia and collecting a midstream sample seem to be the most important steps in preventing contamination, whereas perineal cleansing has little effect.[4,5] We have termed specimens collected in this way "midstream parted catch" (MSPC).

In the ED, nurses usually give instructions for urine specimen collection. It is not known whether such instructions are delivered properly, understood by the patient and carried

out correctly under normal clinical conditions. Potential barriers to proper collection include lack of nurse training; competing nursing priorities that lead to poor quality or omitted instructions; need to collect urine before the specific indication (e.g., UTI testing, sexual transmitted infection [STI] testing, pregnancy testing) is known; poor understanding of instructions by patients due to a language barrier or low literacy; and inability of the patient to physically carry out the instructions despite understanding them. The bottom line is that emergency physicians are often left to interpret the urinalysis while unsure how the specimen was collected.

To our knowledge, there are no published studies specifically assessing urine collection instructions in the ED setting. Data from such a study could be used in developing an evidence-based approach to urine testing in the ED. The objective of this study was to assess whether, according to the patients, MSPC instructions were provided by nurses, understood, and carried out correctly.

METHODS

We conducted a cross-sectional survey of female ED patients in an urban county teaching hospital, in Oakland, California, with an annual ED census of approximately 90,000 visits, from June to December 2010. The local institutional review committee approved the study.

In preparation for the study, the investigators and 2 ED nurse educators developed a nursing urine collection protocol for female patients. The new protocol emphasized ascertaining the indication for urine testing and specified that MSPC instructions should be used if the nurse knew that the main indication for testing was to evaluate for UTI. It was also to be used if the indication was unclear, including when urinalysis was ordered alone or along with urine nucleic acid amplification tests (NAAT) for STI. The MSPC protocol emphasized parting the labia and did not include perineal cleansing. Two months before the study began, the protocol was disseminated in standard fashion, including posting it in staff areas and on our ED nursing website and reviewing it in charge nurse meetings. Our research study was not mentioned.

During the study, urine was usually collected after the patient was placed in her room, by the nurse assigned to that room. When wait times were long, urine could be collected prior to room assignment by the triage or "treatment" nurse. Urine was sometimes collected before a physician saw the patient or an order was written. Clinical nurses were not informed of the study.

Patients were eligible for the survey if they were female, age 18 to 65, fluent in English or Spanish, had a urinalysis and/or urine culture ordered and had provided a voided specimen. Patients were excluded if urine testing was limited to NAAT, pregnancy test or toxicology, if they were physically unable or too ill to perform MSPC (for example if they required a bedpan), had abnormal mental status or were on a psychiatric hold, or if urine was collected by catheterization only.

Three bilingual research assistants administered the survey. Potentially eligible patients were identified using our real-time electronic patient locator system (Wellsoft ™), which includes time-stamped fields for order and diagnostic test processing. The survey was administered within two hours of urine specimen processing. We performed 13 sampling shifts distributed throughout the week at all hours, to approximate the ED week and assure a broad sample of nurses. To assess the distribution of nurses involved, the name of the first nurse assigned to the subject's room was recorded from the electronic medical record, however this information was not linked to the subject's survey results.

The survey instrument was composed of 15 questions covering the following domains: education level and medical literacy, receipt of instructions and understanding, and how urine was actually collected. Most of the survey questions were devised for this study, and thus not previously validated. A single validated question, "how confident do you feel filling out medical forms by yourself?" was used as an indicator of medical literacy.[6] Possible choices presented in the survey were based on our MSPC protocol. The survey instrument was finalized in English and Spanish after it was piloted on four patients.

Outcomes were calculated from the following self-reported measures: the proportion of subjects receiving and understanding urine specimen collection instructions, frequency of each instruction they received, if any, and urine collection steps they actually performed.

We used STATA software (version 11.1, Stata Corp, College Station, Texas, USA) for all analyses.

Table 1. Demographics and health literacy (N=74).

	Number (%)
Age (median IQR)	35 (27-54)
Ethnicity	
African American	25 (34)
Latino	32 (44)
Other	16 (22)
Education	
Eighth grade or less	14 (19)
Some high school	10 (14)
Completed high school	18 (24)
Greater than high school	30 (41)
Confident filling out medical forms (health literacy)	
Quite a bit or extremely	48 (66)
Somewhat	9 (12)
A little or Not at all	16 (22)

IQR, interquartile range

Table 2. Survey results for urine collection questions (total N=74).

	Number	Percent	95% CI
Reported receiving instructions	45	61	50-72
Reported not receiving instructions	29	39	28-51
Self-reported understanding of instructions (N= 45)			
Understood instructions			
Yes	43	96	90-100
No	2	4	0-10
How well understood*			
Completely	37	82	71-93
Most	3	7	0-14
A little	2	4	0-10
What instructions subjects recalled receiving (N=45)			
Wash hands	26	58	43-72
Void into toilet then stop	16	36	22-50
Part labia	7	16	5-26
Void into cup until half full	33	73	60-86
Finish voiding into toilet	12	27	14-40
What steps subjects reported doing (N=74)			
Washed hands	44	59	48-71
Voided into toilet then stopped	33	45	33-56
Parted labia	11	15	7-23
Voided into cup until half full	58	78	69-88
Finished voiding into toilet	37	50	39-61

*Missing data from 1 subject who answered she understood instructions.
CI, confidence interval

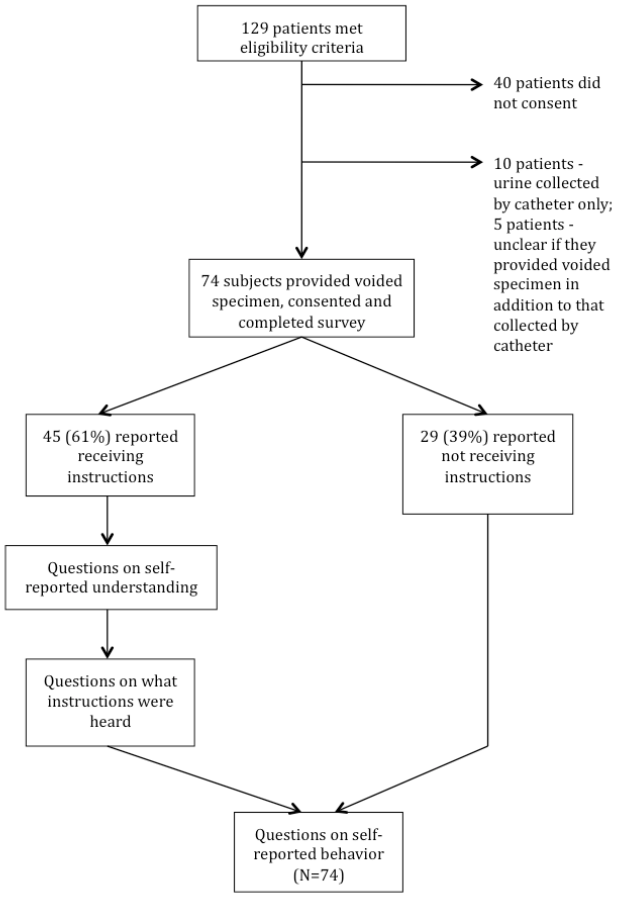

Figure. Study flow.

RESULTS

One hundred and twenty-nine patients met eligibility criteria and were approached to participate in the study, of whom 89 (69%) consented and completed the survey (Figure). Fifteen patients (12%) were excluded because their urine was collected by bladder catheterization only or it was unclear whether a voided specimen had also been obtained. Seventy-four subjects were included in the analysis. There were 50 nurses primarily involved in the care of these 74 subjects, and no single nurse cared for more than four subjects.

Demographic characteristics and health literacy are summarized in Table 1. Twenty-five percent of subjects answered that they were only "somewhat," "a little," or "not at all comfortable" filling out medical forms by themselves, indicating limited or marginal health literacy.[6]

Twenty-nine subjects (39%; 95% CI 28-51) reported not receiving any instructions on how to collect their urine specimens (Table 2). Among the 45 subjects who reported receiving some instruction, 37 (82%; 95% CI 71-93) stated they understood them completely. Sixteen of 45 (36%; 95% CI 22-50) reported being instructed to urinate first into the toilet (a minimum requirement for midstream collection), and seven (16%; 95% CI 5-26) reported being told to part the labia. Six subjects (13%; 95% CI 3- 23) recalled being told to do both these essential steps.

With regard to what steps they actually performed, 33 of 74 (45%; 95% CI 33-56) reported urinating first into the toilet, 11 (15%; 95% CI 7-23) reported parting the labia, and 11 (15%; 95% CI 7-23) reported doing both.

According to their recall, some subjects performed MSPC steps without being instructed, and others failed to perform the instructions they did receive. However, subjects instructed to do a step were significantly more likely to perform it than those not receiving the instruction: for urinating first into the toilet, 85% versus 24% (p=0.004); for parting the labia, 71% versus 8% (p=0.001).

DISCUSSION

Urine tests for diagnosis of infection are unique in that test accuracy is thought to depend on how the specimen is

collected, yet often the specimen is collected by the patient with no direct supervision. Meanwhile, diagnostic testing is increasingly initiated at the point of triage, where there is minimal regard for pre-test probabilities and not enough time or personnel to provide careful patient instructions.

To our knowledge, this is the first study addressing the issue of instructions for urine specimen collection in the ED. We found that female patients with indications for MSPC urine collection often did not recall being instructed on, or performing, the important steps in MSPC. The results suggest that nursing difficulties were more to blame than patient issues, such as poor understanding or an inability or unwillingness to carry out MSPC. While the study's generalizability may be limited and the survey methodology unstable, we suspect our findings reflect the reality in most EDs.

In the broadest sense, this study illustrates the inherent difficulty implementing a seemingly simple ED process of care by way of a nursing protocol. We discovered that communicating carefully and consistently with patients about how to collect a diagnostic sample, based on a particular physician order, in the midst of the ED nursing environment, is a complex process. Nursing-related challenges that were likely at play include difficulty successfully training all nurses about the MSPC policy, competing nursing priorities that led to rushed or omitted instructions, and the need to collect urine shortly after triage before the specific indication (e.g., UTI testing, STI testing, pregnancy testing) was known. While our survey data cannot pinpoint the reason for the low rate of successful MSPC urine instructions, the findings nonetheless suggest areas for practice improvement and future research.

Practice improvements might include ongoing nursing education that emphasizes the important components of MSPC for UTI testing. If possible, nurses should ascertain or anticipate the indication for urine testing before they give collection instructions. Written MSPC instructions using simple language and illustrations could be posted in female patient bathrooms.

Alternatively, given the myriad potential barriers to successful MSPC urine collection, it might be easier to adopt diagnostic strategies that simply eliminate MSPC specimens. In reproductive-age women with cystitis symptoms who have no signs of pyelonephritis or vaginal symptoms, urine testing for UTI is generally not needed, since pretest probability is so high.[7] Physicians could be taught to base treatment decisions in such cases on the history and physical alone, without urinalysis. In the remainder of women with suspected UTI, particularly those unlikely to understand or properly carry out MSPC instructions, a catheterized specimen could be obtained.

Our findings should spur further pragmatic ED studies on the impact of urine collection instructions on urine test performance. The two best studies examining the impact of urine collection technique on urine culture contamination enrolled only university or nursing students, and the investigators themselves gave the collection instructions. These studies came to different conclusions about the importance of collection technique.[4,8] Dipstick urinalysis of midstream specimens, on the other hand, has been studied in a real world outpatient setting, and shown to somewhat improve UTI diagnosis.[9] However, it is still not known whether varying specimen collection instructions, or eliminating instructions, would have an impact on dipstick test accuracy. The study we would like to see would compare the difference in urine dipstick accuracy and the rate of urine culture contamination, among female ED patients randomized to written MSPC instructions versus no instructions.

Further complicating the issue of urine specimen collection in sexually active women is the increasing use of urine nucleic acid amplification tests (NAAT) for STI screening.[10] In contrast to testing for UTI, urine specimens for NAAT should be maximally contaminated with vaginal material. A first void sample, collected without parting the labia, is therefore recommended.[11] Thus far there has been almost no discussion in the emergency medicine (EM) literature about this dramatic difference in optimal urine collection technique between UTI and STI testing, and how it should affect testing strategies. One non-EM report suggested that women be instructed to collect a first void specimen in one cup, stop, then collect a MSPC specimen in a separate cup.[12] This approach would certainly depend on detailed urine collection instructions, and our results suggest it is therefore unrealistic for the ED. Another solution is to use self-administered vaginal swabs for NAAT,[13] which would obviate the need for anything other than MSPC specimens. To the extent that urine NAAT for STI do become more widespread in EDs, it strengthens the case for abandoning MSPC altogether and basing UTI treatment decisions on history and physical alone, or on catheterized specimens.

LIMITATIONS

The study has a number of limitations. Foremost is the possible lack of generalizability of our results from a single center to other EDs. The professional and clinical environment that our nurses face at this busy county facility may have a unique effect on how they deliver instructions to patients. Similarly, characteristics of our patient population and our ED physical plant (such as the bathrooms) might have a unique impact on how well patients can recall instructions or properly perform specimen collection. The health literacy of our population, however, appears to be similar to that of a multicenter ED sample in Boston.[14]

Since about 30% of patients approached did not participate, the survey results may not accurately reflect the experience of the overall target population. In addition, a survey that asks patients to recall a short set of instructions that was part of a long clinical encounter, and to report on their own behavior, may be unreliable. Unfortunately,

there may be no other method besides a survey like this for answering this study question, since directly recording the nurse instructions would introduce unacceptable bias, and actually observing urine collection is not feasible or appropriate. To maximize recall, we did limit the time between urine collection and survey administration.

To the extent that the study did accurately measure how well nurses delivered the new MSPC instructions, it may have been set up to find poor performance. Emphasis on parting the labia and omission of perineal cleansing is likely different from what many nurses were originally taught and have practiced for years. Also, the study population was identified on the basis of the physician orders, usually entered after their history and physical. In cases where urine was collected before orders, nurses may simply have had a different impression, i.e., that UTI was not a concern. However, the nursing protocol did specify to err on the side of requesting MSPC when the indication was unclear.

Finally, this study does not prove whether consistently delivering instructions for MSPC urine collection according to a nursing protocol would actually result in better urine collection technique by patients. Patients' self-reported behavior, however, did seem to be affected by the instructions they recalled receiving.

CONCLUSION

In this ED, despite a nursing protocol, instructions for MSPC urine collection frequently were not given, and patients rarely performed the essential steps. The MSPC process may be too complex to implement consistently in the ED. Further research is needed to develop an evidence-based approach to UTI testing in the ED that considers urine collection technique.

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Comparison of Prehospital Glucose with or without IV Thiamine

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Introduction: Loading of thiamine prior to glucose administration during hypoglycemia to prevent Wernicke's encephalopathy is routine in the prehospital setting. To date no study has looked at the validity of this therapy.

Methods: We evaluated a retrospective cohort of 242 patients who received intravenous glucose for hypoglycemia comparing those who received thiamine supplementation versus those who did not. Study endpoints were heart rate, blood pressure, Glasgow Coma Scale (GCS), reentry into the 911 system, and emergency department (ED) discharge rates.

Results: There were no significant differences between the thiamine, and without-thiamine groups. All patients were discharged neurologically intact or were alert and oriented when refusing transport to the hospital. None of the 242 patients re-called 911 within the immediate 24-hour period or returned to the ED.

Conclusion: To our knowledge this is the first study in the literature which evaluated the use of thiamine with glucose to prevent Wernicke's encephalopathy in the prehospital setting. We found that routine administration of thiamine with glucose did not result in differences in respiratory rate, systolic blood pressure, GCS or ED hospital discharge rates. Until further research is done to validate our results emergency medical services leadership should consider whether the routine use of thiamine in the prehospital setting is appropriate for their system. [West J Emerg Med. 2012;13(5):406-409.]

INTRODUCTION

Wernicke's encephalopathy is a neurological condition characterized by confusion, opthalmoplegia, and cerebellar ataxia.[1] It is caused by a deficiency of intracellular thiamine (vitamin B1), which is necessary for normal glucose utilization. Thiamine serves as a cofactor for pyruvate and α-ketoglutarate dehydrogenase reactions, which produce adenosine triphosphate (ATP).[2] Without it intracellular energy deficits would increase, eventually leading to cell death. To prevent this, the body can store up to 30-50 mg of thiamine and requires only1-2 mg of thiamine per day to function properly.[2] While alcohol consumption may accelerate thiamine depletion by driving the pyruvate dehydrogenase reaction, it would take at least 4-6 weeks to exhaust the body's natural thiamine stores by malnutrition alone.[3] Acute hypoglycemic episodes occur most commonly in diabetic patients and are associated with inadequate food intake, increased physical exertion, medication interactions or sepsis. These patients would not require routine thiamine loading unless they are at risk for thiamine deficiency. The requirement that administration of thiamine should always precede the administration of glucose to prevent the precipitation of acute Wernicke's encephalopathy is unfounded.[4] A Cochrane review determined insufficient evidence of the efficacy of

thiamine for the treatment of Wernicke-Korsakoff syndrome, stating recommendations about the dosage and duration are acknowledged to be arbitrary. The reviewconcluded that there is insufficient evidence to guide clinicians in the dose, frequency, route, or duration of thiamine treatment for prophylaxis against or treatment of Wernicke's due to alcohol abuse.[5]

Current Advanced Life Support (ALS) protocols in many states require that all acutely hypoglycemic patients receive intravenous (IV) thiamine before the administration of glucose to prevent the development of Wernicke's encephalopathy.[6] In our review of national protocols, we were able to find 24 that routinely give thiamine prior to glucose. Recommendations of thiamine loading prior to glucose administration were formulated after Watson et al. published an article in 1981 detailing four case reports of patients who developed Wernicke's encephalopathy after glucose loading without thiamine administration.[7] Each of these patients, however, had been suffering from an episode of acute hypoglycemia related to chronic malnutrition. These patients developed Wernicke's hours after receiving glucose and all 4 had complete resolution of their neurological symptoms when thiamine was administered later in the hospitalization.[8] Recent case reports of patients with Wernicke's have shown similar results.[8-10]

Our state spends approximately 40,000 dollars annually on prehospital thiamine injections for routine loading in all hypoglycemic patients regardless of alcoholism or malnutrition history. The potential benefit of this cost has not been assessed in an empiric way, nor been weighed against the added risk for prehospital providers and patients due to the additional needle stick required for the thiamine. These guidelines may even be detrimental to patients in situations when glucose is delayed in order to administer thiamine. In addition, although uncommon, anaphylaxis from IV thiamine can occur, with life-threatening consequences.[11,12]

In this study we hypothesize that patients would have no difference in physiological parameters, including mental status, when treated with glucose alone vs. thiamine with glucose.

METHODS

The study is a retrospective cohort. It has been approved by our university's institutional review board, which has a subcontract with our hospital. No patient consent was required by the IRB due to the de-identified nature of the data.

This study was conducted in an urban setting at a Level I trauma center. The county population of approximately 800,000 residents is made up of 68.4% Caucasian, 13.9% Asian, 13.6% Hispanic, and 9.1% African-American residents. The county occupies 323 square miles with a combination of cities and suburban communities. The emergency medical services (EMS) system is 2-tiered, comprised of a combination of paid and volunteer basic life support (BLS) units and paid hospital-based Advanced Life Support (ALS) that contain 2 paramedics per unit. Based out of our hospital, there are 8 BLS units and 6 ALS units that respond to approximately 30,000 dispatches per year, 6,500 of these being treated by ALS.

In our system, glucose is administered in the form of 50% dextrose containing 25 grams for patients over the age of21. In patients over the age of 2, 25% dextrose is given. One hundred mg of thiamine can be administered either intramuscularly or intravenously. We have glucometers on all ALS units with protocols for dextrose replacement if the glucometers indicates capillary blood glucose (CBG) is less than 70mg/dl.

As no previous studies have shown the incidence of Wernicke's induction with glucose administration, we selected a consecutive sample of 242 patients who were treated by ALS for hypoglycemia between May 1, 2008 and August 11, 2009.

The search terms "hypoglycemia" and "IV glucose" were used in our electronic medical record (EMR) (www.emscharts.com, Atlanta, Georgia). This database was cross-referenced with the ED database, Sunrise Clinical Manager (SCM) (Eclipsys Corporations, Atlanta, Georgia) to investigate outcomes data.

All patients who were administered thiamine received 100 mg IV. Patients received glucose in the form of D50 if above 21 and D25 if above 2 years of age. No patients in our study were less than 2.

In choosing outcome measures we reviewed case reports of Wernicke's encephalopathy for signs and symptoms that might be captured in routine EMS charting. Our review identified abnormal vital signs being induced by the carbohydrate load of glucose as an early predictor of Wernicke's encephalopathy. These endpoints are routinely measured by prehospital care providers. Opthalomoplegia and ataxia are not documented routinely nor are they taught in our paramedic programs, but the Glasgow Coma Scale (GCS) has been shown to have high inter-rater reliability, is predictive of changes in mental status, and is routinely captured in EMS charts. GSC was our primary outcome with changes in heart rate, respiratory rate, and blood pressure as secondary outcomes. We also evaluated rates of discharge and reentry into the 911 system for patients who refused transport to the hospital. We estimated that a decrease in GCS of > 1, an increase in systolic blood pressure (SBP) > 10mmHG, and a heart rate increase by 20 to indicate a clinically significant change.

We calculated simple means and standard deviations of health indicators were calculated at each individual time point for patients administered and not administered thiamine. Means and standard deviations of percent changes in these health indicators were also calculated.

We used linear models to examine the effects of administration of thiamine (versus not) on changes in health indicators, adjusting for age and gender. Age- and gender-adjusted mean percent changes are presented along with 95% confidence intervals. We conducted sensitivity analyses

Table. Pre- and post-treatment means, standard deviations, and percent changes. Estimates, 95% confidence intervals (CI) and p-values are given for adjusted mean percent changes in each measure.

Health Indicator	With or without Thiamine	Mean (SD) N			Difference* in % change, adjusted for age & gender
		Before	After	Percent (%) change	Estimate (CI) N, p-value
Systolic	Without	150.0 (23.9) 28	142.8 (23.9) 30	-3.8 (13.2) 27	-3.0 (-9.2, 3.1) 197, 0.33
	With	144.3 (25.3) 174	141.7 (25.8) 187	-0.7 (15.2) 170	--
Diastolic	Without	77.8 (16.1) 27	81.1 (14.0) 30	6.1 (21.5) 26	4.6 (-4.6, 13.8) 192, 0.32
	With	78.0 (15.1) 171	77.0 (16.3) 185	1.3 (22.1) 166	--
Heart Rate	Without	81.2 (16.8) 30	78.4 (14.0) 30	-2.5 (11.1) 29	-4.2 (-9.6, 1.3) 211, 0.14
	With	80.2 (16.6) 185	81.0 (16.5) 188	1.6 (14.3) 182	--
Respiratory Rate	Without	17.8 (3.5) 28	17.5 (1.7) 30	-0.1 (12.6) 28	-2.4 (-8.8, 4.0) 209, 0.46
	With	16.9 (3.3) 186	17.0 (2.2) 186	2.5 (16.3(181	--
GCS	Without	10.8 (3.1) 30	14.7 (0.8) 29	54.7 (75.7) 29	-22.8 (-61.5, 15.9) 210, 0.25
	With	9.8 (3.6) 191	14.5 (1.9) 181	76.9 (101.0) 181	--

* Without minus with; *SD*, standard deviation; *GCS*, Glasgow Coma Scale

excluding individuals who were administered Thiamine after D50 from the analyses described.

Because percent change in GCS was not normally distributed, we used a non-parametric analysis of variance as a sensitivity analysis. Specifically, we used a Kruskal-Wallis test to examine differences between the Thiamine and non-Thiamine groups in percent change in GCS. The significance of the effect of Thiamine derived from the Kruskal-Wallis test was similar to that reported from the linear model (data not shown).

We used the SAS software (SAS system for Windows, version 9.1.3; SAS Institute Inc, Cary, North Carolina) for all analyses.

RESULTS

During the 15-month study period 242 hypoglycemia patients were treated for hypoglycemia. Two hundred five patients (84.7%) received a loading dose of thiamine, while 37 (15.3%) did not receive the loading dose.

Means and standard deviations of pre- and post-treatment means are presented in Table. Also presented are the adjusted percent changes. There were no significant differences between the thiamine and no thiamine groups.

Of the 242 patients evaluated, 180 refused transport to the hospital. They signed an "against medical advice" (AMA) form after their mental status return to baseline (as measured by GCS). Sixty-two patients (25.6%) were transported to the hospital. All of these patients were discharged neurologically intact from the ED or the hospital. None of the patients were clinically intoxicated as subjectively judged by EMS. None of the 242 patients reentered the 911 system within 24 hours or returned to the original ED.

DISCUSSION

State guidelines for thiamine administration to the hypoglycemia patients are inconsistent. Some use it in every case of hypoglycemia, others give it only to the malnourished, and a few do not give thiamine at all. Despite these state-to-state discrepancies in protocols, overall cases of dextrose-induced Wenicke's encephalopathy are exceedingly rare. Administering it to only those patients at the highest risk for developing Wernicke's would be the most efficacious strategy for treating hypoglycemia in the prehospital setting. Administering thiamine to only this subset of patients in the prehospital setting would reduce both costs and needle stick injuries. None of our patients who received thiamine were judged to be acutely intoxicated;however, it is possible that chronic alcoholism or other malnourished states existed.

LIMITATIONS

Our study is limited to a single institution in our specific geographic region. EMS systems in various locations could produce different results. However, we do not believe that hypoglycemia would present differently in various locations.

A limitation of this study was loss to follow up after patients were successfully relieved of their hypoglycemic symptoms. We know that none of them re-entered the 911 system, but cannot exclude that they were seen by providers outside this system. Seventy-four percent of the patients we studied refused medical attention after ALS resolved their symptoms with either thiamine and dextrose or just dextrose. However, were able to verify that none of the "refusing medical attention" group returned to our ED within 24 hours. It is possible that patients could have developed Wernicke's

after discharge from the ed. We were only able to follow-up patients returning to our ED and not surrounding hospitals.

All patients should have received thiamine under state standing orders. It is possible that those not receiving thiamine were sicker as determined by the paramedic and they subsequently did not have time to draw up the thiamine and inject it. Thiamine is under standing orders in the state. Paramedics must make contact with the base-station physician at some point during standing orders, which include dextrose and then thiamine. The paramedic can make an individual decision when to contact the base-station physician. If base station contact is made prior to administration of thiamine then it is the physician's discretion whether to give it to the patient.

We only used the search terms "IV and glucose." It is possible that patients were missed in our EMR secondary to improper data input. Since our system uses drop down menus, a few potential patients were lost. In addition we only searched data using IV. It is possible that some patients received oral glucose loading and resolved without IV access; however, we believe this is rare since oral glucose loading is not under state standing orders.

Lastly, we used GCS as a measure of mental status because it was available. Since the initial sign of Wernicke's may be confusion it could cause changes in the GCS. However we acknowledge that GCS may decrease for other reasons than confusion.

In our study, hypoglycemic patients treated by ALS had the same neurological outcomes after glucose administration regardless of the inclusion of thiamine. On follow up, all 62 patients brought by ALS into our facility had complete resolution of their symptoms, 9 of whom had not received prehospital thiamine. This is because most patients receiving the thiamine with glucose regimen are suffering from a complication of diabetic treatment and are not chronically malnourished or alcoholics. These patients require immediate glucose administration; therefore, delays due to thiamine administration, or the potential for anaphylaxis from thiamine, can be detrimental to patient outcome.

Given the rarity of Wernicke's encephalopathy, with no known determination of incidence, we likely have not studied sufficient patients to exclude this complication of dextrose administration. It remains possible that thiamine may indeed be necessary to avoid this condition. We did not specifically search for the ED diagnosis of Wernicke's encephalopathy, instead using vital signs and GCS as surrogate diagnostic markers.

CONCLUSION

This is the first study in the literature known to us which evaluated the use of thiamine with glucose to prevent Wernicke's syndrome in the prehospital setting. We found that routine administration of thiamine with glucose did not result in differences in respiratory rate, SBP, GCS or emergency department hospital discharge rates. Until further research is done to validate our results EMS leadership should consider whether the routine use of thiamine in the prehospital setting is appropriate for their system.

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Factors Influencing Emergency Department Preference for Access to Healthcare

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Introduction: African-Americans are more likely than Caucasians to access healthcare through the emergency department (ED); however, the reasons behind this pattern are unclear. The objective is to investigate the effect of race, insurance, socioeconomic status, and perceived health on the preference for ED use.

Methods: This is a prospective study at a tertiary care ED from June to July 2009. Patients were surveyed to capture demographics, healthcare utilization, and baseline health status. The primary outcome of interest was patient-reported routine place of healthcare. Other outcomes included frequency of ED visits in the previous 6 months, barriers to primary care and patient perception of health using select questions from the Medical Outcomes Study Short Form 36 (SF-36).

Results: Two hundred and ninety-two patients completed the survey of whom 58% were African-American and 44% were uninsured. African-Americans were equally likely to report 3 or more visits to the ED, but more likely to state a preference for the ED for their usual place of care (24% vs. 13%, $p < 0.01$). No significant differences between groups were found for barriers to primary care, including insurance. African-Americans less often reported comorbidities or hospitalization within the previous 6 months (23% vs. 34%, $p = 0.04$). On logistic regression modeling, African-Americans were more than 2 times as likely to select the ED as their usual place of healthcare (OR 2.24, 95% CI 1.22 - 4.08).

Conclusion: African-Americans, independent of health insurance, are more likely than Caucasians to designate the ED as their routine place of healthcare. [West J Emerg Med. 2012;13(5):410-415.]

INTRODUCTION

The emergency department (ED) has become the "safety net of health care" for the indigent and uninsured who often lack a primary medical provider. [1] The observation, however, that compared to Caucasians, African-Americans more often lack a usual source of healthcare and use the ED out of necessity for non-emergent medical concerns is controversial.[1-4] The medical literature cites limited access to care, lower quality of care, and evidence of distrust toward medical providers as potential sources of the racial gap in ambulatory care.[5-10]

In fact, minorities are more likely to be uninsured and comprise a disproportionate share of patients enrolled in publicly funded health programs.[2,11] Moreover, cost barriers or lack of insurance coverage impede minorities' access to adequate primary care.[1] Such difficulty in accessing primary care is problematic and contributes to the 23.1% rise in ED visit rate observed from 1997 to 2007, most significant among Medicaid and African-American patients.[12] However, beyond these traditional barriers to primary care, it is essential to consider the impact that patients' baseline health and preference for site of care have on ED use.

This pilot study aims to evaluate the effect of race,

insurance status, age, and socioeconomic factors on patient preference for routine place of care. We then define the extent to which barriers to primary care and baseline health influence use of the ED. Understanding patient preferences in the ambulatory setting is necessary to inform the discourse on healthcare reform and to establish future interventions that would improve access to primary care, and thereby reduce ED overcrowding.[12]

METHODS

This prospective study employed a cross-sectional survey design and included patients visiting the ED over a 2-month period, from June to July 2009. To obtain a representative sample of patients, research assistants staffed the ED Monday through Saturday for 24 hours per week between the hours of 8AM and midnight. Patients were excluded if they were < 19 years old, did not speak English, had a chief complaint of altered mental status, or if they were triaged at higher acuity levels I or II. Eligible patients were approached in the ED waiting room for participation in the study and provided written informed consent. We obtained approval for the study from the Institutional Review Board.

A 30-question survey inquired of patients' demographics, use of the healthcare system, and perception of general health. To assess ED use, participants were asked how many times they had frequented the ED in the previous 6 months, including the visit on the day of study enrollment, and where they preferred to receive medical care, given the choice of physician's office, community clinic, ED, or no regular place of care. Three potential barriers to primary care: paying for healthcare, obtaining transportation to the hospital, and taking time off work were assessed using a 4-point Likert scale with 1 = Not difficult at all and 4 = Very difficult, as previously described.[4] Health status was evaluated based on select questions from the Medical Outcomes Study Short Form 36 (SF-36), patient-reported comorbidities, smoking status, and hospital admission in the preceding 6 months. From the SF-36, a well-described, reliable and validated survey to examine disease burden, we included all 6 items from the general health scale.[13] The survey also assessed current presentation to the ED, inquiring of patients' chief complaint, severity and novelty of complaint, and route of referral.

We primarily evaluated preferred place of healthcare, comparing physician's office, health clinic, the ED, and no routine place with respect to race and insurance status. Other outcomes of interest were similarly stratified and included frequency of ED visits, barriers to primary care, and perception of overall wellbeing. Participants' medical records were accessed to verify patient-reported insurance status, chief complaint and to obtain their final disposition.

For analysis purpose, patient race was classified as Caucasian or African-American. Asian and Hispanic patients were excluded as only 9 were identified in our study. Also, for usual place of healthcare, physician's office and community health clinic were grouped as 1 category since both establishments provide continuity in medical records, in contrast to the 58 % of frequent ED users in 1 study who visited 2 or more different EDs in a 12-month period.[14] We performed statistical analysis using SAS 9.1.3 (SAS Institute, Cary, NC). Categorical variables were evaluated using chi-square or Fisher exact tests. Significance was set at a p-value ≤ 0.05.

We created a logistic regression model using usual place of healthcare as the outcome, specifically by combining the ED and no routine place of healthcare, and response variables as race and insurance status. As observed in the literature,

Table 1. Characteristics of the emergency department (ED) study population according to race.

Characteristics	Caucasian n=124 n (%)	AA n=168 n (%)	*P* value
Age			0.07
19 to 31	34 (27)	70 (42)	
32 to 45	38 (31)	42 (25)	
46 to 65	40 (32)	47 (28)	
65+	12 (10)	9 (5)	
Female sex	62 (50)	119 (71)	0.0003*
Education level			0.01*
No high school	25 (21)	22 (13)	
High school graduate	59 (49)	111 (67)	
College graduate	36 (30)	33 (20)	
Annual household income			0.0003*
< $20,000	53 (46)	98 (67)	
$20,001-40,000	23 (20)	33 (22)	
$40,001-60,000	20 (18)	10 (7)	
$60,001-100,000	12 (11)	5 (3)	
> $100,000	6 (5)	1 (1)	
Health insurance			0.64
Private/Medicare	52 (42)	66 (39)	
Medicaid	21 (17)	24 (14)	
None	51 (41)	78 (46)	
Living situation			0.22
Live alone	21(17)	43 (26)	
Live with family or friends	94 (77)	115 (69)	
Other	7 (6)	9 (5)	
Referral to ED			0.0006*
Self	79 (66)	139 (84)	
Phone- nurse/physician	33 (28)	24 (15)	
Physician office visit	8 (7)	2 (1)	
Employed	46 (37)	61 (37)	0.95

AA, African American
* Statistically significant

the ED where this study was conducted functions as a safety net of healthcare for individuals without a regular source of care, supporting the decision to combine the two options for analyses.[1,17] We made adjustments for potential confounders, including age, gender, greater than 3 previous ED visits, and admission status. Household income and education level were not significantly associated with usual place of healthcare, so these variables were not included in the model.

RESULTS

Two hundred and ninety-two patients met inclusion criteria; 58% were African-American and 44% had no insurance. Group characteristics by race are shown in Table 1. African-American respondents were more likely to be female, to earn an annual income less than or equal to $20,000 and to arrive at the ED without referral from a nurse or doctor. There were no significant differences between racial groups with respect to age, health insurance, employment rate, or living situation.

Patients' preference for usual place of healthcare by race and insurance status are shown in Figure 1 and Figure 2, respectively. African-Americans were significantly more likely than Caucasians to prefer the ED for their medical care (24% vs. 13%, $p < 0.01$). With respect to insurance status, 28% of uninsured patients selected the ED for their usual place of care, a significantly higher proportion than Medicaid patients (16%) and Private/Medicare patients (11%) ($p = 0.001$). Likewise, uninsured patients more often chose no usual place of healthcare as compared to insured patients (33% vs. 13%).

Patient-reported number of ED visits in the 6 months preceding study enrollment is shown in Table 2. Overall, 38% of patients reported 3 or more visits to the ED. African-Americans were equally likely to report 3 or more visit to the ED as Caucasians (41% vs. 34%, $p = 0.36$). Likewise, insurance status ($p = 0.33$) or age ($p = 0.57$) was not significantly associated with frequency of ED visits. As compared to uninsured and Medicaid patients, Private/Medicare respondents frequented the ED least often with 41% reporting 1 visit and 31% reporting 3 or more visits. Usual place of healthcare and recent hospitalization were significant predictors of frequent ED

Table 2. Patient-reported emergency department (ED) visits in the last 6 months.

Variables	1 visit n=100 n (%)	2 visits n=80 n (%)	≥3 visits n=110 n (%)	*P* value
Race				0.36
Caucasian	48 (39)	34 (27)	42 (34)	
African-American	52 (31)	46 (28)	68 (41)	
Insurance Status				0.33
Private/Medicare	48 (41)	33 (28)	37 (31)	
Medicaid	14 (32)	12 (27)	18 (41)	
None	38 (30)	35 (27)	55 (43)	
Age				0.57
19 to 31	40 (38)	29 (28)	35 (34)	
32 to 45	22 (28)	22 (28)	34 (44)	
45 to 65	29 (33)	22 (25)	36 (41)	
65+	9 (43)	7 (33)	5 (24)	
Gender				0.66
Female	60 (33)	53 (29)	67 (37)	
Usual place of healthcare				0.0002*
Physician's office/ Health clinic	74 (41)	50 (27)	58 (32)	
ED	5 (9)	17 (31)	33 (60)	
No usual place	21(41)	13 (25)	17 (33)	
Self-referral to ED	80 (37)	56 (26)	81 (37)	0.81
Hospital admission				<0.0001*
In last 6 months	9 (12)	20 (26)	47 (62)	

* Statistically significant

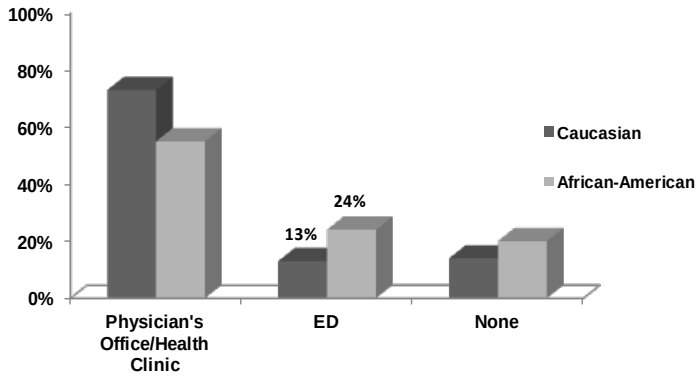

Figure 1. Patient-reported usual place of health care by race.

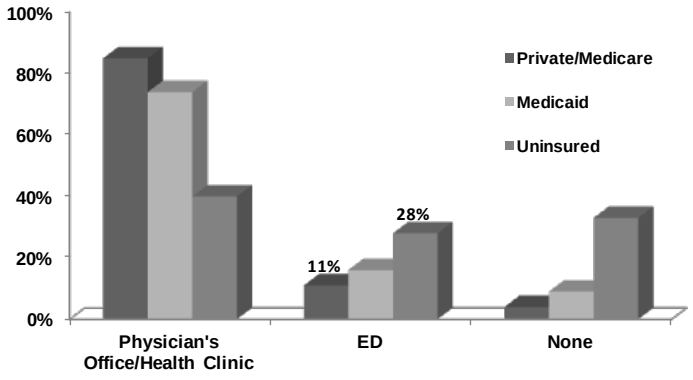

Figure 2. Patient-reported usual place of health care by insurance status.

Table 3. Patient-reported health status according to race.

	Patient race		
	Caucasian	AA	p
Comorbidities	N (%)	N (%)	
Obesity	28 (23)	27 (16)	0.14
Hypertension	46 (38)	72 (43)	0.36
Diabetes mellitus	18 (15)	28 (17)	0.65
Asthma	19 (16)	21 (13)	0.46
COPD	5 (4)	2 (1)	0.11
Myocardial infarction	12 (10)	3 (2)	0.002*
Stroke	8 (7)	4 (2)	0.08
Depression	38 (31)	26 (16)	0.002*
Seizure disorder	7 (6)	9 (5)	0.88
Cancer	13 (11)	6 (4)	0.02*
Chronic pain	34 (28)	29 (17)	0.03*
Smoking			0.01*
Current smoker	56 (45)	46 (28)	
Previous smoker	9 (7)	15 (9)	
Hospital admission			
In last 6 months	40 (34)	37 (23)	0.04*
For current ED visit	20 (16)	23 (14)	0.56
Perception of health (SF-36 questions)			
Overall health (qualitative)			0.31
Excellent/ Very good	20 (17)	39 (24)	
Good	42 (35)	55 (34)	
Fair/Poor	58 (48)	69 (42)	
True statements†:			
"I get sick a little easier than other people."	35 (30)	43 (27)	0.8
"I expect my health to get worse."	32 (28)	16 (10)	<0.0001*
"I am as healthy as anybody I know."	39(34)	77(48)	0.004*
"My health is excellent."	30(26)	73(46)	0.0003*

AA, African-American; *ED,* emergency department

* Statistically significant

† Other individuals answered either false or, " I don't know."

use. Patients who routinely visit a physician's office or health clinic were significantly less likely to report 3 or more visits to the ED than those patients who designate the ED as their usual place of healthcare (32% vs. 60%, p = 0.0002). Of patients who reported hospitalization in the previous 6 months, 62% reported 3 or more visits to the ED while 12% reported 1 visit (p < 0.0001).

Patient-reported health status by race is shown in Table 3. African-American patients less often than whites reported a previous myocardial infarction, depression, cancer, chronic pain, or a smoking habit. Compared to African-Americans, Caucasians more often reported a hospital admission within the previous 6 months (23% vs. 34%, p = 0.04); however, final disposition for this ED visit did not differ significantly between racial groups (p = 0.56). Select questions from the SF-36 form showed that African-Americans were less likely than whites to expect their health to get worse (10% vs. 28%, p < 0.0001). Also, compared to whites, African-Americans were more likely to believe their health is excellent (p = 0.0003) or that they are as healthy as anyone else (p = 0.004). Analysis of barriers to primary care found no significant differences between racial groups for payment, transportation, or taking time off work (data not shown).

Table 4. Multivariable analysis of preference for the emergency department(ED) for care.**

Variables	Odds ratio (95%CI)	p
Race		
Caucasian	Reference group	
African-American	2.24 (1.22- 4.08)	0.002*
Insurance		
None	Reference group	
Medicaid	0.242 (0.105-0.555)	<0.0001*
Private/Medicare	0.154 (0.076-0.313)	<0.0001*

* Statistically significant

**Controlled for age, gender, number of previous ED visits, and admission status.

CI, confidence interval

Multivariable analyses revealed that race (p = 0.002) and insurance status (p < 0.0001) were independent determinants for usual place of healthcare following adjustment for confounders, including age, gender, greater than 3 previous ED visits, and admission status (Table 4). There was no significant interaction between these factors influencing healthcare choice of the patient. Compared to Caucasians, African-Americans were more than 2 times as likely to select the ED or no routine place of care as their usual place of healthcare (odds ratio 2.24, 95% confidence interval 1.22- 4.08).

DISCUSSION

Our study demonstrates that compared to Caucasians, African-Americans are significantly more likely to select the ED for their usual place of care or report that they have no routine place of healthcare. Importantly, the racial disparity does not appear to result from differences in health insurance, barriers to primary care or patient perception of health. Uninsured patients similarly comprised a disproportionate share of patients who lack a usual place of care or use the ED routinely for medical concerns. After adjustment for age, gender, number of previous ED visits, and admission status, race and insurance remained significant, independent determinants of usual place of healthcare. Such findings highlight the complexity of healthcare reform and imply that insurance coverage for all individuals does not guarantee a change in patterns of access to care.

Our findings are in accordance with several studies, which

found that African-Americans, and Medicaid and uninsured patients are less likely to have ongoing primary care.[4,15,16] Figure 2 reaffirms previously published data that the ED serves as the chief medical provider for the uninsured. Such data emphasizes to healthcare policymakers the need for improved insurance coverage and its potential benefits on healthcare delivery. Also, similar to our results in Figure 1, Baker et al.[4] observed that African-Americans were more likely to identify the ED as their regular source of care, and Caucasians typically select a private physician as their routine provider. Previous research, however, cites traditional determinants of healthcare: age, health insurance, and access barriers as the basis for selecting the ED over a primary care facility, which our data did not support.[4,15-17] Also, in contrast to our findings, several studies found a significantly higher number of ED visits reported by African-Americans, uninsured patients, and other payment groups.[4,15,17,18]

Such apparent inconsistencies may be explained by study design, specifically how one defines outcome variables. In our study, we defined barriers to primary care by measuring 3 common parameters: payment, transportation, and time off work; however, sociocultural factors, child care concerns, availability of local providers or, as 1 study demonstrated, distrust of healthcare providers can impede access to primary care and inform patients' preference for site of care.[9] In support of our findings, 1 survey study employed the same definition of access barriers and found that independent of race, patients reported difficulties in all parameters, yet African-Americans were more likely than Caucasians to report use of the ED for their health concerns.[4] Moreover, Gornick et al[19] showed that minorities, despite having Medicare, have higher use of acute care services than white patients with Medicare.

We can speculate the reasons underlying an association between site of care and patient populations. For uninsured patients, it seems plausible that the ED is the only alternative place for care. Indeed, the percentage of physicians providing charity care has dropped in recent years and the Emergency Medical Treatment and Active Labor Act (EMTALA) ensures that vulnerable populations receive medical care, regardless of ability to pay.[20] The concept of usual place of healthcare in the African-American population is less clear. Our study could not explain the difference between races by health insurance, barriers to primary care, or patient perception of health; however, unmeasured factors must be considered. Reasons for frequent ED use cited previously include unmet medical needs, dissatisfaction with the choice of a primary care provider, and anticipated expediency.[21] Physician supply in proximity to patient's residence, the strength of the patient-physician relationship, and sociocultural factors may also account for racial differences in routine place of care.[2,9] Moreover, disparity in patient presentation may contribute, as a recent study in *Archives of Surgery* showed that after controlling for socioeconomic status, African-Americans were more likely than Caucasians to present with acute hernia complications requiring emergent surgery.[22] Despite African-Americans disproportionately selecting the ED as their routine place of care, as noted in Table 4, the African-American patients in our study reported a similar frequency of ED visits in recent months as white patients. The most obvious explanation for this finding is that many factors in addition to preferred place of healthcare influence an individual's frequency of ED use, including age, underlying illnesses, and health emergencies. These variables, as well as other unmeasured factors, may have narrowed any difference in ED use among African-Americans and whites in our study population. For 3 or more visits to the ED, the racial disparity widened, although not statistically significant, and the reason for this difference remains unclear. Perhaps, racial differences for frequency of ED visits are only statistically evident among patients who visit the ED at a rate greater than our study examined.

LIMITATIONS

Our findings must be interpreted in the context of several limitations. This single-site study surveyed a limited patient population over a 2 month time block. The findings may not generalize to other hospital locations, demographic populations, or seasons of the year. We chose to include only Caucasians and African-Americans because this racial makeup reflects the majority of our ED population. Other groups were difficult to include due to underrepresentation at our ED. However, conducting a study with non-English speakers and racial groups besides Caucasians and African-Americans would reflect today's multiracial society and provide a more comprehensive answer to the study's question. A survey study limits participants to responses pre-constructed by the research investigators; an interview would be less feasible in the ambulatory setting, but this alternative method of data collection could provide greater insight into the rationale behind an individual's health-seeking behavior. Patient-reported data from a cross-sectional survey, moreover, is difficult to verify and only represents the patient's response at the time the survey was completed.

CONCLUSION

Race, independent of insurance status, is a significant predictor for where patients report they prefer to obtain medical care. The finding that African-Americans prefer to access care through the ED is informative to patient counseling and the discourse on healthcare reform. From our data it does not appear that providing insurance coverage alone will change patterns of access to healthcare. This study illustrates the need for patient education regarding the appropriate uses of ambulatory care in African-American and uninsured populations. Such a change in access to healthcare would reduce patient volume in the ED and hospitalization rates, improve face time between patient and provider, and by

extension enhance the quality of patient-centered care in the ED. Future research needs to extend beyond this observational study to investigate strategies and practical applications for improving access to healthcare for all racial groups.

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How Frequently are "Classic" Drug-Seeking Behaviors Used by Drug-Seeking Patients in the Emergency Department?

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Introduction: Drug-seeking behavior (DSB) in the emergency department (ED) is a very common problem, yet there has been little quantitative study to date of such behavior.The goal of this study was to assess the frequency with which drug seeking patients in the ED use classic drug seeking behaviors to obtain prescription medication.

Methods: We performed a retrospective chart review on patients in an ED case management program for DSB. We reviewed all visits by patients in the program that occurred during a 1-year period, and recorded the frequency of the following behaviors: complaining of headache, complaining of back pain, complaining of dental pain, requesting medication by name, requesting a refill of medication, reporting medications as having been lost or stolen, reporting 10/10 pain, reporting greater than 10/10 pain, reporting being out of medication, and requesting medication parenterally. These behaviors were chosen because they are described as "classic" for DSB in the existing literature.

Results: We studied 178 patients from the case management program, who made 2,486 visits in 1 year. The frequency of each behavior was: headache 21.7%, back pain 20.8%, dental pain 1.8%, medication by name 15.2%, requesting refill 7.0%, lost or stolen medication 0.6%, pain 10/10 29.1%, pain greater than 10/10 1.8%, out of medication 9.5%, and requesting parenteral medication 4.3%. Patients averaged 1.1 behaviors per visit.

Conclusion: Drug-seeking patients appear to exhibit "classically" described drug-seeking behaviors with only low to moderate frequency. Reliance on historical features may be inadequate when trying to assess whether or not a patient is drug-seeking. [West J Emerg Med. 2012;13(5):416-421.]

INTRODUCTION

Pain is cited as the most common reason for visits to the emergency department (ED).[1-3] In 1997, 94.9 million ED visits, accounting for 22% of all ED visits, resulted in the administration of pharmacotherapy for pain.[4] Despite the frequent use of pharmacotherapy, many studies have suggested that emergency physicians (EP) undertreat patients' pain in what is termed oligoanalgesia.[5] While there are numerous reasons for which EP are hesitant to provide opiate analgesia, concern for patients seeking medication for non-therapeutic purposes is among the most common.[3,6-9] Such patients are estimated to account for as many as 20% of all ED visits, and are often labeled as "drug-seeking." Furthermore, they often present with conditions that are difficult to evaluate and easily feigned, such as headache, back pain, and dental pain.[8-11]

Despite their prevalence, there is no uniform method established to identify these drug-seeking patients. Some ED have developed habitual patient files and case management programs to track patients with frequent use of emergency care, while others have increased physician education as a means to improving identification of these patients.[8,10,12-16] Additionally, several screening methods (Screener and Opioid Assessment for Patients with Pain - Revised, Opioid Risk Tool, Current Opioid Misuse Measure, Diagnosis, Intractability, Risk, and Efficacy inventory, and Addiction Behaviors Checklis) have been developed to assist in identifying problematic narcotic use in chronic pain patients. However, these screening methods were developed in pain clinics and may be lengthy, making them difficult to use in the ED.[17-24] Uniform among all of these approaches is the reliance on the identification of drug-seeking behavior as a means of identifying problem patients. Such behaviors frequently cited as being present in ED patients include complaining of headache, back pain, dental pain, requesting medication by name, requesting a refill of narcotics, benzodiazepines, or muscle relaxants (high risk medications for abuse[HRM]), reporting HRM as having been lost or stolen, reporting being out of HRM, reporting greater than 10/10 pain, and requesting HRM parenterally. While there is a preponderance of publications on the subject of drug-seeking patients, there is very little literature that quantifies the prevalence of these behaviors.[10,25-29] By identifying the frequency of these drug-seeking behaviors we can begin to understand whether our current approach in identifying these patients is both effective and substantiated.

Previously, we reported what we believe to be an innovative study that provided quantitative data as to the relative frequency of drug-seeking behaviors in patients suspected of non-therapeutic use.[29] This case- control study proved instructive in identifying the most common classic drug-seeking behaviors, which included requesting parenteral medication and reporting greater than 10/10 pain. The study did not, however, assess the prevalence of these classic drug-seeking behaviors among drug-seeking patients. Our goal for this investigation was to assess the frequency with which drug seeking patients in the ED use classic drug-seeking behaviors to obtain prescription medication.

METHODS

This study consisted of a retrospective chart review performed at a 205-bed community hospital that receives approximately 55,000 ED visits each year. The hospital is located in a suburban area, in a city of approximately 30,000 people. The hospital also serves several neighboring cities, serving a total of approximately 100,000 people in the area. This study was given Institutional Review Board (IRB) exemption by the hospital committee on research

The hospital ED has a case management program that functions to assist in the care and management of difficult patients in the ED, particularly those patients frequently seeking emergency care for problems related to prescription medication addiction. Patients may be considered for enrollment in this program if they are identified as having 5 or more visits in a 1-month period or if any member of the ED staff is concerned about repetitive use of the ED for drug-seeking behavior. Furthermore, any patient identified by the California Bureau of Narcotic Enforcement as having committed prescription forgery or fraud is automatically enrolled in the program. As the criteria for enrollment in the program are not strictly defined, the reason for enrollment is not kept in the patients' case management files. While not all patients in the case management program are enrolled for problems related to substance abuse, nearly 95% of the patients have a case management care plan that limits the prescription of controlled substances or referral to chemical dependency.[15] The goal of the case management program is not to capture all drug-seeking patients in the ED; rather, it is to address the patients with excessive ED use secondary to drug-seeking behavior and other issues.

Inclusion criteria for patients in our study were the following: any patient enrolled in the case management program that was given a referral to chemical dependency and any patient enrolled in the case management program that had a care plan involving limitation of narcotics, benzodiazepines, or muscle relaxants.

Exclusion criteria for patients in our study were the following: all patients enrolled in the case management program whose care plans did not involve either a chemical dependency evaluation or limitation of narcotics, benzodiazepines, or muscle relaxants. We did not exclude patients with known painful chronic medical conditions.

For each of the patients that met our inclusion criteria, we reviewed all visits to the ED for a 1-year period prior to enrollment in the case management program. Patient medical records were accessed using the hospital's medical record system, Horizon Patient Folder (McKesson, 2002), and all physician and nurse documentation for each visit was carefully reviewed. For each patient, we recorded the number of times that patients exhibited any of the 10 behaviors listed in Table 1. As this study was a retrospective chart review, physicians and nurses treating these patients were not expected to look for or document the presence or absence of these behaviors; rather, we recorded the number of times these behaviors were documented in the medical record. If 2 (or more) behaviors occurred at a single visit, then both (or more, if present) behaviors were recorded as individual events. Furthermore, we only looked at each drug-seeking behavior in isolation. We did not record the number of visits at which a patient demonstrated multiple behaviors.

These 10 behaviors were chosen for assessment as they represent drug-seeking behaviors frequently reported in the literature, and are often described as being "classic" for such behavior.[10-12,25,30-32] While certain behaviors commonly

Table 1. List of studied behaviors.

Behaviors
Complaint of headaches
Complaint of back pain
Complaint of dental pain
Request for narcotic, benzodiazepine, or muscle relaxant medication by name
Requesting a refill of narcotic, benzodiazepine, or muscle relaxant medication
Reporting that narcotic, benzodiazepine, or muscle relaxant medication had been lost or stolen
Reporting ten-out-of-ten pain
Reporting greater than ten-out-of-ten pain
Reporting being out of narcotic, benzodiazepine, or muscle relaxant medication
Requesting medication parenterally

Table 2. Demographic information of study group.

Characteristic	Number	Percentage (%)
Male	61	34.3
Female	117	65.7
White	121	68
African-American	25	14
Latino	21	11.8
Asian	4	2.2
Other ethnicity	7	3.9
Medicaid	54	30.3
Medicare	39	21.9
Commercial insurance	34	19.1
Workers compensation	6	3.4
Military	5	2.8
Veterans administration	3	1.7
Other insurance	2	1.1
No insurance	35	19.7
Has primary care doctor	156	87.6
No primary care doctor	22	12.4

associated with drug-seeking behavior, such as headache and reporting a non-narcotic allergy, are easy to assess in a chart review, behaviors such as exaggeration of symptoms are not. We thus chose to look for complaining of 10/10 pain and complaining of greater than 10/10 pain as measurable equivalents to assess for exaggeration of symptoms.

Due to limitations on access to the hospital's medical record system, each chart was reviewed by a single physician reviewer. To standardize the chart review and data collection process, we collected and entered data into a pre-formatted Excel spreadsheet (Microsoft, 2007) consisting of 1 column for patient medical record number followed by 10 columns (one for each studied behavior).

Once data collection was complete, we analyzed the data using Excel (Microsoft, 2007). For each of the 10 behaviors studied, we tallied the total number of times each behavior was exhibited. We then calculated the percentage of total visits at which patients in our study demonstrated each behavior, as well as a 95% confidence interval for each calculated percentage.

RESULTS

Review of patients in the case management program identified 178 patients meeting inclusion criteria. The average age of studied patients was 42.7 years, with complete demographic information listed in Table 2. These 178 patients contributed to 2,488 visits to the ED in the 1-year prior to enrollment in the case management program, which represented an average of 13.9 visits per patient per year. We recorded that our studied behaviors occurred 2,775 times in total, which corresponds with a calculated average of 1.1 behaviors per visit.

The frequency of each of the classic drug-seeking behaviors is outlined in Table 3. The most prevalent classic drug-seeking behavior was complaint of 10/10 pain, followed by complaint of headache, and then complaint of back pain. The least prevalent behavior was complaint of lost medication.

DISCUSSION

In this study, which represents one of the largest groups of drug-seeking ED patients studied to date, we found that drug-seeking patients appear to exhibit "classically" described drug-seeking behaviors relatively infrequently. In reviewing this data, it appears that relying on the presence of any single one of our studied behaviors would be of low sensitivity to identify drug-seeking patients in the ED. As such, EP may attempt to use the presence of multiple drug-seeking behaviors to identify patients presenting to the ED to obtain prescription medications. However, our patients demonstrated approximately 1.1 drug-seeking behaviors per ED visit, which suggests that multiple behaviors at a single visit is a relatively uncommon event. Additionally, the behaviors most frequently used (headache, back pain, and 10/10 pain) are extremely common complaints in the ED, and are likely not very specific for the diagnosis of drug-seeking behavior. These results are concerning, as they suggest that utility of using historical features to identify drug-seeking patients in the ED is limited. Reliance on any single historical feature to identify drug-seeking patients is likely inadequate as a result of the low frequency of each behavior. Furthermore, reliance on

Table 3. Frequency of classic drug-seeking behaviors among emergency department drug-seeking patients.

Studied behavior	Total	Percent of total visits	95% Confidence interval
Complaint of 10/10 pain	724	29.1	27.3-30.9
Complaint of headache	539	21.7	20.1-23.3
Complaint of back pain	516	20.8	19.2-22.4
Medication by name	377	15.2	13.8-16.6
Complaint of out of medication	235	9.5	8.3-10.6
Chief complaint of refill	174	7.0	6.0-8.0
Request for parenteral administration	106	4.3	3.5-5.1
Complaint of dental pain	45	1.8	1.3-2.3
Complaint of 10+ pain	44	1.8	1.3-2.3
Complaint of lost medication	15	0.6	0.3-0.9

the presence of multiple historical features is inadequate as a result of the low frequency with which multiple behaviors are used at a single visit.

Our results are particularly important in the context of nonmedical use of prescription medication reaching near-epidemic proportions in the United States, especially that of narcotics and benzodiazepines. Approximately 7 million Americans over the age of 12 use prescription medications for non-therapeutic reasons each year, and non-medical use of prescription medications leads to upward of 700,000 ED visits yearly.[33,34] Furthermore, death from narcotic overdose has more than tripled between 1999 to 2006, with nearly 14,000 opiate-related deaths in 2006. Research on opiate-related deaths has shown that patient non-adherence and underlying substance use disorders are 2 of the major factors contributing to prescription-misuse related mortality.[35] Prescription misuse is particularly common in the ED, with up to 20% of all ED visits being made by drug-seeking patients.[4] This unfortunate situation places an impetus on EP to be vigilant and skilled in detecting patients trying to obtain medications for non-therapeutic reasons. With the data from this study demonstrating the inadequacy of history alone in detecting drug-seeking patients, EP are in dire need of a better way to identify patients who are trying to obtain narcotics for non-therapeutic reasons. The vast majority of states in the U.S. now have state-run prescription monitoring programs, which allow physicians and pharmacists to access a patient's prescription record for controlled substances. Previous research by Baehren et al has demonstrated that access to such prescription monitoring programs in the ED affects EP prescribing behaviors, but research on the use of such programs in the ED is extremely limited.[36] As it pertains to the results of this endeavor, none of the physicians at our study site had access to such a database during the time of study.

Further research on the use of prescription monitoring programs in treating drug-seeking patients in the ED is imperative, as it may allow EP to better detect addiction in the ED. Potentially useful research on the topic includes how to interpret the information obtained in a prescription monitoring record when assessing a patient presenting to the ED, whether or not the routine use of prescription monitoring programs increases detection of drug-seeking patients in the ED, and an assessment of the accuracy of EP in diagnosing drug-seeking behavior by comparing EP clinical assessment of drug-seeking to the prescription record.

One major difficulty in studying patients suspected of drug-seeking behavior is that there is no way to definitively determine the motive of the patient s trying to obtain prescription medication. Pseudoaddiction is a condition resulting from inadequate pain management, in which patients may exhibit "classic" drug-seeking behaviors to obtain medication so as to relieve their pain. Once a patient's pain is adequately treated, the patient's drug-seeking behaviors cease. Unfortunately, the behaviors used by patients seeking prescription medication who are suffering from pseudoaddiction are extremely difficult to differentiate from those of patients with prescription medication addiction, particularly in the acute care setting.[30] As a result, we made no attempt in our study to determine the cause of a patient's behaviors, and simply focused on the different behaviors associated with drug-seeking regardless of the cause.

Lastly, it is important to consider whether or not the data presented here may be comparable to patient populations at other sites. Previous research by McNabb et al on a group of 37 drug-seeking patients at an urban tertiary care center consisted of approximately 50% males, with an average age of 39.5 years.[27] Furthermore, previous research by Zechnich et al on a group of 30 drug-seeking patients at an urban academic medical center consisted of 50% males, with an average age of 34.3 years.[10] Our study population consisted of more women and was slightly older than these 2 populations, but does not seem to vary markedly from these 2 previous study groups.

The institution from which our data comes is a community hospital in a moderate-sized suburban city, which likely makes it most applicable to other community hospitals in such a setting.

LIMITATION

Our study had several limitations, which should be taken into consideration when reviewing the data presented. First, in performing a chart review, the quality of the data is dependent on the quality of physician and nursing documentation, which may lack completeness or uniformity. It also may be biased in that a care provider who suspects a patient is drug-seeking may be more likely to document particular behaviors or actions. Possible variations in the quality of the documentation by physicians and nurses could also be attributed to experience level, burnout, familiarity with the patient, overall patient load, and time needed to document drug-seeking behaviors appropriately.

Second, it is nearly impossible to assess whether or not our patients were suffering from addiction or pseudoaddiction, as both groups may exhibit drug-seeking behavior. As such, we do not know the prevalence of pseudoaddiction in our study group, which may limit how applicable our data is to the consideration of addiction in the ED. As mentioned above, the prevalence of drug-seeking behaviors in our study might not be generalizable to other drug-seeking patient populations, such as those seeking to sell medication for profit. Additionally, frequent users may decide not to come into the ED based on a particular physician or nurse working at the time, which could impact the prevalence of documented behaviors.

Third, the patients in our study consisted of patients exhibiting drug-seeking behavior who were also predominantly frequent users of a single ED. Our results may be poorly applicable to drug-seeking patients making a single visit to an ED or patients who frequent multiple ED. Additionally, we used patients in an existing case management program as our study population. Enrollment criteria for this program were not clearly defined and included physician or nursing concern as enrollment criteria, which may have been a source of bias in selecting our study group. As it pertains to the methodology of our research, we used a single physician reviewer to perform data abstraction from all charts, which may have been a source of bias. Finally, we only looked at each drug-seeking behavior in isolation. We did not record the number of times a patient exhibited more than 1 behavior at a single visit.

The authors recognize that there are several limitations to the study, which provides the possibility for bias and error in a number of places. However, when trying to study a condition (drug-seeking behavior) for which there is no confirmatory test or diagnostic criteria, conducting research is difficult. While our study design and methodology has a number of limitations unrelated to the behaviors we are trying to study, our hope is that we can provide some preliminary data on a subject of increasing public health concern and a subject that will require much research in the future. We hope that our study can be hypothesis-generating for other researchers.

Directions for future research

Despite the limitations of this study, our data suggests that the reliance on the use of classic drug-seeking behaviors may only help identify a minority of drug-seeking patients. Although prospective research is needed to confirm these results, the data begin to illuminate a much larger question of whether our reliance on the use of drug-seeking behaviors as a means of identifying drug-seeking patients is an efficient and reliable method to decrease irresponsible administration of narcotics. Moreover, there are unintended consequences of our system's current reliance on the use of drug-seeking behaviors as a primary means of identifying these patients. Research suggests that our current ED culture is resulting in the undertreatment of those patients who actually require narcotics to achieve effective and responsible pain control, such as patients with pseudoaddiction.[9]

As more research continues to highlight the issues associated with responsible pain control in the ED and throughout the healthcare system, there are foreseeable steps in achieving this reality. The ED culture should begin to create a more systematic approach to addressing pain. If a patient presents to the ED with a pain severity requiring narcotics administration, the EP should consider checking his or her habitual patient files/case management program or prescription monitoring record. This can empower the physician to help identify true drug-seeking patients instead of relying simply on the seemingly unreliable classic drug-seeking behaviors. We plan to research whether the use of a habitual patient files/case management program/or alternative data system is a more reliable method of identifying these patients.

CONCLUSION

Drug-seeking patients appear to exhibit "classically" described drug-seeking behaviors with only low to moderate frequency, with each of the studied behaviors in this study being recorded as present in less than one third of all ED visits. This data suggests that reliance on historical features of a patient encounter may be inadequate when trying to assess whether or not a patient is drug-seeking.

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

Prescription Drug Monitoring Programs and Other Interventions to Combat Prescription Opioid Abuse

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

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The Center for Disease Control and Prevention (CDC) has published significant data and trends related to opioid prescription pain relievers (OPR). In 2008, 20,044 deaths were attributed to prescription drug overdose of which 14,800 (73.8%) were due to OPR, an amount greater than the number of overdose deaths from heroin and cocaine combined. The majority of these deaths were unintentional. Between 1999-2008, overdose deaths from OPR increased almost four-fold. Correspondingly, sales of OPR were four times greater in 2010 than in 1999. Most significant to emergency physicians is the estimate that 39% of all opioids prescribed, administered or continued come from the emergency department (ED). We present findings from the CDC's Morbidity and Mortality Weekly Report (MMWR) with commentary on current recommendations and policies for curtailing the OPR epidemic.[1] [West J Emerg Med. 2012;13(5):422-425.]

CDC MMWR FINDINGS

In the November 4, 2011, issue of the Morbidity and Mortality Weekly Report (MMWR), the CDC published data and trends related to opioid prescription pain relievers (OPR). The MMWR article mainly examined figures related to overdose deaths from prescription OPR, while also discussing usage among different demographics and U.S. states. The report clearly demonstrated that deaths from opioid painkillers have continued to increase along with several other concerning trends.

To gather data related to overdose deaths, the CDC used the "multiple cause-of-death mortality files," a subset of data from the National Vital Statistics System database (maintained by the National Center for Health Statistics). The "multiple cause-of-death mortality files" provides mortality data by cause of death for all deaths occurring in the United States (U.S.) from 1959 – 2009. Data are obtained from death certificates filed in the National Vital Statistics System offices in each state and the District of Columbia. CDC researchers accessed these data between 1999 and 2008 and were able to sort causes of death due to drug overdose, prescription drug overdose and overdose related to OPRs by using ICD-10 (*International Classification of Disease – 10th edition)* codes.

In 2008, 36,450 deaths were attributed to drug overdose, of which 27,153 were due to identifiable drugs. Of the 27,153 deaths attributed to identifiable drugs, 20,044 (75%) involved one or more prescription drugs. OPR were involved in 14,800 (73.8%) of the 20,044 deaths related to prescription drug overdose. The majority of these deaths were listed as unintentional, versus suspected suicide or undetermined. Between 1999-2008, overdose deaths from OPR increased exponentially; overdose deaths attributed to OPR were almost four times greater in 2008 than in 1999. Correspondingly, sales of OPR were four times greater in 2010 than in 1999.[1]

Data from the MMWR showed that deaths due to OPRs were not uniform across demographic groups. OPR overdose deaths in 2008 seemed to be significantly greater among men (5.9/100,000 population) than women (3.7/100,000). OPR overdose death rates in 2008 among Non-Hispanic whites (6.3/100,000 population) and American Indians/Alaska Natives (6.2/100,000) were approximately 3 times higher than Hispanics (2.1/100,000) and blacks (1.9/100,000) and

approximately 12 times greater than Asians/Native Hawaiians/Pacific Islanders (0.5/100,000). This is in contrast to overdose death rates for illicit substances, where the rates among blacks (4.0/100,000) were significantly greater than Non-Hispanic whites (2.9/100,000), Hispanics (2.5/100,000) American Indians/Alaska Natives (2.7/100,000) and Asians/Native Hawaiians/Pacific Islanders (0.6/100,000). Differences in OPR overdose mortality by race/ethnicity match the pattern for medical and nonmedical use of OPRs, with the lowest rates for medical and nonmedical use among Asians and blacks and the highest rates among American Indians/Alaska Natives and non-Hispanic whites. By age, the overdose death rate due to OPR was substantially higher for those ages 25-54 then other groups.[1]

Additional data from the MMWR showed that trends in OPR sales, OPR use for non-medical purposes and total drug overdose deaths varied widely across states. In 2010, the 5 states with the highest levels of OPR sales were: Florida (12.6 kg OPR sold/100,000 population), Nevada (11.8/100,000), Tennessee (11.8/100,000), Oregon (11.6/100,000) and Delaware (10.2/100,000). From 2008 to 2009, the 6 states with highest rate of persons age 12 and older using OPR non-medically were: Oklahoma (8.1 persons age 12 or older/100,000 population), Oregon (6.8/100,000), Washington (6.1/100,000), Rhode Island (6.1/100,000), Arizona (6.0/100,000) and Kentucky (6.0/100,000). In 2008, the 5 states with the highest rate of drug overdose deaths were New Mexico (27.0 deaths /100,000 population), West Virginia (25.8/100,000), Nevada (19.6/100,000), Utah (18.4/100,000) and Alaska (18.1/100,000).[1]

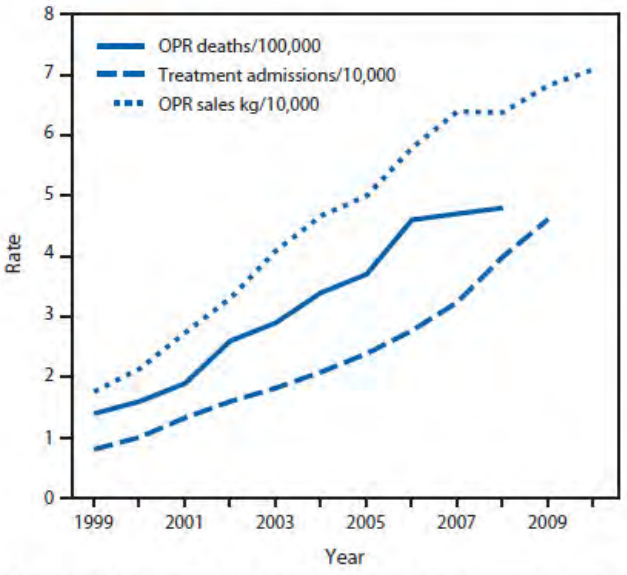

Figure 1. Rates of opioid pain reliever overdose death, treatment admissions and kilograms of opioid pain relievers sold in the United States, 1999 – 2010.[1]

It is instructive to compare the rates of overall drug overdose deaths with rates of non-medical use and sales. One would expect those states with high non-medical use rates and high OPR sales to be more likely to have above average overdose death rates. Indeed, that appears to be the case. Among the 27 states with drug overdose death rates above the national rate, 21 (77.8%) had rates of nonmedical use of OPR above the national rate. Among the 24 states with drug overdose death rates at or below the national rate, only 6 (25.0%) had rates of nonmedical use of OPR above the national rate. Among these same 27 states with drug overdose death rates above the national rate, 21 (77.8%) had rates of OPR sales above the national rate. Among these same 24 states with drug overdose death rates at or below the national rate, only 5 (20.8%) had rates of OPR sales above the national rate.[1]

The CDC stated that there are limitations to the findings in the MMWR. Vital Statistics information underestimates the rates of prescription and illicit drugs because the type of drug is not specified on many death certificates. Additionally, respondents might underreport nonmedical use of OPR in surveys.

COMMENTARY

A clinical scenario frequently encountered by many emergency physicians (EP) follows: A 27-year-old woman is brought in by ambulance to the ED with a Glasgow Coma Scale score of 5. EMS found the patient unresponsive at her home with shallow respirations at 5 per minute. The patient has pinpoint pupils, suggesting opioid overdose. The patient is given multiple rounds of intravenous naloxone that succeed in reversing the overdose and resuscitating her. This clinical scenario is not unfamiliar to most EDs, but a fact that may not be known is that there is over a 50% likelihood that the opiates causing the overdose were legally manufactured prescription painkillers.[1] The CDC estimates that 14,800 deaths in 2008 were due to OPRs, a figure which is greater than the number of deaths attributed to heroin and cocaine combined.[1] Perhaps most significant to EPs is the estimate that 39% of all opioids prescribed, administered or continued come from the ED.[2]

Although our patient was successfully resuscitated, many patients are not as fortunate. It is believed that the number of overdoses due to OPRs have nearly quadrupled over a 10-year period from 1999 – 2008.[1] This increase in overdose deaths seems directly correlated with the large increase in sales of prescription opioids, which also quadrupled between 1999 – 2010.[1] The CDC estimates that in 2010 enough OPRs were sold to medicate every American with a typical 5 mg dose of hydrocodone every 4 hours for 1 month.[1] It is clear that prescription opioid abuse, dependence and overdose are growing epidemics that will continue to claim lives unless interventions are made.

There are a number of potential reasons for the increase in incidence of opiate abuse and dependence in the U.S. A

possible major driving factor of the epidemic is that OPRs are a legally available alternative to illicit substances, such as heroin, and also have the potential to create euphoria and addiction. It is likely that many patients with chronic pain misrepresent their need for OPRs and then either abuse their obtained medications or sell them to others.[3] Ultimately, it is prescriptions written by physicians that enable such patients to have access to drugs with a high potential for abuse. Physicians face the difficult challenge of balancing the treatment of legitimate chronic pain patients with combating the OPR epidemic that is claiming so many lives.

To manage this issue, health policy analysts at the CDC have listed several recommendations. Of these recommendations, the one that has significant potential for assisting EPs in curtailing the epidemic is the use of Prescription Drug Monitoring Programs (PDMPs). PDMPs are state-run electronic databases that track the prescribing and dispensing of controlled prescription drugs to patients. The PDMPs enable physicians to assess whether patients have received unusually high or excessive amounts of controlled substances in the past and adjust their prescribing decisions accordingly. The CDC also believes PDMPs will enable physicians to control "Doctor Shopping," the practice where pain-medication seeking patients visit many different physicians (oftentimes in multiple states) to obtain prescriptions.[1] The CDC recommends that PDMPs link to electronic health-records systems, so that PDMP information is better integrated into healthcare providers' day-to-day practices. These recommendations have already been adopted by many hospitals, and professional organizations such as the American College of Emergency Physicians (ACEP) have actively encouraged members to integrate PDMP usage into their general practice.[4]

One study has monitored how PDMPs influence EP prescribing practices; Baehren et. al in 2008 examined the effect of the Ohio state PDMP, the Ohio Automated Rx Reporting System, on ED prescribing practices. This study of 179 patients was conducted at one ED in Ohio and found that EPs changed their prescription decision after accessing the state PDMP in 41% of the cases. In 61% of the cases where the EP's original decision was altered, fewer or no opioid medications were prescribed than originally planned. In 39% of the cases where EPs altered their original decision, more opioid medications were prescribed than previously planned.[5] The results of this study indicate that PDMPs have the potential to assist physicians in making more judicious decisions when prescribing opioid pain medications. More clinical research and data is needed to measure the impact of these statewide PDMPs, as another study found that states with PDMPs already in place had no significant decrease in the number of overdose deaths from opioids.[6] This suggests that physician education in an attempt to change practice patterns can be an effective way to maximize the clinical utility of PDMPs. If PDMPs are shown to be an effective means of appropriately managing prescribing of OPRs, national and statewide efforts to incentivize physicians to use PDMPs are viable future strategies for controlling OPR abuse.

The CDC also believes that physician education regarding use of OPR is another important strategy to control the prevalence of OPR abuse and overdose. On a national level, the CDC has suggested mandatory prescriber education, including requiring prescribers to be trained in appropriate prescribing of opioids before obtaining their controlled substance registration from the Drug Enforcement Administration (DEA).[3] This recommendation has already been listed as a planned action item in the Presidential 2011 report on the prescription opioid epidemic. Another planned intervention listed in the report is collaborating with appropriate medical boards to institute required educational curricula in health professional schools and using continuing medial education programs to teach the safe and appropriate use of OPR. The report also included working with the American College of Emergency Physicians to develop evidence-based clinical guidelines that establish best practices for opioid prescribing in the ED.[7]

Other recommendations made by the CDC (which are outside the typical day-to-day practice of physicians) also show significant promise in combating the OPR abuse epidemic. These recommendations include instituting regulations against rogue pain clinics, or "pill mills," and practitioners who unethically dispense prescription pain medications. There have already been efforts at both the federal and statewide level to take actions against these unscrupulous distributors of prescription medication. The Drug Enforcement Administration has worked alongside state and municipal law enforcement agencies to shut down rogue pain clinics and prosecute the physicians that work for them. In the state of Florida alone, 477 illegal pain clinics have been shut down by authorities over the last 2 years.[8] A 2011 report by the American College of Surgeons details how a number of states have instituted regulations against pill mills and penalties against healthcare workers that deviate from state specific guidelines for prescribing controlled substances. Louisiana has instituted its own guidelines for pain clinics under a Pain Management Clinic Law; violation of the law can result in a fine up to $50,000 or a 5-year prison sentence. Texas rogue pain clinic laws make it illegal to own or operate a pain clinic without certification from the Texas Medical Board and owners and employees must go through a background check. The state of Florida has passed legislation that establishes standards for physicians who prescribe narcotic-grade pills. This same legislation increased penalties against physicians who overprescribed narcotics to a minimum of $10,000 and a 6-month license suspension. The law also bans physicians from on-site dispensing of the most abused pills, including oxycodone and hydrocodone.[9] Some states have sought more severe charges against unethical

physicians; a Southern California physician, who wrote 27,000 prescriptions for opiates and benzodiazepines over a 3-year period, is being prosecuted for second-degree murder in relation to overdose deaths. If convicted, this physician faces a 45-year prison sentence.[10]

In addition to increased regulation and use of PDMPs, the CDC also recommends states increase access to substance abuse treatment programs. Although the CDC has not given specific recommendations, several initiatives are being reported nationwide to improve access. The newly passed Affordable Care Act requires coverage for substance abuse services by health insurance plans.[11] The 2011 Presidential report on the prescription opiate epidemic set a goal of expanding funding for substance abuse treatment by 10% over the next 36 months.[7] Eleven states have taken measures to allow Vivitrol (Naltrexone) to be more easily available to physicians by allowing pharmacies to bill Medicaid directly for reimbursement (versus having physicians who administer the medicine pay for it out of pocket and then seek reimbursement from Medicaid).[12] In 2006 Congress passed legislation that made Suboxone (buprenorphine) another drug used in detox from opiates, more accessible to patients needing substance abuse treatment. The new legislation increased the limit of patients per physician that may receive Suboxone from 30 to 100.[13] Since 2010 the state of Maryland expanded access to substance abuse treatment services by increasing service reimbursement rates to Medicaid providers and expanding benefits of state substance abuse program to include outpatient substance abuse treatment.[14] These are all examples of federal and statewide efforts to increase access to substance abuse treatment programs. However, due to the alarming rate of growth of the OPR epidemic, it is clear that more will need to be done across the nation to treat those already struggling with opiate addiction.

In summary, abuse of prescription opiates and corresponding overdose deaths are rapidly growing issues for our society. Many of the CDC's recommendations to combat the epidemic have been adopted at both the federal and state level. Because a large number of prescriptions for these medications come from EDs, emergency physicians will be at the forefront of efforts to control inappropriate prescription of opiate painkillers. PDMPs are promising tools that can be used by physicians to better control their prescribing practices.

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In the Soup: Caustic Ingestion from the Improper Consumption of a Self-Heating Soup

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INTRODUCTION

There are an estimated 5,000-15,000 caustic injuries resulting from ingestion per year in the United States, with bimodal peaks of incidence at <5 and between 20-30 years of age.[1,2] Most of these ingestions represent alkali exposures; however, in developing countries, acids are more readily available and result in more injuries.[1-3] The source of caustic exposure is commonly from household chemicals.[3-7]

We report a case of a caustic exposure presenting to the emergency department (ED) from the improper use of a food product. The ingested substance in our case was an alkali solution used to heat the product. OnTech® Hillside made several self-heating food product canisters, such as coffee and soup containers. These food canisters were marketed as a means for commuters, sports enthusiasts, and other people with no readily available heating source to have hot soups and drinks.[8] The top compartment of the can contains the food product and the bottom compartment has a calcium oxide heating element and a small bag of water. The underside of the bottom compartment has a peel-off metal lid concealing a button. Pushing down upon the button releases the water and activates the calcium oxide heating element, producing calcium hydroxide and heat. The 2 compartments remain separate, allowing the food compartment to be heated without mixing with the calcium hydroxide. The outside of the can has a small heat sensitive label that changes color when the product is at the proper temperature for consumption. After the ideal temperature is reached, the top of the container can be opened and the product can be consumed (Figure).

CASE PRESENTATION

The patient is a 54-year-old male who opened a can of OnTech® Hillside tomato soup one morning after consuming a large, but unquantified amount of alcoholic beverages. The patient says he opened the top food-containing compartment of the canister and poured the soup into a bowl. He subsequently cut open the bottom calcium oxide containing compartment of the canister with a pocket knife and combined

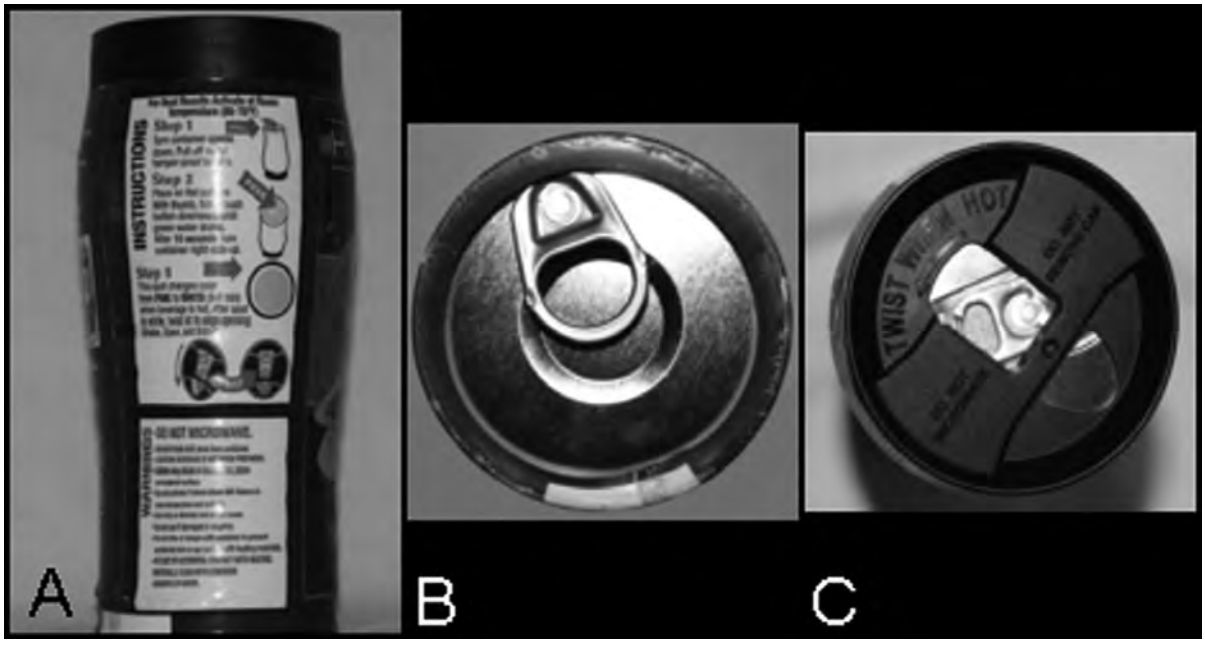

Figure. Self-Heating Soup Can. A) Side of can with instructions. B) Bottom of can. C)Top of can

the powdered heating element with the soup. Upon consuming the mixture, he stated he began feeling an intense burning sensation in the back of his throat. It was at that time he also noted that the mixture was getting hard "like plaster." He immediately drank a can of beer in an attempt to soothe the burning sensation.

About 45 minutes after the ingestion he reported to the ED complaining of pain with swallowing that radiated into his chest. He denied drooling, hoarseness, dyspnea, abdominal pain, nausea, vomiting, diarrhea, or bloody stools. He also denied any recent illness or history of odynophagia or chest pain. He had medical history significant for hypertension, chronic obstructive pulmonary disease, gastroesophageal reflux disease (GERD), and anxiety. His medications included olanzapine, lisinopril, lorazepam, omeprazole, verapamil, fluoxetine, and zolpidem. He stated that he consumes an unquantified amount of alcohol daily, smokes occasional marijuana, and is a former tobacco smoker. His review of systems was negative except for the presenting complaints.

On physical exam the patient appeared uncomfortable, but was in no acute respiratory distress. His breath smelled of alcohol, but he was alert, oriented, and appeared clinically sober. He was acting and conversing appropriately with good insight. His presenting vital signs were a blood pressure of 152/74 mm Hg, a pulse of 92 beats per minute, respirations of 18 breaths per minute, an oral temperature of 98.2^0 F, and a room air pulse oximetry reading of 95%. He showed no external signs of trauma and was not drooling. He was noted to have mild erythema in the posterior oropharynx, with no edema, blistering or exudate. He was able to swallow water, but experienced severe pain doing so. His neck was supple with no jugular venous distention, his lungs were clear to auscultation, and his cardiac exam revealed normal heart tones without murmurs. His abdominal examination revealed normal bowel sounds, soft, nontender, no rebound or guarding, no organomegaly, and his stool was negative for gross or occult blood. On neurological examination he was alert and oriented to person, place and time with no focal deficits.

After the initial history and physical exam, an intravenous (IV) line was placed and his pain was treated with intravenous fentanyl. A search of the product website revealed that the chemical powder contained calcium oxide, which forms calcium hydroxide and heat when mixed with water. This added concern for an alkali burn along with thermal burn. The Statewide Poison Control Center was contacted as it was not immediately clear what comprised the ingested powder. The Statewide Poison Control Center was not familiar with the product, but felt it may have contained an iron and charcoal compound that could produce an exothermic reaction when mixed with water. Their advice was to obtain a serum iron level, and treat the ingestion like a thermal burn.

He was found to have an iron level of 103 mcg/dl, a TIBC of 326 mcg/dl, a ferritin level of 131 ng/ml, a serum alcohol level of 135 mg/dl, a hemoglobin of 14.5 g/dl, a hematocrit of 42.0%, a total white blood cell count of 7, 900 cells/HPF, and platelets of 237,000. A comprehensive metabolic panel was normal except for slightly elevated glucose level of 167 mg/dl.

A chest radiograph was obtained and showed a normal cardiac and mediastinal silhouette, with no pneumomediastinum or abdominal free air. A noncontrast chest computed tomography (CT) showed no evidence of esophageal perforation or abnormality. The patient continued to have worsening pain in posterior pharynx radiating down to the chest, as well as odynophagia not well controlled with intravenous narcotic pain medication. The case was discussed with the oncall gastroenterologist and he was consulted for an emergent esophagogastroduodenoscopy (EGD). During the bedside EGD, the patient was found to have no esophageal perforation and no transmural or deep esophageal injury. Mild posterior oropharyngeal irritation and a non-erosive gastritis was noted, and not believed to be related to the ingestion. The patient improved and was subsequently discharged home with sucralfate for 7 days and gastrointestinal (GI) follow up in 1 week, at which time he was lost to follow up.

DISCUSSION

Generally, adult caustic ingestions are much more serious due to the suicidal intent and the large volume consumed.[1,3] Our presented case, as described, is an accidental ingestion of a caustic substance and therefore is not what is typically encountered with an adult caustic ingestion. The typical adult ingestion is a purposeful ingestion with suicidal intent using large consumed volumes.[1,3] Children account for about 80% of the accidental caustic ingestions and tend to be less severe due to the smaller volume consumed.[1,3]

No other cases of caustic ingestion due to improper consumption of self-heating soup were found on a search of Medline, Ovid, or the internet. This case was unique as it is the first documented human ingestion of a self-heating element together with a food product, despite clear labeling instructions for preparing the soup. The can states to flush with "generous amounts of water" in case accidental contact with heating material occurs, but makes no comment about what to do in case of accidental ingestion.

The pH of a caustic substance should be considered after any ingestion. A search of the product website did not reveal a pH of the calcium oxide heating element solution. However, according to a material safety data sheet (MSDS) for calcium oxide, a 1% solution has a pH of 10.[9] We were unable to determine what the exact concentration the solution was for this ingestion, but the pH was likely <12, although a determination was never conducted. It was most likely a small amount of the substance, and then diluted shortly after ingestion due to the burning sensation our patient felt, which reduced the concentration and contact time. Of interest,

this patient diluted the substance by drinking beer after the exposure. The beer consumption may have also had the benefit of removing any potential solid particles that may not have dissolved into solution from the mucosa.

Knowing the potential complications of caustic ingestions, emergency physicians should be aggressive in diagnostic staging if any adult or child presents with concerning history or findings. Hoarseness or stridor can indicate epiglottic or laryngeal involvement, and an evaluation and management of the upper airway should occur.[3] Dysphasia, odynophagia, abdominal pain, substernal chest pain, vomiting, and drooling are other worrisome findings that should prompt imaging and possibly endoscopy.[3,6,7] Endoscopy is generally considered safe immediately after caustic injury, but should be avoided 5-15 days after exposure due to mucosal sloughing and lack of collagen deposition during this time period.[3] There is conflicting evidence regarding diagnostic staging in pediatric ingestion. Some studies state that an asymptomatic child with accidental ingestion and no objective signs of injury can safely be discharged from the ED without EGD, while other studies recommend laryngoscopy and esophagoscopy 48 hours after all pediatric ingestions.[3,6,7] Unfortunately, the lack of symptoms has not been proven to preclude need for emergent endoscopy; therefore, clinical suspicion and the type and amount of the caustic ingestion must also be taken into account.[3,6]

In this case the pH, volume, concentration, and physical state of the ingested substance were not definitively known. Our patient continued to have worsening symptoms of odynophagia, and had objective erythema of posterior oropharynx. These signs and symptoms, coupled with a lack of established experience with the ingested substance, and the potential for long-term complications, determined our need for the emergent EGD.

There is also conflicting evidence and some controversy about the use of steroids and antibiotics after a caustic ingestion.[1,3,5,6] Some anecdotal evidence indicates that sucralfate is beneficial in stricture prevention.[3] Acid reflux may worsen a caustic injury, so acid suppression therapy in patients with GERD has been recommended.[3] Physicians may want to consider usage in all patients, due to the possibility that acid reflux can result from the injury itself.[3] We addressed acid suppression therapy in this case by encouraging compliance with his current PPI therapy, the addition of sucralfate and GI follow up.

CONCLUSION

We presented a case of an unusual caustic ingestion with a benign diagnostic EGD. Despite this patient having oropharyngeal erythema and prolonged odynophagia, only a minor injury was sustained from the ingestion. Given this presentation, future ingestions of this type and quantity are likely to be of low risk. However, this represents only one case report; clinical circumstances should still dictate management strategies.

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Development of a Data Collection Instrument for Violent Patient Encounters against Healthcare Workers

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Introduction: Healthcare and social workers have the highest incidence of workplace violence of any industry. Assaults toward healthcare workers account for nearly half of all nonfatal injuries from occupational violence. Our goal was to develop and evaluate an instrument for prospective collection of data relevant to emergency department (ED) violence against healthcare workers.

Methods: Participants at a high-volume tertiary care center were shown 11 vignettes portraying verbal and physical assaults and responded to a survey developed by the research team and piloted by ED personnel addressing the type and severity of violence portrayed. Demographic and employment groups were compared using the independent-samples Mann-Whitney U Test.

Results: There were 193 participants (91 male). We found few statistical differences when comparing occupational and gender groups. Males assigned higher severity scores to acts of verbal violence versus females (mean M,F=3.08, 2.70; $p<0.001$). While not achieving statistical significance, subgroup analysis revealed that attending physicians rated acts of verbal violence higher than resident physicians, and nurses assigned higher severity scores to acts of sexual, verbal, and physical violence versus their physician counterparts.

Conclusion: This survey instrument is the first tool shown to be accurate and reliable in characterizing acts of violence in the ED across all demographic and employment groups using filmed vignettes of violent acts. Gender and occupation of ED workers does not appear to play a significant role in perception of severity workplace violence. [West J Emerg Med. 2012;13(5):429-433.]

INTRODUCTION

Violence in the healthcare setting is not uncommon, and the emergency department (ED) has the highest rate of violence in the hospital.[1] In 2004 the Bureau of Labor Statistics released data collected from 1996-2000, reporting that nearly half of all acts of workplace violence occur in healthcare settings.[2] While often thought to be a phenomenon encountered primarily in large urban EDs, violent acts occur regardless of practice size and setting.[3] Many acts of violence towards staff go unreported as they are considered "part of the job." The ED is unique among healthcare settings in that it serves a higher proportion of patients suffering from substance abuse and psychiatric illness. EDs are frequently chaotic, crowded, and understaffed. Patients often wait hours for care and frequently occupy hallway beds, both of which can lead to frustration. Not infrequently, patients and their visitors carry weapons.[4]

Workplace violence influences job performance, retention, and stress.[5-7] Gates et al found that in the ED 25% of nurses seldom or never felt safe at work, and that there was a significant inverse relationship between feeling safe and job satisfaction.[7] This was supported by Kansagra et al[6] in a survey of 65 EDs that showed 25% of staff across all occupational groups felt safe sometimes, rarely, or never. Victims also experience more permanent scars as 1 study found that over one-third suffered psychological problems following assault.[8]

Kowalenko et al surveyed Michigan emergency physicians and showed that over a 1 year period 75% were

threatened verbally and 28% were physically assaulted.[9] Multiple survey-based studies have confirmed these high rates of violence against ED healthcare workers in the United States and internationally.[1,3-11]

Review of the literature reveals there are no studies that describe a validated tool or survey instrument that may be used to prospectively evaluate violence in the ED. Much of the literature relies on survey data and the bulk focuses on violence towards a single occupational group.[1,3,5-10] Additionally, most studies define violent acts as physical acts, neglecting the importance of verbal threats.

The purpose of this pilot study was to develop and evaluate a survey instrument (Figure 1) for prospective collection of data relevant to ED violence and to document ED personnel's perception of aggressive patient encounters based on filmed vignettes. This tool will enable investigation into environmental and behavioral factors surrounding violence against ED healthcare workers and may be used to potentially develop effective interventions to decrease the incidence and severity.

METHODS

All ED personnel employed at the time of the study initiation (April, 2008) at a large, tertiary care hospital were eligible. This study was specifically designed to incorporate all ED workers to assure that the survey instrument consistently and accurately captured the appropriate violent act regardless of gender or job title. Participants viewed 11 vignettes on-line or via DVD depicting acts of physical, sexual, and verbal violence of varying degrees of severity, and completed the survey instrument (Figure 1). They then rated the severity of the incident on a scale from 1-6, with 1 being "least" severe and 6 being the "most" severe. Participants were asked to use the following definitions when answering the survey questions about the vignettes:

> **Physical assaults** include hitting with body part, slapping, kicking, punching, pinching, scratching, biting, pulling hair, hitting with an object, throwing an object, spitting, beating, shooting, stabbing, squeezing, and twisting.
>
> **Physical threats** include actions, statements, written or non-verbal messages conveying threats of physical injury which were serious enough to unsettle your mind. It includes expressions of intent to inflict pain, injury, or punishment.
>
> **Verbal harassment** includes cursing, cussing, yelling at or berating a person in front of another, racial slurs, or humiliating and patronizing actions.
>
> **Sexual harassment** includes unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature, insulting gestures, whistling, jokes or humor about gender specific traits, offensive pictures, and offensive contact, such as patting, pinching, brushing against body, attempting or actual fondling, or kissing.

These definitions have been used in other studies to identify physical, verbal, and sexual assaults.[12] Participants were also informed that complaining and profanity alone without an imbedded threat, should not be considered a violent act.

Participants were over 18 years of age, and recruited via workplace e-mail. This study was approved by the University of Michigan Institutional Review Board.

We adapted the survey instrument from the questionnaire used by Kowalenko, et al,[9] which was originally designed to capture violent acts perpetrated against attending physicians in a retrospective manner and had many questions geared toward determining resources available, who was the perpetrator, and the physician's response to the acts. This study also looked at encounters outside the ED and incidents of stalking, neither of which were necessary in the current study's questionnaire given the real-time nature of the vignettes. The survey questions extracted from the Kowalenko et al[9] study were those that focused on demographics and the specific type of violent act. The instrument was further revised by members of the research team to ensure question clarity. It was then sent to an independent group of ED personnel, including an attending, resident, and nurses for suggestions and or revisions. The tool and vignettes were then piloted by several personnel prior to initiation of the study. Although these differences did not reach statistical significance.

The vignettes were based on actual reported violent encounters in the ED and scripted by an experienced emergency physician well-versed in healthcare workplace violence. These vignettes represented a broad range of violent incidents which commonly occur in EDs. These were reviewed and edited by a small group of ED personnel that included physicians (attending and resident), a nurse, a medical student, and a research coordinator. Using the aforementioned definitions of violent acts as a guideline, this group collectively reached consensus apriori determining the type and intended level of violence perpetrated prior to the surveys and vignettes being sent to participants. To avoid biasing viewers' responses due to personal relationships, the vignette actors were volunteers who did not work in the ED. The vignettes consisted of an incident portraying an angry patient who does not specifically threaten harm, 3 situations in which a verbal threat is made to a healthcare provider, 5 physical assault incidents of varying severity, and 2 portrayals of sexual assault involving inappropriate touching (1 victim was male, the other female). Respondents were asked to provide comments regarding the tool after completion of the survey.

Table 1. Relationship between gender, occupational group and response to sexual, verbal and physical assault.

	Sexual Violence			Verbal Violence			Physical Violence		
	Mean	STDV	p-value	Mean	SD	p-value	Mean	STDV	p-value
Males	3.44	1.35	0.947	3.08	1.22	**0.001**	4.46	1.31	0.358
Females	3.49	1.46		2.70	1.29		4.34	1.43	
Attending	3.31	1.29	0.977	2.90	1.36	0.518	4.34	1.31	0.724
Resident	3.39	1.18		2.72	1.02		4.41	1.30	
Nurse	3.59	1.50	0.420	2.93	1.51	0.794	4.46	1.47	0.343
Physician	3.34	1.24		2.82	1.22		4.38	1.31	
Clinical	3.46	1.31	0.944	2.85	1.31	0.663	4.42	1.37	0.955
Non-Clinical	3.47	1.45		2.87	1.14		4.43	1.30	

SD, standard deviation

Table 2. Subgroup comparison of violence perception grouped by violence score: Low (scores of 1-2), Medium (3-4), High (5-6).

	Sexual Violence			Verbal Violence			Physical Violence		
	Low	Medium	High	Low	Medium	High	Low	Medium	High
Males	25.2%	51.2%	23.7%	**33.4%**	**55.4%**	11.3%	9.90%	35.6%	54.5%
Females	27.9%	45.0%	27.0%	**51.0%**	**40.1%**	8.90%	13.0%	34.3%	52.6%
Nurse	28.9%	51.1%	20.0%	47.6%	**41.7%**	**10.7%**	8.00%	42.9%	49.0%
Physician	27.8%	55.6%	16.7%	42.3%	**55.4%**	**3.00%**	6.90%	42.6%	50.4%
Clinical	25.0%	46.9%	**28.1%**	41.4%	43.1%	**15.5%**	11.3%	32.2%	**56.5%**
Non-Clinical	28.4%	53.1%	**18.5%**	44.9%	47.7%	**7.40%**	7.60%	42.8%	**49.6%**

We performed descriptive statistics and comparisons using PAWS Statistic 18 - SPSS (IBM, 2010). The differences between demographic and employment sub-group's severity rating of each vignette was examined using the independent-samples Mann-Whitney U test, stratified by gender and occupation. All tests of statistical significance were set at a predetermined level of 0.05.

RESULTS

There were 193 participants, (91 male, 89 female, and 13 who declined to provide a gender identifier). This included 42 attending physicians, 28 residents, 3 mid-level providers, 32 nurses, 18 technicians, 36 security officers, 15 social workers, and 12 clerks. The majority of respondents worked in the adult ED (n=143, 76.9%). However, a substantial proportion (n=75, 40.3%) worked in the pediatric ED and in the psychiatric ED (n=66, 35.5%). Most worked in more than one setting, therefore the percentages are greater than 100%.

Occupational and gender groups overall had very similar perceptions of sexual, verbal and physical acts of violence in the ED (Table 1). Males perceived acts of verbal violence to be more severe than their female co-workers (mean M, F=3.08, 2.70; p<0.001).

There were no differences between any groups with regard to severity scores of sexual or physical violence. There were no statistically significant differences between nurses and physicians, nor clinical and non-clinical workers in the response to depictions of sexual, verbal, or physical violence (Table 1).

To look at subtle differences between gender and occupational groups, post hoc analysis was performed examining violence severity ratings grouping them into "Low" severity (scores of 1-2), "Medium" severity (scores of 3-4), and "High" severity (scores of 5-6) (Table 2). This revealed that attending physicians rated acts of verbal violence higher than resident physicians, and nurses assigned higher severity scores to acts of sexual, verbal, and physical violence versus their physician counterparts.

The only consistent comment regarding the study was that it took participants a long time to complete 11 vignettes; however, there were no specific comments or concerns regarding the survey instrument itself.

DISCUSSION

Many previous studies have reported on the incidence and reaction to violence against healthcare workers; however, none have specifically looked at the data collection tool. Most of these studies have been performed in a retrospective manner. As a result of the retrospective nature of the data collection, it is subject to personal recall bias and it is unclear if any 2 individuals perceived the violent act the same way. Having a tool that accurately captures the violent act is important for future epidemiologic and prevention studies. To our knowledge no one has had multiple healthcare workers independently view the same violent act, then report on it using a single survey instrument. This pilot study was intended to create a survey tool that would accurately capture violent severe acts perpetrated against healthcare workers in real time.

In our study multiple different ED healthcare workers viewed vignettes of a broad range of violent acts commonly seen in the ED and reported on what they saw using a single survey instrument. The vignettes were designed and agreed upon by the research team along with several other healthcare workers apriori to depict several different verbal, physical and sexual assaults.

While it may be anticipated that non-clinical workers and those who work primarily in a pediatric setting may be less accustomed to acts of physical violence and therefore assign higher severity scores, this was not the case. Males assigned higher severity scores than females to acts of verbal violence. This appeared somewhat counter intuitive. This may be due to males generally experiencing more acts of violence, thereby causing them to be more sensitized and have a lower tolerance threshold. An alternative explanation is that females want to appear, or just are, less disturbed by threats because they have become so accustomed to the frequency of events. That nurses gave higher severity scores than physicians for all subtypes of violence is not surprising given that nurses are on the "front line" of patient care and more frequently experience physical violence.[7, 10]

While not statistically significant, differences were found between attending and resident physician responses with regard to verbal threats, as attendings assigned higher severity scores. This may be due to the resident's perception of having to "perform" for both their attendings, as well as the patients. They cannot appear to be upset by this affront in the eyes of those evaluating them. In addition, residents frequently spend proportionally more time with patients and therefore are more likely to be exposed to verbal threats. This may help them become more accustomed or tolerant.

Consideration should be given to the setting and study population. Healthcare workers who self-select for ED employment may be more accustomed to coping with workplace violence than those in other clinical settings. Application of this tool should be expanded to incorporate the perceptions of workers hospital-wide.

To collect meaningful data that characterize violence in the ED (and potentially other healthcare settings) a validated tool is needed. The lack of variability between respondents in the ED suggests this is a reliable tool to characterize healthcare workers' response to violence in the workplace. The specific aims of this study were to create a reliable instrument that consistently and accurately captured data regarding the actual violent or threatening acts regardless of who saw or experienced the event. This tool has achieved these goals.

LIMITATIONS

Of the eligible participants, 55% completed the survey instrument for all 11 vignettes. It is unclear if those who did not participate would have answered differently. However, the respondents made up a representative sample of ED personnel and it is unlikely that a greater response rate would have resulted in different findings.

Given the lack of variation between gender and occupational groups with regard to severity score, it is unlikely that a correction coefficient would be necessary in applying this tool.

Additionally, this tool was assessed in a single, tertiary care academic ED. It is unclear whether responses would be different in other settings. Filmed vignettes may not illicit the same emotional response as when an individual is an actual victim to a violent incident, thereby resulting in lower response scores.

CONCLUSION

The survey instrument used in this pilot study is the first tool to be used in characterizing acts of violence using filmed vignettes across demographic and employment groups. This tool should be employed and evaluated in actual ED settings to confirm its validity. This tool has the potential to assist in data collection for the prospective evaluation of ED violence. Gender and occupation of ED workers does not appear to play a significant role in perception of severity workplace violence. The authors intend to use this tool in a prospective study to examine both verbal and physical violence in the ED to better define this widespread problem. This tool will enable further investigation into environmental and behavioral factors that can be used in the development of effective interventions that may decrease the incidence and severity of violence against healthcare workers.

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Intramedullary Spinal Neurocysticercosis Presenting as Brown-Sequard Syndrome

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Cysticercosis is an emerging disease in the United States. Neurocysticercosis may rarely cause disease within the spinal cord, but the occurrence of such pathology can produce debilitating symptoms for patients. We present the second report in the literature of intramedullary spinal neurocysticercosis presenting with a Brown-Sequard syndrome. [West J Emerg Med. 2012;13(5):434–436.]

CASE REPORT

A 42-year-old Mexican-born male with no past medical or surgical history presented to a Los Angeles emergency department with complaints of 1 month of progressive left lower extremity numbness and right lower extremity stiffness limiting his ability to walk. He reported no history of trauma, as well as no systemic complaints of fevers, chills, weight loss, or night sweats.

A detailed neurologic examination of the cranial nerves and upper extremities was completely normal. The examination of the right lower extremity showed hyperreflexia and 4/5 strength for all muscle groups. The left lower extremity had diminished sensation to noxious stimulation from the inguinal crease to the plantar surface of the foot. A noncontrast computed tomography of the head was initially performed and yielded no significant findings. An emergent thoracolumbar spine magnetic resonance imaging (MRI) was then ordered for further evaluation.

The MRI revealed a heterogenous intermedullary mass in the spinal cord at the T10 to T11 level with mild enhancement and mass effect (Figure). The mass was localized to the left lateral aspect of the cord, with the cord displaced to the right. Significant edema was noted on the right lateral aspect of the cord. The initial differential included cavernoma and ependymoma. The patient was admitted to the hospital and urgent neurosurgery was performed.

The patient underwent a laminectomy at T10 to T11, and 2 distinct cystic structures—one left lateral and superficial and one more deeply invested—were identified and removed from the cord. Intraoperatively, the patient was tested for somatosensory evoked potentials and motor-evoked potentials on his right lower extremity. They were initially diminished but improvement was noted as early as the time of closure. Pathology reports identified the cysts as neurocysticercosis. The patient recovered well from surgery and was ambulating with improved strength at the time of discharge to a rehabilitation facility.

DISCUSSION

Cysticercosis is caused by the parasite *Taenia solium* and is the most common parasitic disease worldwide.[1] Its larval stage begins in pigs, passes to humans via undercooked pork, and then develops into an adult within humans. There the adult tapeworm eventually produces eggs, which pass throughout the body, lodge into tissues, and cause symptomatic cysts.[2] Neurocysticercosis is the central nervous system (CNS) manifestation of this disease and is the most common parasitic infection of the CNS worldwide.[3] Cysticercosis is endemic in Mexico and Latin America (as well as areas of Africa, India, and Asia) but is an emerging disease in the United States with up to 1,000 new cases a year being diagnosed.[4] These cases are predemoniantly in the Southwest owing largely to immigration from endemic areas.[5] In Los Angeles in particular, the disease burden is so heavy that up to 10% of adults receiving neuroimaging for a new onset seizure in the emergency department were diagnosed with neurocysticercosis.[6]

Although neurocysticercosis is common, only 1% to 5% of cases demonstrate spinal cord involvement.[7] Of those cases,

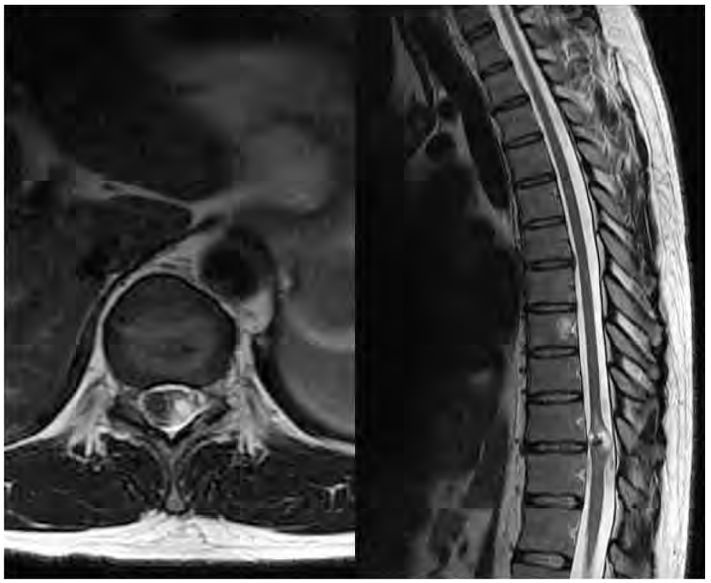

Figure. Thoracolumbar T2-weighted magnetic resonance imaging showing hypointense cystic lesion with surrounding hyperintense edema.

leptomeningeal involvement is 6 to 8 times more common than the intramedullary disease our patient displayed.[8] The results of a recent literature review indicate that this patient represents the 55th reported case of intramedullary neurocysticercosis in the literature.[9] Manifestation of this lesion as Brown-Sequard syndrome is even rarer, with a review of the literature yielding only a single other report.[10]

Brown-Sequard syndrome was described in 1850 by the neurologist Charles-Édouard Brown-Séquard to describe the clinical syndrome accompanying hemisection of the spinal cord.[11] The classic syndrome involves "crossed" findings, with hemiplegia, hyperreflexia, and loss of light touch and proprioception affecting the ipsilateral side, and sensory defects of painful touch and temperature affecting the contralateral side. This asymmetrical presentation results from the crossing of neural fiber tracts at different levels within the CNS.

The 3 distinct neural tracts that travel within the cord are the corticospinal tract, the dorsal columns, and the spinothalamic tract. The corticospinal tract carries upper motor neurons, which originate in the brain and decussate high up in the cervicomedullary junction to travel distally down the spine to provide motor control. The dorsal, or posterior, columns transmit light touch and proprioceptive information and also cross proximally in the CNS, at the level of the medulla. The spinothalamic tract conveys pain and temperature information. This tract has a different anatomic pathway from the corticospinal and posterior column tracts, with decussation distally in the CNS, rather than high within cervicomedullary region. This is usually via the anterior white commissure, 1 to 2 spinal segments above the dermatome it enervates.[12]

When the cord is hemisected, all 3 pathways are disrupted to give the classic syndrome. In clinical practice, complete transection is rare and partial transection with incomplete Brown-Sequard syndrome is more common.[13] The transection of the corticospinal tract causes hemiplegia ipsilateral to the lesion, accompanied by hyperreflexia due to the loss of regulatory upper motor neuron control. The posterior columns also carry information to the ipsilateral side and account for the loss of proprioception and light touch to the same side as the cord lesion when severed. The spinothalamic tracts remain uncrossed until the distal spinal cord. When a lesion causes hemisection, pain and temperature sensation are lost on the contralateral side, at a level 1 to 2 segments below the crossed motor symptoms. Bladder function, which receives bilateral autonomic innervation, is typically spared by the hemisection.[12]

Our patient had all the symptoms of Brown-Sequard syndrome: ipsilateral motor weakness, hyperreflexia, and loss of proprioception and light touch, with a contralateral sensory deficit starting at L1, 2 segments below the T10 to T11 lesion. Interestingly, the right-sided tracts were disrupted in this case despite the cyst being on the left. The right side was affected by edema and mechanical pressure, known to cause neural disruption.[14] It was these factors that caused the tracts to be disrupted, rather than the slow-growing cyst.

LIMITATIONS

This is an isolated case of a rare disease. The cystic lesion occurred on the left lateral cord and the clinical syndrome implicated only the right-sided tracts. Edema and displacement were seen on the right and are known to causes neuronal disruption, yet the possibility remains that the cyst on the left contributed to the overall clinical picture.

CONCLUSION

Brown-Sequard syndrome is a classic but rare entity. It remains a topic in medical education owing to the complex neuroanatomy displayed through its clinical manifestations. It is overwhelmingly associated with penetrating trauma, but nontraumatic causes, such as neoplasm and infection, are reported and do need to be considered. Neurocysticercosis is an evolving medical reality in North America that is largely tied to immigration from endemic areas. This case not only represents an exceedingly rare infectious etiology of this classic syndrome, but also reminds us that physicians must remain aware of the emerging patterns of disease in the patients they treat and evolve their differential diagnoses to reflect these patterns.

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Occult Pneumothoraces in Acute Trauma Patients

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Introduction: Many traumatic pneumothoraces (PTX) are not seen on initial chest radiograph (CR) (occult PTX) but are detected only on computed tomography (CT). Although CR remains the first tool for detecting PTX, most trauma patients with significant thoracoabdominal injuries will receive both CT and CR. The primary objective of this study was to retrospectively determine the effectiveness of CR for detecting PTX in trauma patients. Our hypotheses were that CR is a sensitive indicator of PTX on CT, that chest pain and shortness of breath are good predictors of PTX on CR, and that we could determine other predictors of PTX on CR.

Methods: All trauma patients presenting to our Level I trauma center with a CT-diagnosed PTX over a 2-year period who had both a CR and a chest CT were included. The CT reading was considered the gold standard for PTX diagnosis. Electronic medical records were searched using key words for diagnoses, symptoms, demographics, and radiologic results. We recorded the official radiologist readings for both CR and CT (positive or negative) and the size of the PTX on CT (large, moderate, small, or tiny). The outcome variable was dichotomized based on presence or absence of PTX detected on CR. Descriptive statistics and χ^2 tests were used for univariate analysis. A regression analysis was performed to determine characteristics predictive of a PTX on CR, and 1 variable was added to the model for every 10 positive CRs. With equal-size groups, this study has the power of 80% to detect a 10% absolute difference in single predictors of PTX on CR with 45 subjects in each group.

Results: There were 134 CT-documented PTXs included in the study. Mean age was 42, and 74% were men. For 66 (49%) patients, PTX was detected on CR (sensitivity = 50%). The CR detected 30% of small PTX, 35% of moderate PTX, and 33% of large PTX. Comparing patients with and without PTX on CR, there were no significant differences in shortness of breath or chest pain. There no relationships between PTX detected on CR and age, gender, penetrating versus blunt injury, bilaterality of the PTX, or presence of lung contusion or hemothorax on CT. After adjusting for all significant variables, predictor of a PTX detected on CR was air in the tissue on CR (adjusted odds ratio [OR] = 3.8) and PTX size (compared to a tiny PTX, adjusted OR = 2.0 for a small PTX, 7.5 for a moderate PTX, and 51 for a large PTX). Chest tubes were used in 89% of patients with PTX on CR and 44% of patients with PTX only on CT (difference 45%; 95% confidence interval 30, 58).

Conclusion: Factors associated with PTX on CR included air in the soft tissue on CR and size of the PTX. Even when PTX is not apparent on CR, 44% of these PTXs received placement of a chest tube. [West J Emerg Med. 2012;13(5):437–443.]

INTRODUCTION

More than 50,000 traumatic pneumothoraces (PTX) occur in the United States annually; PTX is the second most common traumatic chest injury, and it is seen in 40% to 50% of patients with chest trauma.[1,2] Occult PTX (OPTX), that is, PTXs not detected by clinical examination or a chest radiograph (CR) but later diagnosed by computed tomography (CT), have been shown to occur in 54.8% of chest trauma cases.[3] A small undetected PTX can rapidly progress to tension PTX, severe dyspnea, and hemodynamic collapse,[2,4] thereby increasing mortality rates in trauma patients.[5] This is particularly important in patients receiving positive pressure ventilation, where it has been demonstrated that 38% of OPTX progress.[4] Early detection is essential and could influence ongoing assessment and management[1,6] and could possibly be a life-saving intervention before a CT can be safely performed.

Trauma patients in the emergency department (ED) are necessarily supine, and air in the pleural space moves anteromedially; thus, the pleural line typically used to diagnose PTX in an upright anteroposterior (AP) CR is not generally seen. It is well established that many traumatic PTXs are not seen on an AP supine CR (SCR).[1] However, currently the AP SCR remains the first diagnostic tool for the detection of PTX. With the increased use of abdominal and thoracic CT, however, there has been a predictable increase in the published incidence of OPTX diagnoses by CT ranging from 3.7% in injured children and to 64% in intubated patients with multiple trauma.[3,7–9] The incidence numbers reflect the type of trauma patient.

Although Wolfman et al[1] provided a size classification system and management approach based on the CT, there is still considerable debate whether this changes management of a patient with OPTX because many can be treated expectantly.[8,10] Most importantly, there is criticism regarding the excessive use of CT because of their minimal impact in changing the management of patients with OPTX; some argue for the refinement of CT use to identify critical lesions instead of trivial findings.[11] Although CT will continue to be the gold standard for diagnosing PTX, there is scant evidence in the literature accurately characterizing the ability of AP SCR to detect PTX in trauma patients. The vast majority of studies simply report the increased incidence of OPTX with the advent of CT without providing any statistical analysis comparing AP SCR to CT. Furthermore, the studies include patients from select categories, such as "thoracic trauma" and "chest or multiple trauma," or ill-defined categories, such as "blunt trauma," without specifically describing which patients qualify, which makes comparisons and application difficult or impossible. Recent studies comparing thoracic ultrasound to CR and CT in the emergency setting have reported an extreme variability in the sensitivity of AP SCR for detecting PTX ranging from 27% to 75% when using CT as the gold standard.[12–14] Accurately characterizing the sensitivity of AP SCR, especially for particular subsets of patients, may help clinicians determine which patients need to be more closely monitored and potentially which less severe patients need only be monitored without having to undergo a CT at all.

In our setting, patients with chest pain after trauma, very major trauma, and/or altered mental status with a mechanism that could result in chest trauma (eg, abrasions on the chest, ecchymoses) generally had a CT chest and CR performed. This is based on severity and mechanism and subject to the discretion of the physician.

The primary objective of this study was to determine the effectives of CR for detecting PTX in trauma patients. Our hypotheses were that CR is a sensitive indicator of PTX on CT, that chest pain and shortness of breath are good predictors of PTX on CR, and that we could determine other predictors of PTX on CR.

METHODS

Study Design and Setting

This was a retrospective cohort study at an urban ED with an emergency medicine residency program with approximately 75,000 patient visits per year. There is a trauma team onsite and major trauma patients undergo a trauma activation protocol (TAP) based on severity of injuries and mechanisms of injury. The site is the only Level I trauma center in the state.

At our institution activation of the trauma team is based on physiologic abnormalities and mechanism of injury. Vital signs, severity, of injury and expected time of arrival are paged to the team, which includes a trauma attending physician, an ED attending physician, residents, radiology technicians, respiratory therapists, and a pharmacist. The TAP depends on multiple possible factors, including airway, breathing, or circulation compromise; disability (neurologic deterioration); exposure (penetrating injuries, amputations, crush injuries, burns); and pregnancy with significant mechanism. Mechanisms such as rollover, ejection, and prolonged extrication time are also included in the TAP mechanism.

A focused assessment with sonography for trauma (FAST) exam is typically included in the trauma room, especially for patients with major traumas and any alteration of level of conscious and depending on mechanism of injury. It is up to the discretion of the team at the time of injury. The lungs are not typically included in the evaluation at our institution.

An electronic trauma database is kept updated with all trauma patients who are seen and/or admitted by the trauma service. The ED or trauma physicians order all imaging while the patient is in the trauma area. This is done either verbally or on a separate paper order form, which is then entered by a technician. Almost universally a patient with a chest injury in the major trauma area undergoes initial plain films of the chest and abdomen, then proceeds to the CT scanner for a CT of the chest and/or other areas. However, during the period of the study there was no requirement for imaging.

For research purposes the researchers obtained access to

the trauma database. The study was approved as exempt by the institution's Human Research Review Committee

Selection of Participants

All consecutive trauma patients presenting to our Level I trauma center with a CT-diagnosed PTX over a 2-year period (2008–2010) who had both a CR and a chest CT were included. The CT reading was considered the gold standard for PTX diagnosis. Electronic medical records were then searched for diagnoses, demographic data, and CT and CR results. Official readings from the radiologist were used.

Patients with chest trauma who did *not* have a CT of the chest and those who did not undergo an initial CR in the ED were excluded. Patients without a PTX were also excluded.

Each patient's ED and hospital records were reviewed. Electronic medical records were searched for diagnoses, symptoms, demographics, and radiologic results. Key search words and terms were those used by the trauma data-entry personnel, including pneumothorax, lung collapse, chest trauma, chest tube, and lung injury; common abbreviations and abbreviations known to be used by data-entry personnel were also included. We recorded the official radiologist readings for both CR and CT (positive or negative) and the size of the PTX on CT (large, moderate, small, or tiny).

Data collected included demographics, medical history, CR reading, CT reading, size of PTX, whether surgery was needed, admission data, and whether a chest tube was placed. Additionally rib fractures (numbers), breath sounds (decreased), and presence of subcutaneous (SQ) air were recorded.

At our institution, chest tubes are inserted at the discretion of the physician. Typical indicators include PTX with significant size (ie, too large for a pigtail catheter) and significant clinical symptoms, PTX with potential for increase in size, or a hemothorax or other complicating issues.

Training for Data Gathering and Agreement

A data collection sheet was formulated from several sessions over a period of approximately 2 months based on previous studies in the literature. Data were obtained by 2 trained abstractors. Meetings and sessions to educate the abstractors on data collection and methods of analysis were held over a period of approximately 2 weeks. In addition, the data gathered were analyzed by another author of the study to determine agreement. A κ statistic was calculated to measure agreement in observations between authors in all data collection for approximately 20% of the data. This was chosen as a representative of the sampling and thought to be adequate to determine agreement.

PTX Size Determination

Our radiologists use a well-defined approach to categorizing the size of PTX. The tiny category was defined as less than 1 cm thick on the CT.[15] The small category was defined as <2 cm presence of a visible rim or approximately 10% PTX. The medium category included all cases of PTX between the small and large parameters. A large PTX was defined as 31% or greater. This is based on previous literature calculating the size of the PTX based on the size of the space between the deflated lung and the chest wall. In patients with large PTX, the size of the space is more than 2 cm, which corresponds to greater than 30% PTX.[16]

Statistical Analysis

The study group was dichotomized based on presence or absence of PTX detected on CR. Descriptive statistics and the χ^2 test were used for univariate and bivariate analysis. Sensitivity of CR for detecting PTX was calculated.

Regression Analysis

A binary logistic regression model was fit to the data. A priori determination for model inclusion was any variables with significance up to and including 0.1 on bivariate analysis. As is customary, the maximum number of variables included was capped at 1 per 10 positive cases of PTX on radiograph. A Hosmer-Lemeshow goodness of fit variable was used to determine fitness of the model with a significant result indicating overfitting.

Power Analysis

With equal size groups, this study has the power of 80% to detect a 10% absolute difference in single predictors of PTX on CR with 45 subjects in each group. Alpha was set at 0.05.

Kappa Scoring

To ensure that data collection was consistent among authors, κ statistics were calculated for a proportion of the data. We chose 20% as a representative sampling.

Human Subjects Approval

The study underwent review by our human subjects protection organization and was approved as exempt. No consent was required as no identifiers were collected.

RESULTS

Over the 2-year study period, the number of recorded trauma patients presenting to the ED was 6,732. Of these, 2,694 had some kind of chest trauma with anything coded from thorax with Abbreviated Injury Scale codes between 40009.9 to 451022.5. The search was done with a word search function. Also searched were the keywords chest tubes (34.04) and CT of the chest (87.41). A total of 367 patients had chest CTs done.

There were 134 CT-documented PTX included in the study. At our institution, CT is the gold standard for those with PTX related to trauma; therefore, standard of care at our institution is to obtain a chest CT. Mean age of patients was 42, and 74% were men. PTX was detected on CR for 66 of 134 (sensitivity = 49%). See Table 1.

Table 1. Overall patient demographics.

Age	42 ± 16 years
Gender	
Male	99 (74%)
Female	35 (26%)
Average Injury Severity Score	24 ± 18
Disposition	
Discharged	7 (5%)
Admitted	127 (95%)
Died	9 (7%)
Went to surgery	43 (32%)
Abdominal	17 (13%)
Thoracic	7 (5%)
Head/face	5 (4%)
Orthopedic	12 (9%)
Other	2 (1%)
Mechanism of injury	
Motorized vehicle (motorcycle, car, ATV)	76 (57%)
Penetrating trauma	34 (25%)
Fall	13 (10%)
Other	11 (8%)

ATV, all-terrain vehicle.

The majority of the PTXs were small (52%), as illustrated in Table 2. PTX was detected on CR in 30% of small PTXs, 35% of moderate PTXs, and 33% of large PTXs. See Table 3. Chest tubes were inserted in 89% of patients with PTX detected on CR and 44% of patients with PTX detected only on CT (difference 45%; 95% confidence interval 30, 58).

Comparing patients with and without PTX on CR, there were no significant differences in shortness of breath (68% vs 73%, respectively) or chest pain (76% vs 80%, respectively). There were also no relationships between PTX detected on CR and age, gender, penetrating versus blunt injury, bilaterality of the PTX, presence of rib fractures, or presence of lung contusion or hemothorax on CT. We found differences up to a significance of 0.1 in bivariate analysis for smokers, male gender, presence of SQ air, and larger-sized PTXs. These variables were then entered into the multivariable analysis. See Table 3.

When adjusting for all variables on bivariate analysis that reached a significance level of 0.1, significant predictors of a PTX detected on CR were air in the tissue (adjusted odds ratio [OR] = 3.8; $P = 0.02$) and PTX size (adjusted OR = 51.0; $P < 0.01$) for a large PTX compared to a tiny PTX. See Table 4.

In approximately 20% of patients, a different author was responsible for checking data entry for agreement. No changes were made in the data based on this reexamination of the extraction techniques. The κ statistic for agreement was excellent at 0.88 (0.87 to 1).

Table 2. Characteristics of patients in the study (n = 134).

Characteristic	n	%
Smokers	25	19%
Chest pain	91	68%
Shortness of breath	82	61%
Detected on chest radiograph	66	49%
Air in the tissue on chest radiograph	58	43%
Rib fractures	100	75%
Bilateral	25	19%
Pulmonary contusion	65	49%
Hemothorax	52	39%
Chest tube inserted	89	66%
Size of pneumothorax		
Tiny	6	5%
Small	69	52%
Moderate	34	26%
Large	24	18%

Missing Data

For 17 (13%) subjects, information on presence of chest pain and shortness of breath was missing. For 1 (0.7%) patient, information on the size of the PTX was missing. There were no missing entries for other data.

DISCUSSION

Overall, we found that the only significant predictors of occult PTX on CR were SQ air in the tissue on CR and size of PTX. Air in the tissue was a CR finding, and PTX size was a CT finding, so neither would be available when a patient presents.

None of the variables available before the CR was performed were helpful in predicting PTX on CR. These variables of patient condition and demographics were not predictive of the presence of OPTX. Neither symptoms of chest pain nor shortness of breath predicted whether we could see a PTX on CR. We conclude that in patients with major trauma and a high Injury Severity Score (ISS), CT is necessary to ensure the diagnosis of PTX regardless of symptoms.

Even after a CR was completed, we found that it was not a sensitive indicator of PTX on CT. Air in the tissue was the only variable on the CR that could have helped predict OPTX and that only increased the odds fourfold. In a previous study the rates were similar.[1] We conclude that CT is necessary to ensure PTX diagnosis regardless of CR findings.

An important finding of this study was that no PTX was apparent on half of the CRs and yet 44% of these patients with OPTX required chest tube placement. Again, this suggests that the CR was of little value in affecting the management of these patients. Other studies have shown similar rates.[2,10] Other

Table 3. Bivariate analysis of characteristics in occult versus nonoccult pneumothorax (PTX). Differences and 95% confidence intervals (CI) were calculated for significant differences only. All variables with a significance of $P < 0.1$ were included in the multivariable model (up to a maximum of 1 per 10 positive cases of visible PTX).

Characteristic	Occult PTX on CR (CT only)	Visible PTX on CR	Difference (95% CI)	*P* value
n	68	66		
Continuous variables				
Age	41 ± 17	42 ± 16		NS
Injury Severity Score	21 ± 16	26 ± 19		NS
First oxygen saturation	96 ± 4	95 ± 5		NS
Dichotomous variables				
Smokers	13%	24%	11% (−2, 24)	0.1
Shortness of breath	68%	73%		NS
Chest pain	76%	80%		NS
Gender (% men)	66%	82%	12% (1, 30)	0.03
Penetrating trauma	25%	26%		NS
SQ air	25%	62%	37% (21, 51)	<0.01
Bilateral	16%	21%		NS
Rib fractures	71%	79%		NS
Lung contusion	47%	50%		NS
Hemothorax	35%	42%		NS
Size of PTX				
Tiny	8%	2%	6% (−2, 15)	NS
Small	73%	30%	43% (26, 56)	<0.01
Medium	16%	35%	–15% (−4, −33)	<0.01
Large	3%	33%	–30% (−18, −43)	<0.01

CR, chest radiograph; *NS*, not significant; *SQ*, subcutaneous.

studies have shown that it is acceptable to expectantly manage such cases, unless positive pressure ventilation (PPV) is necessary.[9] Up to 38% of OPTXs may progress with PPV.[15] This is similar to the findings of a previous study. The other side of the issue is that because the CR was positive in about half of the patients, it could have led to an earlier placement of a chest tube in all of these patients. However, Yadav et al[17] found that chest tube placement in patients with OPTX was not safer or any more effective than managing with observation alone. There is nothing in the literature to suggest that an earlier placement of a chest tube in patients with OPTX leads to better outcomes.

As in most other studies of PTX most of our patients were men and most causes were secondary to blunt trauma. A large percentage of our patients had chest pain and/or shortness of breath (>60%). None of these variables, however, were associated with a higher incidence of OPTX

Our results suggest either the need for routine CT or another approach to OPTX detection. Some studies have used different approaches to detect PTX without requiring CT, including use of oblique chest radiographs[18] and use of ultrasound.[12–14,19,20] Ultrasound as part of a routine FAST exam showed a high sensitivity for detecting OPTX and is safe and expedient for diagnosing them.[19,20] We did not routinely use ultrasound in our ED, except in patients with hypotension.

Most of the OPTXs treated in our ED were categorized as small. There is much controversy in these measurements,

Table 4. Regression Analysis (Hosmer-Lemeshow goodness of fit = 0.8) Variables were entered only if they were significant in the bivariate analysis. Up to 6 variables were allowed with 66 of 134 cases positive for pneumothorax (PTX) on chest radiograph (CR). All variables with bivariate significance were included in the model.

Predictors of PTX on CR	Adjusted OR	95% CI	*P* value
Male gender	1.4	0.5, 3.8	NS
SQ air	3.8	1.6, 8.9	0.02
Smoker	2.0	0.7, 5.8	NS
Size of PTX			
Tiny	reference		
Small	2.0	0.2, 22.9	NS
Moderate	7.5	0.6, 90.3	NS
Large	51	3.0, 847	<0.01

OR, odds ratio; *NS*, not significant; *SQ*, subcutaneous.

however, and they can be hospital dependent.[21–23] Only about a third of the PTXs in each of these categories were detected on initial CR in our study. This is a surprising finding as almost a third of large PTXs detected on CT were also detected on initial CR. Location of the PTX or patient positioning may have been a factor.

For most of the patients in our study, the initial CR was done with the patient in a supine position. Other techniques have been used to delineate PTXs, including the use of supine films, expiratory films, lordotic views, oblique views, or lateral CRs.[18] Even though these methods may demonstrate PTX on initial CR, this is often not possible in the trauma patient since the trauma patient can be unstable and is, therefore, impractical. Matsumoto et al[18] describe use of an oblique view of the chest which revealed a visceral pleural line, consistent with PTX. Signs on film taken with the subject in the supine position that may indicate PTX include deepening of the costophrenic angle (deep sulcus sign) or the presence of 2 diaphragm/lung interfaces (double diaphragm sign). Sensitivity is poor in detecting PTX, however.[18] Other studies have shown that ultrasound can be a useful approach as it is a good tool for determining movement of the diaphragm, which is absent in many PTXs.[12–14] However, this technique was not routinely used in our ED in 2008–2010.

A recent study comparing ultrasound to CR and CT showed that ultrasound was more sensitive (82%) and specific (100%) than CR in diagnosing PTX. More PTXs were detected by CT. The conclusion of the study is that ultrasound of the lungs should be included in the FAST.[23]

For our regression analysis, predictors of PTX included large size and air in the tissue. When corrected for these variables, gender and smoking history, which were significant in univariate analysis, fell out of the model. These demographic and social factors (ie, gender and smoking history) are not helpful in predicting a diagnosis at a patient's initial presentation. Therefore, it is still essential to obtain an image that will be useful for diagnosing PTX, and CT and ultrasound may be the best tests for this purpose.

In summary, symptoms, patient demographics, and mechanism of injury were not useful in detecting OPTX. Only the presence of air in the tissue on CR was a valuable clue to the presence of an OPTX. Size of the PTX matters in detecting it on CR, and there is still controversy on whether the smaller PTXs should be treated or observed. However, CT use must either continue to be the gold standard or other alternatives must be found for PTX detection.

LIMITATIONS

This study was retrospective in nature, some of the patients with PTX may have been missed. It is unknown how many were missed because they only received a plain CR and did not undergo CT; however, this is potentially rare.

The study was limited because we did not evaluate any alternative methods of PTX detection. At the time of the study, the institution did not routinely do ultrasound and it is not part of our routine FAST exam. Ultrasound may prove to be a method for decreasing the number of CTs necessary in the future.

Data extraction may have been flawed because we used 2 abstractors. However, we made every effort to ensure that both abstractors were given equivalent education. In addition, we evaluated about 20% of the data for comparison and found excellent κ statistic agreement among data extractors.

No known records were left out because of incomplete data. Some may have been missed because the injury was improperly categorized; however, it is likely a very small number. It is impossible to determine numbers that were not entered correctly or were never entered.

The need for a chest tube was based on the clinical judgment of the individual clinicians. Studies have shown that clinical observation of a patient with a small PTX is possible. Because of the retrospective nature of this study, it is not possible to determine if these patients could have been observed.

At our institution ultrasound is available in the trauma area; however, lung evaluation for PTX is not typically part of the routine evaluation for patients. Ultrasound is a quick, noninvasive, and accurate method of detecting a PTX. Whether chest tubes would be placed or not based on an ultrasound diagnosis alone is uncertain.

The study was based on chart review, and cases may have been missed or study data miscoded when the chart was recorded. The study did not evaluate cases in which a PTX was found on CR and for which a CT was not obtained; however, in our institution the overwhelming practice is to proceed to CT if there is possibility of chest injury.

The ISS values in our patients varied widely from 6 (minor) to 42 (very severe). This may have skewed results considerably in our study. In addition, unidentified confounder variables likely exist that were not included in our regression analysis.

CONCLUSIONS

Factors associated with PTX on CR included air in the soft tissue on CR and size of the PTX. Even when PTX is not apparent on CR, 44% of these PTXs received placement of a chest tube.

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Pneumothorax in a Single Lung Patient

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An 80-year old man referred to the emergency department for chest pain and dyspnea on exertion reported a medical history of left pulmonary tuberculosis in babyhood, treated by therapeutic pneumothorax. This was commonly used to treat tuberculosis prior to the development of antimycobacterial agents. Successful therapeutic pneumothorax resulted in fibrosis and encapsulation of the diseased lung and containment of the infection. Forty-eight hours prior to admission, he underwent chest trauma caused by a staircase fall. Physical examination revealed extensive subcutaneous emphysema of the chest, neck and arms. Thoracic computed tomography unexpectedly revealed a single right lung expanded through the entire thorax cavity, a partial anterior pneumothorax (Figure), a fracture of the ninth right rib and extensive soft tissue emphysema. Left lung was hypoplastic in posterior position. As a consequence, mediastinum was fully shifted in left posterior position. Pneumothoraces due to trauma usually require the placement of a chest tube.[1] In this case of limited anterior pneumothorax, insertion of a chest tube was not indicated, and the patient spontaneously recovered in a few days.

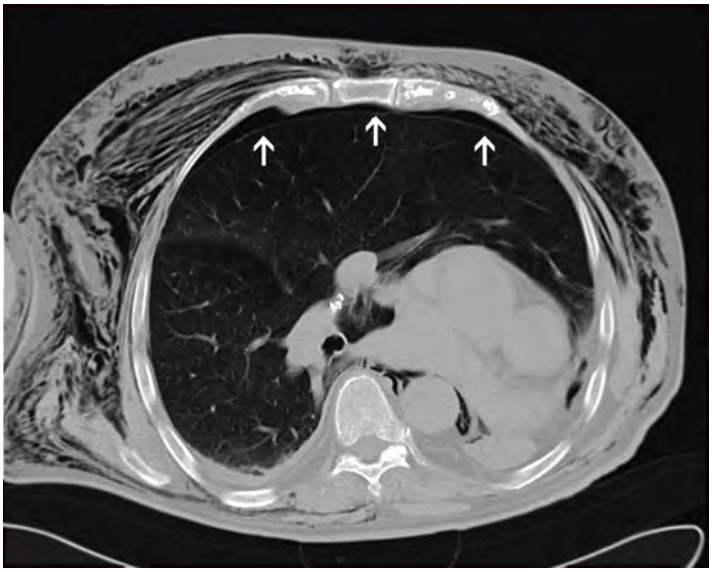

Figure. Cross-sectional computed tomography image of the pneumothorax

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Hospital-Based Coalition to Improve Regional Surge Capacity

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Introduction: Surge capacity for optimization of access to hospital beds is a limiting factor in response to catastrophic events. Medical facilities, communication tools, manpower, and resource reserves exist to respond to these events. However, these factors may not be optimally functioning to generate an effective and efficient surge response. The objective was to improve the function of these factors.

Methods: Regional healthcare facilities and supporting local emergency response agencies developed a coalition (the Healthcare Facilities Partnership of South Central Pennsylvania; HCFP-SCPA) to increase regional surge capacity and emergency preparedness for healthcare facilities. The coalition focused on 6 objectives: (1) increase awareness of capabilities and assets, (2) develop and pilot test advanced planning and exercising of plans in the region, (3) augment written medical mutual aid agreements, (4) develop and strengthen partnership relationships, (5) ensure National Incident Management System compliance, and (6) develop and test a plan for effective utilization of volunteer healthcare professionals.

Results: In comparison to baseline measurements, the coalition improved existing areas covered under all 6 objectives documented during a 24-month evaluation period. Enhanced communications between the hospital coalition, and real-time exercises, were used to provide evidence of improved preparedness for putative mass casualty incidents.

Conclusion: The HCFP-SCPA successfully increased preparedness and surge capacity through a partnership of regional healthcare facilities and emergency response agencies. [West J Emerg Med. 2012;13(5):445–452.]

INTRODUCTION

Hospital emergency departments (ED) are crowded and often at overcapacity, yet most local and regional community surge plans call for transporting all seriously ill and injured patients to regional EDs for immediate stabilization and definitive care.[1] Catastrophic events have recently tested responses of these communities and have illustrated the need for further improvement.[2] Such events include the Haitian earthquake in 2010, the novel influenza H1N1 (swine flu) pandemic of 2009, and Hurricane Katrina in 2005. Furthermore, national-level exercises such as "Dark Winter" and the Homeland Security Exercise and Evaluation Program (HSEEP) have repeatedly exposed areas where the need for improvement in response is clear.[3–7] For political leaders, health officials, hospital leaders, and emergency management officials, upholding public confidence in their respective institutions before, during, and after a catastrophic event is crucial. This can be done by increasing preparedness for public health emergencies, largely those that require the ability to treat a large influx of patients (surge capacity).

The purpose of this article is to describe an approach to improve surge capacity, in this case for hospital and ED treatment areas. The timely availability of these treatment areas is crucial for all seriously ill and injured patients, and for the public's health, when a mass casualty incident (MCI) occurs. The region in which these activities took place is

demographically consistent with much of the United States, insofar as it includes a locale containing multiple hospitals of various sizes and capabilities; emergency medical service (EMS) and emergency management agencies (EMA) as response agencies; limited public health services; and both sparsely and densely populated areas, including small towns, rural areas, and modest urban and suburban populations.

We used the resources enabled by a federal grant purposed to examine the benefit of developing a partnership of healthcare facilities as part of The Hospital Preparedness Program (HPP) of the Department of Health and Human Services.[8] The HPP was created "to improve the state of medical and public health."[9] While part of the HPP's mission is to increase preparedness in hospitals and emergency response systems for natural and terrorist disasters, there are scant data on its effectiveness or on how implementation can be achieved.

The Healthcare Facilities Partnership of South Central Pennsylvania

The Healthcare Facilities Partnership of South Central Pennsylvania (HCFP-SCPA; Partnership) consists of the following counties of Pennsylvania: Adams, Cumberland, Dauphin, Franklin, Lancaster, Lebanon, Perry, and York. The region is composed of both rural and micro and metro urban areas, and has a hospital capacity and capability that ordinarily serves the needs of these communities (Figure 1). Within this region, a total of 17 acute care hospitals became members of the Partnership, which was supported by a federal grant from September 1, 2007, to August 8, 2009, inclusive of 2 no-cost extensions to the initial award.

METHODS

Background

The Partnership leveraged the structure of the South Central Pennsylvania Regional Counter-Terrorism Task Force (SCTF), EMAs, and the Emergency Health System Federation (EHSF, regional EMS agency) as important and established entities with an identical geography to that of the HCFP-SCPA with which to formulate planning efforts. The SCTF's mission is to deliver a comprehensive and sustainable regional "all-hazards" emergency preparedness program that addresses planning, prevention, response, and recovery for events in South Central Pennsylvania that exceed local capabilities. The SCTF, supported primarily by grants from the Department of Homeland Security, is organized into approximately 10 functional groups and committees. It consists of representatives from 16 hospitals, the Office of Public Health Preparedness, 8 county EMAs, and other critical entities required for public health and safety for a population of about 2 million people.

The EHSF is the regional EMS council for the South Central Pennsylvania region. It consists of more than 200 quick response services, basic life support services, and advanced life support services. It provides information and education for the community and EMS personnel. The EHSF also works to improve preparedness and recruitment and provides regional resources that can be deployed in the event of a required response.

Also in place before the development of the Partnership was the federal Emergency System for Advance Registration of Volunteer Health Professionals Program (ESAR-VHP). The ESAR-VHP (a product of HHS in response to volunteer-related complications on September 11, 2001) is a registration program of healthcare professionals who will potentially volunteer their efforts in the event of a mass casualty event. ESAR-VHP expedites the volunteer's verification of identity, licenses, credentials, and accreditations. In the state of Pennsylvania, ESAR-VHP is known as The State Emergency Registry of Volunteers in Pennsylvania (SERV-PA).

Structure

The project responded to 6 objectives: (1) enhance situational awareness of capabilities and assets in the South Central Region of Pennsylvania; (2) develop and pilot test advanced planning and exercising of plans in the region; (3) augment written medical mutual aid agreements (MMAA) between healthcare facilities in the region, with special emphasis on hospitals; (4) develop and strengthen partnership relationships through joint planning, frequent communication, simulation, and evaluation of preparedness; (5) ensure National Incident Management System (NIMS) compliance; and (6) develop and test a plan for effective utilization of the ESAR-VHP.

After the grant was awarded, personnel from the SCTF, the largest 7 EMS companies, and 11 hospitals within the region were provided the opportunity to participate in specific roles including planning, collaboration, development, and training activities. The project contracted with additional key partners to provide both technical assistance and outcomes measurements.

Four primary teams were formed within the Partnership to establish modes, mechanisms, procedures, and evaluation techniques to fulfill the goals created for the grant. These teams were (1) education and development, (2) technology and simulation, (3) evaluation and integration, and (4) surge enhancement. Each team consisted of 6 to 10 members including 1 acting team leader and 1 coleader. Teams met regularly to discuss current developments and to further the goals as set forth by the HCFP as a whole. The response to this model (Figure 2) for completing the work was received favorably by members of the Partnership and this proved an efficient means of task management for its overall goals.

Through early Partnership discussions, a consensus was reached that surge capacity would be defined as "the number of adequately staffed beds that can be provided in addition to the normal demand within 2 hours of an incident," which includes accounting for both inpatient and ED treatment beds. The Partnership focused around this unifying, central concept.

Specific, measurable, achievable, realistic, and time-framed (SMART) objectives were created from the 6 grant

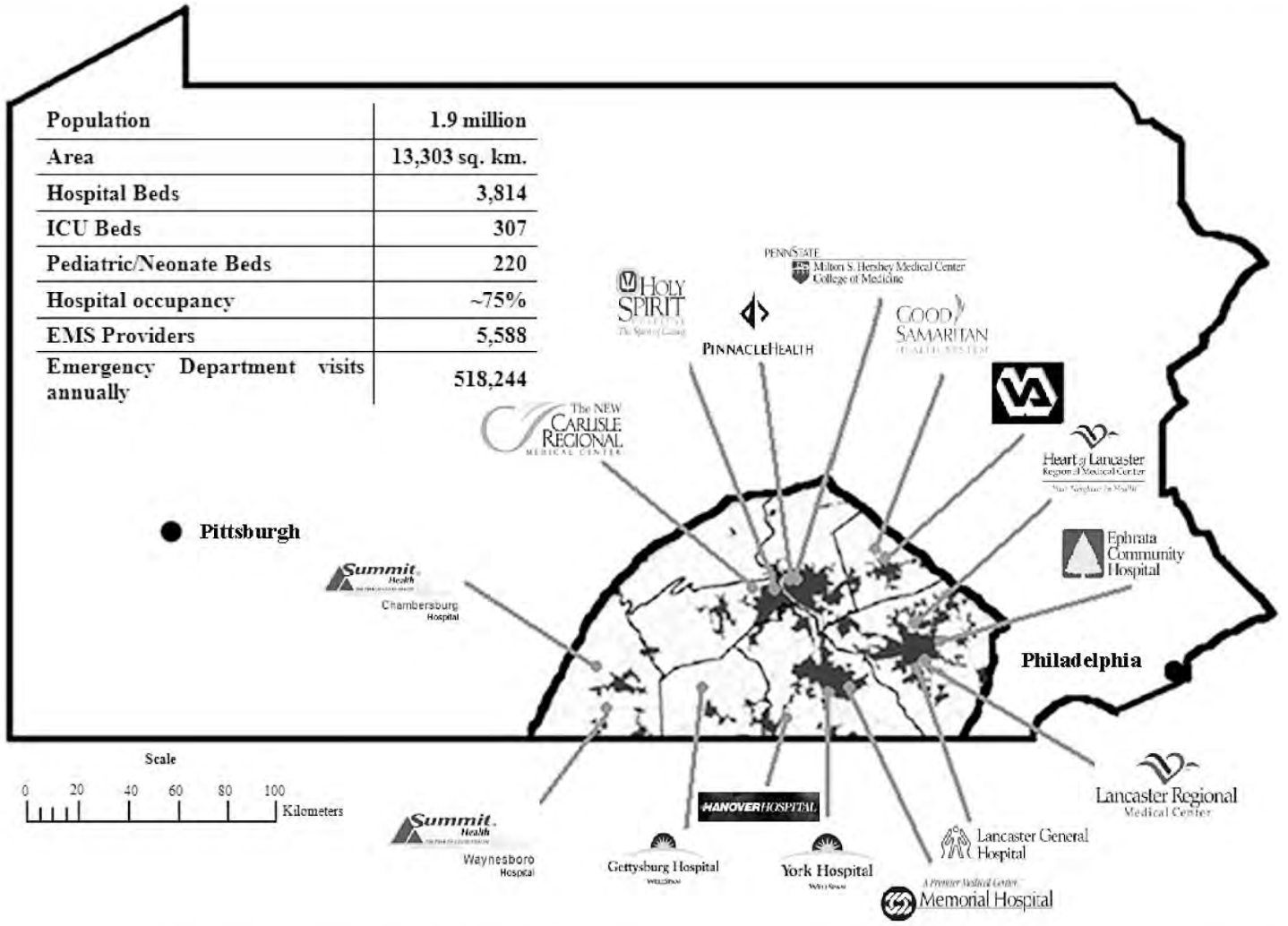

Figure 1. The South Central region of Pennsylvania consists of 8 counties (Adams, Cumberland, Dauphin, Franklin, Lancaster, Lebanon, Perry, and York), 17 acute care hospitals, emergency medical services (EMS), and county-based emergency management. Higher population densities are indicated by darker areas. Table inset summarizes geographic, population, and medical assets. *ICU*, intensive care unit.

objectives. These SMART objectives centered on multiple projects and assessments. Each of the 59 SMART objectives created by the Partnership included a description of how to measure or document the objective, and the person or persons who took the lead to implement each, and provided a deadline for completion.

Obtaining the Six Goals

Inclusive and frequent communication was evaluated as essential for the Partnership to act as 1 cohesive unit. Two specific tools were implemented to enhance contact during meetings and to immediately collaborate on data and information: a desktop-sharing tool and a toll-free number. The desktop-sharing program (Webinar, Web-based seminar) was fully interactive, which allowed all attendees to present, respond to, and discuss information in real time. The Webinar program was complemented by a toll-free number. Attendees of Webinar meetings were able to communicate verbally during sessions by calling into a phone conference. Using the Webinar with phone, meetings could be held and "attended" by all parties, regardless of their location within the 8 counties (approximately 13,303 km^2). This significantly reduced travel costs and allowed partners to complete their other regular duties with less interruption to their everyday workflow.

The Partnership conducted regularly scheduled discussions between regional healthcare facilities on shared needs to enhance surge capacity. Emphasis was based on frequent development, reduced dependency on face-to-face meetings, and growth of mutual understanding of hospital-based procedures.

To better communicate situational awareness, emergency alert systems were improved. These systems were the Facility Resource Emergency Database (FRED) system, an 800-MHz radio system, and the Health Alert Network (HAN) system.

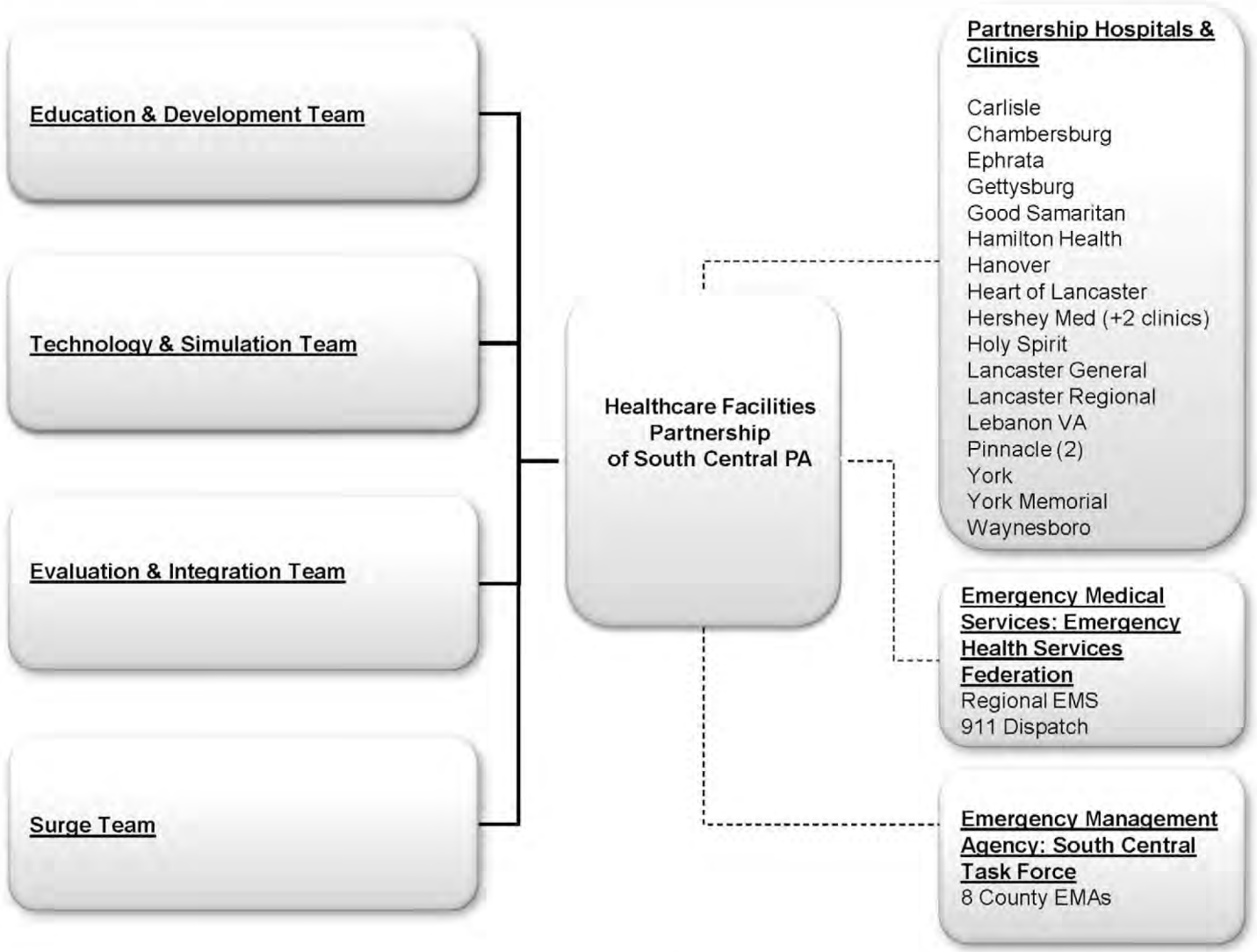

Figure 2. Partnership structure. The Healthcare Facilities Partnership of South Central Pennsylvania is composed of personnel from 17 hospitals, emergency medical service (EMS), and emergency management agencies (EMA) in the region. The Partnership created 4 work teams to accomplish its goals: the Surge Team, the Evaluation & Integration Team, the Technology & Simulation Team, and the Education & Development Team.

FRED is an Internet-based system that alerts facilities in the event of a crisis or situation that may warrant a coordinated response. It provides information about the emergency and enables facilities to report about available resources. The 800-MHz radio is a system implemented by the Pennsylvania Department of Health as a means to alert and communicate in the event of failure of primary communication methods. HAN is a national system developed by the Center for Disease Control that alerts facilities of any health threat using Web- and satellite-based technologies, and then links organizations critical for preparedness and response to said events.

These alerts were tested, improved, and practiced by using the Comprehensive Hazard and Vulnerability Analysis (HVA), the HSEEP, the pandemic influenza exercise (PanSurge07) assessment, and the PanFlu assessment. The Partnership also established triggers for activating those systems and created an "ideal communication" flow chart for the South Central Pennsylvania region.

A Web-based portal (http://hcfp-scpa.org) was created that had both a public and private (secured) component. On the secured access portion of the portal, members of the Partnership are able to share information about the surge capability of their particular hospital. Hospitals reported bed capacity in key areas such as the ED, intensive care unit, pediatric intensive care unit, and medical/surgical floors. The portal also kept a central repository for information regarding availability of equipment, similar to that of the National Hospital Available Beds for Emergencies and Disasters System developed by the Agency for Healthcare Research and Quality. On the public portion of the Web site, the Partnership created a

way to communicate with the region's communities about preparedness efforts and emergency situations.

To gather effectiveness and outcomes data, brief Web-based surveys and polls, as well as larger hospital and regional exercises, were performed to quantify various outcomes and clarify roles and responsibilities. To develop a library of low-cost repeatable training exercises, 3 computer simulations were created: a pandemic influenza outbreak (gradual and persistent surge simulation), mass casualty blast incident (sudden surge simulation), and a hospital evacuation scenario ("reverse" surge simulation). These flat-screen, computer-based simulations incorporated the HVA, PanSurge07, and PanFlu assessment results for at-risk medical populations.

Regional hospital MMAAs were examined and updated, where possible. All participating healthcare facilities reviewed, enhanced, and agreed upon updated MMAAs that now included the availability of volunteers (SERV-PA). Updated MMAAs were also signed between EMS agencies.

A SERV-PA administrator at each of the HCFP-SCPA hospital facilities was designated and trained. The administrators were given responsibility and oversight for volunteer alerts and organization of volunteers during an actual event. The HCFP-SCPA carried out a week-long recruiting event to encourage volunteers to register at each regional facility. The SERV-PA program was advertised on the Partnership Web site and at several of the hospitals in the region to further encourage volunteer enrollment. Following recruitment, the SERV-PA system was tested to determine how many new volunteers were generated.

The NIMS training requirements were simplified to become more appropriate for the hospital-based participants, and training was made more accessible to all Partnership hospitals, with an online certification process. A new NIMS compliance template was created and distributed on the Partnership Web site.

After several months of information gathering and discussion, the Partnership evaluation and integration team identified 6 gaps in the overall progress and focused on remediating these specific gaps. The gaps were identified as requirement for (1) increased capacity through staffing and alternative care sites, (2) improved efficiency through preparedness standardization, (3) decompression of hospitals by working with alternative care sites, (4) development of command and control and NIMS compliance, (5) development of improved transportation planning, and (6) enhanced surge capacity through broader participation.

RESULTS

Outcomes of the Partnership were targeted to be realistic, measurable, time-conscientious, and repeatable so as to be available for implementation by other hospital expanses looking to develop partnerships. Progress was evaluated by the completion of the 59 SMART objectives (Table) and tested through implementation of 17 brief regional exercises.

Preparedness

The HCFP-SCPA produced various resources to strengthen emergency preparedness. The 3 computer-based simulations were created and used throughout the region as an education tool. Along with this, the Partnership launched a Web-based portal with a public and secure access to facilitate communication between partners and with the public. A regional "ideal communication flow chart" (Figure 3) was created and trigger points for surge response were identified and agreed upon to further strengthen communication.

Preparedness was also strengthened through assessment. Seventeen regional data gathering and assessment exercises were conducted during the time period of the grant. After each was performed, the partnership evaluated and reviewed the results to identify limitations in the region as a whole and within each Partnership facility.

Relationships were built and strengthened by the HCFP-SCPA. The frequent communication between partners improved relationships informally. Formally, MMAAs were signed and updated between facilities. Outside the partners, alternative care sites were identified and officially recognized.

Training, policies, and procedures for working with volunteers during a surge were developed or adopted. Fifteen of 17 hospitals appointed SERV-PA managers and all were sufficiently trained by the end of the granting period. More than 500 SERV-PA volunteers had been added within the region since the start of the project. This compares favorably with the 600 volunteers that were available statewide at the beginning of the Partnership.

After implementation of the grant projects, NIMS compliance increased in the independent study (IS) 100 by 1,395; in the IS 200 by 1,439; in the IS 700 by 220; and in the IS 800 by 120, in the region. This should lead to a greater ability for hospitals to meaningfully participate in disaster response.

During the initial HAN alert system exercise, 76% of the hospitals confirmed receipt of HAN alerts and 45% of the personnel within the hospital received the alert. After review and improvements were made, a second exercise was completed. In the repeated exercise, HAN alert system No. 2, 100% of the hospitals confirmed receipt of the alert and 47% of the personal within the hosptials confirmed receipt.

At baseline, an average of 38% of healthcare facilities responded to scheduled weekly alerts on the FRED and 800-MHz systems. In all, 50% of hospitals were responding to the 800-MHz alert system, and 62% of hospitals were using the FRED alert system (31% used both systems). Some facilities did not respond to the FRED or the 800-MHz system. At the conclusion of the grant, all hospitals had the 800-MHz radio, wired and monitored continually, and had practiced receiving the FRED alert.

Table. Primary objectives of the healthcare facilities partnership during a 2-year period.

Objectives*	Fall 2007	Fall 2008	Fall 2009
Increase awareness	38% of facilities respond to weekly scheduled FRED and 800-MHz alerts.†	100% of facilities respond to HAN alerts. Communications chart created.†	FRED and 800-MHz alerts wired and monitored.†
Pilot test advanced planning	Initial exercise used to identify gaps in plans.	16 exercises completed and reviewed. Simulations created, 133 persons trained in region.	All 17 exercises completed and reviewed. Simulations made accessible via mobile training vehicle, 347 persons trained in region.
Medical mutual aid agreements	Out-of-date agreements existed between hospitals.	Agreement for 14/17 hospitals updated and signed.	Agreements for 14/17 hospitals updated and signed.
Develop and strengthen relationships	Hospitals were not communicating about emergency preparedness and surge capacity.	Averaged more than 10,000 minutes of communication per month.	Averaged more than 10,000 minutes of communication per month.
National Incident Management System compliance	1,477 trained employees in region. No facility had a trained employee available 24/7.	2,168 trained employees in region. Trained person available at each facility 24/7.	4,651 trained employees in region. Trained person available at each facility 24/7.
Strengthen utilization of volunteers	1 SERV-PA volunteer registered. No plan for utilization of volunteers.	15/17 hospitals appointed SERV-PA managers.	All hospitals have SERV-PA managers, all are trained, more than 500 volunteers registered.
SMART objective completion, %	0	90	97

FRED, Facility Resource Emergency Database; *HAN*, Health Alert Network; *SERV-PA*, The State Emergency Registry of Volunteers in Pennsylvania; *SMART*, specific, measurable, achievable, realistic, and time-framed; *24/7*, 24 hours a day, 7 days a week.
* For details, see the "Structure" section, first paragraph.
† For details, see the "Obtaining the Six Goals" section, third paragraph.

Surge Capacity

Surge capacity was analyzed by a contemporaneous phone survey of cooperating hospitals of the region. This was performed by using the Health Alert Network and Web portal communications as an alerting activity, followed by a teleconference documenting capacity for surge at 0700 and 1500 hours at each facility. At baseline in 2007, it was determined that total regional surge capacity for critical adult patients was 10 or less and for critical pediatric patients, 2 or less. Regionally, this had not been available previously on a contemporaneous basis. After exercises, self-reported capacity for the responding hospitals showed an average regional hospital surge capacity of 342 beds over the baseline of 3,192 beds (a 10.7% regional increase with surge capacity). After these surge capacity exercises, we were able to demonstrate the following increases in hospital beds: 25% increase in adult floor beds, 37% increase in critical care beds, 27% increase in ED beds, and a total regional increase of 24%. However, no increase in pediatric capacity could be created regionally without changing the Department of Health regulations on designated use of adult and pediatric beds. In subsequent practice sessions, verifiable alternative care expansion and personnel availability were shown to produce more than 3,600 low-acuity, staffed evaluation and treatment rooms for surge capacity enhancement within the region. These exercises asked hospital organizations to identify usable, staffed clinical areas that could be directed to care for patients needing education, immunization, and low-acuity visits but not requiring services only available within the affiliated hospital. These sessions assumed that the ESAR-VHP was used to augment staffing of available beds (ie, movement of providers assured between hospital organizations), that memorandum of understandings between hospital organizations resulted in enhanced coordination between overloaded and other hospital organizations, and that staffed beds for low-acuity patients could provide a load of 4 patients per treatment room per hour.

DISCUSSION

During initial review, it was clear that many improvements to the emergency response system were needed in the region. Many systems that were expected to respond to MCI and other surge emergencies, such as NIMS, MMAAs, and ESAR-VHP, were in existence but not functioning optimally.

During the granting period, we observed and demonstrated the importance of testing emergency response, not only as a single healthcare entity but also as a regional healthcare system. In particular, it is important for key jurisdictions within a healthcare region to practice communication in order for a flow

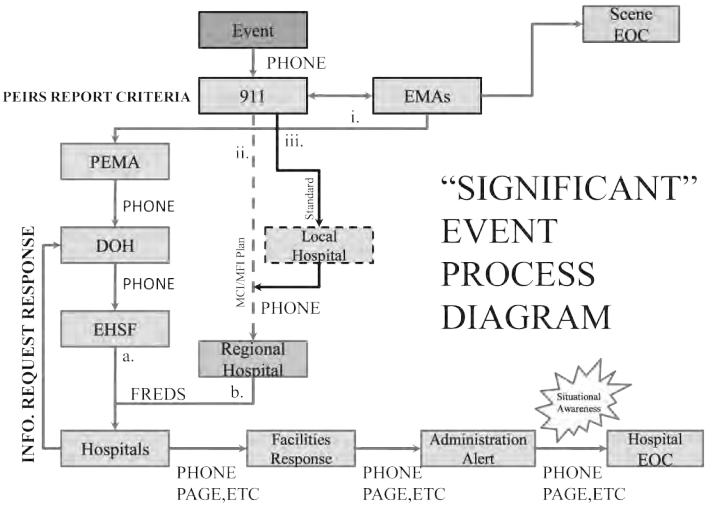

Figure 3. Communication flow chart. In the eventuality of an event, 911 is notified, emergency medical service is dispatched, and emergency management agencies (EMA) are contacted (when a mass casualty incident [MCI] has/may have occurred). Incident scene operations may require emergency operations center (EOC) support for MCIs of significant magnitude. The EMAs are then responsible for producing a Pennsylvania Emergency Incident Reporting System (PEIRS) report. Information on the PEIRS report is passed through the Pennsylvania Emergency Management Agency (PEMA), to the Pennsylvania Department of Health (DOH), to the Emergency Health Services Federation (EHSF), and then to the hospitals who will be receiving the patients. To achieve faster situational awareness for hospitals, the 911 service now directly contacts local hospitals in the event of a significant occurrence for which surge is possible. These local hospitals then contact regional hospitals capable of creating a Facility Resource Emergency Database (FRED) alert that notifies all hospitals in the region.

of information to go from the initial dispatch to all of the key jurisdictions that need to respond, including hospitals. It was clear to the Partnership that without significant practice and troubleshooting, the path of communication did not move rapidly from the initial dispatch to all of the event catchment hospitals.

We highlighted the need for effective practice exercises and simulations. Practice made it possible to troubleshoot the complex decision making effectively. Simulation training with the regional facilities is a priority and is crucial to sustain regional disaster preparedness. The computer-based simulation added additional interactive and qualitative data and measurements that exceeded previous real-time exercises, such as tabletops.

LIMITATIONS

This project had several important limitations. Although the South Central Pennsylvania region has many communities, hospital facilities, and demographics that are similar to other regions, no 2 points across the country are the same. Each region has individual requirements, restrictions, and resources, which may differ from ours. However, we believe that much of our technique can be replicated elsewhere.

The members of the partnership were asked to disclose information to the HCFP-SCPA, and much of the data were reliant on this self-reporting. Furthermore, we rely on the partners to uphold preparedness and surge quality after the end of the grant period. Although we believe that our partners are dedicated to emergency preparedness and increasing surge capacity, the incident of fraudulence is possible. Similarly, while we feel that improvement in hospital personnel participation is a result of participation in, and actions of, the HCFP-SCPA, the possibility exists that subjects improve or modify an aspect of their behavior that is being experimentally measured in response to the fact that they are being studied.

CONCLUSION

The Partnership successfully increased preparedness and surge capacity through a coalition of regional healthcare facilities and emergency response agencies. At baseline, the healthcare facilities in our region of Pennsylvania had the ability to accommodate 10 critically ill patients. At the conclusion of the study, the Partnership has practiced a regional response to a large surge event and has found an increase in capacity that exceeds 100 patients.

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