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Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

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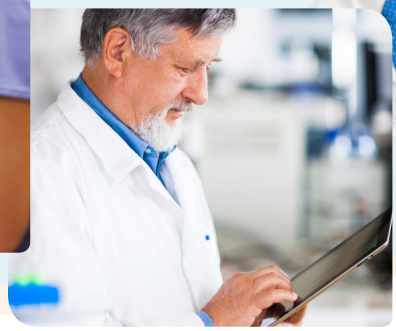

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Identify-Isolate-Inform: A Tool for Initial Detection and Management of Measles Patients in the Emergency Department

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Measles (rubeola) is a highly contagious airborne disease that was declared eliminated in the U.S. in the year 2000. Only sporadic U.S. cases and minor outbreaks occurred until the larger outbreak beginning in 2014 that has become a public health emergency. The "Identify-Isolate-Inform" tool will assist emergency physicians to be better prepared to detect and manage measles patients presenting to the emergency department. Measles typically presents with a prodrome of high fever, and cough/coryza/conjunctivitis, sometimes accompanied by the pathognomonic Koplik spots. Two to four days later, an erythematous maculopapular rash begins on the face and spreads down the body. Suspect patients must be immediately isolated with airborne precautions while awaiting laboratory confirmation of disease. Emergency physicians must rapidly inform the local public health department and hospital infection control personnel of suspected measles cases. [West J Emerg Med. 2015;16(2):212–219.]

INTRODUCTION

The 2014 Ebola outbreak, a public health emergency originating in West Africa, as well as the emergence of Middle East Respiratory Syndrome and pandemic influenza, are stark reminders that we must prepare our healthcare systems for emerging infectious diseases (EIDs).[1] The public health threat includes not only novel diseases, but also the reemergence of existing diseases that were previously well controlled, such as measles in the U.S. In 2014, 644 cases of measles from 27 states were reported to the U.S. Centers for Disease Control (CDC), the greatest number reported since the endemic disease was declared eradicated in the year 2000. From January 1 to March 6, 2015, CDC reported 173 people from 17 states and the District of Columbia to have measles, with most related to a multi-state outbreak linked to an amusement park in southern California.[2]

Measles is one of the most transmissible diseases in existence, with at least a 90% infection rate in susceptible populations.[3] The incubation period ranges from 7-21 days, and humans are the only natural host. Measles can be contagious four days prior to the onset of rash and, in fact, is most contagious prior to rash manifestation. Measles can mimic influenza, croup, bronchiolitis or pneumonia before the rash occurs. It can be transmitted from surfaces and air for up to two hours after an infected person leaves a room. Yet most clinicians in industrialized countries have never seen even a single case of measles.

Following a brief review of measles, this paper describes the novel 3I tool, initially developed for Ebola virus disease,[4] as adapted for use in the initial detection and management of measles patients in the emergency department (ED).

Clinical Presentation

Symptoms and signs

Measles classically presents with a high fever (often >104°F [40°C]), generally of 4-7 days in duration. This initial sign occurs after an incubation period of 1-2 weeks following exposure (average 10-12 days). During this prodromal phase, a classic triad of cough, coryza and conjunctivitis (the "3 Cs") is often present.[5] Patients may have photophobia. The eyes have a characteristic appearance, typically showing erythema of the palpebral conjunctiva with nonpurulent discharge (Figure 1) and sometimes periorbital edema. Patients may also report malaise, myalgias, anorexia, and diarrhea. Adults often develop transient hepatitis.[6]

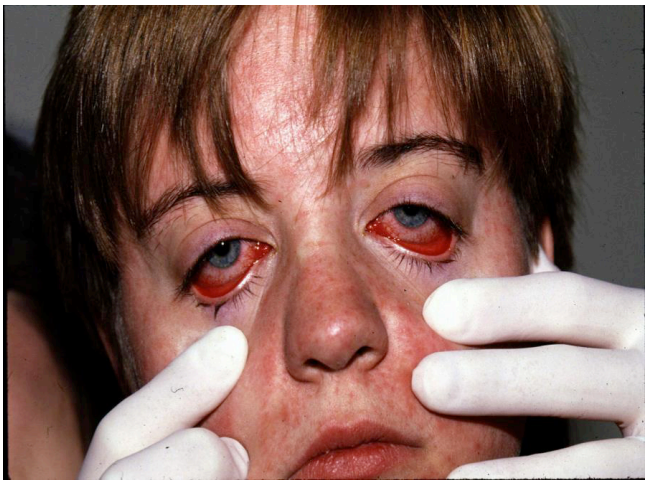

Figure 1. Nonpurulent conjunctivitis and facial rash of measles one day after rash began. Photo used with permission of Michael J. Burns, MD.

Koplik spots, when seen, are pathognomonic of measles (Figure 2). If present, they manifest 1- 2 days prior to the rash and last for 3-5 days. They appear as bluish-gray enanthema ("small grains of sand") on a red base and are typically seen on the buccal mucosa opposite the second molars. Therefore, it is essential to have proper lighting to visualize them. During a measles outbreak, after donning appropriate respiratory protection, emergency physicians (EP) should carefully assess the oropharynx in patients presenting with non-specific viral syndromes and assess for the presence of Koplik spots.

The rash of measles generally erupts about 14 days after exposure, which is usually 2-4 days after onset of symptoms. Unlike rashes of some infectious diseases that start on the lower extremities or trunk, the rash of measles begins on the face and progresses cephalocaudally to the torso and extremities. Thus, assessing the pattern of rash evolution is essential to identify measles patients. Erythematous macules and papules coalesce into patches and plaques within about 48 hours (Figure 3).

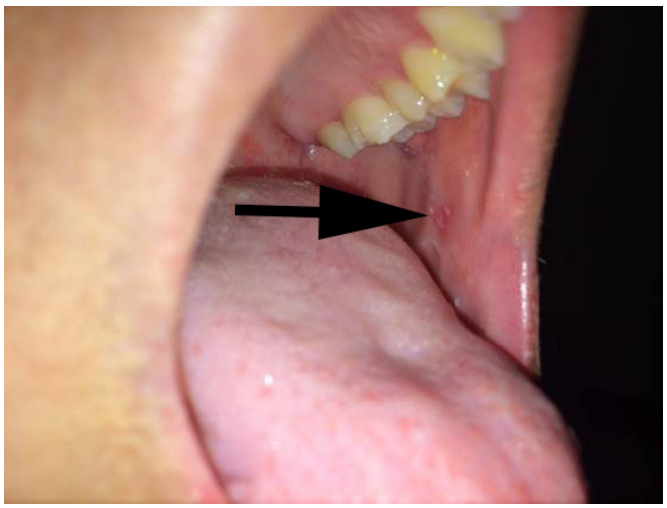

Figure 2. Koplik spots. Photo used with permission of Michael J. Burns, MD.

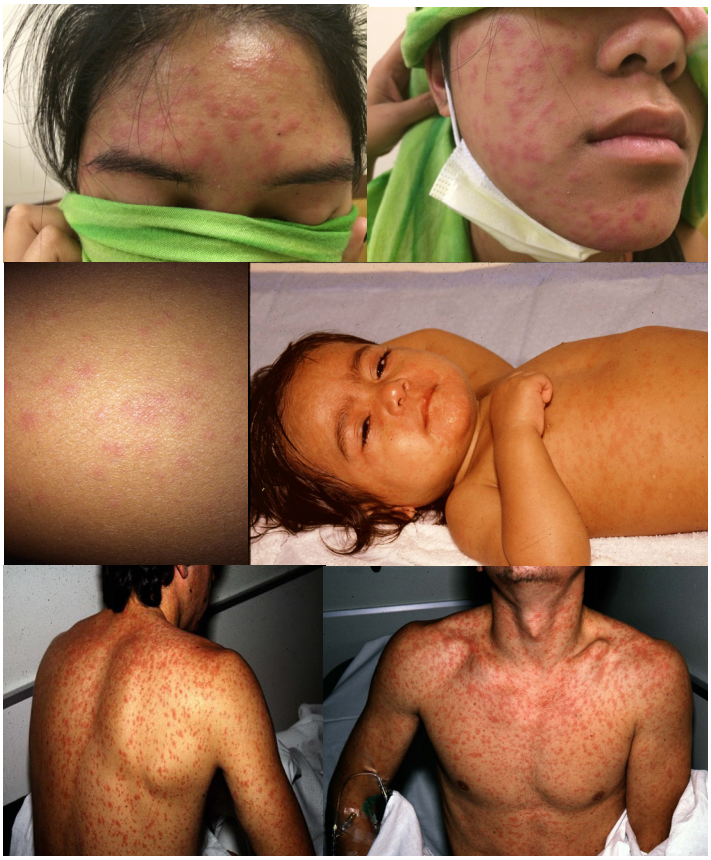

Figure 3. Measles rash. Photos used with permission of Michael J. Burns, MD.

Petechia and ecchymosis can also be seen. By the time a rash develops, within 1-2 days, patients will be ill appearing. After 5-7 days, the exanthem begins to fade, forming coppery-brown hyperpigmented patches that may desquamate. The rash initially disappears at the location where it first appeared. The rash can be more difficult to detect on dark-skinned patients (Figure 4).

Manifestations of infection

Disease manifestations are often more severe in children under five and adults over 20 years of age. Patients who are immunocompromised may present atypically and may not develop a rash. During a measles outbreak, clinicians should advise patients with viral syndromes who are being discharged from the ED to monitor for appearance of a rash, especially one that first appears on the face. If a rash develops, children or adult patients should avoid public places and seek immediate medical advice.

Atypical Measles

People who received vaccinations between 1963 and 1967 with the original killed-virus measles vaccine may have incomplete immunity and present with milder symptoms. During those years, this vaccine was only administered to U.S. children at about one year of age, so persons presenting in 2015 with "atypical measles" would be 48-52 years of

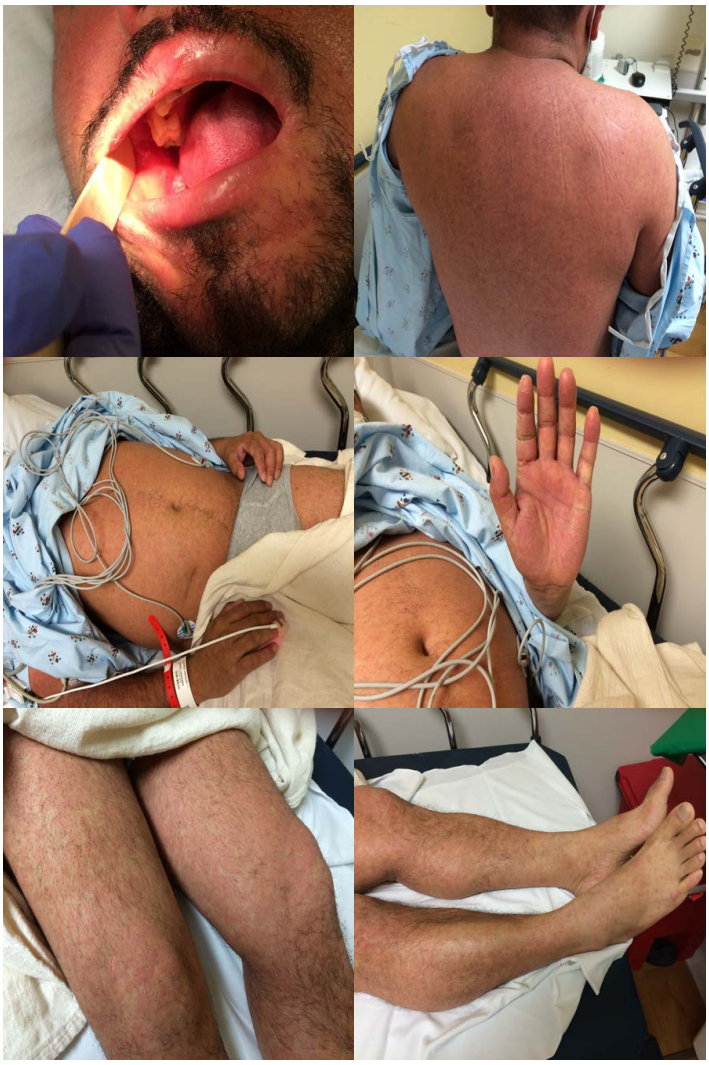

Figure 4. Measles rash and Koplik spots in an adult male. Photos used with permission of Michael J. Burns, MD.

age. A prodrome of fever, headache, abdominal pain and myalgias can be subclinical. In these atypical presentations, the rash can be macular, vesicular, petechial, or urticarial and can begin on the hands and feet and spread centripetally. When atypical measles was first reported in the late 1960s and early 1970s, it was often mistaken for Rocky Mountain Spotted Fever.

In patients who receive post-exposure prophylaxis with serum immunoglobulin, a modified variety of measles can occur with similar but milder signs and symptoms and an incubation period of up to 21 days.

Risk Factors

The population most at risk for measles are those persons who are exposed, but not immunized, or with inadequate immunity. This includes infants too young to receive immunizations (under 12 months), children whose parents have declined immunization, travelers from countries where immunization rates are low, and immunocompromised patients.

Diagnosis

When measles is suspected, the clinician should collect separate swabs of the throat and nasopharynx using viral culture swabs and contact the local health department for real-time polymerase chain reaction (RT-PCR) testing. Serum can also be obtained and sent for measles-specific IgM antibody, but the test may be negative early in the course of disease. Some local health departments may also request additional testing of serum and urine for RT-PCR testing. According to the CDC, there are no data supporting routine checking of serum antibody titers, particularly given the fact that they have notable false negative result rates.[7]

Complications and Special Populations

Pregnant women and other persons with deficiencies in cell-mediated immunity are at increased risk for serious complications, including primary measles giant cell pneumonia with respiratory failure. Spontaneous abortion and premature delivery have been described. However, there is no increased risk for congenital anomalies as has been reported in other diseases contracted during pregnancy, such as toxoplasmosis, rubella, cytomegalovirus, herpes simplex, and human immunodeficiency virus.

The vast majority of patients with measles who are well-nourished (not vitamin A deficient) recover; however, measles can lead to several complications and even death.[5,8] While certain groups of patients are at high risk for complications, even previously healthy children can become severely ill and require hospitalization.

The following are well-described complications of measles:

- 1 in every 10 children develops bacterial otitis media (can lead to permanent hearing loss)
- 1 in every 20 children develops bacterial pneumonia
- 1 in every 1000 children develops acute encephalitis (often resulting in permanent brain damage)
- Unknown frequency of measles giant cell pneumonia in pregnant and other immunocompromised patients
- 1 in every 1000 children dies (from respiratory and neurologic complications)
- Febrile seizures are also seen

In addition, a rare late complication (7 to 10 years after measles infection) is subacute sclerosing panencephalitis (SSPE), a fatal degenerative disease of the central nervous system characterized by behavioral and intellectual deterioration and seizures. Permanent blindness may also result from measles infection.

Transmission and Personal Protective Equipment

Measles is transmitted by the airborne route. It can be

contracted for up to two hours from the air or from airborne particles on surfaces in a room that was occupied by a measles patient. In addition to standard precautions, all practitioners, even if immunized, who enter a room with a suspected or confirmed measles patient should wear fit-tested N95 respirators or equivalent respiratory protection.

Differential Diagnosis

Prior to onset of rash, measles can mimic influenza, croup, bronchiolitis, other viral illnesses, and pneumonia. Once the rash develops, particularly with accompanying fever, other entities, including common childhood diseases, are in the differential diagnosis. Characteristics of these diseases help to distinguish them from measles (Figure 5). In addition to alternate infections, EPs must distinguish the rash of measles from other acute rash presentations with systemic symptoms, including allergic drug reactions.

Treatment

Treatment for measles is primarily supportive care. Hydration and antipyretics, such as in other viral illnesses, are the mainstays of therapy. If a secondary bacterial infection such as otitis media or pneumonia develops, appropriate antibiotics are indicated. Vitamin A is a measles-specific treatment that is critical in any patient with low levels; it can be administered orally.[5] This treatment can lessen severity and even prevent mortality. The dose of vitamin A for measles patients is large, typically 200,000 international units (IU) for two days (50,000 IU if under 6 months and 100,000 IU for 6-11 months).[9]

Measles is a major cause of death in refugee camps where vitamin A deficiency is common, immunity is poor, and conditions are crowded. For every case of measles, 50 more persons in the camp are thought to be incubating disease. Vitamin A supplementation significantly reduces mortality.

Prevention

The vast majority of cases of measles in patients with intact cellular-mediated immunity are uncomplicated and resolve by about 7-10 days after onset of illness. In fact, in prevaccination times, mothers used to purposely expose their children so they would all get sick at once and develop immunity before adulthood. Nevertheless, in modern days, disease prevention should be the goal.

All persons should be vaccinated against measles (as part of the measles, mumps and rubella [MMR] vaccine) unless there is a medical contraindication to live virus immunization. Vaccination is highly effective in preventing disease, but it is not 100% protective, even in persons who have received two doses of vaccine at appropriate intervals. Also, some patients are too young to be vaccinated, i.e., those under 12 months of age.

There has been a movement in the U.S. by some parents to avoid or delay vaccination based on personal, philosophical beliefs that are not medical or religious in origin. While this is permitted in some states, it results in decreased herd immunity, placing persons with medical contraindications to vaccination and others at greater risk. This reluctance to vaccinate is based in part on a 1998 study that reportedly found a link between the MMR vaccine and autism.[10] This study has been discredited, the researcher accused of providing fraudulent data, and the paper has been retracted.

Post-Exposure Prophylaxis and Precautions

Infants under six months of age and nonimmune/nonimmunized pregnant women, if exposed, should receive passive immunity with intramuscular immune serum globulin. When administered within six days of virus exposure, these antibodies can prevent measles or reduce illness severity. If they are over six months, infants should receive a standard vaccination. Other nonimmunized persons who are exposed to measles should receive vaccination as well, ideally with 72 hours of the exposure. While vaccination might not prevent the disease, if illness develops it is generally less severe and for a shorter duration than in completely unvaccinated persons.

Household contacts should be advised that measles is highly contagious and infected family members should be isolated from four days before to four days after the rash manifests. Anyone at risk who is not fully vaccinated should receive vaccine as soon as possible. Most people born or living in the U.S. before 1957 have had measles and are therefore immune.

Disposition

As with any other patient presenting to the ED, it is important for EPs to be familiar with admission vs. discharge criteria. Admission criteria for measles patients are similar to those for others. However, there are special considerations for patients being discharged. As measles is highly contagious, there are public health considerations as well as individual concerns for patients who do not meet hospitalization parameters. Infected patients must be isolated from others and public health must be notified so that contact tracing and community protective measures can be instituted.

EPs should provide return precautions. In addition to routine instructions, these should include the following: 1) monitor for occurrence of rash if one is not already present, and 2) pay special attention to the development of respiratory distress and neurologic symptoms. For someone being discharged, clinicians should document that the patient is well nourished and that the family is not in poverty (therefore not suspected to be Vitamin A deficient), and that there are no neurological or respiratory risks.

Identify-Isolate-Inform

The Identify-Isolate-Inform tool initially developed for

	Causative agent	Rash characteristics and distribution	Associated symptoms and signs
Adenoviruses	Adenovirus	• Maculopapular "rubelliform" or petechial rash in a small minority of patients	• Acute respiratory disease: fever, conjunctivitis, coryza, pharyngitis, bronchitis, tracheitis, or pneumonia • Epidemic keratoconjunctivitis • Gastroenteritis • Uncommonly: hemorrhagic cystitis, meningo-encephalitis, or myocarditis
Drug rash	Allergic and non-allergic reactions to drugs, including: urticaria, angioedema, hypersensitivity vasculitis, exfoliative dermatitis, DRESS (drug reaction with eosinophilia and systemic symptoms), Stevens Johnson syndrome and toxic epidermal necrolysis	• Red macular, papular, vesiculobullous, petechial, palpable purpura, or desquamative rash • Vary in severity from mild to peeling of the entire skin • Rashes may appear suddenly or may be delayed	• Fever, oral mucosal lesions, conjunctivitis, or vomiting
Enteroviruses	Coxsackieviruses, echoviruses, and other enteroviruses	• Maculopapular or petechial or vesicular rash more prominent on the extremities	• Fever, oral vesicles/ulcers, conjunctivitis • Meningitis or encephalitis
Erythema infectiosum (Fifth disease)	Human parvovirus B19	• Red macular rash on cheeks ("slapped cheeks") lacy, reticular macular rash most prominent on extensor surfaces of extremities	• Fever and systemic symptoms are absent or low grade in children • Very painful symmetrical arthralgias and arthritis may occur in adults
Infectious mononucleosis	Epstein-Barr virus	• Nonpruritic macular, petechial, scarlatiniform, urticarial or erythema-multiforme-like rash in about 5% of patients • Pruritic maculopapular rash after ingestion of ampicillin or amoxicillin	• Fatigue, prolonged malaise, pharyngitis, headache, fever, nausea and anorexia, lymphadenopathy, hepatomegaly, palatal petechiae, jaundice, uvular edema, or splenomegaly
Rickettsia and rickettsia-like organisms (Rocky Mountain Spotted Fever [RMSF]), Murine Typhus, Ehrlichiosis, Anaplasmosis	*Rickettsia, Ehrlichia, Anaplasma*	• RMSF: small red macules begin on distal extremities and gradually progress centrally, becoming petechial • Murine typhus: small red macules beginning centrally and gradually spreading distally, becoming petechial • Ehrlichiosis and anaplasmosis: macular, papular and petechial rash in a minority of patients	• Fever, headache, malaise, and sometimes nausea and vomiting, may become severe
Roseola infantum	Human Herpes Virus 6 & 7	• Pink maculopapular rash on the trunk → the neck	• Fever, may develop febrile seizure • Rash starts after fever subsides
Rubella (German Measles)	A togavirus	• Blanching erythematous maculopapular rash begins on head and neck → trunk → extremities	• Fever, sore throat, prominent postauricular, posterior cervical +/- suboccipital adenopathy (patients are not ill appearing) • Forschemier spots (soft palate petechiae, not specific for rubella)
Rubeola (Measles)	A paramyxovirus	• Blanching erythematous maculopapular rash starts on head and neck → trunk → extremities	• Fever, cough, coryza, and conjunctivitis • Koplik spots on buccal mucosa

Figure 5. Pediatric exanthems that may mimic measles.

	Causative agent	Rash characteristics and distribution	Associated symptoms and signs
Scarlet fever	Exotoxin-mediated rash caused by group A streptococcus	• Coarse, sandpaper-like, erythematous, blanching rash with desquamation • Starts on head and neck ⟶ trunk ⟶ extremities	• Fever, sore throat, submandibular lymphadenopathy, circumoral pallor, strawberry tongue and palatal petechiae
Smallpox	Variola virus	• Delayed onset of rash, beginning after 1-2 days of illness, in centrifugal distribution (more predominant on oral mucosa, face, extremities, palms and soles, less on trunk); rash begins as macules progressing to deep-seated vesicles and later pustules over several days; lesions in same stage of development in one area of the body (unlike varicella)	• Fever, chills, headache, backache, vomiting, prostration • Dermal petechiae may sometimes develop at onset of illness
Varicella (Chickenpox)	Varicella-zoster virus	• Red macules that progress to discrete vesicles surrounded by erythema, beginning on face ⟶ trunk and extremities	• Fever and malaise, and cough • Lesions in varying stages of development and minimal distal extremity involvement
Kawasaki disease	Febrile vasculitis	• Initial reddening or edema of the palms and soles ⟶ membranous desquamation of the finger and toe tips ⟶ polymorphous generalized rash (may be limited to the groin or lower extremities)	• Fever (prolonged, more than 5 days), irritability, nonexudative bilateral conjunctivitis, anterior uveitis, perianal erythema, strawberry tongue and lip fissures, hepatic, renal, and gastrointestinal dysfunction, myocarditis, pericarditis, and lymphadenopathy (single, enlarged, nonsuppurative cervical node measuring approximately 1.5cm)

Figure 5. Pediatric exanthems that may mimic measles, continued.

Ebola virus disease[4] can be modified for the ED evaluation and management of patients under investigation for measles virus (Figure 6). While patients typically present to the ED with symptoms, during an outbreak, concerned but asymptomatic patients and parents of potentially exposed children may seek care. Therefore, the first branch of the algorithm involves determination of whether the patient is symptomatic or asymptomatic. For asymptomatic patients, the goal is prevention of disease in both the individual and the population. This is accomplished by assessing exposure history and patient risk and, if it exists, providing post-exposure prophylaxis (with vaccine or with immune serum globulin if the patient is immunocompromised).[11] The patient must then undergo public health monitoring for 21 days to monitor for the development of signs and symptoms. Home quarantine should be strongly considered, as patients with measles may be contagious for a few days prior to onset of symptoms.[12]

Conversely, patients with signs and symptoms of measles (prodrome of fever, cough/coryza/conjunctivitis, Koplik spots followed by rash), should be immediately masked and isolated using airborne precautions. To assist in risk assessment, EPs should inquire about immunization status, sick contacts, and travel to a region with measles. All healthcare providers, including those who have been vaccinated, should don N95 respirators or equivalent respiratory protection prior to caring for suspected measles patients. As with other airborne diseases, clinicians must be current on their "fit testing" requirements (typically renewed annually) in order to properly use an N95 respirator. Isolated patients should have samples obtained urgently and sent to the local public health department laboratory for disease confirmation.

Whether patients are symptomatic and immediately isolated or asymptomatic and exposed/at risk, public health authorities must be immediately notified 24/7. In addition, clinicians should promptly inform the hospital infection control and prevention practitioner on duty, regardless of time of day.

CONCLUSION

Measles is a highly contagious preventable viral disease that had been declared eradicated in the U.S., but made a resurgence starting in 2014. Identify-Isolate-Inform is a tool for EPs to apply when patients who may have measles present to the ED. In addition, several pearls

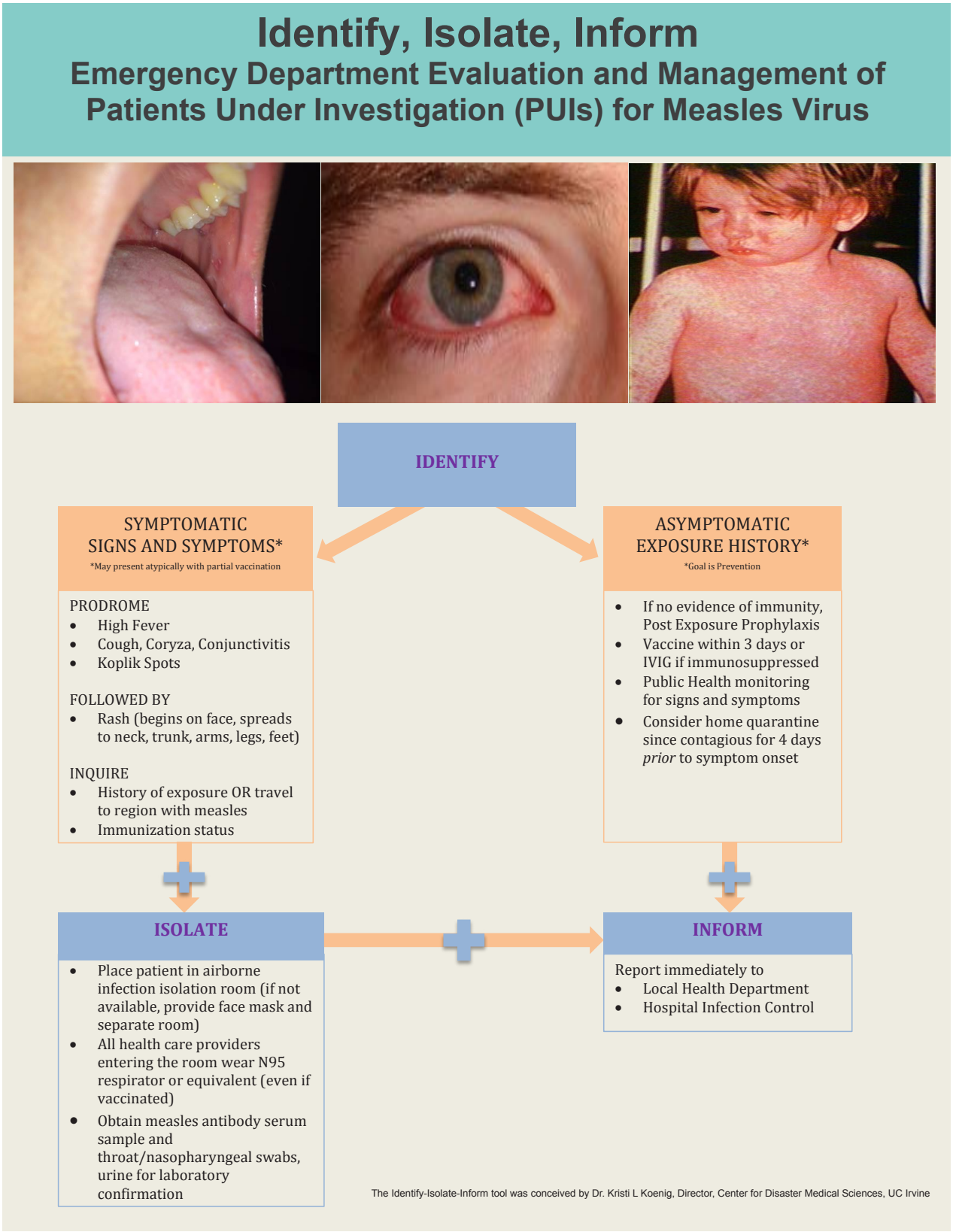

Figure 6. Identify, isolate, and inform tool.
IVIG, intravenous immunoglobulin

are helpful when managing measles patients (Figure 7). As emergency physicians working on the front lines of clinical medicine, we must be prepared for emerging and reemerging infectious diseases.

- Check immunization status
- Ask about travel and exposure history
- Essential history: rash should begin on face and neck and spread distally, with delayed onset of rash after illness began
- Check for Koplik spots on patients presenting with severe viral respiratory syndromes
- Advise patients discharged with viral syndromes to monitor for later development of rash
- Remember that immunocompromised patients may not develop a rash

Figure 7. Measles pearls.

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Kiosk versus In-person Screening for Alcohol and Drug Use in the Emergency Department: Patient Preferences and Disclosure

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Introduction: Annually eight million emergency department (ED) visits are attributable to alcohol use. Screening ED patients for at-risk alcohol and substance use is an integral component of screening, brief intervention, and referral to treatment programs, shown to be effective at reducing substance use. The objective is to evaluate ED patients' acceptance of and willingness to disclose alcohol/substance use via a computer kiosk versus an in-person interview.

Methods: This was a cross-sectional, survey-based study. Eligible participants included those who presented to walk-in triage, were English-speaking, ≥18 years, were clinically stable and able to consent. Patients had the opportunity to access the kiosk in the ED waiting room, and were approached for an in-person survey by a research assistant (9am-5pm weekdays). Both surveys used validated assessment tools to assess drug and alcohol use. Disclosure statistics and preferences were calculated using chi-square tests and McNemar's test.

Results: A total of 1,207 patients were screened: 229 in person only, 824 by kiosk, and 154 by both in person and kiosk. Single-modality participants were more likely to disclose hazardous drinking (p=0.003) and high-risk drug use (OR=22.3 [12.3-42.2]; p<0.0001) via kiosk. Participants who had participated in screening via both modalities were more likely to reveal high-risk drug use on the kiosk (p=0.003). When asked about screening preferences, 73.6% reported a preference for an in-person survey, which patients rated higher on privacy and comfort.

Conclusion: ED patients were significantly more likely to disclose at-risk alcohol and substance use to a computer kiosk than an interviewer. Paradoxically patients stated a preference for in-person screening, despite reduced disclosure to a human screener. [West J Emerg Med. 2015;16(2):220–228.]

INTRODUCTION

Background

In the United States, emergency department (ED) patients are more likely than the general population to report alcohol and substance abuse.[1,2] Eight million ED visits annually are attributable to alcohol,[3] leading to increased rates of ED crowding due to alcohol-related diseases and injuries.[4] Furthermore, ED patients with unmet substance abuse treatment needs were 46% more likely to return to the ED within a year than patients who did not report substance abuse problems.[5]

Consistent with Healthy People 2020 recommendations,[6] the American College of Surgeons Committee on Trauma

requires that all Level I trauma centers have a mechanism to identify and provide intervention for trauma patients with at-risk alcohol use.[7] Screening, brief intervention, and referral to treatment (SBIRT), provides a validated program for alcohol/drug use screening and intervention among ED patients to assess risk for alcohol and substance abuse, reduce future traumas,[3] and reduce future hazardous drinking.[8] Positive effects of SBIRT interventions have been shown with respect to multiple health outcomes, including blood pressure, fetal alcohol syndrome, and rates of future ED visits/hospitalizations.[9] SBIRT tools have also been validated among populations comprised of a variety of racial and ethnic groups.[10]

Nevertheless, ED staff rarely assess for substance and alcohol use.[5] Clinicians have identified a number of barriers to alcohol and drug use screening in the course of an ED visit, including lack of resources for patients who are identified as at risk or dependent, insufficient education and training in screening for drug and alcohol use, and lack of specific treatment protocols[11] Computer-based screening tools, such as kiosks, have been proposed to help alleviate the burden on ED staff and reduce social desirability bias that may discourage patients from reporting as alcohol and substance use.[12] Previous studies have suggested that ED kiosks are accepted by most patients,[2] are easy to use,[13] can help patients better recall health promotion advice,[14] and can effectively screen at-risk drinkers.[15,16] Computer-administered brief substance-abuse interventions have been shown to be effective at reducing hazardous drinking at 12-month follow up.[17,18]

In this study, we aimed to 1) compare results of alcohol and drug disorder screening via kiosk vs. in-person modalities, and 2) compare population capture for patients screened by kiosk vs. in-person, estimating the additional yield offered by having kiosk screening available 24 hours a day, 7 days a week. We hypothesized that computerized kiosk screenings for alcohol and drug use would yield similar disclosure rates when compared with in-person screening.

METHODS

Study Design

This study consisted of a cross-sectional, survey-based study of patients presenting to the ED from June through September 2013. Patients were screened for alcohol and substance use with the Alcohol Use Disorders Identification Test (AUDIT)[19] and the Drug and Alcohol Screening Test (DAST-10),[20] via one or both of the following convenience methods: a) computer-based kiosk general health screening including multiple general physical and mental health surveys, or b) in-person survey administration in a private area of the ED waiting room or a private patient care room (screening method used for each patient was determined based on patient preference, and based on time of day of patient arrival, as the research assistant (RA) was present in the ED 40 hours per week.

Setting

This study was conducted in a large, inner-city, safety net hospital in the southeastern United States with a Level I trauma center. The annual ED volume exceeds 120,000 patient visits. Patients at this ED are predominantly African American, low socioeconomic status, and uninsured. The institutional review board at the hospital and the affiliated school of medicine approved the study protocol.

Inclusion/Exclusion Criteria

Participants were included if they were at least 18 years old, presenting to walk-in triage for medical care at the ED, able to understand English, and able to provide consent. We excluded participants if they presented to the ED by ambulance, were younger than 18 years, critically ill or medically unstable, acutely intoxicated, presenting for an acute psychiatric complaint, incarcerated, or otherwise unable to provide informed consent. The kiosk survey was self-initiated and did not require inclusion criteria to complete; however, any patient under the age of 18 was excluded from this analysis.

Participant Recruitment

The kiosk computer was located in the ED waiting room, and was available for use 24 hours per day, every day. The kiosk screening included multiple validated instruments focusing on general health, mental health, intimate partner violence risk, and alcohol/substance use. For drug and alcohol use screening, the kiosk screening used the AUDIT and the DAST-10. Patients were informed by signs posted in the ED and/or a dedicated project RA that they could use the kiosk to obtain a "free health screening." Results of the kiosk screening were provided to patients via a computer print-out, with relevant education and support services referrals. Information about patient responses to the kiosk screening was not placed into the medical record or otherwise available to the ED care team.

For participation in the in-person screening, a trained RA was present in the ED Monday through Friday, 9am-5pm. The RA approached eligible patients in both the ED waiting room and in patient care rooms during naturally occurring downtime in the patient's medical care (such as while awaiting lab or imaging tests to occur or while awaiting test results). Patients were eligible for in-person screening participation regardless of prior completion of the kiosk screening. When approached for in-person screening, participants were informed that the RA was surveying people about health behaviors and survey modality preferences, and that participation was voluntary, confidential, and any choice to agree/decline to participate would have no bearing on the patients' medical care. All participants provided signed informed consent (Figure 1).

Survey Instruments

Kiosk Screening

The kiosk presented a variety of survey instruments

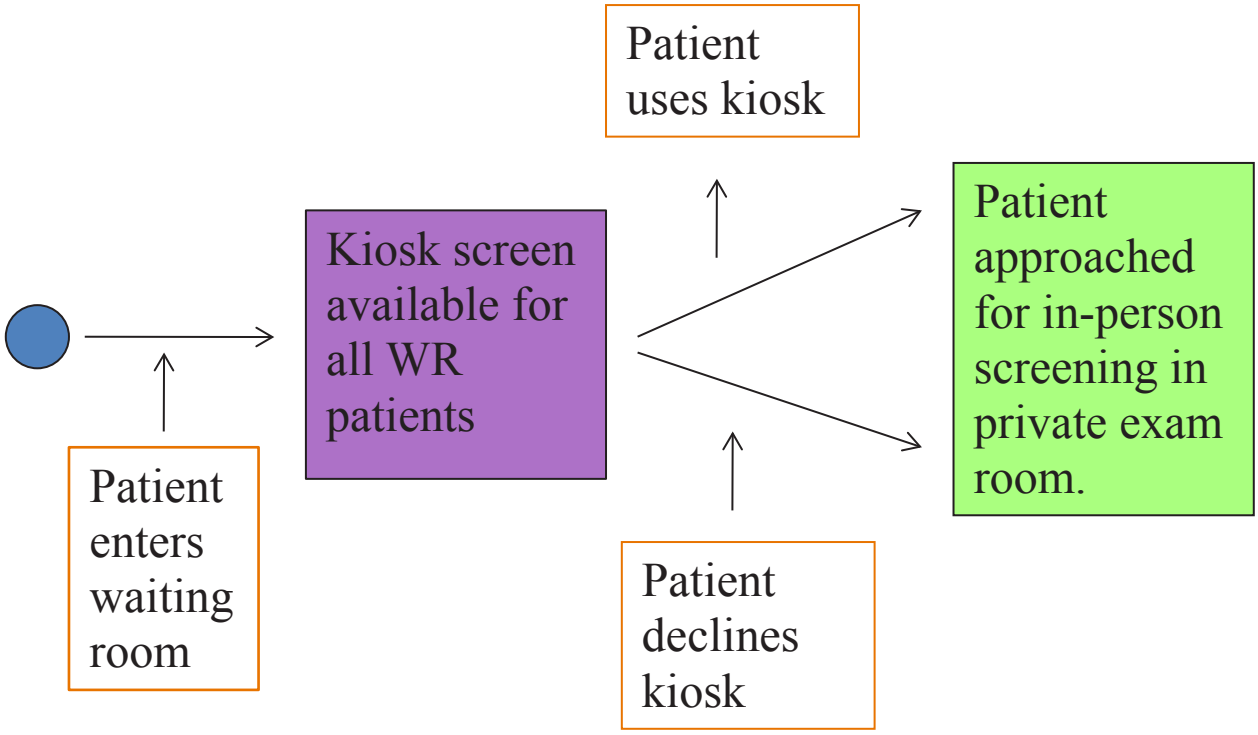

Figure 1. Patient flow diagram of participation in alcohol and drug use screening, using kiosk and in-person modalities. *WR,* waiting room

focused on demographics, nutrition, intimate partner violence, sexual health, as well as the AUDIT and DAST-10 for alcohol and drug use screening. Only demographics and alcohol/drug survey items were included in the analysis described here. All kiosk survey responses were automatically collected using a Microsoft Access database. Participants who disclosed any adverse health behaviors were provided print outs with referrals to appropriate local services.

We assessed alcohol use with the AUDIT, a previously validated 10-item survey.[21] The range of possible AUDIT scores is 0-40. In standard practice, AUDIT scores are translated to alcohol use risk categories: low risk (0-7), moderate risk (8-15), high risk (16-19), or dependent (20 or higher). The AUDIT has been previously validated with an internal consistency of α=0.83[22] compared to biomarkers, the AUDIT has been shown to have a sensitivity=0.98 and specificity=0.34 at the ≥8 threshold.[21]

Substance use was assessed with the DAST-10,[20] a previously validated 10-item survey (Appendix) with an internal consistency of α=0.94.[23] Possible DAST-10 scores range from 0-10. The DAST-10 was categorized thus: lowrisk (0-2) or high-risk (≥3) drug use. Using a threshold of ≥3, the DAST-10 has been shown to have a sensitivity=0.41 and specificity=0.99 relative to biomarkers.[23]

In-person survey

The in-person survey items included patient demographics, alcohol use, drug use, and screening modality preferences. Demographic data collected included race, gender, age, employment, education, and marital status. Alcohol use was measured via the AUDIT and the DAST-10. After completion of the other survey instruments, patients were asked a brief series of questions regarding attitudes about and comfort with alcohol and drug screening via computer-based vs. in-person screening. The preferences instrument was modified from a pre-existing survey of patient preferences regarding screening modality of choice for patients surveyed about intimate partner violence.[24] This survey was not included in the kiosk screening.

Participants were considered "at risk" if they scored ≥8 on the AUDIT or ≥3 on the DAST-10, based on previously established standards for SBIRT interventions.[25,26] Participants whose screening results showed that they were "at risk" for either alcohol or drug abuse during the in-person survey were offered immediate referral to a trained substance abuse specialist.

All dual participants took the kiosk survey prior to the in-person survey, due to both study and clinical patient flow requirements.

Data Analysis Methods

We summarized and compared demographic characteristics by kiosk status (kiosk only, in-person only, or dual) using a chi-square test to assess for independence between kiosk status and categorical demographic variables and analysis of variance (ANOVA) to assess for independence between kiosk status and age. We

assessed differences among participant screening modality preferences using a chi-square test.

Among patients who used only one screening modality, alcohol and modality were compared using a Cochran Mantel-Haenszel chi-square test; drug use and modality were compared using a chi-square test. Among patients screened via both modalities, we compared alcohol and modality using a Friedman's chi-square test for repeated measures; drug use and modality were compared using McNemar's test.

To account for missing data, we conducted an intention-to-treat analysis comparing alcohol/drug use to screening modality. All tests described in the previous paragraph were conducted under the conservative assumption that any missing patient was categorized in the lowest possible alcohol/drug risk category.

To address the second aim of population capture by time of day, we summarized when participants took each screening modality, and quantified the additional yield by having the kiosk available during off-hours. Business hours were categorized as Monday through Friday, 9am-5pm off-hours were defined as any other time of day or week. We also summarized which time of day at-risk participants were more likely to take the kiosk. All data were analyzed using SAS Version 9.3 (SAS Institute, Cary, NC).

RESULTS

Among the 569 participants approached for in-person screening, 382 consented (67.1%). Among patients who did not consent, reasons for refusal included not feeling well (n=66), not interested (n=80), wariness of the study (n=13), lack of English proficiency (n=13), busy (n=9), and other (n=4). During the same period of time, 978 total patients initiated the kiosk screening, with 154 patients participating in both kiosk and in-person screening. Among the remaining 824 participants who only attempted the kiosk, 620 (75.2%) completed any portion of the AUDIT or DAST-10 instruments.

Participants who took the kiosk were significantly less likely than participants who took the in-person survey to complete both the AUDIT and DAST-10 instruments (16.2% vs. 99.9%, p<0.0001). Among participants who only took the in-person modality, 229 participants completed the AUDIT (100%) and 228 completed the DAST-10 (99.6%). Among the 620 participants who attempted only the kiosk, 461 completed the AUDIT (55.9%) and 127 completed the DAST-10 (20.5%). Among the 154 dual participants, 154 completed the AUDIT in-person (100%), 148 (96.1%) completed the kiosk AUDIT survey, 154 (100%) completed the DAST-10 in person, and 32 completed the DAST-10 on the kiosk (20.8%)

Table 1 summarizes the demographics of participants in each of the three screening categories (kiosk, in-person, dual). Among participants who took only the in-person screening, 50.2% were male, compared to the kiosk-only and dual participants, who were 59.5% and 42.9% male, respectively. The majority of participants in each screening group were African American, reflecting the overall ED population; however, participants who used the kiosk-only modality were more likely to identify as white, Asian, Hispanic/Latino, or multiracial than the other screening categories. Participants who took only the in-person survey were less likely to have graduated from high school (74.6%) than participants who took only the kiosk (83.8%) or participants who took both surveys (90.8%; p=0.0001*)*.

Comparing participants who completed a screening via only one survey modality, either the kiosk or the in-person screening, participants were more likely to report moderate-risk, high-risk, and dependent alcohol use when screened via the kiosk than when screened in-person (p=0.003). This finding extended to the DAST-10 instrument, with participants showing a higher likelihood of reporting high-risk drug use when screened via the kiosk than in-person screening (OR=22.3, 95% CL [12.3-42.2]; p<0.0001) (Figure 2).

Among study participants who were screened via both the kiosk and in-person (Figure 2), there was no difference in disclosure rates for at-risk alcohol use. (p=0.16); however, the participants were more likely to disclose high-risk drug use via the kiosk (p=0.003).

Due to the high rate of DAST-10 survey non-completion among kiosk users, we analyzed study results using an intention-to-treat analysis, categorizing all participants who did not complete a survey as low risk. In this analysis, the probability of disclosing high-risk drug use via the kiosk remained significantly higher than via in-person screening (p<0.05), and probability of disclosing high-risk alcohol use remained significant among participants screened via one modality (Figure 3).

When asked about survey modality preferences, participants were more likely to identify in-person screening as "private" (43.6% vs. 34.4%), more likely to elicit honest responses from patients (48.7% vs. 35.3%), and participants identified in-person screening as a modality that they were "more comfortable" with (56.2% vs. 12.1%), and a majority of participants stated they would prefer to complete a 20-minute survey in person (56.2%) (Table 2).

Additionally, to assess the overall yield of kiosk availability at all hours vs. an in-person screener present during routine business hours, we compared capture of participants during business hours vs. off-hours (Table 3). Among kiosk-only participants (n=824), 56.6% of participants took the kiosk survey during off-hours, capturing 106 more participants than during business hours.

Among participants who were at risk and took an in-person survey (n=36), 47.2% accepted a substance abuse specialist referral, 47.2% declined seeing a substance abuse specialist, and 5.6% noted that they were already in a treatment program.

DISCUSSION

The ED has been identified as an important site to

Table 1. Demographic distribution of participants in each alcohol and drug use screening modality (N=1,207).

Variable	In-person only (n=229) n(%)	Kiosk-only (n=620) n(%)	Dual (n=154) n(%)	p-value
Gender*				
Female	114 (49.8%)	251 (40.5%)	88 (57.1%)	<0.001
Male	115 (50.2%)	369 (59.5%)	66 (42.9%)	-
Race*				
Black	189 (82.5%)	462 (70.9%)	122 (79.2%)	0.02
White	22 (9.6%)	101 (15.5%)	20 (13.0%)	-
Asian	2 (0.9%)	23 (3.5%)	2 (1.3%)	-
Hispanic	5 (2.2%)	22 (3.4%)	1 (0.6%)	-
Other/multiracial	11 (4.8%)	44 (6.7%)	9 (5.8%)	-
Age				
Mean (SD)	35.85 (10.82)	39.31 (18.83)	37.67 (16.13)	0.02
Education*				
<9th grade	10 (4.4%)	26 (4.4%)	2 (1.3%)	<0.0001
Some high school	48 (21.1%)	70 (11.8%)	12 (7.9%)	-
High school	78 (34.2%)	164 (27.6%)	56 (36.8%)	-
Some college	58 (25.4%)	166 (27.9%)	44 (28.9%)	-
College	34 (14.9%)	168 (28.3%)	38 (25.0%)	-
Marital status*				
Single	143 (63.8%)	356 (64.0%)	60 (65.2%)	<0.0001
Separated	24 (10.7%)	30 (5.4%)	7 (7.6%)	-
Divorced	16 (7.1%)	62 (11.2%)	6 (6.5%)	-
Widowed	10 (4.5%)	59 (10.6%)	1 (1.1%)	-
Married	31 (13.8%)	49 (8.8%)	18 (19.6%)	-
Employment				
In school	9 (4.1%)	-	5 (3.2%)	0.52
Employed part-time	38 (17.4%)	-	22 (14.2%)	-
Employed full-time	59 (26.9%)	-	53 (34.2%)	-
Unemployed	93 (42.5%)	-	51 (32.9%)	-
On disability	20 (9.1%)	-	12 (7.7%)	-
Other	10 (4.4%)	-	7 (7.7%)	-

*Statistically significant (p<0.05). Chi-square test of general association and analysis of variance (ANOVA) were used to compare proportions and means, respectively.

screen for, identify, and intervene among individuals who are at increased risk of poor health outcomes due to health behaviors or exposure to external risk factors, ranging from smoking to unintended pregnancy risk to intimate partner victimization. Due to the safety net role of the ED in our healthcare system, screening in this setting identifies patients who may not have access to primary care or mental healthcare providers, and thus provides an opportunity to identify groups who are most at risk, including minority patients, patients of low socioeconomic status, and patients who are un- or underinsured.

Within this landscape of increased and broadened screening, understanding differing patient attitudes and behaviors when screening via different modalities – most notably, comparing use of computerized to in-person screening - is critical to maximizing the beneficial impact of screening while minimizing the interruption of ED care. This study sheds light on this question, finding that patients were more likely to disclose drug and alcohol use when interacting with a computer kiosk, and that the magnitude of difference was significantly more pronounced when comparing drug screening disclosure with alcohol use disclosure. This finding suggests that patients may be more likely to disclose socially 'undesirable' behaviors or behaviors that patients may feel embarrassed about or ashamed of.

On the other hand, patients were less likely to complete the screening instruments on a kiosk terminal when compared with screening by a RA in person, and when asked about

Participants screened via either in-person *or* kiosk screening:					
Alcohol Use					
		In-person (n=229)	Kiosk (n=461)		p-value
Low-risk (0-7)		204 (89.1%)	371 (80.5%)		0.003
Moderate-risk (8-15)		18 (7.9%)	48 (10.4%)		
High-risk (16-19)		2 (0.8%)	22 (4.8%)		
Dependent (20+)		5 (2.2%)	20 (4.3%)		
Drug Use					
		In-person (n=228)	Kiosk (n=127)		p-value
Low-risk (0-2)		211 (92.1%)	45 (35.4%)		<0.0001
High-risk (3+)		17 (7.4%)	82 (64.6%)		
Participants screened via both in-person *and* kiosk screening:					
Alcohol Use					
		In-person (n=148)	Kiosk (n=148)		p-value
Low-risk (0-7)		135 (91.2%)	131 (88.5%)		0.16
Moderate-risk (8-15)		9 (6.1%)	10 (6.8%)		
High-risk (16-19)		2 (1.4%)	4 (2.7%)		
Dependent (20+)		2 (1.4%)	3 (2.0%)		
Drug Use					
		High-risk (3+)	Low-risk (0-2)	Row Total	p-value
In-person (n=32)	High-risk (3+)	5 (15.6%)	1 (3.1%)	6 (18.8%)	0.003
	Low-risk (0-2)	12 (37.5%)	14 (43.8%)	26 (81.2%)	
	Row total	17 (53.1%)	15 (46.9%)	32	

Figure 2. Relationship between reported alcohol/drug use and survey type among participants using only one survey modality and patients screened via both in-person and kiosk screening.

Participants screened via either in-person *or* kiosk screening:					
Alcohol Use					
		In-person (n=229)	Kiosk (n=461)		p-value
Low-risk (0-7)		204 (89.1%)	371 (80.5%)		0.003
Moderate-risk (8-15)		18 (7.9%)	48 (10.4%)		-
High-risk (16-19)		2 (0.8%)	22 (4.8%)		-
Dependent (20+)		5 (2.2%)	20 (4.3%)		-
Drug Use					
		In-person (n=229)	Kiosk (n=461)		p-value
Low-risk (0-2)		211 (92.1%)	379 (82.2%)		0.0003
High-risk (3+)		18 (7.9%)	82 (17.8%)		-
Participants screened via both in-person *and* kiosk screening:					
Alcohol Use					
		In-person (n=154)	Kiosk (n=154)		p-value
Low-risk (0-7)		141 (91.6%)	137(89.0%)		0.08
Moderate-risk (8-15)		9 (5.8%)	10 (6.5%)		-
High-risk (16-19)		2 (1.3%)	4 (2.6%)		-
Dependent (20+)		2 (1.3%)	3 (1.9%)		-
Drug Use					
		Kiosk (n=154)			
		High-risk (3+)	Low-risk (0-2)	Row Total	p-value
In-person (n=154)	High-risk (3+)	5 (3.3%)	3 (1.9%)	8 (5.2%)	0.04
	Low-risk (0-2)	12 (7.8%)	134 (87.0%)	146 (94.8%)	-
	Row Total	17 (11.0%)	137 (89.0%)	154	-

Figure 3. Intention-to-treat analysis of relationship between reported alcohol/drug use and survey type.

Table 2. Participant preferences for screening modality (N=383).

Variable	Computer, n(%)	Interviewer, n(%)	No preference, n(%)	Combined, n(%)
Privacy	131 (34.4%)	166 (43.6%)	84 (22.1%)	-
Honesty	135 (35.3%)	186 (48.7%)	61 (16.0%)	-
Comfort	46 (12.1%)	214 (56.2%)	121 (31.8%)	-
Duration	67 (17.8%)	171 (45.4%)	49 (13.0%)	90 (23.9%)

Table 3. Capture of total participants and participants at risk for drug/alcohol disorders by screening modality and time of day.

Variable	In-person only	Kiosk-only	Dual
Total			
Business hours	224/227 (98.7%)	358/824 (43.4%)	152/154 (98.7%)
Off-hours	3/227 (1.3%)	466/824 (56.6%)	2/154 (1.3%)
At-risk			
Business hours	16/17 (94.1%)	38/82 (46.3%)	16/17 (94.1%)
Off-hours	1/17 (5.9%)	44/82 (53.7%)	1/17 (5.9%)

*Business hours were categorized as Monday through Friday, 9am-5pm. Off-hours were defined as any other time of day or week.

their screening preferences, they were more likely to state a preference for in-person screening.

The discrepancy between patients' stated preference for in-person screening vs. the increased rate of disclosure when being screened by kiosk may be related to relatively lower levels of comfort with technology among patients served by urban, safety-net EDs. This could be addressed by collaboration with consumer groups to create user-friendly, low-literacy-oriented kiosk interfaces and providing brochures or videos to educate patients about the kiosk use and data safety/confidentiality.

It may also be that the kiosk provides a protected, non-judgmental interaction for disclosure of behaviors that a patient might otherwise feel uncomfortable about disclosing, which leads to the increased rate of disclosure of substance/alcohol use. However, patients may state a preference for in-person screening because they may want to have the opportunity to discuss their alcohol/drug use concerns with a health provider. These concerns could be addressed by providing an option for a patient using a kiosk to highlight topics that they want to discuss with their providers.

An additional factor when comparing an in-person screening vs. kiosk screening is screening cost and availability. Within the present study, the RA was present five days per week, from 9am-5pm, whereas the kiosk screening was available at all times. Given the nature of the ED as a healthcare access point that is always open, providing preventive services to patients who present on nights and weekends presents an ongoing challenge. The kiosk screening offers not only round-the-clock availability, but also is not subject to fatigue, a factor that might lead clinicians to skip screening about health behaviors during overnight hours. Providing continuous screening in the ED via the kiosk in our sample allowed us to identify 106 additional at-risk patients than were identified via screening during business hours.

LIMITATIONS

There are several limitations to this study. Responses were collected through self-report, which is susceptible to recall or social desirability bias. Due to study methodology constraints – specifically the availability of the kiosk screening in the waiting room, while most in-person screenings took place once patients were in an exam room, allowing a private location for in-person screening – all dual-screening participants responded to kiosk questions first, followed by in-person screening. Thus, dual participants may have experienced testing fatigue from answering the same alcohol and drug surveys twice, and this may have biased them towards being less comfortable disclosing sensitive behaviors during the in-person screening.

An additional study limitation was the relatively low numbers of patients screened in person or via both modalities as compared with patients who screened via the kiosk only. This limitation was due in part due to methodological constraints with respect to limited private spaces in which to conduct in-person screening. Furthermore, the fact that patients were allowed to choose a screening modality may have introduced bias. A future, randomized study would address this limitation and would provide further insight into result generalizability. A randomized design would also address the possible bias introduced by the convenience-sample design of this study, as well as potential bias introduced into the current study due to availability of kiosk screening on nights and weekends, when the in-person screening was not available.

Finally, another limitation is the high rate of survey non-completion among kiosk participants. While many participants may have failed to complete the survey due to boredom or

because they may have been called for evaluation by the ED nursing staff, it is possible that non-completers were disproportionately likely to screen either positive or negative for substance use. This could be addressed in the future by ensuring that kiosk surveys be kept brief and possibly by enhancing the user interface to increase likelihood of survey completion by participants.

Future studies may examine why participants skip drug use questions on a kiosk, and studies might assess computer-user interfaces that might keep a participant engaged and encourage screening completion in the absence of the social pressure to complete a survey that accompanies an in-person screener. Additionally, given the discrepancy between higher rates of risky drug use disclosure when screening via kiosk vs. participants' stated preferences for in-person screening, future research into factors that increase acceptability of and confidence in kiosk screening for the general ED population might increase comfort with this screening modality. Finally, given the lack of patient diversity in the population this ED serves, future studies should include other clinical sites with different patients population demographics.

CONCLUSION

In this study, patients in the ED undergoing drug and alcohol use screening were more likely to disclose at-risk alcohol and substance use to a kiosk than an in-person interviewer. In contrast, when patient preferences were surveyed, they stated a preference for an in-person screening over kiosk screening. Comparing findings for substance use screening compared with alcohol screening, we found that alcohol disclosures were also higher via kiosk, although this difference was statistically significant only when comparing participants screened via a single modality, rather than the smaller subset of participants who were screened both via kiosk and in-person. These findings highlight the potential for computerized health screening in the emergency department, especially for health topics that patients may feel uncomfortable disclosing to a clinician. However, our findings also underscore the importance of patient education and interface design to maximize patient comfort with and trust of computerized screening.

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Patients Who Use Multiple EDs: Quantifying the Degree of Overlap between ED Populations

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Introduction: The degree to which individual patients use multiple emergency departments (EDs) is not well-characterized. We determined the degree of overlap in ED population between three geographically proximate hospitals.

Methods: This retrospective cohort study reviewed administrative hospital records from 2003 to 2007 for patients registered to receive ED services at an urban academic, urban community, and suburban community ED located within 10 miles of one another. We determined the proportion who sought care at multiple EDs and secondarily characterized patterns of repeat encounters.

Results: There were 795,176 encounters involving 282,903 patients. There were 89,776 (31%) patients with multiple encounters to a single ED and 39,920 (14%) patients who sought care from multiple EDs. The 39,920 patients who sought care from multiple EDs generated 185,629 (23%) of all encounters. Patients with repeat encounters involving multiple EDs were more likely to be frequent or highly frequent users (30%) than patients with multiple encounters to a single ED (14%).

Conclusion: While only 14% of patients received care from more than one ED, they were responsible for a quarter of ED encounters. Patients who use multiple EDs are more often frequent or highly frequent users than are repeat ED visitors to the same ED. Overlap between ED populations is sufficient to warrant consideration by multiple domains of research, practice, and policy. [West J Emerg Med. 2015;16(2):229–233.]

INTRODUCTION

Patients often seek emergency services on more than one occasion, and patterns of repeat utilization within a single emergency department (ED) are increasingly reported.[1-5] The degree to which patients may visit multiple EDs, as opposed to using a single ED multiple times, is less characterized. Several studies have shown that some patients use multiple EDs within a relatively short time period,[6-8] but most attention has been focused on ED patients that use the ED frequently.[9,10] The magnitude of multiple ED use over longer periods (i.e. >1 year) has not been explored, and only one study[11] has reported the frequency of multiple ED use by ED patients who are not frequent users. Similarly unknown is whether persons who use multiple EDs differ from those who frequent the same ED multiple times.

Overlap in patient populations between multiple EDs could have broad implications for regional planning of ED service capacity, interventions targeting repeat ED utilization, ED market share calculations that use patients rather than encounters as the unit of analysis, community-wide follow-up in research studies, public health intervention, and health information systems.[1,12-18] In this exploratory report using

data from three hospitals, we estimate the proportion of ED patients who seek care using a sample of three geographically contiguous mostly adult EDs in a region with a total of 18 EDs and one dedicated pediatric ED and describe patterns of multiple ED use over a five-year period. Secondarily, we explore differences in the population that visits multiple EDs versus the population that uses only one ED and also the degree to which frequent and highly frequent ED users contribute to multiple ED utilization.

METHODS

This multi-center, retrospective cohort study involved automated electronic query of hospital administrative databases. We included all patients who were registered to receive ED services at any of the three study site hospitals. The study was institutional review board approved.

We obtained data from an urban academic, urban community, and suburban community hospital, all located within 10 miles of each other. The urban facilities were less than two miles from each other. These facilities cared almost exclusively for adult patients, as a large pediatric hospital is nearby. Each ED hosted research and residency training and was staffed by the same emergency physician group. In 2007, at the end of this study period, the surrounding county had a population of 855,062 that was 72% white, 25% black, 2% Asian, and 2% Hispanic. These demographics were stable throughout the study period.

During the study period, the hospitals were partnered in terms of purchasing, information technology, and other operational support, but they were owned separately and generally perceived to have distinct patient populations and differing missions. The hospitals were open to all patients, with no regional payer exclusions and no structured referral system. Fifteen other EDs in the metropolitan area were not included in the study.

Hospital administrators directly exported an electronic data set of ED encounters from billing databases using a standardized query. Data were available for all three hospitals from 2003 to 2007. Individuals presenting for care were registered using date of birth, social security numbers, names, and government identification. Patients were issued a unique medical record number at their first encounter that remained static across time and across facility. Each separate encounter generated a unique account number, which was linked to information about when and where that encounter occurred. To facilitate billing and reconciliation, the hospitals conducted ongoing internal quality assurance review that included merging records, purging of duplicate records, and updating of names.

Upon receiving the exported data set, we considered each unique medical record number to represent a unique patient. Each patient was then considered to have had one or more ED encounters, determined by the number of unique account numbers linked to each unique medical record number. We then categorized patients with multiple encounters as to whether their encounters involved only one ED, or occurred at multiple EDs.

The primary outcome was the proportion of all ED patients across study hospitals who sought care at multiple EDs. Secondary outcomes included demographics for single and multiple ED users, distribution of encounters between sites, duration of time between encounters at different EDs by the same patient, the proportion of ED encounters that were from patients who were multiple ED users, and the proportion of frequent and highly frequent ED users who sought care at more than one ED. To classify patients based on frequency of ED use, we used the commonly considered metric of number of encounters within a calendar year. Specifically, we assigned patients as being single users (1 encounter), repeat users (2-3 encounters), frequent users (4-7 encounters), or highly frequent users (8 or more encounters) based on the year in which they had the most encounters. We performed data management and analyses using SPSS 21.0 (IBM Corporation, Armonk, NY).

RESULTS

There were 795,176 encounters by 282,903 patients for the three EDs from 2003 to 2007. The median number of encounters per patient was two (range 1-352, IQR 5). There were 443,593 (56%) encounters at the academic ED, 184,874 (23%) at the urban community ED, and 166,709 (21%) at the suburban ED.

Proportion of Patients Seeking Care at Multiple EDs

Of the 282,903 patients in the study, 39,920 (14%) sought care at more than one facility during the five-year period. Figure depicts the proportion of patients seen by each ED or various combinations of EDs. Table 1 shows patient-level demographics at the first visit to the system for the patient cohort overall, the subset of patients with ED encounters involving multiple facilities, and the subset with either single or multiple encounters involving only one ED.

Patterns of ED Use

There were 153,207 (54%) patients with only a single encounter and 129,696 (46%) patients with multiple ED encounters during the study period. Of those with multiple ED encounters, 89,776 (69%) patients used only one ED and 39,920 (31%) used more than one ED.

Repeat ED users who visited only one ED accounted for 456,340 (57%) of all encounters. Patients had a median of three encounters to that ED (range 2-344, IQR 3) over the five-year study period. Patients with repeat ED encounters involving more than one ED accounted for 185,629 (23%) of all encounters. These patients had a median of six encounters across all EDs (range 2-352, IQR 9). The median number of days between the first encounter and second encounter at the ED was 393 days (0 to 1,824 days, IQR 656).

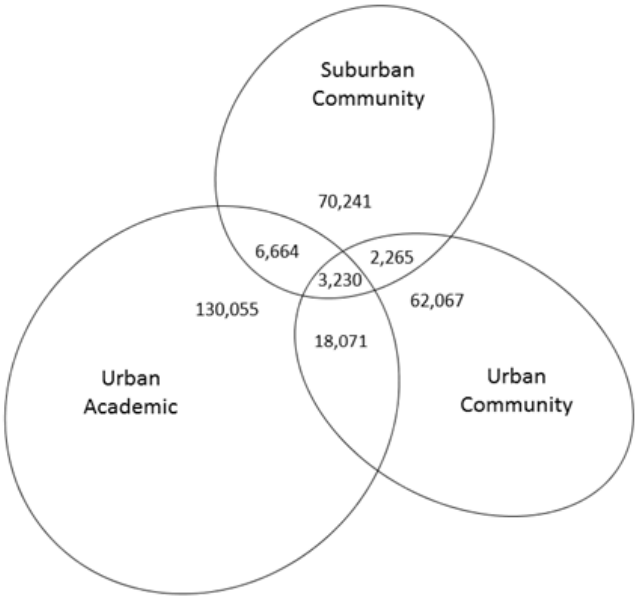

Figure. Overlap between emergency department patient populations. Of all patients receiving emergency care (n=282,903), the proportion who were seen in only one emergency department (ED) or in various combinations of multiple EDs over a five-year period. Size of oval and overlapping sections are proportional to number that each section represents.

Multiple ED Use by Frequent Users of ED Services

Table 2 shows patterns of single and multiple ED use stratified by frequency of ED use. Of the 282,903 patients in the study, 20,144 (7%) were frequent users, with at least four visits in any single year, and 4,901 (2%) were highly frequent users, with at least eight visits in any single year. Of frequent users, 9,119 (45%) presented to multiple EDs. Of highly frequent users, 3,098 (63%) presented to multiple EDs. Frequent and highly frequent users who sought care in multiple EDs contributed 57,393 (7%) and 69,514 (9%) encounters respectively. Patients with encounters at multiple EDs were more likely to be frequent or highly frequent ED users compared to patients with multiple encounters to only a single ED (30.6% vs. 14.3%, difference in proportions 16.3%, CI_{95} 15.8.% - 16.8, $p<0.0001$).

DISCUSSION

In this longitudinal exploration of the overlap in ED patient populations between hospitals, we found that although patients often visit the ED repeatedly, most repeat encounters occur within a single ED rather than among multiple EDs. Nonetheless, nearly one of every four ED encounters were by patients who also visited another ED during the study period. Overall, our findings indicate there is the potential for both repeat and highly frequent ED use

Table 1. Characteristics of emergency department (ED) patients* by utilization of single or multiple EDs.

	Total patients N=282,903		Patients with encounters to multiple EDs N=39,920		Patients with single or multiple encounters to only one ED N=242,983	
	N	(%)	N	(%)	N	(%)
Age†	42	(20)	40	(18)	43	(20)
Race						
Caucasian	169,869	(60.0)	18,111	(45.4)	151,758	(62.5)
African-American	91,154	(32.2)	20,653	(51.7)	70,501	(29.0)
Other/not documented	16,126	(5.7)	892	(2.2)	15,234	(6.3)
Hispanic	4,267	(1.5)	172	(0.4)	4,095	(1.7)
Asian	1,487	(0.5)	92	(0.2)	1,395	(0.6)
Sex						
Female	145,846	(51.6)	23,010	(57.6)	122,836	(50.6)
Male	137,050	(48.4)	16,910	(42.4)	120,140	(49.4)
Payor						
Commercial	102,755	(36.3)	10,746	(26.9)	92,009	(37.9)
Self-pay	84,258	(29.8)	13,335	(33.4)	70,923	(29.2)
Medicare	57,449	(20.3)	8,659	(21.7)	48,790	(20.1)
Medicaid	25,467	(9.0)	5,813	(14.6)	19,654	(8.1)
Other	12,974	(4.6)	1,367	(3.4)	11,607	(4.8)

*Includes only first encounter to any ED during the study period; future encounters excluded to avoid patient duplication.
†Presented as mean and (standard deviation).

Table 2. Frequency of emergency department (ED) use for patients with multiple ED encounters by use of single or multiple EDs.

	Total patients with multiple ED encounters N=129,696		Patients with encounters to multiple EDs N=39,920		Patients encounters to only one ED N=89,776	
	N	(%)	N	(%)	N	%
No more than one visit in any single calendar year	35,309	(27.2)	8,305	(20.8)	27,004	(30.0)
More than one visit in any single calendar year						
Repeat utilizer*	69,342	(53.4)	19,398	(48.6)	49,944	(55.6)
Frequent utilizer†	20,144	(15.5)	9,119	(22.8)	11,025	(12.2)
Highly frequent utilizer‡	4,901	(3.8)	3,098	(7.8)	1,803	(0.2)

ED, emergency department
*In at least one year, minimum 2 visits.
†In at least one year, minimum 4 visits.
‡In at least one year, minimum 8 visits.

to go unrecognized when looking at only a single hospital. Our results demonstrate the need for large-scale and detailed analyses, inclusive of all EDs in a given region, to fully demonstrate and describe this phenomenon.

Many interesting potential implications of repeat ED use have been discussed previously,[1,5,11,12] but this discussion has largely focused on repeated use of a single ED. There are many issues likely to result from failure to consider overlapping patterns of ED use and thus underestimating ED use. The costs of ED utilization for any given patient would be greater when considering multiple EDs as would the aggregate costs attributable to repeat rather than single ED use especially in the realm of radiologic and laboratory testing. From a health systems perspective, planning of ED services depends not only on the number of ED encounters but also the number of patients served; this study demonstrates that the number of patients cared for by EDs within a region is less than would be expected if simply adding the number of patients cared for by each ED. Similarly, adding data from multiple EDs will somewhat overestimate the prevalence of disease within a population. Any market-share calculations that consider the number of people using the ED rather than the number of ED encounters would be complicated by the sizeable minority of patients that are shared between EDs. Moreover, research commonly considers return visits to the ED in outcome assessments, which may be underestimated unless multiple EDs are included.

There are also several direct practice implications arising from the phenomena of multiple ED use. Most notably, there is the urgent need for shared information systems with real-time access to improve care and reduce harmful or expensive duplication of services.[10] Our data also suggest that interventions to coordinate and streamline healthcare (i.e. Accountable Care Organizations, capitated payments, and readmission penalties) should consider multiple ED utilization. Finally, any burden of prevention intervention[13] or care-coordination[9,14] interventions would be less if shared between hospitals to affect the overall population of ED users within a community.

LIMITATIONS

Our findings may not be fully generalizable. Data were from a relatively small collection of hospitals within a single region, all of which were characterized by residency programs and non-rural location. Our analysis also did not involve children. Nonetheless, our findings are strengthened by the inclusion of different types of EDs that are sufficiently close to at least partially attenuate transportation barriers. We do not know what other local EDs these patients might have visited, or their motivations to seek care at more than one ED.

Our study does not demonstrate the extent to which using multiple EDs is problematic or inappropriate. We do not know the extent to which encounters were related or if they were at all preventable. In addition, there may be multiple logical explanations for choosing different EDs. For example, insurance coverage may change over time, home or job location can change, or a hospital's reputation for different patient conditions might sway patient preferences. It may be that use of different EDs depending on circumstances is a strength rather than a weakness of the current healthcare system. The association between more frequent ED users and multiple ED use could arise, at least in part, from the fact that the random chance of using more than one ED would increase as frequency of ED use increases.

The likelihood of overlap for these particular sites may have been biased in either direction by the affiliation of the study-site EDs within a consortium of hospitals. However, we are unaware of any particular insurance patterns or policies that would have influenced a patient's choice for or against this particular set of hospitals. We note that the affiliation between these hospitals was limited and not well understood by the patient population. For example, most patients would not have known that the same emergency physician group

staffed all three hospitals.

Our data are subject to the limitations of existing data sets collected for clinical and administrative purposes, including inaccurate or missing data. Whether some patients had different medical record numbers is likely to be rare given the multiple identifiers collected and maintained by the hospital and the ongoing internal quality checks performed. If some patients did erroneously appear to have different identities at different encounters, this might have been more likely between different hospitals than within single hospitals. Our sample may have included some patients transferred between hospitals. When exploring this possibility, we identified only 332 (0.07%) encounters at the academic facility that occurred within one calendar day of discharge from a community facility with an indication of "discharged to another facility". This suggests that the number of ED to ED transfers is small relative to the overall number of patients using multiple EDs. Our results may also be skewed by the fact that some patients may have died or moved during the study period, though in gross terms, the region's population remained steady during the study period.

CONCLUSION

This manuscript demonstrates that repeat encounters by the same patients are common, and most repeat encounters occur within a single ED rather than among multiple EDs. However, the small amount of patients who visit multiple EDs contribute significantly to overall visits and are more likely to be frequent and highly frequent utilizers of ED care than are those who use only one ED on a repeat basis. The magnitude of population overlap between EDs is sufficient to suggest that research, practice, and policy should move further towards considering emergency departments as a combined system and not as individual units.

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Do Emergency Physicians and Medical Students Find It Unethical to 'Look up' Their Patients on Facebook or Google?

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Introduction: The use of search engines and online social media (OSM) websites by healthcare providers is increasing and may even be used to search for patient information. This raises several ethical issues. The objective of this study is to evaluate the prevalence of OSM and web-searching for patient information and to explore attitudes towards the ethical appropriateness of these practices by physicians and trainees in the emergency department (ED).

Methods: We conducted an online survey study of Canadian emergency physicians and trainees listed under then Canadian Association of Emergency Physicians (CAEP) and senior medical students at the University of Toronto.

Results: We received 530 responses (response rate 49.1%): 34.9% medical students, 15.5% residents, 49.6% staff physicians. Most had an active Facebook account (74%). Sixty-four participants (13.5%) had used Google to research a patient and 10 (2.1%) had searched for patients on Facebook. There were no differences in these results based on level of training, and 25% of physicians considered using Facebook to learn about a patient "very unethical." The most frequent ethical concerns were with violation of patient confidentiality, dignity, and consent. The practice was usually not disclosed to patients (14%), but often disclosed to senior colleagues (83%).

Conclusion: This is the first study examining the prevalence of and attitudes towards online searching for obtaining patient information in the ED. This practice occurs among staff physicians and trainees despite ethical concerns. Future work should explore the utility and desirability of searching for patient information online. [West J Emerg Med. 2015;16(2):234–239.]

INTRODUCTION

Search engines and social media websites, such as Facebook, are being used increasingly in professional, social, and political arenas. The frequency of Facebook use by physicians is comparable to that of the general public, with at least 53% subscribing.[1,2]

In the emergency department (ED), key past medical history and demographic information can be missing, particularly in new, unidentified or non-communicative patients. This may contribute to diagnostic uncertainty, treatment errors and delays in disposition, and may increase the likelihood of adverse events. Online social media (OSM) offers users an unprecedented opportunity to share and access personal health information,[3] which can be searched for and accessed online by health professionals when it is not available by more traditional means of obtaining a medical history. However, the intersection of private health information with public online tools poses risks to medical professionalism. Recent major popular media outlets highlight the importance of balancing the need for urgent information (that could be obtained via OSM or search engines) versus the need to maintain patient privacy and public trust.[4,5] Although the volume of personal information accessible

online is increasing, the boundaries of the digital doctor-patient relationship have not yet been defined.[1,6]

Recently medical authorities have published guidelines discussing OSM use, primarily addressing interactions directly with patients and online posting of patient results.[2,6-13] The American College of Physicians[12] and the American Heart Association (AHA)[11] guidelines highlight principles of online professionalism. The AHA primarily discourages the practice of searching for patients online, unless it is used to advance patient care (such as in emergency situations). However, the prevalence of this practice in the ED is currently unknown.

The goals of this survey study are to 1) establish the prevalence of OSM and web searching of patient information by emergency physicians and trainees and to determine whether the searches were disclosed to patients or senior preceptors; 2) determine the variables associated with the likelihood of looking-up a patient using Facebook; and 3) explore attitudes regarding the ethical appropriateness of these practices.

METHODS

Survey Development

We based survey development on a formal review of OSM literature in healthcare. A 25-item questionnaire was then generated using a commercially available online survey tool, available at SurveyMonkey.com. (SurveyMonkey Inc, Palo Alto, California, USA) We piloted the survey among 40 participants (including residents and staff) at one of our academic EDs. Key demographic data included age, gender, residency program and level of training. Respondents were asked about their use of electronic resources and OSM within the previous year, and the frequency with which they have used Facebook and Google to "search" for patients in the ED. Finally, respondents were surveyed on their views regarding the ethicality of online searching for patient information.

Survey Distribution

The survey was distributed between November 2010 and June 2011 to 683 staff physicians, 116 residents and 54 medical students using the Canadian Association of Emergency Physicians (CAEP) email list, as well as to 226 fourth-year medical students at the University of Toronto. The survey was deployed using a modified Dilman approach:[14] an introductory email was sent to potential respondents followed by the survey link and a reminder email two weeks later. Consent was implied by participation and after reading information provided by the investigators on Page 1 of the online survey. The study was approved by the Research Ethics Board at St. Michael's Hospital and the University of Toronto Undergraduate Medical Education Office in Toronto, Canada.

Data Analysis

Responses were automatically compiled and generated into Excel 2007 (Microsoft, Inc. Redmond, WA) as data tables by the SurveyMonkey tool (SurveyMonkey Inc., Palo Alto, CA). We then stripped these tables of any identifiers and each participant was assigned a unique ID number. Descriptive statistics were generated for all categorical data. We calculated chi-square test statistics for all binary and categorical data, and a p-value of <0.05 was considered significant. Uni- and multivariable-adjusted logistic regression models were used to assess the odds of using Facebook in the ED and a post-hoc analysis to determine the odds of searching a patient on Google. Variables included staff-status; age; gender; use of electronic patient record in the past year; and self-reported ethical objections to using OSM to research patients in the ED. We ascertained respondents' locations via IP address geo-mapping using an online tool (batchgeo.com, BatchGeo LLC.). Statistical analysis was carried out using SAS 9.3 (Cary, North Carolina). For the multivariable adjusted logistic regression we incorporated all available data points and responses without excluding respondents who had missing data in their surveys.

RESULTS

Of the 1,079 physicians and trainees surveyed, 530 responded (response rate of 49.1%). Forty-nine percent of those who responded were staff, 34.9% were medical students, and 15.5% were residents. Age, gender, program and level of training of the respondents are summarized in Table 1. Current use of social media by respondents is summarized in Table 2. Responses came from across Canada, including Ontario (47%), Manitoba (19%), British Columbia (8%), Alberta (7%) Quebec (5%), Eastern provinces (6%), Northern Territories and Saskatchewan (2%), as well as from international locations (6%). The majority of respondents (67.7%) had used an electronic medical record system for patient care in the ED during the past year.

Three-hundred and ninety-two (74%) respondents had a Facebook account, 102 (19.2%) had a Twitter account, 88 (16.6%) were on LinkedIn, and 98 (18.5%) reported having had a personal blog in the past year.

Sixty-four participants (12.1%) reported having used Google and 10 (1.9%) Facebook to search for patients while investigating them in the ED in the previous year. Patients were characterized as medical (43.1%), undifferentiated (33.3%), psychiatric (20.8%) or surgical (2.7%). As part of additional expletory questions, we queried respondents if they disclosed such a search to either patients or supervising senior physicians. Among those who used Google or Facebook to search for patients, only four (13%) disclosed that action to their patient. However, 29 (83%) trainees disclosed this information to their staff or senior resident.

On a Likert scale of one to seven (from very unethical to very ethical), among 435 replies to that question, 130 (29.8%) physicians and trainees considered the use of Facebook in this context "very unethical." Eighteen (3.5%) respondents considered this practice "very ethical" (Figure). When asked about the ethical values breached by Google searching,

Table 1. Demographics of survey respondents.

	Medical student (n=185)	Trainee			Staff (n=258)	Total (n=530)
		PGY1-2 (n=46)	PGY3-5 (n=32)	>PGY5/Fellow (n=8)		
Age group, n (%)						
18-24	60 (98.36)	1 (1.63)	0	0	0	61
25-34	122 (51.05)	43 (17.99)	26 (10.88)	6 (2.51)	41 (17.15)	239
35-44	2 (1.57)	2 (1.57)	6 (4.72)	1 (0.79)	116 (91.34)	127
45-54	1 (1.35)	0	0	1 (1.35)	72 (97.30)	74
55+	0	0	0	0	29 (100)	29
Male gender, n (%)	74 (26.24)	19 (6.74)	17 (6.03)	7 (2.48)	164 (58.16)	282
Training program, n (%)						
Emergency medicine	-	31 (44.93)	30 (43.48)	8 (11.59)	-	69
Internal medicine	-	1 (33.33)	2 (66.66)	0	-	3
Family medicine	-	9 (100.00)	0	0	-	9
Surgery	-	3 (100.00)	0	0	-	3
Anesthesiology	-	2 (100)	0	0	-	2

PGY, postgraduate year

Table 2. Electronic record and social media use among survey respondents.

	Medical student (n=185)	Trainee			Staff (n=258)	Total (n=530)
		PGY1-2 (n=46)	PGY3-5 (n=32)	>PGY5/Fellow (n=8)		
Facebook account, n (%)	170 (43.37)	41 (10.46)	29 (7.40)	7 (1.79)	144 (36.73)	392
Twitter account, n (%)	32 (31.37)	10 (9.80)	5 (4.90)	4 (3.92)	50 (49.02)	102
LinkedIn account, n (%)	27 (30.68)	5 (5.68)	5 (5.68)	2 (2.27)	49 (55.68)	88
Personal blog, n (%)	43 (43.88)	13 (13.27)	5 (5.10)	2 (2.04)	35 (35.71)	98
EMR use in past year, n (%)	95 (26.46)	39 (10.86)	26 (7.24)	6 (1.67)	193 (53.76)	359
Used Facebook to research patients, n (%)	4 (40)	1 (10)	0	2 (20)	3 (30)	10
Used Google to research patients, n (%)	11 (17.19)	9 (14.06)	6 (9.38)	2 (3.13)	36 (56.25)	64

EMR, electronic medical record

respondents chose the following: confidentiality 184 (34.7%), informed consent 157 (29.6%), and patient dignity 124 (23.4%). Similarly, researching patients on Facebook was viewed as violating patient confidentiality 195 (36.8%), informed consent 168 (31.7%), and dignity 130 (24.5%).

A multivariable logistic regression demonstrated that there was no significant difference between staff and trainees in the likelihood of researching a patient on Facebook or on Google. The only statistically significant predictor of Facebook use was the belief that looking up a patient is "neutral, ethical or very ethical." Those who responded that it was ethical or very ethical to use Facebook to research a patient were 10.37 (95% CI 1.28, 84.15) times more likely to do so than those who did not believe that it was ethical (Table 3). Similar results were obtained for the likelihood of searching patients on Google (Table 4).

DISCUSSION

When faced with a paucity of patient data, especially in an unresponsive or uncooperative patient, EPs or trainees may explore several routes of obtaining patient information. Searching for patient information online may be a more modern version of searching through a patient's wallet for information when they present with an altered level of consciousness. Although an online search will only reveal publically accessible information, it may nonetheless cause problems with respect to patient consent and accuracy of information.

Our results are consistent with previous reports that many physicians and healthcare professionals use Facebook, Twitter, and LinkedIn.[1,2,6,9,11,12,15,16] With the exception of case reports,[17] the practice of online searching for patient information has not been studied. This is the first study to examine the prevalence

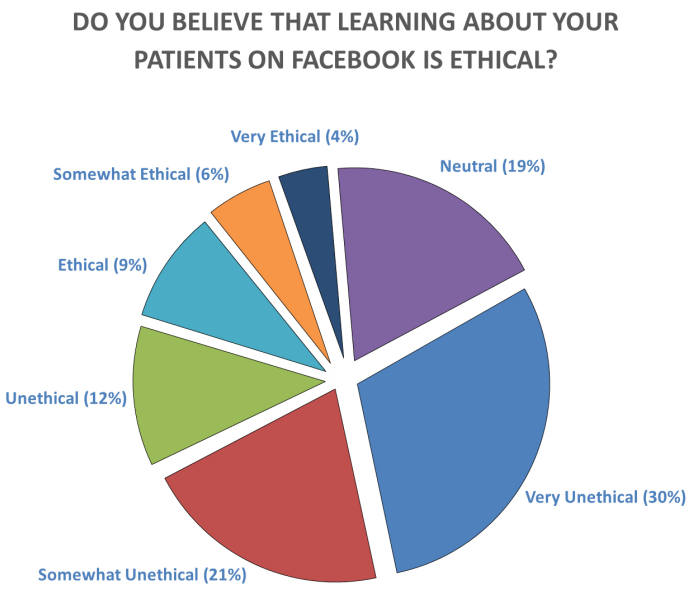

Figure. Responses to survey question about ethics of searching for patients online.

of physician and trainee use of Google or Facebook to search for patients who have presented to the ED. We demonstrated that while the practice is not very common, it does occur. Most existing studies citing breaches of privacy using social media, involve trainees.[3,16,18-25] We found that the practice of searching for patients occurred equally among trainees and staff physicians. This held true even when we accounted for variations in non-professional use of social media by individuals. Based on our demographics, wide geographical coverage and fair response rate, we believe that our results are generalizable.

The behaviour was not usually disclosed to patients, although trainees sometimes disclosed this practice to senior colleagues. This raises questions about whether those engaging in the practice of online searches felt it was either questionable behavior and therefore not disclosed vs. unnecessary to disclose to patients since information was publicly available. Future scholarship should clarify this aspect.

The ethics and professionalism issues surrounding the use of OSM in medicine must be viewed from a multitude of perspectives.[11] Our study highlights ethical concerns encountered by physicians attempting to learn more about their patients using online tools. When Bosslet et al. (2011) surveyed a general population of physicians through the American Medical Association (AMA), their results showed that 58% of physicians considered it unethical to view an online patient profile or communicate via OSM.[1] In another study that used hypothetical vignettes to explore the same practice, faculty found the practice to be unethical, while trainees were open to using social media if it would help clinical care.[16]

Our results show that 29% of emergency medicine providers regarded searching for patients via Facebook to be "very unethical." Those who felt it was ethical were significantly more likely to engage in the practice, which highlights the controversial nature of searching online for patients, rather than suggesting that physicians and trainees acted unethically. Even though information available on the Internet is public, respondents felt there could be a breach of confidentiality. They also felt that searching for patients could violate a patient's dignity – implying that the issue goes beyond simply what information is publically available, to what information a patient would want his healthcare provider to know. Finally, informed consent was an ethical concern for respondents suggesting that perhaps a proportion of these searches were done in patients who had decisional capacity, although we do not have data to determine in which patients the searched were performed.

Although OSM offers many opportunities for knowledge dissemination, collaboration, education and interaction with the public, professional authorities and medical associations have cautioned physicians and trainees against its use and provided guidelines.[2,26-29] The American College of Physicians (ACP)[12] policy statement mentions both potential benefits and

Table 3. Crude and multivariable-adjusted odds ratios of baseline variables for use of Facebook to research patients.

Variable	Crude odds ratio (95% CI)	Multivariable-adjusted odds ratio (95% CI)
Staff	0.39 (0.1-1.5)	0.13 (0.02-1.01)
Age		
25-34	1.97 (0.55-7.08)	1 (reference age class)
35-44	1.27 (0.32-4.98)	4.57 (0.60-34.78)
45-54	0.61 (0.08-4.92)	2.89 (0.18-46.03)
55+	1.85 (0.72-4.71)	1.12 (0.27-4.7)
Male gender	2.01 (0.51-7.85)	1.77 (0.43-7.39)
Use of electronic patient medical record in past year	2.29 (1.10-4.79)	1 (0.2-4.99)
Respondents who are neutral or believe that using Facebook to research patients is ethical	11 (1.41-89.35)	10.37 (1.28-84.15)

Table 4. Crude and multivariable-adjusted odds ratios of baseline variables for use of Google to research patients.

Variable	Crude odds ratio (95% CI)	Multivariable-adjusted odds ratio (95% CI)
Staff	0.39 (0.1-1.5)	1.09 (0.42-2.81)
Age		
18-34	0.78 (0.46-1.33)	1 (reference age class)
35-44	1.29 (0.72-2.30)	0.99 (0.37-2.67)
45+	1.07 (0.56-2.02)	0.88 (0.30-2.61)
Male gender	2.04 (1.16-3.60)	1.75 (0.94-3.26)
Use of electronic patient medical record in past year	2.89 (1.28-6.52)	2.12 (0.91-4.90)
Respondents who are neutral or believe that using Google to research patients is ethical	2.93 (1.66-5.16)	2.64 (1.48-4.70)

pitfalls of social media use. Benefits include observing and counselling patients on health-related behaviors, and intervening in emergency situations. Pitfalls include threatening the trust in the doctor-patient relationship and obtaining inaccurate sources of information.[12] The AMA addresses the issue of posting confidential information online; however, they do not discuss that of accessing patient information online.[29] Three provincial regulatory bodies in Canada have social media policies and all caution against the use of OSM or any form of online patient interaction.[13,17,26,27] Searching online for patient information may be morally justifiable when it is done with the intent of enhancing patient care. However, healthcare professionals need to be cautious about "voyeuristic" searching for patients.[11,12] Prior to engaging in an online search for patient information, healthcare professionals should thoughtfully consider the possible implications and accuracy of findings.[11,12] We believe that when consent may not be obtained in the obtunded or uncooperative patient, when possible an online search should be disclosed to the patient in order to maintain the trust of the individual patient as well as public trust in general. Future research should further clarify patients' perspectives on using online social media to search for information about them.

LIMITATIONS

Our study is limited by several factors. The survey did not question whether physicians used Google+, LinkedIn, Twitter or other platforms to research patient information in order to limit the length of the survey. We also did not ascertain whether patients who were searched for online presented with an altered level of consciousness or inability to communicate or the type of information that was sought. The usefulness of information sought in the online search was difficult to ascertain due to a low response rate to that question in the survey.

EPs who were not members of CAEP were omitted from our study population. It is possible that the CAEP mailing list over- or under-represents the true population of interest. Our demographics and results parallel existing general population trends[30] and Canadian reports on OSM use by physicians.[2] Additionally, the demographics of our staff group of respondents are similar to those reported by the CMA.[31] Our trainee data comes from a single academic center. However, our medical school and residency training programs are the largest in Canada and trainees come from across the world and should represent a diversity of backgrounds and perspectives. While the survey was anonymous, since survey data is self-reported, the prevalence found may not represent the true prevalence of this practice.

Lastly, the response rate was lower than intended, even after numerous reminders, likely due to "survey fatigue" and a long survey (25 items) among physicians.[32] Nonetheless, the response rate is higher than that of previously published surveys on physician use of social media.[1,2] Additionally, the nature of survey studies is that results are self-reported and often difficult to validate, unless more complexe and resource-intensivemethods are employed. Given all our limitations, compared with previous studies,[1,2] ours is still strengthened by a good response rate from a representative population in an ED clinical setting.

CONCLUSION

Our findings suggest that although some emergency physicians and trainees use OSM and Google to research their patients, many consider it unethical. Furthermore, we found no age or training-level differences in the likelihood of using Facebook to research patients. Future work should focus on exploring patients' views on whether this act is desirable and permissible. Research should also explore the nature and content of online searches performed on patients, and the usefulness of information obtained. As the prevalence of social media use by patients increases steadily, individuals, institutions, and professional bodies will need to ethically integrate social media into patient care and medical education.[33] Autonomy and beneficence should be guiding principles so that we benefit, rather than harm, our patients and profession.

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Inferior Vena Cava Filter Fracture: Potential Liability for Emergency Physicians

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INTRODUCTION

A 58-year-old female presented to the emergency department complaining of low back pain following a motor vehicle crash. She denied loss of consciousness, headache, or extremity weakness. Her past medical history was notable for inferior vena cava (IVC) filter placement many years ago due to multiple pregnancy-associated deep venous thromboses (DVTs). Physical exam was unrevealing: no spinal point tenderness and a nonfocal neurologic exam. Posteroanterior lumbosacral radiograph demonstrated fracture and displacement of the posterolateral IVC filter leg (Figure 1). Computed tomography showed the filter leg to be perforated through the IVC (Figure 2). After consultation with the interventional radiologist, it was decided that the risks of retrieval outweighed potential benefits, and the patient was discharged for outpatient monitoring of the fractured limb.

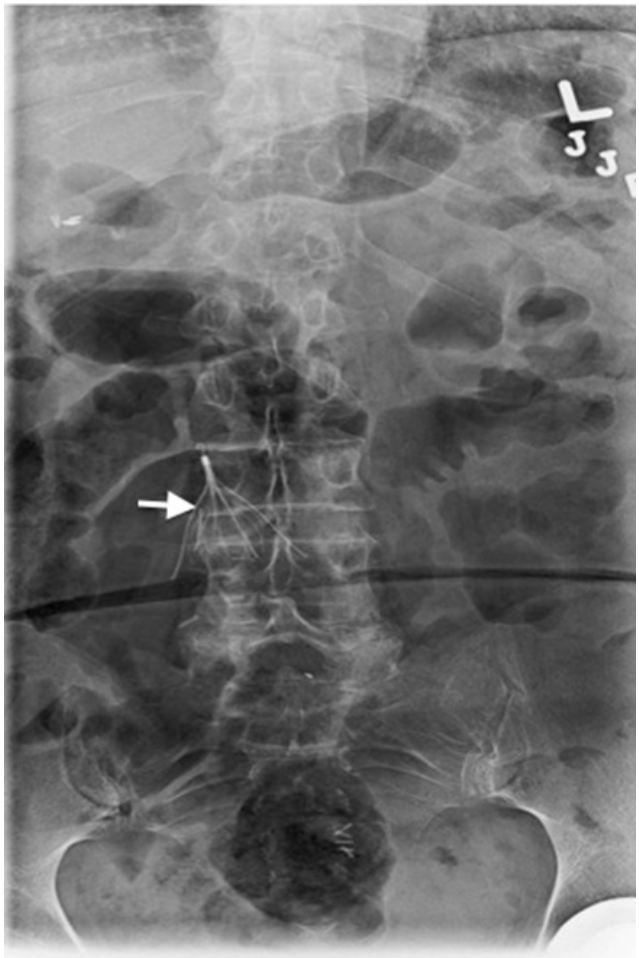

Figure 1. Posterior to anterior view of lumbosacral spine. Arrowhead demonstrates fracture and displacement of the posterolateral inferior vena cava filter leg.

DISCUSSION

From 2000-2009, the number of IVC filters placed in the United States increased from 56,380 to 132,049, with the majority in patients with a pulmonary embolism or DVT. Paralleling this increase, a rise in complications is also anticipated, including IVC filter migration, embolization and strut fracture.[1] The incidence of IVC filter strut fracture ranges from 2% to a predicted 40% at 5.5 years.[2,3] Strut fracture may predispose an IVC filter or a portion thereof to embolize and may also alter flow mechanics, decreasing the IVC filter's ability to prevent a pulmonary embolism.[1] In 2010, the U.S. Food and Drug Administration issued warnings regarding the safety of IVC filters after life-threatening complications occurred from filter fracture and embolization of filter limbs, including ventricular wall laceration resulting in cardiac tamponade and tachycardia induced by cardiac irritation.[4,5] Given these risks, failure to identify and refer patients with IVC filter fracture for further evaluation and potential retrieval may represent a potential liability for emergency physicians in the event of embolization and subsequent injury.[6]

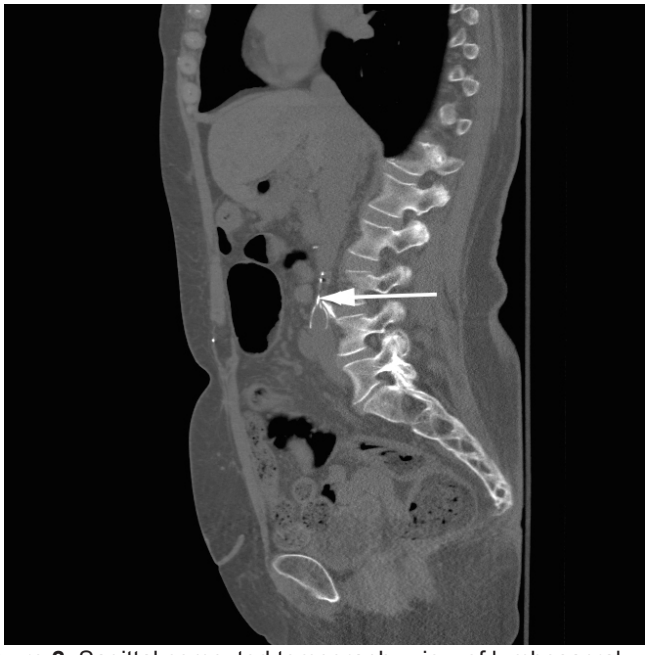

Figure 2. Sagittal computed tomography view of lumbosacral spine. Arrowhead demonstrates fracture and displacement of the posterolateral inferior vena cava filter leg.

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The Social Media Index: Measuring the Impact of Emergency Medicine and Critical Care Websites

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Introduction: The number of educational resources created for emergency medicine and critical care (EMCC) that incorporate social media has increased dramatically. With no way to assess their impact or quality, it is challenging for educators to receive scholarly credit and for learners to identify respected resources. The Social Media index (SMi) was developed to help address this.

Methods: We used data from social media platforms (Google PageRanks, Alexa Ranks, Facebook Likes, Twitter Followers, and Google+ Followers) for EMCC blogs and podcasts to derive three normalized (ordinal, logarithmic, and raw) formulas. The most statistically robust formula was assessed for 1) temporal stability using repeated measures and website age, and 2) correlation with impact by applying it to EMCC journals and measuring the correlation with known journal impact metrics.

Results: The logarithmic version of the SMi containing four metrics was the most statistically robust. It correlated significantly with website age (Spearman r=0.372; p<0.001) and repeated measures through seven months (r=0.929; p<0.001). When applied to EMCC journals, it correlated significantly with all impact metrics except number of articles published. The strongest correlations were seen with the Immediacy Index (r=0.609; p<0.001) and Article Influence Score (r=0.608; p<0.001).

Conclusion: The SMi's temporal stability and correlation with journal impact factors suggests that it may be a stable indicator of impact for medical education websites. Further study is needed to determine whether impact correlates with quality and how learners and educators can best utilize this tool. [West J Emerg Med. 2015;16(2):242–249.]

INTRODUCTION

The number of educational blogs and podcasts in emergency medicine and critical care (EMCC) has increased dramatically in the past decade,[1] paralleling the growth of digital scholarship in other areas of science.[2,3] This proliferation has led to difficulty finding high quality resources[2,4] and assessing their scholarly

value.[3,5] If these problems are not addressed, early adopters could err due to the consumption of poor quality information, and educators could stop contributing due to a lack of recognition. Impact and quality assessment tools for these resources would help address both potential problems.

Unfortunately, minimal research has been done to date on how to critically appraise the quality of secondary resources in medical education. Blogs and podcasts could be viewed as the 21st century equivalent of textbooks and lectures,[6] but these historic parallels provide little guidance on quality assessment. Continuing medical education lectures do not typically undergo full peer review before presentation and printed textbooks have variable review processes. Solutions such as incorporating formal peer review processes into blogs and podcasts have been pioneered[7] but have not been widely adopted.

New metrics are needed to assess the impact of blogs and podcasts in a similar way that impact factors assess journals. The journal impact factor (JIF) and Eigenfactor™ metrics were developed to illustrate the scientific importance of traditionally published academic literature.[8–11] While never devised to be a marker of quality, "the use of the impact factor as a measure of quality is widespread because it fits well with the opinion we have in each field of the best journals in our specialty."[11,12] Despite arguments that impact factors are a poor surrogate for quality, they are used for university rankings and inform the hiring, funding, and promotion/tenure decisions that affect scholars.[11,13] Regardless, the indices that are used for traditional journals cannot be applied to websites.

Alternative metrics ("altmetrics") that assess online engagement through a broad range of measures have been found to correlate with the citations of journal articles,[14] and are increasingly being recognized by institutions and granting organizations.[3] Altmetrics from social media sources such as Twitter, Facebook, Google+, LinkedIn, and Reddit have been found to "crowd-source" impact assessment by combining individual endorsements.[15] External composite rankings of website importance, popularity, and impact, such as Alexa Rank[16] and Google PageRank,[17] are metrics that use proprietary methods that incorporate website traffic and inbound/outbound links. Impact Story is a new, web-based tool that helps to quantify the impact of individual blog posts, datasets, and research articles for individual authors.[18,19] While these novel metrics are potentially useful for assessing the impact of an individual blog post or podcast, they are unable to identify high-impact blogs and podcasts for learners and educators.

In this paper we propose and define the Social Media index (SMi), a new metric that combines various altmetrics to measure the impact of websites as a whole. It differs from the metrics previously described in that it combines social media followership with composite website rankings into a score for a website rather than an article, blog post, or journal. It was derived using open-access EMCC podcasts and blogs because of the large number of these resources available.[1] In addition, we assessed the ability of the SMi to measure impact by calculating the SMi scores for EMCC journals and assessing their correlation with known journal impact metrics.

METHODS

The SMi was developed by the lead author of this paper (BT). Pilot versions have previously been published on the emergency medicine blogs *BoringEM*[20] and *Academic Life in Emergency Medicine*.[21]

Website and Journal Inclusion Criteria

We obtained a list of 245 EMCC websites using a previously described methodology.[1] A prospective, snowball sampling technique was used prospectively on an annual basis between 2002 and 2013 to compile a database of blog and podcast websites that were linked to each other. Additional websites were identified through personal communications, social media accounts, and a self-report form on the *Life in the Fast Lane* (http://lifeinthefastlane.com) website. We conducted a retrospective keyword search using Google in November 2013 using the terms: ("emergency medicine" OR "critical care" OR "intensive care") AND (podcast OR blog) to identify any websites missed using the other processes. All websites found were reviewed and included in the study if they hosted freely accessible blogs or podcasts related to EMCC, were written in English, were active within the previous six months, and were not hosted on an institution's or medical journal's website.

Journal inclusion criteria were decided *a priori* to provide a broad range of literature of relevance to EMCC physicians. As categorized by the 2012 Journal Citation Report Journal Impact Factor,[22] the top five "medicine, general & internal" journals (in order: *New England Journal of Medicine*, *Journal of the American Medical Association*, *Lancet*, *British Medical Journal*, and *PLOS Med*) and all "emergency medicine" and "critical care" journals composed in English were considered for inclusion. Journals with Facebook and Twitter accounts were included in the analysis.

Variable Selection

The five variables described in Table 1 (Alexa Rank, Google PageRank, Twitter Followers, Facebook Likes, and Google+ Followers) were assessed to be components of the SMi. We considered these variables because they were publicly available metrics used by many EMCC websites. Personal or website accounts (whichever was greater) were eligible for Twitter Followers and Google+ Followers because a large number of websites are promoted on these platforms exclusively using openly accessible personal accounts. Only the Facebook pages of websites (rather than individuals) were eligible for inclusion because personal accounts are considered private.

Data Collection

We gathered data on all five metrics from the included

Table 1. Definitions of the variables considered for the Social Media index.

	Website variable	Medical journal variables	Collection methodology
Alexa Rank	Alexa Rank of the blog/podcast website divided by 1000.	Alexa Rank or the website of the journal[a] or the journal's sponsoring organization[b] (whichever is greater) divided by 1000. Journal pages on publisher's websites were not used.	Alexa data was obtained using the Chrome SEO Status Toolbar[30] and confirmed using Alexa.com.
Google PageRank	PageRank of the blog/podcast website.	PageRank of the journal website.	Google PageRank data was obtained using the Chrome SEO Status Toolbar[30] and confirmed using the website CheckPageRank.net.
Twitter Followers	The number of followers of a contributor[c] or website handle (whichever is greater).	The number of followers of a journal or sponsoring organization[b] (whichever is greater).	Twitter follower data were obtained directly from the identified Twitter profile page.
Facebook Likes	The number of likes for the blog/ podcast page.	The number of likes for the journal or sponsoring organization [b] page (whichever is greater).	Facebook like data were obtained directly from the identified Facebook page.
Google + members / followers	The number of website community members or followers (whichever is greater).	The number of journal or sponsoring organization[b] community members or followers (whichever is greater).	Google+ members or followers data were obtained directly from the identified Google+ page.

[a] The Alexa Ranks for Journal websites that were part of a publisher's website were not used as they represented the Alexa Rank of multiple journals.
[b] A medical organization listed as an official sponsor on the About page of the Journal.
[c] An author or editor listed on the Author or About page of the website.

EMCC websites for four consecutive weeks between December 29, 2013 and January 19, 2014 and again on July 27, 2014. The final collection point was initially planned for six months; however, the authors were unavailable to collect data until nearly seven months. On each date, data for all websites were collected within a single 12-hour period by one of two authors (QP, JS) and audited by a third (BT). Data were gathered on the EMCC journals on January 20, 2014, within 24 hours of the website data collection on January 19, 2014.

Deriving the Social Media Index

We initially calculated the SMi using raw data. However, due to high skewness, modified versions were calculated using logarithmically transformed data and ordinal data. In all formulas each of the five metrics was given equal weight by normalizing the individual values relative to the highest value. We then added the scores for each component to calculate the SMi.

Analysis

The rankings of the SMi and each of its components were calculated separately for EMCC website and journals. This allowed the relative rank and impact of each website and journal to be assessed in their respective category.

We calculcated descriptive statistics for the website SMi and each of its components. We determined its temporal stability by correlating its values at one time point with its values one week, two weeks, three weeks, and seven months later. We also determined the correlation between the SMi on December 29, 2013, and the age of each website.

We measured the correlation between traditional journal impact metrics (Journal impact factor, Five-year journal impact factor, Immediacy index, Cited half-life, Eigenfactor, and Article influence score), the journal SMi score, and the components of the journal SMi (Google PageRank, Alexa Rank, Twitter Followers, and Facebook Likes). Spearman rank correlations were used for the analysis due to the non-linear monotonic associations present in the data. We used a two-sided alpha of 0.05 to determine statistical significance.

RESULTS

One hundred sixty-three of 245 (66.5%) of the websites and 29 of 44 (65.9%) of the journals met the outlined inclusion criteria. The mean (SD) and median (IQR) age of EMCC websites was 2.9 (1.9) years and 2.0 (2.0) years with the oldest being 12 years old.

SMi Derivation

We assessed five selected variables for inclusion in the SMi, but Google+ was excluded because few (6.7%) of the websites had substantive accounts (>100 followers). Substantive accounts were available for a much greater proportion of websites on Alexa (95.7% ranked), PageRank (76.7% rated >0), Twitter (71.8% had >100 followers) and Facebook (25.2% had >100 likes).

The formulas that we considered are listed below where A=Alexa; P=PageRank; T=Twitter; F=Facebook; x=blog, podcast, or journal; m=maximum value; Rx= rank of x (Figure). The four

$$RawSMi_x = 2.5\,x\,\frac{1/A_x}{1/A_m} + 2.5\,x\,\frac{P_x}{P_m} + 2.5\,x\,\frac{T_x}{T_m} + 2.5\,x\,\frac{F_x}{F_m}$$

$$\boldsymbol{LogSMi_x = 2.5\,x\,\frac{1/\log(A_x)}{1/\log(A_m)} + 2.5\,x\,\frac{\log(P_x+1)}{\log(P_m+1)} + 2.5\,x\,\frac{\log(T_x+1)}{\log(T_m+1)} + 2.5\,x\,\frac{\log(F_x+1)}{\log(F_m+1)}}$$

$$OrdinalSMi_x = 2.5\,x\,\frac{A_{Rx}}{163} + 2.5\,x\,\frac{P_{Rx}}{163} + 2.5\,x\,\frac{T_{Rx}}{163} + 2.5\,x\,\frac{F_{Rx}}{163}$$

Figure. Formulas used for Social Media index (SMi) calculation.

components were given equal weight by normalizing the values on a scale of 0 to 2.5 to produce a total website SMi or journal SMi with a minimum score of 0 and maximum score of 10.

Although the logarithmic and ordinal versions of the SMi were highly correlated (Spearman r>0.95), the logarithmic version of the SMi (logSMi) was judged to have the best operational characteristics because it was the most normally distributed and least subject to skewness of the individual components. Therefore, it was selected as the definitive SMi formula for further evaluation and henceforth will be referred to as the SMi.

Temporal Characteristics

The SMi was significantly correlated with website age (r=0.372, p-value<0.001) and itself over one-week, two-week, three-week, and seven-month periods:

December 29, 2013 to January 5, 2014, r=0.991, p-value<0.001; December 29, 2013 to January 12, 2014, r=0.796, p-value<0.001; December 29, 2013 to January 19, 2014, r=0.806, p-value<0.001; December 29, 2013 to July 27, 2014, r=0.929, p-value<0.001.

Social Media Followership

The SMi demonstrated a wide range with normal distribution. For websites the mean (SD) was 4.52 (1.65), with a range from 1.06 to 9.40. When applied to the included journals the SMi had a mean (SD) of 6.27 (1.30) with a range from 3.84 to 9.26.

Social media followership for websites and journals varied widely across each component of the SMi (Table 2). ECG Experts Study Cards (112,696 Facebook followers) and Life in the Fast Lane (14,216 Twitter followers) had high social medial followership for websites while the *New England Journal of Medicine* (847,603 Facebook followers) and *JAMA* (350,000 Twitter followers) had high social media followership for journals.

Ranked in their own media categories by SMi (Table 3a and 3b), the top three websites were Life in the Fast Lane (9.40), Academic Life in Emergency Medicine (8.89), and EMCrit (8.68). The top three journals (Table 3) were *New England Journal of Medicine* (9.26), *British Medical Journal* (9.09), and *JAMA* (8.75). The large increase in SMi, by approximately one standard deviation, between *American Journal of Critical Care* and *Lancet* illustrates the jump from specialty-specific EMCC journals to general medical journals. The highest ranked emergency medicine-specific journals were *Annals of Emergency Medicine* (6.61), *Emergency Medicine Journal* (6.22), and *Academic Emergency Medicine* (5.96).

Correlation with Journal Impact Factors

Traditional journal impact metrics correlated significantly with journal SMi score (Table 4). The strongest correlations were seen between the journal SMi score and Immediacy Index (r=0.609, p-value=<0.001) and Article Influence Score (r=0.608, p-value<0.001). Five-year Journal Impact Factor (r=0.526, p-value=0.001), Journal Impact Factor

Table 2. Summary statistics for the Social Media index and their individual components (163 websites and 29 journals).

	Minimum	Maximum	Median (IQR)	Mean (SD)
Websites (Jan 19, 2014)				
Alexa Rank	62	22300	5476 (6978)	7090 (5733)
Facebook Likes	0	112696	0 (120)	1407 (9614)
Google PageRank	0	5	2.0 (2.0)	2.2 (1.5)
Twitter Followers	0	14216	410 (1113)	1135 (1892)
RawSMi	0.01	7.65	1.17 (0.95)	1.39 (1.10)
LogSMi	1.06	9.40	4.58 (2.17)	4.52 (1.65)
OrdinalSMi	0.21	9.82	3.87 (3.65)	4.22 (2.37)
Journals (Jan 20, 2014)				
Alexa Rank	11	11939	1554 (3862)	3378 (4135)
Facebook Likes	0	847603	984 (19516)	31515 (128371)
PageRank PageRank	3	8	5.0 (2.0)	5.30 (1.19)
Twitter Followers	0	350000	1303 (4664)	18741 (60116)
Journal LogSMi	3.84	9.26	6.22 (1.54)	6.27 (1.30)

SMi, Social Media index

Table 3a. The top five websites as calculated and by the Social Media index and its components.

Website Jan 19, 2014	Alexa Rank	Facebook Likes	Twitter Followers	SMi[c]
1st	LITFL[b] (62)	ECG Experts Study Cards (112696)	LITFL[b] (14216)	LITFL[b] (9.40)
2nd	ALiEM[a] (140)	EMS 12 lead (45080)	EMCrit (9213)	ALiEM[a] (8.89)
3rd	EMCrit (219)	ALiEM[a] (15591)	EMS 12 lead (7144)	EMCrit (8.68)
4th	Don't forget the bubbles (292)	Dr. Smith's ECG Blog (10259)	RAGE podcast (6413)	EMS 12 lead (8.52)
5th	PedEM Morsels (492)	ImpactED Nurse (7356)	iTeachEM (6413)	ImpactED Nurse (7.65)

The numbers in parentheses indicate the raw value for each website or journal. PageRank values excluded from the table due to ties (only integer values from 0 to 10 are available).
[a] ALiEM, Academic Life in Emergency Medicine
[b] LITFL, Life in the Fast Lane
[c] SMi, logarithmic formula for the Social Media index

Table 3b. The top five journals as calculated by the Social Media index and its components.

Journal Jan 20, 2014	Alexa Rank	Facebook Likes	Twitter Followers	Journal LogSMi[g]
1st	BMJ[b] (11)	NEJM[g] (847603)	JAMA[d] (350000)	NEJM[e] (9.26)
2nd	NEJM[e] (23)	SJTREM[f] (121000)	NEJM[e] (162000)	BMJ[b] (9.09)
3rd	JAMA[c] (28)	JAMA[c] (86938)	BMJ[c] (104000)	JAMA[c] (8.75)
4th	Lancet (47)	Lancet (72074)	Lancet (101000)	Lancet (8.23)
5th	PLOS[d] Med (179)	CHEST (39177)	PLOS[d] Med (23000)	AJCC[a] (6.89)

The numbers in parentheses indicate the raw value for each website or journal. PageRank values excluded from the table due to ties (only integer values from 0 to 10 are available).
[a] AJCC, American Journal of Critical Care
[b] BMJ, British Medical Journal
[c] JAMA, Journal of the American Medical Association
[d] PLOS, Public Library of Science
[e] NEJM, New England Journal of Medicine
[f] SJTREM, Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine
[g] SMi, logarithmic formula for the Social Media index

Table 4. Spearman's correlation of the journal Social Media index (January 20, 2014) and its components with traditional journal impact metrics[22] (n=29 journals).

	SMi		Google PageRank		Alexa Rank		Twitter Followers		Facebook Likes	
Journal metric	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value
Immediacy index	0.609	0.0006	0.603	0.0007	0.731	<0.0001	0.492	0.008	0.515	0.005
Article influence score	0.608	0.0008	0.693	<0.0001	0.708	<0.0001	0.494	0.009	0.512	0.006
Five-year journal impact factor	0.590	0.001	0.668	0.0001	0.692	<0.0001	0.466	0.01	0.503	0.007
Journal impact factor	0.526	0.003	0.572	0.001	0.647	0.0001	0.398	0.03	0.449	0.01
Eigenfactor	0.425	0.02	0.617	0.0004	0.577	0.001	0.336	0.07	0.284	0.14
Cited half-life	0.407	0.03	0.475	0.01	0.417	0.03	0.416	0.03	0.270	0.17

(r=0.526, p-value=0.003), and the Eigenfactor score (r=0.425, p-value=0.02) correlated less strongly.

When assessed alone, each of the journal SMi components also correlated with traditional journal impact metrics (Table 4). This was particularly true for Alexa Rank and Google PageRank, which correlated more strongly than the journal SMi in several cases.

DISCUSSION

Regardless of one's beliefs in the merit of using secondary

sources such as blogs and podcasts for medical education, their rapid growth[1] and surveys of medical learners[23,24] suggest that they are increasingly being created and used. We developed the SMi score as a first step to identify a metric to assess the quality of social media-based educational resources, because such a gold standard currently does not exist. As an indirect measure of quality, we identified online measures of impact based on four followership variables, similar to how journals historically use impact measures as a surrogate for quality in the academic world.[11,12]

The SMi has several characteristics that make it a viable measurement of impact for learners, educators, and administrators. First, learners, educators, and administrators can apply these publically available metrics and transparent SMi formula without permission or cost. Second, our assessments of the SMi's temporal attributes suggest that it measures long-term impact, rather than spikes in popularity. Furthermore, it is not unduly influenced by longevity, suggesting it is possible for new resources to be recognized.

Because no gold standard exists to measure social media educational resource impact, we examined how the SMi formula for journal websites would perform in comparison to traditionally recognized journal impact metrics. Our data found that a journals' online followership, as quantified by the SMi formula, correlates with these metrics. Its particularly strong correlation with the Immediacy Index[25] and Article Influence Score[9,10] suggests that in journals it is most predictive of fast citations and influential articles. Further optimization of the SMi by weighting its components based on their correlation with journal impact was not performed because (1) no single gold standard exists for journal impact and (2) the impact of educational websites and journals may not correlate perfectly with the impact of journals.

Two of the four components of the SMi, Alexa Rank and Google PageRank, focus on website traffic and inbound links.[16,17] As higher-impact journals are likely to have higher traffic webpages and a greater number of inbound links, it follows that these two web rankings correlated strongly with traditional measures of journal impact presumably because they publish articles that are discussed and read more frequently. However, to our knowledge this finding has not previously been reported in the literature. It may be of interest to journal publishers who would like to track their impact more closely.

The other two components of the SMi, Twitter Followers and Facebook Likes, also correlated with traditional journal impact factors. This is unsurprising as the altmetrics of individual articles have been shown to correlate with future citations,[15] and journals with higher social media followership would be more likely to have their content shared. However, the correlations for Twitter Followers and Facebook Likes with journal impact factors were not as high as Alexa Rank and Google PageRank. Despite this, we believe Twitter Followers and Facebook Likes are important indicators to include within the SMi because they are likely better measures of followership, whereas Alexa and Google PageRank focus slightly more on viewership.[26] We hypothesize that followership is an indirect measure of source credibility and thus an important measure of impact for these resources. While it is not a perfect parallel, following the social media accounts of a blog or podcast mirrors subscribing to a journal and is a significantly greater commitment than reading a single post, listening to a single podcast, or downloading a single journal article. For this reason we believe that the followership of social media channels, despite not correlating quite as well with journal impact, provides a different but important perspective on the impact of blogs or podcasts that would be lost were one of the other two metrics (Alexa or Google PageRank) considered alone.

To further the research agenda on the assessment of social media educational resources, our research group is in the process of deriving a quality assessment tool for blogs and podcasts using education literature and data from modified Delphi surveys of stakeholders. Future studies will assess the validity of this quality assessment tool and its correlation with the SMi. Our hypothesis that followership is a surrogate marker of quality will continue to be tested and modified with this research.

Moving forward, we are designing a program that will gather the required data, calculate the SMi, and update a webpage on a weekly basis. The results will be openly accessible on the website http://aliem.com/social-media-index. Additionally, as online resources are developed outside of EMCC we anticipate calculating rankings for medical education blogs and podcasts in other health professions.

LIMITATIONS

Whenever an evaluation tool is developed that openly defines the individually measured components, it becomes possible to 'game' the system.[27] The ability of the SMi to assess impact would be compromised if websites attempted to influence their scores by purchasing fictional followers and web traffic. This underhanded and artificial means to boost analytics numbers, however, would sabotage the professional credibility and reputation of the website owners. The tremendous risk of losing reader/listener trust and respect, along with the associated costs, would likely sway these volunteer websites away from manipulating such metrics. Notably, this limitation is not exclusive to the SMi as gaming has been a strong criticism of traditional impact metrics through self-referencing and preferential article publication/classification.[28,29]

There are many other social media platforms used by blogs and podcasts that were excluded from the SMi. Not taking these platforms into account may underscore websites that use platforms such as Google+, YouTube, and iTunes to distribute their content. However, due to the small number of websites using these platforms (Google+ and YouTube) and lack of publicly available metrics (iTunes) they were excluded from the current iteration of the SMi. As social media continues to evolve, the SMi may be modified to

accommodate trends in its use.

In this study the SMi was derived using a subpopulation of medical education websites (blogs and podcasts) focused on a relatively specific field (EMCC). This was done intentionally to provide a homogenous group of websites for derivation of the SMi. However, its generalizability would be strengthened if it were applied successfully to other online educational products from various fields of medicine. Follow-up studies using the methodology outlined in this study and websites/journals from other specialties could provide further validity evidence for the SMi.

The selection of time intervals to assess the temporal stability of the SMi was somewhat arbitrary. We intended to demonstrate short-term stability with the weekly intervals and medium-term stability with follow-up approximately six months later; however, other time intervals could have been selected. We cannot speculate as to how this would have affected our results. While the collection of our final data point was slightly delayed, the strong week-to-week correlation at the beginning of the study suggests it would have been unlikely to change our results.

CONCLUSION

The number of educational websites continues to grow, especially in the field of EMCC. The SMi has the potential to be a stable and accessible indicator of their impact. If the results of this study can be replicated it would benefit medical professionals by identifying resources for learners and assessing scholarly impact of educators that are using these media. Regardless of whether the SMi becomes the gold standard for the assessment of impact for online medical education resources, it should contribute to the discussion towards the development and validation of impact and quality metrics.

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Non-thrombotic Abnormalities on Lower Extremity Venous Duplex Ultrasound Examinations

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Introduction: Emergency physician-performed compression ultrasonography focuses primarily on the evaluation of the proximal veins of the lower extremity in patients with suspected deep venous thrombosis (DVT). A detailed sonographic evaluation of lower extremity is not performed. The objective of this study was to determine the prevalence of non-thrombotic findings on comprehensive lower extremity venous duplex ultrasound (US) examinations performed on emergency department (ED) patients.

Methods: We performed a retrospective six-year review of an academic ED's records of adult patients who underwent a comprehensive lower extremity duplex venous US examination for the evaluation of DVT. The entire US report was thoroughly reviewed for non-thrombotic findings.

Results: We detected non-thrombotic findings in 263 (11%, 95% CI [9.5-11.9%]) patients. Among the non-thrombotic findings, venous valvular incompetence (81, 30%) was the most frequent, followed by cyst/mass (41, 15%), lymphadenopathy (33, 12%), phlebitis (12, 4.5%), hematoma (8, 3%), cellulitis (1, 0.3%) and other (6, 2.2%).

Conclusion: In our study, we detected a variety of non-thrombotic abnormalities on comprehensive lower extremity venous duplex US examinations performed on ED patients. Some of these abnormalities could be clinically significant and potentially be detected with point-of-care lower extremity US examinations if the symptomatic region is evaluated. In addition to assessment of the proximal veins for DVT, we recommend sonographic evaluation of the symptomatic area in the lower extremity when performing point-of-care ultrasound examinations to identify non-thrombotic abnormalities that may require immediate intervention or close follow up. [West J Emerg Med. 2015;16(2):250–254.]

INTRODUCTION

Deep venous thrombosis (DVT) affects approximately 250,000 individuals annually in the United States with an average incidence of one person per 1,000 population.[1,2] Data from the National Ambulatory Medical Care Survey and National Hospital Ambulatory Medical Care Survey suggest that a majority of DVT diagnoses were made in the emergency department (ED) setting.[3] Since the incidence of this disease is so high and progression from DVT to pulmonary embolism can result in significant morbidity and mortality, early detection and treatment of DVT is critical to improve patient outcomes. Duplex ultrasonography of the lower extremity has become the first-line diagnostic test to detect DVT, with a sensitivity of 91% to 96% and a specificity of 98% to 100%.[4]

In the recent years, ultrasound (US) equipment has become more compact, portable, and affordable, which has

facilitated the rapid evolution of emergency ultrasonography.[5] The use of point-of-care US by emergency physicians is increasing dramatically both for diagnostic purposes and procedural guidance. The accuracy and noninvasive characteristics of portable US make it an excellent tool for rapid diagnosis of serious and life-threatening conditions in the ED.[6] Prior studies have shown that emergency physician-performed bedside US improves diagnostic accuracy, procedural safety and ED throughput.[7-9]

The accuracy of emergency physician-performed compression ultrasonography in the diagnosis of DVT has been extensively studied. In a recent systematic review and meta-analysis, the estimates for emergency physician-performed compression ultrasonography sensitivity and specificity for detecting DVT were 96.1% and 96.8% respectively.[10] A simplified three-point or two-point compression technique is generally used for DVT evaluation by emergency physicians.[11,12] Two-point compression (common femoral vein and popliteal vein) ultrasonography was found to be equivalent to whole-leg ultrasonography when used for the management of symptomatic patients with suspected DVT.[13] Regardless of the technique used, emergency physician-performed ultrasonography focuses primarily on the evaluation of proximal veins of lower extremity. A detailed sonographic evaluation of the lower extremity is not performed. In contrast, whole-leg ultrasonography can detect conditions other than venous thrombosis that may be causing leg symptoms. It is unclear if emergency physicians should modify the lower extremity point-of-care US technique to assess for non-thrombotic abnormalities. To our knowledge, the clinical significance of failure to evaluate for non-thrombotic abnormalities with point-of-care compression ultrasonography has not been studied. It is important to understand the nature of the non-thrombotic abnormalities in order to assess the significance of such findings and determine the implications for point-of-care compression ultrasonography.

The objective of this study was to determine the prevalence of non-thrombotic findings on comprehensive lower extremity venous duplex US examinations performed in ED patients.

METHODS

Study Design

This was a retrospective review of ED patients who received a lower extremity venous duplex US examination over a six-year period. The institutional review board at our institution approved this study.

Study Setting and Population

We conducted this study at an academic medical center with an annual ED census of approximately 45,000 patients. The ED has a residency training program and an active emergency sonography program. The primary investigators of this study were two emergency physicians with expertise in bedside US. We included in this study all adult patients who received a lower extremity venous duplex US examination for evaluation of DVT in the ED.

Study Protocol

A retrospective review of adult (≥19 years) patients who presented to the ED with symptoms suspicious for DVT and received a comprehensive lower extremity venous US examination were included in this study. ED visits for the study period were extracted from the hospital electronic medical record system. We identified all ED patients who received a comprehensive lower extremity venous duplex ultrasound examination during the study period using current procedural terminology (CPT) code for lower extremity venous duplex US examination from our DVT research database.[14] In the ED, clinical assessment was performed by emergency medicine residents and faculty. All subjects also underwent a single comprehensive lower extremity duplex venous US (B-mode and Doppler) for evaluation of DVT in the ED. The US examinations were performed by vascular surgery division sonographers and interpreted by board-certified vascular surgeons. The US protocol included both B-mode and Doppler color flow analysis of deep veins of lower extremity including calf veins. B-mode imaging of lower extremity veins without and with transducer compressions was performed for assessing venous patency at each of the following levels: common femoral vein, junction of the common femoral vein with the greater saphenous vein, femoral vein, deep femoral vein, popliteal vein, anterior tibial vein, posterior tibial vein and peroneal vein. Spectral Doppler waveforms of lower extremity veins were obtained showing variations with respiration and/or flow augmentation. Any vascular and nonvascular abnormalities, if detected were thoroughly assessed. We did not include point-of-care US data in this study due to inconsistencies in documentation and US image archiving.

Three physicians independently performed data extraction from medical records after a training session to standardize data collection strategies. The training session lasted approximately four hours. The data abstractors were not blinded to study objectives. A standardized data extraction form was used for data collection from medical records. Any discrepancies in the data extraction were resolved by discussion between the data abstractors. They reviewed medical records for final US reports. The entire US report was thoroughly reviewed for non-thrombotic findings. Each US report was initially reviewed by only one data abstractor. To assess the accuracy of data extraction, a second data abstractor then reviewed a randomly sampled 20% of US reports.

Data Analysis

We used descriptive statistics to summarize the data using SAS software 9.1 (SAS Institute Inc., Cary, North Carolina, USA). Continuous data are presented as percent frequency

of occurrence with 95% confidence intervals. Inter-observer agreement among data abstractors for the presence of non-thrombotic findings was assessed by kappa analysis.

RESULTS

A total of 2,390 lower extremity US reports were reviewed. Non-thrombotic findings were detected in 263 (11%, 95% CI [9.5-11.9%]) patients over the six-year period. Inter-observer agreement among chart reviewers for the presence of non-thrombotic findings was high (k=0.98). The different non-thrombotic findings found in lower extremity venous duplex US examinations are summarized in the Table (Figures 1-4 and Videos 1-4). Some patients had more than one non-thrombotic abnormality.

Among the non-thrombotic findings, venous valvular incompetence was the most frequent finding. In patients who had a mass or cyst, Baker's cyst was found in 27 cases. Bilateral Baker's cysts were found in three patients. One patient had a loculated Baker's cyst. Four patients were found to have a mass in the calf. One patient had a fluid-filled mass in the distal left thigh with no vascular flow signals. Six patients (categorized as "other" in the table) had the following abnormalities: popliteal artery aneurysm with evidence of distal ischemia, bilateral popliteal artery aneurysms, subcutaneous fluid in calf, superficial femoral artery occlusion with monophasic posterior tibial artery waveforms, ankle effusion and absence of Doppler signals in the pedal arteries.

Table. Non-thrombotic findings detected in lower extremity venous duplex ultrasound examinations.

Non-thrombotic findings	N (%) [95% CI]
Venous valvular incompetence	81 (30%) [76.3% - 85.7%]
Cyst/mass	41 (15%) [35.1% - 46.9%]
Lymphadenopathy	33 (12%) [27.3% - 38.7%]
Phlebitis	12 (4.5%) [76.3% - 85.7%]
Hematoma	8 (3%) [8.1% - 15.9%]
Cellulitis	1 (0.3%) [-0.2% - 2.2%]
Other	6 (2.2%) [3.1% - 8.9%]

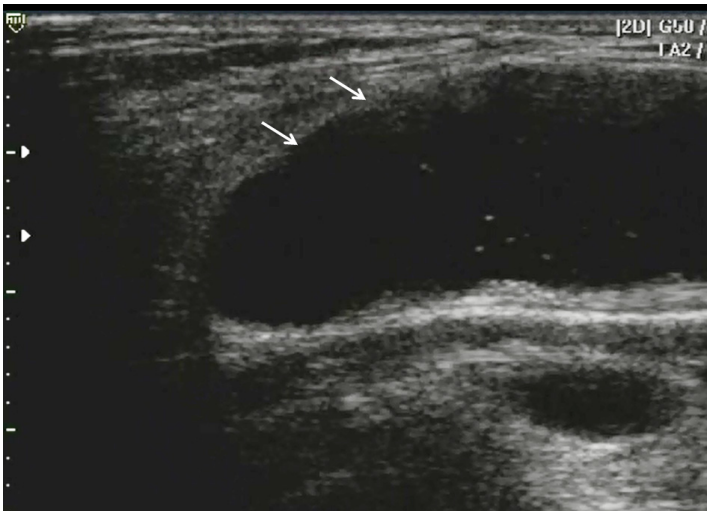

Figure 1. Baker's cyst (arrows, anechoic distension of the semimembranosus-medial gastrocnemius bursa).

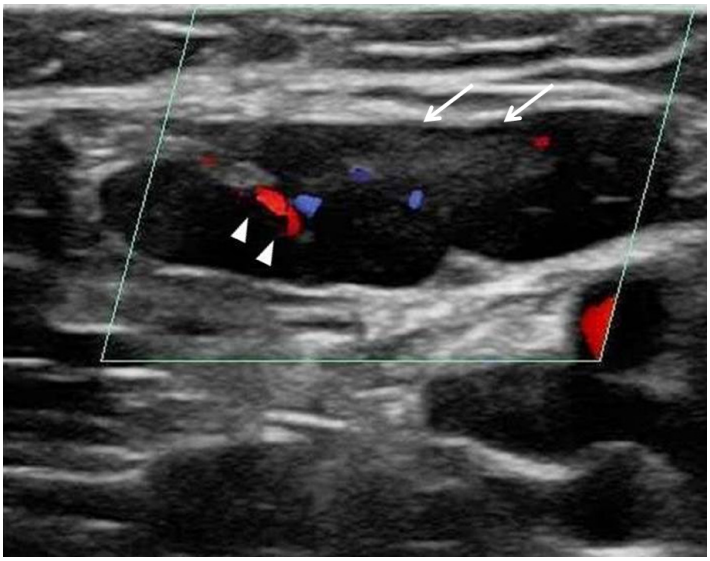

Figure 2. Enlarged inguinal lymph node (arrows) demonstrating flow in the hilar region with Color Doppler (arrowheads).

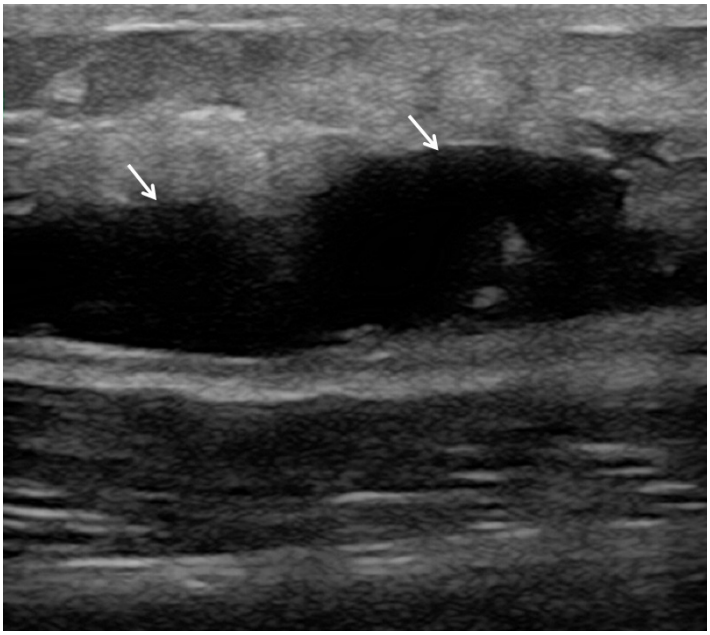

Figure 3. Liquefied hematoma (arrows, anechoic fluid collection).

DISCUSSION

Only a small proportion (15–25%) of patients with clinically suspected DVT have objective evidence of thrombosis when evaluated by ultrasonography.[15] As a result, an alternative diagnosis is considered in a majority of patients. Few prior studies have explored alternate diagnoses in patients

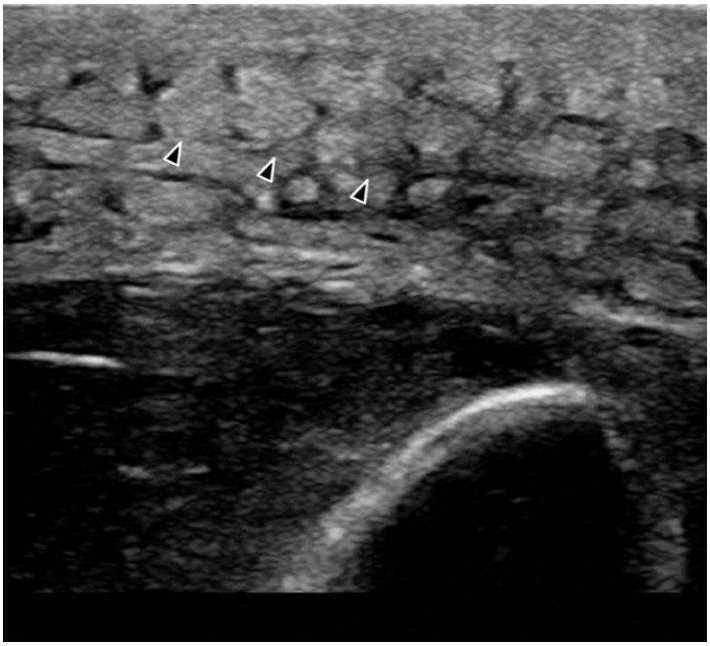

Figure 4. Cobblestone appearance (arrowheads) of subcutaneous tissues suggesting cellulitis.

with suspected DVT who received a lower extremity US examination.[15-17] In contrast to our study,[10] Cate-Hoek et al. studied patients with suspected DVT in the primary care setting. The alternative diagnoses were based on clinical evaluation. The most common alternative diagnoses were muscle rupture, chronic venous insufficiency, erysipelas/cellulitis and superficial venous thrombosis. Lower extremity ultrasonography did not improve the diagnostic yield of alternative diagnoses.

Generally, incidental findings detected on lower extremity US do not alter management of ED patients. Most of these abnormalities do not require urgent treatment, admission or further evaluation during the ED visit. However, conditions such as abscess or hematoma require immediate attention in the ED. These diagnoses are not always clear clinically, especially in the early stages of the disease. Clinical criteria and laboratory data alone are not always helpful to detect the underlying pathology. If not diagnosed and treated in a timely fashion, these conditions may lead to serious complications in patients taking anticoagulants or immunosuppressed patients. Sonographic evaluation of proximal veins alone may not be sufficient in all patients presenting to the ED with lower extremity symptoms. In addition to evaluation of the proximal veins for DVT, we recommend a quick US evaluation of the symptomatic area in the lower extremity to identify these abnormalities. Depending on the expertise of the physician sonologist, a follow-up radiology department US examination may be necessary to further evaluate the abnormalities detected on point-of-care US examinations. Scanning the symptomatic subcutaneous and musculoskeletal regions may aid the clinician in formulating the appropriate treatment and follow-up plans. By adopting this approach, emergency physicians can quickly identify conditions that require immediate therapy (incision and drainage for abscess, or anticoagulant dose adjustment in the presence of hematoma) from those that need less urgent intervention. This approach may also help determine the urgency of follow up and increase patient satisfaction. Currently, not all patients who undergo a point-of-care lower extremity venous US examination are instructed to obtain a follow-up comprehensive lower extremity venous US examination. Additionally, patient compliance with follow-up US examinations was found to be extremely low.[18] Scanning the symptomatic region in addition to the assessment of proximal veins for DVT may help physicians determine who needs a follow-up US examination for non-thrombotic abnormalities.

LIMITATIONS

Our study has several methodological limitations, which may limit the conclusions that can be reached. The most important limitation of this study is that we did not review patient outcomes. It would have been helpful to know the clinical outcomes of patients with non-thrombotic abnormalities in order to determine what proportion were clinically significant. However, based on the nature of the non-thrombotic abnormalities detected in this study, it is reasonable to assume that a significant proportion of our patients required further evaluation and some patients needed emergent treatment including operative intervention. Therefore, we recommend sonographic evaluation of the symptomatic region in the lower extremity while performing point-of-care lower extremity US examinations. The retrospective study design could have introduced selection bias. However, the database that was used to identify our subjects captured all lower extremity venous US examinations performed on ED patients. We were able to obtain final US reports on all consecutive patients who underwent lower extremity venous US examinations. Another limitation is that our study was conducted at a single tertiary care academic center, and results may not be generalizable to other settings. Our vascular surgery division's US protocol includes a complete lower extremity evaluation including assessment of an incidental finding if detected. It is possible that US reports reviewed for data collection may have missed some incidental findings that were not routinely reported. Additionally, we did not include point-of-care compression US examination data in our analyses. In our study, only one patient was found to have cellulitis, which is more commonly found in patients who receive lower extremity US examinations for suspicion of DVT.[16] We only analyzed US reports and did not examine the clinical course, additional diagnostic testing, treatment and resolution of symptoms in these patients.

CONCLUSION

In our study, a variety of non-thrombotic abnormalities were detected on comprehensive lower extremity venous duplex US examinations performed on ED patients. Some of these abnormalities could be clinically significant and can

potentially be detected with point-of-care lower extremity US examinations if the symptomatic region is evaluated. In addition to assessment of the proximal veins for DVT, we recommend sonographic evaluation of the symptomatic area in the lower extremity when performing point-of-care ultrasound examinations to identify non-thrombotic abnormalities which may require immediate intervention or close follow up.

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

Video 1. Baker's Cyst.
Video 2. Enlarged inguinal lymph node.
Video 3. Liquified hematoma in calf region.
Video 4. Cellulitis.

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Can Emergency Physicians Perform Common Carotid Doppler Flow Measurements to Assess Volume Responsiveness?

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Introduction: Common carotid flow measurements may be clinically useful to determine volume responsiveness. The objective of this study was to assess the ability of emergency physicians (EP) to obtain sonographic images and measurements of the common carotid artery velocity time integral (VTi) for potential use in assessing volume responsiveness in the clinical setting.

Methods: In this prospective observational study, we showed a five-minute instructional video demonstrating a technique to obtain common carotid ultrasound images and measure the common carotid VTi to emergency medicine (EM) residents. Participants were then asked to image the common carotid artery and obtain VTi measurements. Expert sonographers observed participants imaging in real time and recorded their performance on nine performance measures. An expert sonographer graded image quality. Participants were timed and answered questions regarding ease of examination and their confidence in obtaining the images.

Results: A total of 30 EM residents participated in this study and each performed the examination twice. Average time required to complete one examination was 2.9 minutes (95% CI [2.4-3.4 min]). Participants successfully completed all performance measures greater than 75% of the time, with the exception of obtaining measurements during systole, which was completed in 65% of examinations. Median resident overall confidence in accurately performing carotid VTi measurements was 3 (on a scale of 1 [not confident] to 5 [confident]).

Conclusion: EM residents at our institution learned the technique for obtaining common carotid artery Doppler flow measurements after viewing a brief instructional video. When assessed at performing this examination, they completed several performance measures with greater than 75% success. No differences were found between novice and experienced groups. [West J Emerg Med. 2015;16(2):255–259.]

INTRODUCTION

The search for a reliable, accurate and non-invasive measure of volume responsiveness in patients in shock is an ongoing endeavor. Shock is a common presentation in the emergency department (ED) and emergency physicians (EP) are often confronted with the challenge of accurate volume assessment and adequate volume resuscitation. In septic patients in particular, improvements in mortality have been linked to early and aggressive volume resuscitation.[1,2] However, recent research also demonstrates increased mortality and increased length of stay in patients with over-aggressive volume resuscitation.[3,4] Therefore, it is important for EPs to have accurate diagnostic tools to

determine which patient will have an increase in their stroke volume, and therefore cardiac output, with additional intravenous fluids. This concept is frequently termed volume responsiveness. In practice, a volume-responsive patient will have improved hemodynamics with fluid administration. Technically, a volume-responsive patient will have at least a 15% increase in stroke volume with a 500mL bolus of crystalloid fluids. Critically ill, unstable patients who are not volume responsive, but are given additional fluids, will not improve their hemodynamics and may, in fact, be harmed via the resulting volume overload.

Currently available methods of measuring volume responsiveness have limitations. Central venous pressure (CVP) has been the primary means of guiding volume resuscitation in sepsis since the inception of early goal-directed therapy. CVP measurements have been shown to be an inaccurate predictor of volume responsiveness in several studies and have low rates of physician use within sepsis bundles.[5-7] Pulmonary artery occlusion pressure (wedge pressure) is invasive, can also be inaccurate and is rarely used in the ED.[8] Likewise, sonographic inferior vena cava measurements may not accurately predict fluid responsiveness.[9,10] Additionally, transthoracic echocardiography can be used to measure cardiac output and, in turn, volume responsiveness; however, it is highly operator dependent with poor test-re-test reliability.[11]

One recent study has shown that common carotid velocity time integral (VTi) measurements can be used with a passive leg raise maneuver to determine volume responsiveness in critically ill patients.[12] The measurements are non-invasive and were found to be accurate in the prediction of volume responsiveness in comparison with a non-invasive cardiac output monitor. This technique has obvious appeal as a useful clinical tool in the ED and could improve upon the currently available methods in use. It is non-invasive, repeatable and the structures of interest are superficial in location, thus easy to image. Sonographic measurements in the cited study were obtained by a vascular certified echocardiographer; however, the average EP does not possess the training or skills of an expert sonographer. The ability to generalize the utility of this technique to EPs with standard point-of-care (POC) ultrasound experience requires further investigation. Prior studies have evaluated the ability of EPs to learn various sonographic techniques with brief training interventions with results indicating success and accuracy with these brief interventions.[13-15] The objective of this study was to determine the ability of emergency medicine (EM) residents to obtain sonographic images and measurements of the common carotid artery VTi for potential use in assessing volume responsiveness in the clinical setting.

METHODS

Study Design and Setting

We conducted this prospective observational study at two affiliated academic medical centers with two EM residency programs and a combined EM/pediatrics residency program. The ED has an active emergency ultrasound training program. Hospital credentialing in POC ultrasound is available for EPs and is based on American College of Emergency Physicians ultrasound guidelines.[16] This study was reviewed by local institutional review committee and approved.

Study Population

Participants in the study were volunteer EM resident physicians from all years of training. All residents from the three affiliated residency programs were invited to participate. None of these residents had any prior experience with carotid ultrasound.

Study Protocol

We created a five-minute instructional video demonstrating a technique to obtain common carotid ultrasound images and measure the common carotid VTi based on previously published methods.[12] The published technique involves obtaining antero-posterior measurements of the common carotid artery diameter in systole within approximately 0.5cm of the common carotid bulb in the long axis with a 12-7 MHz broadband linear array transducer (Figure 1, Video 1). The VTi is then determined through digitalized Doppler spectral envelopes with the sample obtained at the location that the diameter was taken. The Doppler gate is placed in the middle of the artery with a 45- to 60-degree angle of insonation (Figure 2, Video 2). We sent the instructional video by email to all potential participants to review, and it was available for them to review again prior to their performance of the examination. Images were obtained by each participant on two healthy volunteers using a Mindray M7 (Shenzhen, China). Two expert sonographers observed participants performing the technique in realtime. They recorded each participant's performance on nine performance measures as a dichotomous variable, either as successfully completed or not. Participants filled out a questionnaire detailing the number of previous ultrasound

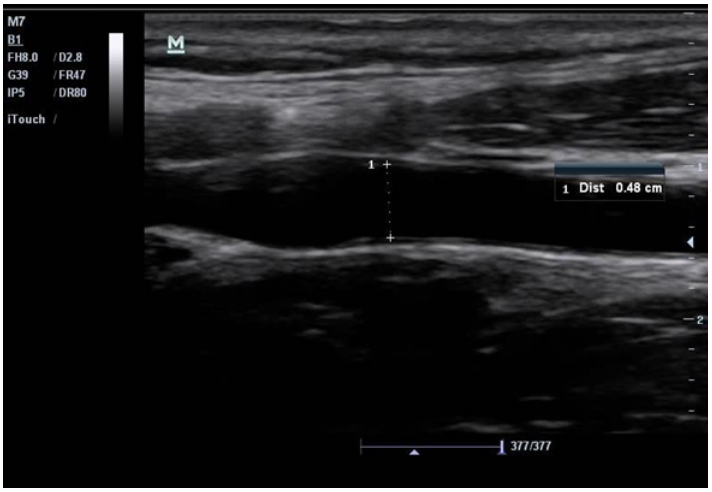

Figure 1. Ultrasound image of common carotid diameter measurement obtained within 0.5 cm of the carotid bulb and measured intima to intima.

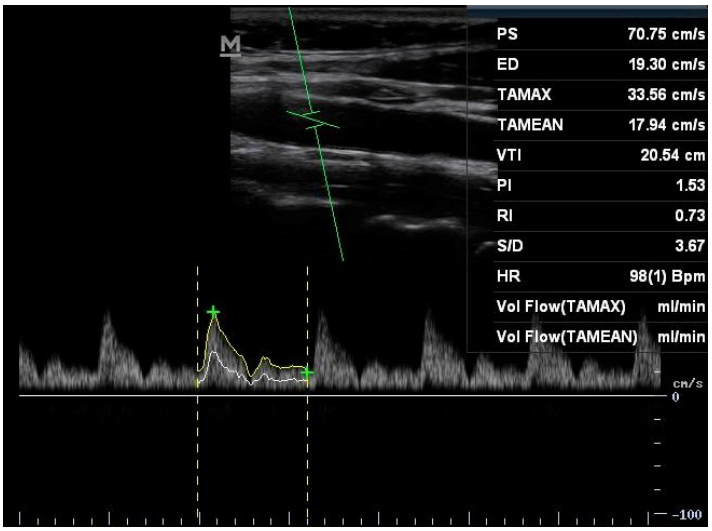

Figure 2. Ultrasound image of common carotid Doppler waveform and velocity time integral measurement acquired with an insonation angle of 58 degrees. The upper spectral waveform tracing (hollow arrow) represents peak flow velocity and the lower spectral waveform (solid arrow) represents mean flow velocity. Plus signs on the spectral waveform represent peak systolic velocity and end diastolic velocity.

examinations they had performed, their comfort level with the technique and their preference for the brief video as a learning method versus others. An additional expert sonographer who was blinded to the study hypothesis reviewed the images and assessed all images for Doppler sample volume placement, accuracy of measurement of common carotid artery diameter and image quality using a scale of 1 (poor image quality) - 5 (excellent image quality). All expert sonographers had performed greater than 1000 POC ultrasound examinations before the study period.

Data Analysis

Data are presented as means, medians, or proportions as appropriate, along with 95% confidence intervals (CIs) or interquartile ranges. We used a paired t-test (time to examination completion) and McNemar's test (performance measures) to test if outcomes differed between the two volunteer models. All confidence intervals for pooled data were calculated accounting for residents as clusters with two measurements (one for each model). No formal power calculation was conducted prior to the study. We used Stata v.12.1 (StataCorp, College Station, TX) for all analyses.

RESULTS

A total of 30 EM residents participated in this study. The number of ultrasound examinations completed by residents prior to participation in the study was between 0-839 with a median of 23 (IQR: 11-154). Residents were stratified into experienced (n=9, 30%) and novice groups (n=21, 70%) based on greater or less than 125 ultrasound examinations previously performed. The proportion of participants in the study that were first-year residents was 80.0% (24/30), while the proportion of non-participants that were first-year residents was 20.2% (24/119; $p<0.001$). All of the participants watched the instructional video prior to performing the examination: 46% of participants watched it once, 46% watched it twice, and 8% watched it more than twice. The greatest number of times the video was reviewed was four.

There was no statistical difference for any outcome variable between the two volunteer models ($p>0.1$), so all data were pooled. Average time required for participants to complete one complete examination was 2.9 minutes (95% CI [2.4–3.4 min]). Mean time to examination completion was 3.0 minutes (95% CI [2.4-3.6 min]) for novices and 2.7 minutes (95% CI [2.0-3.4 min]) for more experienced residents with no significant difference in time to completion between groups.

The proportion of ultrasound examinations in which the physicians successfully completed each performance measure is shown in Figure 3. Residents were able to successfully complete all performance measures greater than 75% of the time, with the exception of obtaining carotid measurements during systole, which was only completed in 65% (95% CI [51.5-76.8%]) of examinations. We compared successful performance of each measure between novice and experienced groups. Obtaining an angle of insonation of 45- to 60-degrees was performed successfully more frequently by novice sonographers than experienced sonographers (92% versus 70%, $p= 0.03$). There was no difference between groups for other performance measures.

Median image quality, as reviewed by an expert sonologist, was 3 (IQR 3-4) on a scale of 1-5 for static carotid diameter measurements. Median image quality for carotid VTi spectral tracings was also 3 (IQR 2-4). There was no difference in image quality between the novice and experienced groups ($p=0.98$).

Median resident overall confidence in accurately performing carotid VTi measurements after this educational intervention (as rated on a scale of 1 [not confident] to 5 [confident]) was 3 (IQR: 3-4). Resident opinion of how technically challenging this technique was rated as a median of 2 (IQR: 2-3) on a scale of 1-5 (1=not challenging, 5=very challenging). All participants responded that it is feasible to obtain carotid Doppler flow measurements in the ED. Ninety-seven percent of residents answered that they would like to learn additional ultrasound techniques in this instructional video format.

DISCUSSION

Accurate, non-invasive measurement of fluid responsiveness is elusive and yet critical for EPs; however, currently available methods have known shortcomings. Making accurate and timely decisions about volume resuscitation and vasopressor initiation is critical in numerous ED patients and in all categories of shock as both under-resuscitation and

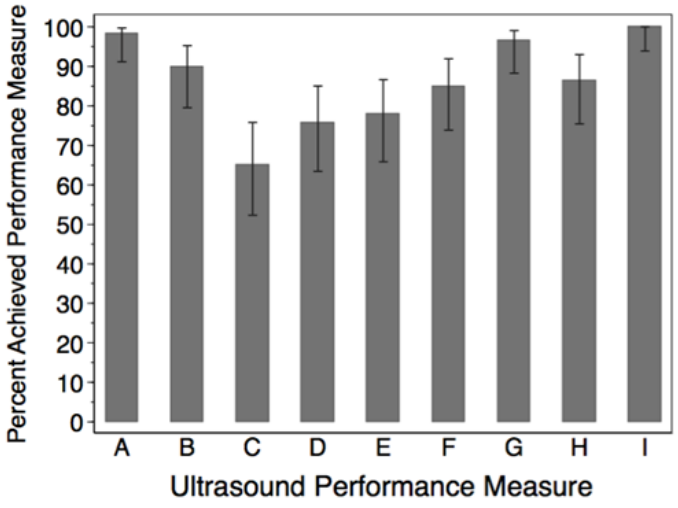

Figure 3. Percent successful completion of ultrasound performance measures. I-bars represent 95% confidence intervals.
N = 30 subjects

over-resuscitation are detrimental. Prior research by Marik et al.[12] examined carotid flow velocities as a possible means of determining volume responsiveness. This technique could potentially improve EP assessment of volume responsiveness and is attractive because ultrasound is non-invasive, readily available in most acute care departments and performed at the bedside.

This study assessed the ability of a group of EM residents at our institution to perform carotid ultrasonographic examination and obtain Doppler measurements of carotid flow. EPs with minimal ultrasound experience learned this technique after a brief instructional video. After this training, they were able to complete each step of the examination greater than 75% of the time with the exception of measuring the carotid diameter during systole. It remains to be seen if residents can truly master this technique; however, there is undoubtedly a learning curve associated with mastery of this skill and improvement would be seen over time.

This is a new technique requiring accurate Doppler measurements, which some may consider an advanced skill. In contrast to our study, Marik et al.[12] used one experienced echocardiographer to obtain all carotid flow measurements. The participants in our study were largely first-year residents and inexperienced sonographers. Even those with minimal ultrasound experience completed each performance measure greater than 75% for all performance measures except one. Among the physicians who learned and obtained the measurements in this study, there was no difference between experienced and novice sonographers suggesting that this technique does not require advanced skills. The ease in obtaining measurements is likely aided by the superficial location of the common carotid artery, the ease of identification of the structures and the ability to visualize the structures regardless of body habitus. These advantages may make this technique potentially preferable for monitoring volume status and responsiveness over other currently available techniques.

Very little time was required to obtain measurements of common carotid VTi, making this an attractive alternative to existing techniques. Time is of the essence when making a decision to initiate vasopressors on a critically ill patient, and the rapid pace of a typical ED demands quick decision-making and assessment. Other techniques take more time, are dependent on patient positioning, body habitus and present challenges.

This study highlights key areas that may require additional emphasis while teaching this technique in the future, namely obtaining the common carotid diameter in systole. It is unclear if the difficulty with this element of the examination was related to the ability of the examiners to identify systole sonographically, failure to adequately teach this element of the examination or mere oversight of this step. The diameter of the common carotid artery changes roughly 0.51mm (95% CI [0.48-0.54mm]) with flow and this is referred to as flow-mediated vasodilatation, which is dependent on several physiologic factors including blood pressure, arterial compliance, intima-media thickness, smooth muscle tone and neural control mechanisms.[17,18] If the area being measured changes, the VTi also changes. Our study participants frequently failed to measure VTi in systole; however, it is unknown if this error of omission would significantly change the calculation of common carotid flow in a clinically meaningful way.

Our study physicians were taught an entirely new technique using only a brief educational video, and they preferred this learning format. As technology is used increasingly in undergraduate and medical education, residents themselves are accustomed and comfortable with electronic learning formats, perhaps more so than traditional lecture formats.

LIMITATIONS

This study is limited by a small sample size. Additionally, this study represents findings from one affiliated group of residents and may not be generalizable across other institutions. The physicians in this study have demonstrated the ability to learn the procedure with the reported proficiency levels after a brief instructional video, but it is unknown whether this degree of competency in learning this technique is adequate when determining volume responsiveness in critically ill patients or what the learning curve is to full mastery of this technique. Further study is required to assess the ability of emergency

physicians to master the procedure with further practice and instruction. True proficiency in performing the examination for carotid flow measurements would require successful performance of all quality measures consistently with each repetition of the examination. A prospective study evaluating the accuracy of these measurements in a clinical setting would be necessary to truly assess the ability of EPs to accurately and adeptly acquire common carotid flow measurements. The actual utility of this technique in assessing volume status or volume responsiveness in ED patients is unknown. While we found minimal differences between novice and experienced sonographers for the outcome measures, the study was not powered for such an analysis and this is a post-hoc stratification.

CONCLUSION

Emergency medicine residents at our institution learned a technique for obtaining common carotid artery Doppler flow measurements after viewing a brief instructional video. When assessed at performing this examination, they completed several performance measures with greater than 75% success. There were no differences in ability to perform key elements of the examination between novice and experienced groups. This technique shows promise as a rapid, easy-to-use method of assessing volume status and volume responsiveness.

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Video 1. Ultrasound of common carotid diameter measurement obtained within 0.5cm of the carotid bulb and measured intima to intima.

Video 2. Ultrasound of common carotid Doppler waveform and velocity time integral measurement acquired with an insonation angle of 58 degrees.

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Bedside Ultrasound Identification of Infectious Flexor Tenosynovitis in the Emergency Department

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Infectious flexor tenosynovitis (FTS) is a serious infection of the hand and wrist that can lead to necrosis and amputation without prompt diagnosis and surgical debridement. Despite the growing use of point-of-care ultrasound (POCUS) by emergency physicians there is only one reported case of the use of POCUS for the diagnosis of infectious FTS in the emergency department setting. We present a case of a 58 year-old man where POCUS identified tissue necrosis and fluid along the flexor tendon sheath of the hand. Subsequent surgical pathology confirmed the diagnosis of infectious FTS. [West J Emerg Med. 2015;16(2):260–262.]

CASE REPORT

A 58-year-old man with a history of diabetes, hypertension and end-stage renal disease on hemodialysis presented to the emergency department (ED) for one day of right hand pain and swelling. The pain was diffuse (hand, wrist and distal forearm), and occurred with any movement. The patient denied any trauma, numbness, weakness, fever, or chills. The patient's vital signs were temperature of 99.0 degrees Celsius, heart rate of 91 beats per minute, blood pressure of 131/76mmHg, and respiratory rate of 18 breaths per minute. On examination, the right hand was more swollen than the left. He held the hand in flexion, with increased pain on both flexion and extension of the fingers and wrist. There was no crepitus, warmth, or erythema, and distal pulses were intact. The patient's neurologic examination was normal. His right upper extremity had a matured vascular shunt, which had a strong bruit and thrill.

Laboratory results revealed a lactate of 1.9mmol/L and a normal white blood cell count. On radiograph of the right hand and wrist, there were degenerative changes and mild soft tissue swelling, but no acute fractures, subluxations, or focal erosion. ED providers performed point-of-care ultrasound (POCUS) using a high-frequency (13MHz to 6MHz) linear transducer (Sonosite M-Turbo™, Bothell WA) that demonstrated a moderate amount of fluid and hypoechoic material in the flexor tendon sheath (as compared to the contralateral hand) (Figure 1, Video 1 and Video 2).

Orthopedics was consulted. The patient was started on broad-spectrum antibiotics and taken to the operating room. Intraoperatively, purulent fluid was found extensively along the flexor tendon sheath of the fifth phalange extending to the common flexor sheath of the wrist. Surgical fluid cultures were positive for *Staphylococcus aureus* with the patient requiring a two-week course of inpatient antibiotic therapy.

DISCUSSION

Infectious tenosynovitis occurs when purulent fluid collects between the visceral and parietal layers of a tendon, caused by infection via direct inoculation (trauma), hematologic spread, or contiguous spread from adjacent tissues.[1,2] The most common location for infectious flexor tenosynovitis is in the hand and wrist and colloquially described as FTS. In the hand, the flexor digitorum superficialis and flexor digitorum profundus tendons lie within the common flexor sheath, which courses through the carpal tunnel into the palm of the hand.

FTS is often diagnosed clinically, using Kanavel's four cardinal signs initially described in 1912.[3] Kanavel's signs are intense pain along the course of a tendon with attempted extension of a partly flexed digit, the finger held in flexion for comfort, swelling over the entire finger, and percussion tenderness over the course of the tendon sheath.[4] Clinical

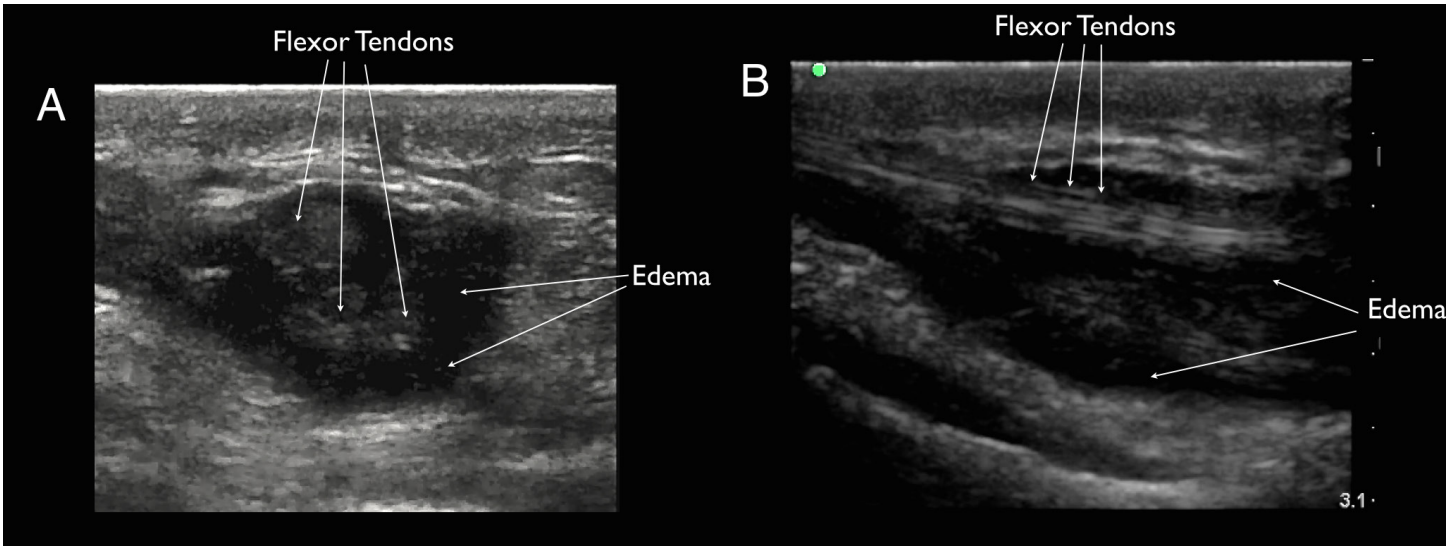

Figure 1. Ultrasound findings of flexor tenosynovitis. Ultrasound image in transverse view (A) and longitudinal view (B) showing increased anechoic edema and debris in the flexor tendon sheath of the right wrist consistent with flexor tenosynovitis. In the correct clinical scenario, these findings are consistent with the infectious form of flexor tenosynovitis.

examination is thought to have high specificity and positive predictive value for infectious FTS. However, a negative exam does not rule out infectious FTS.[5,6] Infectious FTS is treated with empiric antibiotic therapy, as well as emergent surgical debridement and drainage. Early diagnosis and prompt surgical debridement is essential. Delay to diagnosis leads to the local spread of infection to adjacent tissue and bursa, compartment syndrome, and necrosis. Risk factors for poor prognosis include age over 43, diabetes, peripheral vascular disease, renal failure, digital ischemia or subcutaneous purulence.[2] Patients with septic necrosis of the tendon sheath may require amputation of the affected digit.

Hand radiographs are often obtained in cases of suspected infectious FTS to look for trauma, retained foreign bodies, or bone erosion. However, radiograph cannot make the diagnosis of infectious FTS. Magnetic resonance imaging (MRI) and ultrasound are better imaging modalities for the diagnosis.[6,7] While MRI is not typically available in a prompt fashion in the ED, ultrasound is often available to ED providers.[8] Ultrasound has been shown to be more sensitive than clinical exam for detecting tenosynovitis.[5,9] However, there is only one case in the literature describing the use of ED POCUS to diagnosis infectious FTS.[10] Common ultrasound findings for FTS are hypoechoic or anechoic edema with a potentially thickened tendon sheath, as well as the presence of abnormal hypoechoic material within the synovial sheath.[9,11] Typically this can be performed using a linear probe and rocking the transducer to achieve perpendicular orientation of the tendon sheath (not the skin) in the transverse and longitudinal plane (Figure 2).[9]

In the ED setting, we recommend using POCUS in conjunction with the clinical examination to evaluate for suspected infectious FTS. The ability of POCUS to diagnose infectious FTS from inflammatory FTS is unknown. The clinical context is critical when incorporating POCUS to increase diagnostic certainty and perhaps expedite definitive care. While no standard definition exists, the sonographic finding of increased hypoechoic/anechoic fluid or material in the flexor tendon sheath is highly suspicious for infectious FTS in the appropriate clinical scenario. However, a negative POCUS study for FTS should not discourage aggressive consideration of the diagnosis.

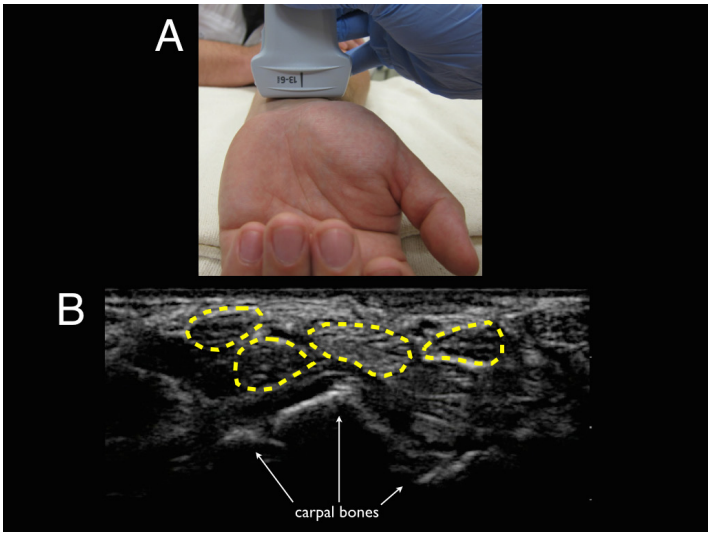

Figure 2. Ultrasound technique and visualization. (A) Appropriate placement of the linear transducer (13MHz to 6MHz) at the wrist crease in transverse plane to evaluate for flexor tenosynovitis. (B) Ultrasound image in transverse view showing normal flexor tendons (highlighted in yellow) with no surrounding edema. The flexor tendons should lie anterior to the carpal bones identified by arrows for reference.

In conclusion, we report a case that introduces the use of POCUS to identify infectious FTS in the ED setting. Oftentimes, history and clinical examination cannot rule out the diagnosis. POCUS may be an ideal adjunct for the ED physician in the evaluation of a patient with suspected infectious FTS.

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

Video 1. Ultrasound video in transverse view showing increased anechoic edema and debris in the flexor tendon sheath of the right wrist consistent with infectious flexor tenosynovitis.

Video 2. Longitudinal view showing increased anechoic edema and debris in the flexor tendon sheath of the right wrist consistent with infectious flexor tenosynovitis.

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Change in Intraocular Pressure During Point-of-Care Ultrasound

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Introduction: Point-of-care ocular ultrasound (US) is a valuable tool for the evaluation of traumatic ocular injuries. Conventionally, any maneuver that may increase intraocular pressure (IOP) is relatively contraindicated in the setting of globe rupture. Some authors have cautioned against the use of US in these scenarios because of a theoretical concern that an US examination may cause or exacerbate the extrusion of intraocular contents. This study set out to investigate whether ocular US affects IOP. The secondary objective was to validate the intraocular pressure measurements obtained with the Diaton® as compared with standard applanation techniques (the Tono-Pen®).

Methods: We enrolled a convenience sample of healthy adult volunteers. We obtained the baseline IOP for each patient by using a transpalpebral tonometer. Ocular US was then performed on each subject using a high-frequency linear array transducer, and a second IOP was obtained during the US examination. A third IOP measurement was obtained following the completion of the US examination. To validate transpalpebral measurement, a subset of subjects also underwent traditional transcorneal applanation tonometry prior to the US examination as a baseline measurement. In a subset of 10 patients, we obtained baseline pre-ultrasound IOP measurements with the Diaton® and Tono-Pen®, and then compared them.

Results: The study included 40 subjects. IOP values during ocular US examination were slightly greater than baseline (average +1.8mmHg, p=0.01). Post-US examination IOP values were not significantly different than baseline (average -0.15mmHg, p=0.42). In a subset of 10 subjects, IOP values were not significantly different between transpalpebral and transcorneal tonometry (average +0.03mmHg, p=0.07).

Conclusion: In healthy volunteer subjects, point-of-care ocular US causes a small and transient increase in IOP. We also showed no difference between the Diaton® and Tono-Pen® methods of IOP measurement. Overall, the resulting change in IOP with US transducer placement is considerably less than the mean diurnal variation in healthy subjects, or pressure generated by physical examination, and is therefore unlikely to be clinically significant. However, it is important to take caution when performing ocular ultrasound, since it is unclear what the change in IOP would be in patients with ocular trauma. [West J Emerg Med. 2015;16(2):263–268.]

INTRODUCTION

Point-of-care ultrasound (US) was introduced into emergency medicine in the 1980s. Portable ultrasound machines are now readily available in many emergency departments (ED), and physicians are becoming increasingly facile with a variety of diagnostic and procedural applications. Ocular US was recently added to the American College of Emergency Physician's (ACEP) core applications,[1] and is recommended for the evaluation of retinal detachment, vitreous hemorrhage, lens dislocations/disruption, intraocular foreign bodies, retrobulbar hemorrhage, globe rupture, and as an indirect measurement of intracranial pressure.[1-4] Point-of-care ultrasound can be performed on a closed eyelid, readily penetrating soft tissue swelling, while causing minimal discomfort to the patient.

Patients with potential globe rupture represent a particular diagnostic dilemma for emergency physicians. The rapid diagnosis of a globe rupture is imperative, since outcomes depend upon timely operative intervention. However, the diagnosis using clinical examination alone can be very challenging. Associated swelling of the eyelid often makes physical examination of the eye difficult, and attempts to manually open the eyelid in these situations may apply unwanted pressure on the globe despite careful precautions. Traditional imaging modalities used to aid in globe rupture diagnosis include radiographs, magnetic resonance imaging (MRI), and computed tomography (CT), but all are limited for various reasons. Conventional radiographs are able to evaluate for major bony injury or metallic foreign bodies, but with an exceedingly low sensitivity. MRI is frequently unavailable for emergent cases, is time-consuming, and is contraindicated in the setting of potential metallic foreign bodies. A thin-section helical CT is often considered to be the optimal study, but it also requires patient stabilization, transport outside of the ED, and exposure to ionizing radiation. More recently, point-of-care US emerged as an alternative modality in the setting of acute ocular trauma. However, controversy remains regarding the safety and theoretical increase in intraocular pressure (IOP) with placement of the US transducer onto the closed eyelid; the theoretical concern is that an increased IOP from external pressure may cause an extrusion of intraocular contents.[5] No study to date has specifically investigated the impact of US on IOP in human subjects.

To evaluate whether the US transducer causes an increase in IOP, the IOP must be measured simultaneously while performing ocular US. A particular challenge arises in the method by which IOP can effectively be measured simultaneously with transducer placement. Tonometry, or the measurement of IOP, has been traditionally measured by applanation devices, which require a compliant patient with an open eyelid. The most common applanation device, the Tono-Pen®, involves compression of a small sensor against the surface of the patient's cornea; an internal microprocessor approximates the IOP from the resistance and deformation of the cornea. Recently the Diaton®, a new type of non-corneal contact tonometer, has been developed, in which pressure can be measured on a partially closed eyelid. The Diaton® has a detector that measures the force necessary to deform the underlying sclera, and digital references are used to approximate IOP. Several studies have compared IOP measurements from this device. Results have been rather controversial: some studies have found concordant results with conventional tonometry,[6-8] while others show limited accuracy with wide confidence intervals.[9-12]

We sought to determine the effect of point-of-care US on IOP in healthy human subjects. Our hypothesis is that the careful placement of an ultrasound transducer on the closed eyelid with a copious amount of gel, creates a minimal increase in intraocular pressure. Our secondary objective was to compare the Diaton® to Tono-Pen® techniques to validate the accuracy of measurements.

METHODS

This is an institutional review board-approved prospective observational study performed on a convenience sample of 40 healthy volunteers. The study was conducted at a tertiary care university medical center. The subjects were healthy volunteers recruited from the emergency medicine residency program and affiliated administrative offices; there were no incentives or payments made to volunteers. Informed written consent was obtained from each subject. We excluded people with known pre-existing ophthalmologic pathology (i.e. glaucoma, retinal detachment, lens dislocation), history of eye trauma, allergy to systemic or local anesthetic agents, and the inability to provide informed written consent.

Four study investigators performed the ocular US examinations and IOP measurements: three emergency medicine residents and one emergency ultrasound fellow. Each operator was credentialed specifically in ocular US prior to participation in the study; this credentialing process followed ACEP guidelines[1] and the guidelines were approved by the participating academic department and ultrasound division. The operator who performed the ocular US examination on each subject was blinded to that subject's IOP results measured before, during, and after the US examination. Both thermal ultrasound images and 6-second video clips were obtained and recorded. US fellowship-trained faculty directors later reviewed the saved clips in order to ensure the adequacy and uniformity of ultrasound images.

This was a pilot study using a convenience sample. Once identified and consented for enrollment, each subject was assigned a study identification number and the researchers recorded data as it was collected. Each subject underwent three intraocular pressure measurements: prior to ultrasound, during ultrasound, and following ultrasound. All IOP measurements were performed in triplicate, and the mean

values were recorded. A baseline IOP measurement first was obtained and recorded for either the right or left eye of each subject. This was recorded as the "pre-US" IOP. We used the Diaton® transpalpebral tonometer (BiCom Inc. Long Beach, NY). The manufacturer's instructions recommend performing measurement on a person in the seated upright position, with a partially open eye by placing the device along the tarsal plate of the superior eyelid. We amended the technique, performing the measurement on a closed eyelid. The subject was placed in a seated position with eyes closed; the tonometer was centered on the eyelid at the superior aspect of the globe and angled perpendicular to ground level (Figure 1). After obtaining the baseline IOP measurements, ocular US was performed on the same eye. A 10-5MHz linear transducer (M-Turbo, Sonosite Inc.) was used and US gel was liberally applied to the transducer surface. The examiner's hand was braced against the subject's maxilla to minimize transmitted force. The transducer was placed directly on the closed eyelid, and the optimal transverse US image was obtained. While maintaining this image, a second researcher simultaneously performed transpalpebral tonometry by placing the Diaton® superior to the US transducer (Figure 2). This second IOP measurement was recorded as the "intra-US" IOP. Lastly, the US transducer was removed from the subject's eyelid and the final transpalpebral IOP was measured and recorded as the "post-US" IOP.

To evaluate the accuracy of our amended transpalpebral technique, we randomly selected 10 of the study subjects to undergo an additional baseline, "pre-US" IOP measurement using the standard applanation tonometer, the Tono-Pen®. For the baseline applanation tonometry subjects, we administered two drops of sterile ophthalmic topical anesthetic prior to examination.

We entered data into a spreadsheet using Microsoft Excel (Redmond, WA). Paired t-test analyses were performed using SOFA Statistics (www.sofastatistics.com).

RESULTS

Forty potential subjects were approached for enrollment, and all agreed to participate and completed the study. We studied 52.5% female and 47.5% male subjects, with a mean age of 31.8 years of age (range 19-59 years); 22.5% of the subjects were contact lens wearers. Contact lenses were all removed prior to study participation.

We calculated mean IOP values for each phase of measurement. "Pre-US" IOP values were 14.28mmHg (95% CI [13.26-15.29]). "Intra-US" IOP values were slightly greater than "pre-US" at 16.08mmHg (95% CI [14.92-17.23]). "Post-US" IOP values were 14.13mmHg (95% CI [13.14-15.11]). Comparing "pre-US" to "post-US" values, the difference of -0.15mmHg (range -3 to +3mmHg) and was not statistically significant (p=0.42). When comparing "pre-US" to "intra-US" IOP values, there was a statistically significant change of +1.8mmHg (range -1 to +7mmHg, p=0.01). The distribution of IOP values for each patient (Figure 3) shows that the maximum increase in IOP was 8mmHg, while for the majority of patients the increase was only 1mmHg (n=12) or 2mmHg (n=10). Overall, 87.5% of patients had an increase of 3mmHg or less.

Figure 1. Diaton® transpalpebral tonometer. Photograph depicting the manufacturer's recommendation for placement of the tonometer on a partially open eyelid.

We compared IOP values between the different methods of tonometry: the traditional Tono-Pen® transcorneal tonometry with the Diaton® tanspalpebral tonometry the difference between the techniques was not statistically significant (+0.03mmHg, range -3 to +4mmHg, p=0.07).

DISCUSSION

Previous studies have established the accuracy and utility of point-of-care ocular US examinations.[13,14] Blaivas et al.[13] prospectively studied 61 patients: 26 were found to have ocular pathology, three with penetrating globe injuries. Overall, point-of-care ocular US was shown to be accurate, with a sensitivity of 100% (95% CI [94%-100%]) and a specificity of 97.2% (95% CI [89%-99%]) in identifying ocular pathology. Following a brief training, Chandra et al.[15] showed that emergency physicians were able to identify ocular rupture in porcine eyes with a sensitivity of 79% and specificity of 51%. In this porcine model, IOP was only increased by 5% with the ultrasound transducer placement. Since there is a paucity of literature regarding the potential increase in IOP with US transducer placement, it is generally advised that caution should be exercised when performing ocular US in the setting of trauma. In these settings, there is particular concern that additional pressure on the orbit may potentially worsen a traumatized or already ruptured globe. We are not aware of any previous studies

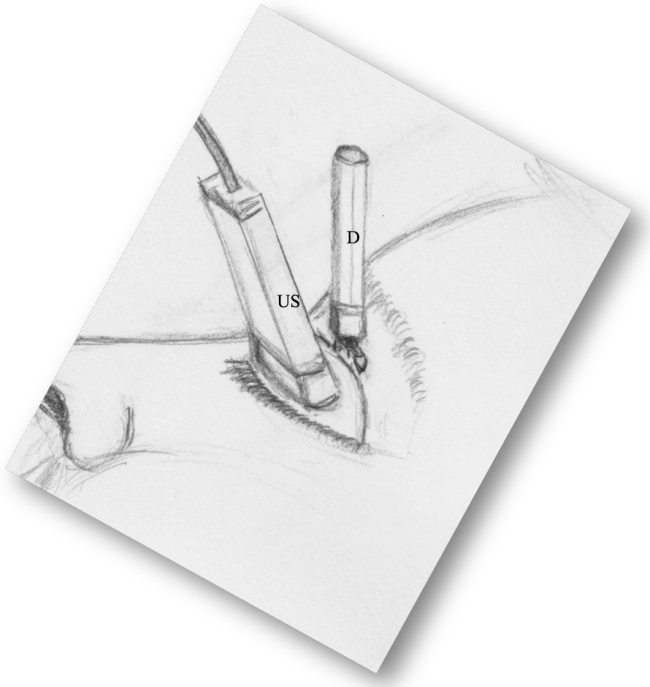

Figure 2. Graphic representation of the modified apparatus setup. The study subject is in a seated upright position, with a closed eyelid. The ultrasound transducer (US) is placed over the eyelid and the Diaton® transpalpebral tonometer (D) placed superior to the transducer.

that have investigated the potential adverse effects of ocular ultrasonography and its effect on IOP in human subjects.

We designed this study to determine the change in IOP during point-of-care ocular US. Our results demonstrate that there is a small and transient increase in IOP during ocular US, with a mean of 1.8mmHg. The magnitude of this change, however, is unlikely to be clinically significant, largely since this is less than the mean diurnal variation in IOP, and less than the IOP generated with physical examination and eyelid speculum. De Venecia et al.[16] found a mean daily IOP variation of 5.9mmHg in healthy subjects. In addition, the IOP has been shown to increase with maneuvers often performed in order to open and examine swollen, traumatized eyes. Gandhi et al.[17] showed that when the examiner held eyelids open while subjects attempted forced eyelid closure, there was an increase in IOP of 1.9 +/- 2.7mmHg (p=0.0002, paired t-test range, -2 to 9mmHg) as measured with the Tono-Pen®. In certain situations, a lid retractor, or eyelid speculum may be used to visualize a swollen, traumatized eye. Epley et al.[18] showed that in pediatric patients, an eyelid speculum increased IOP on average of 4 mm Hg, which was statistically significant for each eye individually as well as aggregately. This finding was also higher than the pressure generated by the US transducer in this study.

It is unclear at what point increased IOP represents a dangerous level, in which intraocular contents would be extruded and/or ocular pathology exacerbated. Vachon et al.[19] described the extremely rare extrusion of intraocular contents despite average increases of 7mmHg when succinylcholine was administered. In addition, Zauberman et al.[20] studied a rabbit model and showed that extrusion occurred most consistently with pressures over 30mmHg. Further, the FDA has established a criterion for elevated IOP in its evaluation of prospective medications. Their published standard is a change from baseline of ≥10mmHg, which represents a potentially dangerous increase in IOP.[21] Overall, though further study is necessary in populations with ocular pathology, we believe that clinicians should be reassured that point-of-care ocular US examination causes a very small elevation in IOP when performed carefully as described above. This knowledge has the potential to allow emergency physicians to safely use ocular US in the ED to diagnose ocular pathology rapidly, non-invasively, and accurately.

Finally, we used transpalpebral tonometry, a novel technique that permitted us to measure IOP in real time during the ocular US exam while subjects' eyes were closed, and without direct corneal contact. Traditional tonometry cannot be performed simultaneously while performing an ocular ultrasound since it requires an open eye. While several studies have previously compared the Diaton® to traditional tonometry, there have been conflicting results,[9-11] and therefore its accuracy has been questioned. Nakakura et al.[12] compared IOP measurements with four different methods of tonometry; the Diaton® did not correlate well, resulting in a wide bias range with wide confidence intervals. However, we found no significant difference between transpalpebral tonometry and transcorneal tonometry pressures in our comparative samples, supporting the validity of this novel technique.

LIMITATIONS

One of the major limitations is that this study only included normal healthy subjects, which resulted in a small increase in intraocular pressure. Our findings may have been different had we studied subjects with acute or chronic ocular pathology. It is unclear whether this increase would adversely affect an individual with ocular pathology such as globe rupture, orbital foreign body, and retrobulbar hematoma. Therefore, further studies need to be performed in patients with ocular pathology.

Other factors may have influenced the IOP measurements. While it has been described that a clear plastic barrier shield may be used to minimize an increase in IOP, it was not used in this study. It is unclear whether this would have affected the results of the IOP changes. In addition, the study investigators were not blinded to the study objectives and ultrasound images. This could have introduced an inherent bias to the results. However, this is unlikely as practitioners concerned about globe injury would be cognizant of the pressure they are applying with US.

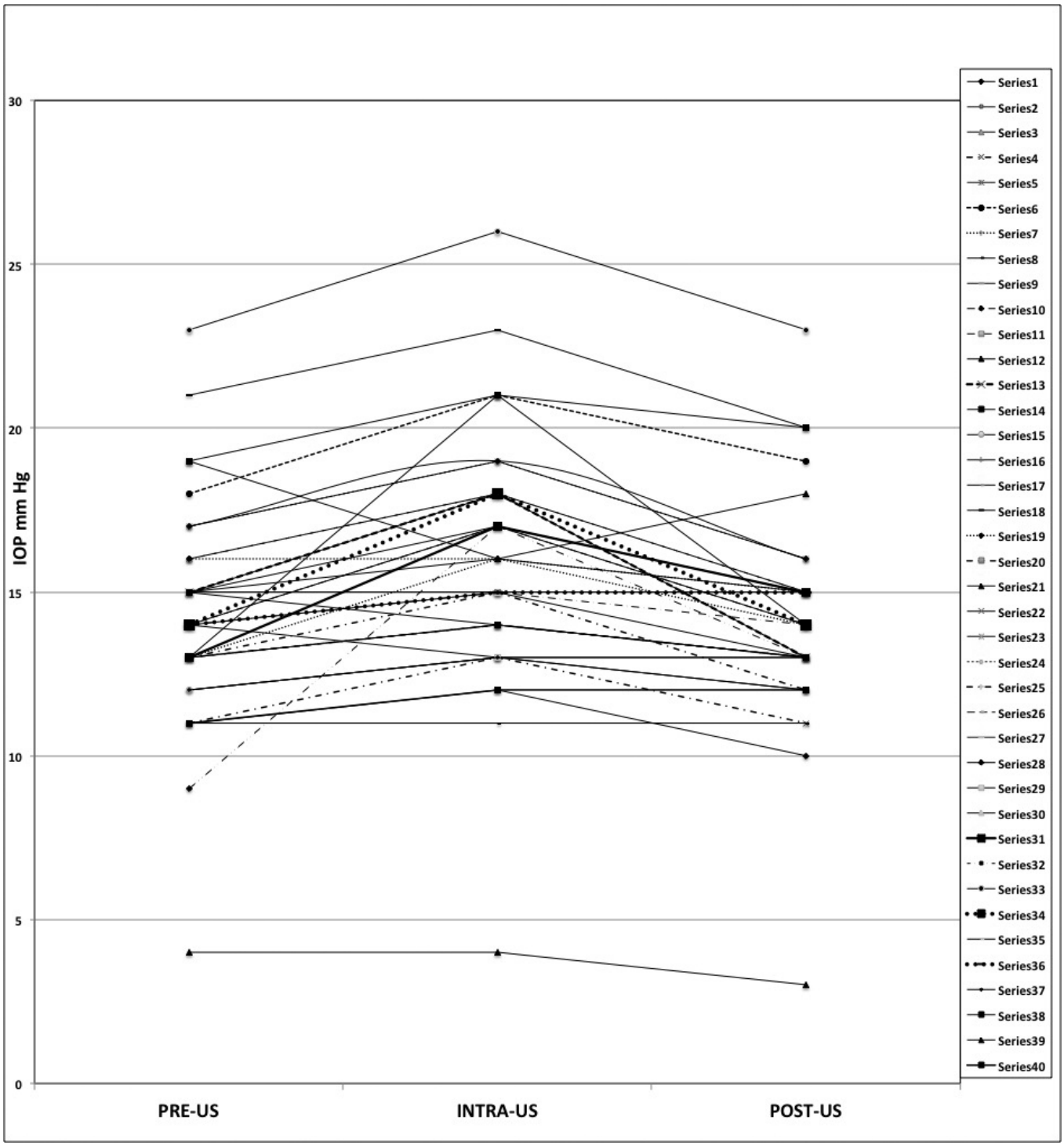

Figure 3. Graphic representation of the results. Each patient's values of IOP (mmHg) are plotted to show the "Pre-US" IOP, "Intra-US" IOP, and "Post-US" IOP values.
US, ultrasound; *IOP*, intraocular pressure

With regards to our secondary objectives, there are some limitations in comparing the Diaton® with traditional tonometry. We used a modified technique, different from that which is recommended by the Diaton® manufacturer. The manufacturer specifies a partially closed eyelid, whereas we had a fully closed eyelid, in order to be able to perform the US. Subjects were also in a sitting rather than in a supine position. Prior studies have shown that IOP is higher in the supine position,[22] but it is only an increase in 1mmHg, which is unlikely to be clinically significant.[23] It is also unclear whether measurements would correlate as well, in the setting of a severely swollen eyelid. Further

studies would need to be performed to evaluate this.

CONCLUSION

Point-of-care ocular ultrasonography causes a small and transient increase in IOP in healthy volunteers. We also showed no difference between the Diaton® and Tono-Pen® methods of IOP measurement. Overall, the resulting change in IOP with US transducer placement is considerably less than the mean diurnal variation in healthy subjects, or pressure generated by physical examination, and is therefore unlikely to be clinically significant. However, it is important to take caution when performing ocular ultrasound, since it is unclear what the change in IOP would be in patients with ocular trauma.

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Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The manufacturer of the intraocular pressure measuring devices (Diaton® and Tono-Pen®) had no role in the design, implementation of presentation of this study.

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Young Patients with Suspected Uncomplicated Renal Colic are Unlikely to Have Dangerous Alternative Diagnoses or Need Emergent Intervention

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Introduction: In the United States there is debate regarding the appropriate first test for new-onset renal colic, with non-contrast helical computed tomography (CT) receiving the highest ratings from both Agency for Healthcare Research and Quality and the American Urological Association. This is based not only on its accuracy for the diagnosis of renal colic, but also its ability to diagnose other surgical emergencies, which have been thought to occur in 10-15% of patients with suspected renal colic, based on previous studies. In younger patients, it may be reasonable to attempt to avoid immediate CT if concern for dangerous alternative diagnosis is low, based on the risks of radiation from CTs, and particularly in light of evidence that patients with renal colic have a very high likelihood of having multiple CTs in their lifetimes. The objective is to determine the proportion of patients with a dangerous alternative diagnosis in adult patients age 50 and under presenting with uncomplicated (non-infected) suspected renal colic, and also to determine what proportion of these patients undergo emergent urologic intervention.

Methods: Retrospective chart review of 12 months of patients age 18-50 presenting with "flank pain," excluding patients with end stage renal disease, urinary tract infection, pregnancy and trauma. Dangerous alternative diagnosis was determined by CT.

Results: Two hundred and ninety-one patients met inclusion criteria. One hundred and fifteen patients had renal protocol CTs, and zero alternative emergent or urgent diagnoses were identified (one-sided 95% CI [0-2.7%]). Of the 291 encounters, there were 7 urologic procedures performed upon first admission (2.4%, 95% CI [1.0-4.9%]). The prevalence of kidney stone by final diagnosis was 58.8%.

Conclusion: This small sample suggests that in younger patients with uncomplicated renal colic, the benefit of immediate CT for suspected renal colic should be questioned. Further studies are needed to determine which patients benefit from immediate CT for suspected renal colic, and which patients could undergo alternate imaging such as ultrasound. [West J Emerg Med. 2015;16(2):269–275.]

INTRODUCTION

Currently there are several guidelines suggesting that the standard of care for the diagnosis of new-onset acute renal colic is a non-contrast helical Computed Tomography (CT).[1,2] Due to the accuracy of CT, its use in suspected renal colic has jumped from 4% to 42.5% from 1996-2007, resulting in over 500,000 CTs performed for renal colic every year in the United States.[3,4] While multiple studies have suggested that CTs for first time renal colic should be routine because of the risk of dangerous alternative diagnoses, there is no evidence that increased utilization has changed outcomes or even increased the rate of dangerous alternative diagnoses detected.[1-3,5-8] Additionally, the risks of radiation have become increasingly apparent to both the medical community and to our patients, and only a minority of patients with uncomplicated renal colic will eventually require urological intervention, with a smaller minority requiring an emergent intervention.[9-14] While clinicians appreciate both the confirmation of stone presence and being able to prognosticate based on the results of the CT, as stone location and size do influence spontaneous passage rates, immediate CT does not change management in the majority of cases.[14,15] Furthermore, it is well documented that patients with renal colic are at risk for multiple CTs during their lifetimes.[16]

Recent studies have attempted to help clinicians predict which patients will have kidney stones prior to CT, with the added benefit that the higher the likelihood of stone, the lower the likelihood of a dangerous alternative diagnosis.[17] Moore et al.[18] demonstrated that the rate of dangerous alternative diagnoses of 10% demonstrated in older retrospective studies was likely an overestimate based on research methodology.[5] While at least one study noted that the only dangerous alternative diagnoses found were in older patients, no studies have attempted to use age to risk stratify patients with suspected renal colic and their risk of dangerous alternative diagnoses.[16]

A recent, large, multi-centered comparative effectiveness trial suggested that "ultrasound-first" is a reasonable approach to renal colic in the ED.[19] However, 27-40% of patients who received "ultrasound-first" went on to have a CT during their visit. While comprehensive, this study did not help distinguish between those who need a CT for identification of a dangerous alternative diagnosis or for the planning of a urological intervention from those who do not see a change in management based on that CT. Although not yet directly studied, we suspect that age may play a role in this question.

We hypothesized that in non-pregnant adult patients age 50 and under who present with flank pain but without pyuria or trauma, the incidence of dangerous alternative diagnoses would be low (less than 3%,) and the rate of immediate urologic intervention would also be low (less than 5%).

METHODS

Study Design

This study was approved by the local institutional review committee for human subjects. This was a retrospective chart review of all non-pregnant patients age 18-50 years presenting to an urban, tertiary care Emergency Department (ED) with the chief complaint of "flank pain" or "suspected kidney stone" during a 12-month period in 2011-2012. Electronic medical records were used so all identified visits had usable, legible records. Attention was paid to previous criticisms of retrospective chart reviews in order to decrease bias and maintain methodologic quality.[20-22] Specifically, abstractors were trained, inclusion and exclusion criteria were clearly delineated *a priori*, data abstraction forms were used with defined variables, abstractors' performance was monitored and compared via interrater reliability testing, the sampling method was determined *a priori*, and the study was IRB approved.[22] We were unable, due to staffing, to make data abstractors blind to the hypothesis of the study, and because we found little missing data of importance as we piloted our chart review, we did not have a systematic plan for dealing with missing data. Regarding more recent criticisms of chart review methodology,[21] we did perform sample size calculations *a priori*, we have included the data collection form (Appendix), we have included a flow diagram regarding inclusion and exclusion (Figure), we piloted the chart review process and avoided decrement of accuracy of coding by having frequent meetings to discuss questions, and we chose to measure interrater reliability for questions that were most likely to affect the outcome of the study (Table 4).

Study Setting and Population

This ED has a combined pediatric and adult volume of >110,000 visits per year. The ED is staffed by attending physicians, residents and physician assistants, and CT is available 24 hours a day, 7 days a week, with attending radiologist interpretation available until midnight and resident preliminary interpretations for 8 hours overnight.

Protocol

Electronic medical records were queried for coded triage complaints of "flank pain" or "possible kidney stone" from June 2011 until May of 2012. Patients were included if they complained of flank pain, were 18-50 years old, and did not have any exclusion criteria. Diagnoses were available as part of original query and could be viewed prior to chart review allowing exclusion of patients with the following diagnoses: trauma, pregnancy, or urinary tract infection (UTI)/ pyelonephritis. Remaining charts were individually reviewed by the authors based on a standardized data collection form and an *a priori* coding plan and charts were then excluded based on the inclusion/exclusion criteria (Figure). Patients were included regardless of whether or not they had a history of kidney stones. Exclusion criteria included: left without being seen, no physician note, painless hematuria, UTI/ pyelonephritis, trauma causing chief complaint (major or minor), pregnancy known or discovered during visit, end stage renal disease on hemodialysis/peritoneal dialysis or kidney

transplant, recent surgical or urological intervention (60 days), already seen for this episode of pain (and index visit captured), or no "flank pain" in physician note. If the patient had a visit within the past 60 days for the same complaint, we checked to see if it was captured by the original query, and if not, the first of the two visits was used, provided it met inclusion criteria. If a previous visit for a similar complaint occurred more than 60 days before captured visit, it was considered another discrete episode and could be included.

All reviewers were trained in the use of the standardized data collection form by the PI, and after training each sub-investigator and research assistant collected data on at least 10 charts with the PI present. Additionally, 10% of the charts were assessed by the PI and another data abstractor for measurements of inter-rater reliability. Data was entered into a RedCap database. The database was reviewed for inconsistencies (such as CT result noted when "CT obtained" marked as "no") and these charts were re-reviewed. CT results were categorized as well as summarized in free text for review, and the free-text was reviewed for appropriate categorization, with review of the original chart if necessary. Final diagnoses as decided by the treating physician were recorded. Basic demographics were collected on all included patients.

Power calculations were done using the hypothesis that we were likely to find zero dangerous alternative diagnoses, and we would like our 95% CI to stay below 3%. Using the "rule of 3" for rare outcomes, 100 subjects would be needed for our 95% CI to stay below 3%.[23]

Measurements

The primary outcome was two-fold: dangerous alternative diagnosis as discovered by renal protocol CT and immediate urologic intervention (upon admission). Per our a priori study design, non-renal protocol CTs obtained were not included in the subset of patients with CT, under the presumption that if a CT with contrast (IV or oral) was ordered, renal colic was not the clinician's primary concern. Secondary outcomes included ED recidivism, admission upon return to the ED, and diagnosis upon return. CT findings were categorized in one of 7 possible categories: 1. Emergent, intervention (surgery/admission/antibiotics) needed immediately (ex. appendicitis, AAA, dissection, diverticulitis, ovarian torsion), 2. Urgent, close follow-up needed (malignancy, unruptured aneurysm), 3. Kidney Stone, likely needing intervention (kidney stone 6mm or larger or severe hydronephrosis), 4. Kidney stone, unlikely needing intervention (5mm or less, no severe hydronephrosis), 5. Non-stone cause of symptoms not needing intervention (ex. Simple ovarian cyst), 6. Incidental findings needing follow-up, 7. Normal. Categories 1 and 2 (Emergent and Urgent) were grouped together as the primary outcome.

Data Analysis

Data were analyzed descriptively including means or proportions and 95% CIs as appropriate. Stata Version 13 (StataCorp LP, College Station, TX) was used.

Inter-rater reliability was assessed for 10% of the charts. We choose to check inter-rater reliability on the outcomes that had the most likely chance of being interpreted differently by data abstractors (final ED diagnosis, return to ED in 60 days, note of urologic intervention in 60 days) as well as those that had the most likely chance of affecting the quality of the study (inclusion/exclusion).

RESULTS

There were a total of 291 patients included after full chart review, with 115 subjects having a non-contrast renal protocol

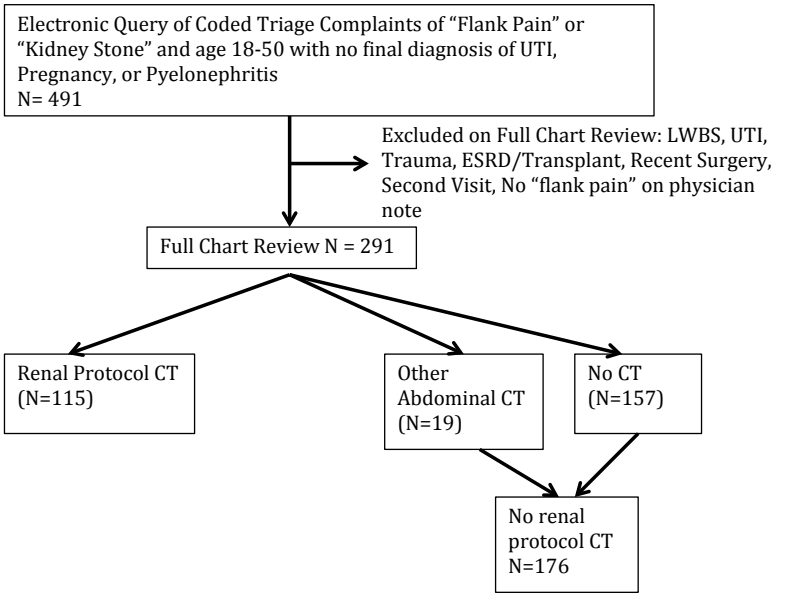

Figure. Flow of chart inclusion.
LWBS, left without being seen; *UTI*, urinary tract infection; *ESRD*, end-stage renal disease; *CT*, computed tomography

CT (Figure). Demographics are presented in Table 1. At our institution there is only one coding for self-reported ethnicity, rather than one for race and one for ethnicity. Our Hispanic population is primarily Puerto Rican and largely "White – Hispanic" by other coding methods.

Primary Outcome

Of the 115 encounters that included a renal protocol CT, there were no findings considered emergent or urgent (one-sided 95% CI: [0-2.7%]). Within the 291 subjects presenting with "flank pain" who met inclusion criteria, there were 7 urologic procedures performed upon first admission (2.4%, 95% CI [1.0-4.9%]).

Secondary Outcomes

Of the 291 subjects, 171 were diagnosed as having renal colic (58.8%) and 11 were admitted, with seven of those undergoing urologic procedures upon admission. Of the 171 diagnosed with renal colic, 51 (29.8%) returned within 60 days for symptoms related to flank pain, and 8 were admitted (4.7%). Of 171 subjects diagnosed with renal colic, there were 29 urologic procedures noted, seven at first admission and 22 at later dates (total 17.0%), however outpatient procedures would be underrepresented in this group due to methodology.

Of the total group, 113/291 (38.8%) returned to the ED within 60 days, and only one was admitted for a non-urological procedure (diagnosis: lap band malfunction), no non-urological surgical emergencies were noted in the returning subjects.

Other imaging included 71 "bedside" or emergency physician-performed renal ultrasounds, and 29 radiology-performed ultrasounds, with 8 patients having both and 20 patients having both a CT and an ultrasound. Bedside ultrasounds were likely under-documented, based on internal reviews of documentation. Of the 92 patients receiving any ultrasound, there were 20 CTs (renal and non-renal protocol) for a proportion of 22%. Of patients not receiving an ultrasound, that proportion was 114 of 199, or 57%. This study was not designed to look at the reasons for this difference. Categorizations and non-stone findings on CT are listed in Table 2. Findings on non-renal protocol CTs are listed in Table 3. No patients in the group who had non-renal protocol CTs had emergent or urgent diagnoses, but it was decided a priori that this group would not be combined with the non-contrast CT group, as the addition of contrast was felt to signify that the provider was looking for something other than an obstructing kidney stone.

Kappas for inter-rater reliability are listed in Table 4. All agreements were found to be "substantial" or "almost perfect."

Table 1. Characteristics of subjects.

Characteristic	All N = 29; N (%)	Renal protocol CT N = 115; N (%)	No renal protocol CT N = 176; N (%)
Mean age (SD)	35.9 (9)	37.0 (9)	35.1 (9)
Sex			
Female	165 (56.7)	63 (54.7)	102 (58.0)
Race			
White	145 (49.8)	56 (48.7)	89 (50.6)
Black	20 (6.9)	9 (7.8)	11 (6.3)
Hispanic	121 (41.6)	49 (42.6)	72 (40.9)
Asian	2 (0.7)	0 (0)	2 (1.2)
Native American	1 (0.3)	0 (0)	1 (0.6)
Not reported	2 (0.7)	1 (0.9)	1 (0.6)
Past medical history			
History of kidney stones	150 (51.5)	50 (43.3)	100 (56.8)
Hypertension	16 (5.5)	6 (5.2)	10 (5.7)
Diabetes mellitus	15 (5.2)	5 (4.3)	10 (5.7)
GERD	9 (3.1)	3 (2.6)	6 (3.4)
Gallstone disease	9 (3.1)	4 (3.5)	5 (2.8)
HIV	8 (2.7)	3 (2.6)	5 (2.8)
Asthma	5 (1.7)	2 (1.7)	3 (2.6)
Medullary sponge kidney	4 (1.4)	0 (0)	4 (2.3)
History of cancer	2 (0.7)	1 (0.9)	1 (0.6)
Final diagnosis of kidney stones by clinician	171 (58.8)	78 (67.8)	93 (52.8)

CT, computed tomography; *GERD,* gastroesophageal reflux disease; *HIV,* Human Immunodeficiency Virus

Table 2. Renal protocol computed tomography results by category (N =115).

Category	N	Examples
1. & 2. Emergent or urgent	0	
3. Kidney stone > 5mm	7	
4. Kidney stone ≤ 5mm	69	
5. & 6. Possible cause of symptoms, not needing follow-up/intervention and incidental findings needing non-urgent follow-up	14	Cholelithiasis without cholecystitis (3), diverticulosis (2), 18mm adrenal adenoma, primary megaureter, 2.9cm adnexal cystic lesion, 4mm pulmonary nodule, umbilical hernia, 6mm splenule adjacent to spleen, low density liver lesions, hepatic steatosis
7. Negative	25	

Table 3. Non-renal protocol computed tomography results by category (N = 19).

Category	N	Examples
1 &2. Emergent or Uurgent	0	
3. Kidney stone > 5mm	3	
4. Kidney stone ≤ 5mm	2	
5. & 6. Possible cause of symptoms, not needing follow-up/intervention and incidental findings needing non-urgent follow-up	9	Ovarian cyst, pulmonary nodule, ovarian mass (later determined benign), possible tuberculosis of bladder, unchanged liver lesions, constipation
7. Negative	5	

Table 4. Kappa values calculated for 10% of charts.

Variable	Kappa	95% CI
Inclusion vs. exclusion	0.89	0.73-1.0
Final emergency department diagnosis	0.77	0.52-1.0
Return within 60 days	0.77	0.44-1.0
Urologic intervention within 60 days	1.0	0.67-1.0

DISCUSSION

This small study suggests that in young patients without urinary tract infection or trauma, the risk of dangerous alternative diagnoses is likely quite low. Since radiation exposure is more concerning in younger patients, further studies regarding the optimum strategy for diagnosing renal colic should consider either stratifying by age or proposing different imaging procedures based on age, such as "ultrasound first."

In addition to a very low proportion of dangerous alternative diagnoses, only a very small percentage of these young, non-infected patients with renal colic required urgent urologic intervention, suggesting that it may be appropriate to delay CT for non-infected young patients with new-onset renal colic, particularly those who clinically improve in the ED. This is consistent with urology literature suggesting that for non-infected obstructing kidney stones, a trial of Medical Expulsive Therapy is reasonable for stones up to 10mm.[24]

In this study, 7 of the 11 patients initially admitted to the hospital had a urologic intervention during their admission. Since these patients were not admitted because of infection (as that was an exclusion criteria), they were likely admitted due to inadequate pain relief. Perhaps "failure to improve in the ED" warrants further study as one in a set of criterion for a decision rule to help guide CT use.

Lastly, return to the ED for renal colic patients is common and any attempt to decrease CT scanning in this group should keep this in mind. Admission rate upon ED return was low, suggesting that symptomatic control was the driving force for revisit.

LIMITATIONS

Inherent in any chart review are limitations regarding patient selection and bias, although we set our criteria as rigorously as possible prior to initiating the review and were prudent to avoid the common errors found in chart reviews.[20-22] As stated above, we were not able to fulfill all criteria for methodologic quality in chart reviews.[21]

This chart review was limited to one large hospital. While this hospital has a geographically large and socioeconomically diverse catchment area, it is possible that test utilization at this hospital is slightly different than at other hospitals, which could bias results.

Our study did not seek to evaluate the differences in

care received by patients with and without a history of renal colic. We sought to include both groups because the actual management of any individual's one kidney stone is based more on their clinical presentation at that time than on their history of stone. While it has been argued that those without a history of stones should be subject to a different diagnostic algorithm (for example CT to prove presence of stone), one could argue that need for a test should be determined by its likelihood to change management, not by the desire for simple confirmation.

The majority of patients in our study did not get a CT, so it is possible that surgical emergencies were missed in this group. However, our follow-up data on these patients suggests this is unlikely to be the case; it is likely that these patients did not get CT because physicians noted prior history of multiple CTs or felt they were not concerned about acute pathology other than renal colic.

This study was not designed to look at ultrasound versus CT for the diagnosis of kidney stone. While we collected data on rates of ultrasound, our internal documentation of bedside ultrasound is far from perfect, and ultrasounds reported are an underestimation of unknown magnitude.

This study was done in Massachusetts, which may be a limitation to the generalizability of conclusions about this study, as our patients are overwhelmingly insured by private or public insurance, and therefore generally able to get follow-up with their primary care physician (PCP) or a urologist. In other populations where being seen by a urologist or PCP as an outpatient is not possible, it may be more important to CT these patients while they are in the ED.

Lastly, while our capture of inpatient procedures is likely very accurate (7 procedures for first presentation, out of 291 encounters), our capture of procedures that happened later is not. Not all of our local outpatient surgical centers have operating notes captured by our EMR, and if patients went out of the region, their procedure would not be captured. Similarly, we are unable to say the time period in which these procedures occurred, only that they did not happen on hospital admission. Therefore, if a patient was discharged from the ED but had an outpatient lithotripsy the next day, it may not have been captured. This does leave some gray area for clinicians hoping to have patients avoid immediate CT and instead follow-up with their doctors, as it is unclear how long a patient should wait before seeking either a CT or urologic intervention.

CONCLUSION

This study adds to the growing evidence that not all patients with suspected renal colic benefit from immediate CT, and provides some evidence that limiting or delaying scanning in non-infected patients under 50 may be safe. Future work should focus on creating algorithms and decision tools to help clinicians avoid immediate CT scanning in these patients.

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Characteristics of Patients That Do Not Initially Respond to Intravenous Antihypertensives in the Emergency Department: Subanalysis of the CLUE Trial

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Introduction: Hypertensive emergency has a high mortality risk and the treatment goal is to quickly lower blood pressure with intravenous (IV) medications. Characteristics that are associated with non-response to IV antihypertensives have not been identified. The objective is to identify patient characteristics associated with resistance to IV antihypertensives.

Methods: This was a subanalysis of patients enrolled in the previously described comparative effectiveness trial of IV nicardipine vs. labetalol use in the emergency department (CLUE) study, a randomized trial of nicardipine vs. labetalol. Non-responders were defined as those patients who did not achieve target systolic blood pressure (SBP), as set by the treating physician, within thirty minutes of IV antihypertensive medication, +/- 20mmHg. Stepwise logistic regression was used to identify covariates associated with the measurement outcomes.

Results: CLUE enrolled 226 patients, 52.7% female, 76.4% black, mean age of 52.6±14.6 years, of whom 110 were treated with nicardipine and 116 with labetalol. The median (IQR) initial systolic blood pressure was 211mmHg (198, 226), 210 (200, 230), and 211mmHg (198, 226), for the total, non-responder, and responder cohorts, respectively (p-value=0.65, 95% CI [-5.8-11.3]). Twenty-nine were non-responders, 9 in the nicardipine and 20 in the labetalol group. In univariate analysis, several symptoms suggestive of end organ damage were associated with non-response. After multiple variable logistic regression (AUC = 0.72), treatment with labetalol (OR 2.7, 95% CI [1.1-6.7]), history of stroke (OR 5.4, 95% CI [1.6-18.5]), and being male (OR 3.3, 95% CI [1.4-8.1]) were associated with failure to achieve target blood pressure.

Conclusion: Male gender and history of previous stroke are associated with difficult to control blood pressure. [West J Emerg Med. 2015;16(2):276–283.]

INTRODUCTION

Hypertension, defined as a blood pressure of greater than 140/90mmHg, affects almost one fourth of the adult U.S. population.[1] Complications from hypertension include stroke, cardiovascular disease, and renal failure, among others. It has been estimated that 7.1 million deaths worldwide can be attributed to hypertension and its long term effects.[2] Suboptimal blood pressure control is also thought to be responsible for up to 62% of cerebrovascular disease and 49% of ischemic heart disease.[2]

The frequency of hospitalizations for a hypertensive emergency increased from 101/100,000 U.S. adults in 2000

to 111/100,000 U.S. adults in 2007, an average increase of about 1.1% over the seven year time period.[3] It is recommended that any patient presenting with hypertensive emergency, defined as a blood pressure greater than 180/120 in conjunction with evidence of end organ damage,[4] should be given intravenous (IV) medications to immediately lower blood pressure, as the one year mortality rate for untreated hypertensive emergency is as high as 90%.[5] There is no clear evidence as to the optimal pharmacological approach to blood pressure control in hypertensive emergency. A recent Cochrane review concluded that there is wide overlap in blood pressure lowering between agents, and that therefore it is difficult to recommend any particular antihypertensive for treatment of hypertensive emergencies.[6] Characteristics that may predispose patients to having resistant hypertension have been reported for oral medication therapy, but none have been defined for IV therapy.[7]

It has long been recognized that overly aggressive lowering of blood pressure can be harmful, and even catastrophic in some cases. Therefore, *a priori* identification of patients that may be resistant to initial treatments would be helpful to identify those whom would benefit from a more aggressive approach, such as more rapid titration or early addition of a second agent. Identifying patients who may need prolonged IV antihypertensive therapy is important because it allows for appropriate disposition and monitoring of the patient. Patients receiving prolonged IV antihypertensive medications require close clinical monitoring to avoid overshooting target blood pressure and other significant hemodynamic consequences. The objective of this analysis is to identify characteristics of those patients resistant to parenteral antihypertensives for the treatment of hypertensive crisis in the emergency department (ED).

METHODS

Study Design

This study is a descriptive sub-analysis of the multicenter Evaluation of IV Cardene (Nicardipine) and labetalol use in the emergency department (CLUE) trial, a U.S.-based, prospective, randomized, open-label study of the management and outcomes for patients with acute severe hypertension treated with IV antihypertensive therapy in the emergency department.[8] The study was approved by the institutional review boards at all sites. The methods for the primary CLUE trial were previously published and described in detail elsewhere[8] and registered at ClinicalTrials.gov with identifier NCT00765648.

Study Setting and Population

Adult patients (aged ≥18 yrs) who presented to one of 13 participating hospitals' emergency departments with acute severe hypertension were eligible for inclusion. Patients provided written informed consent, including authorization to use protected health information, for inclusion into the study. Acute severe hypertension was defined as two consecutive systolic blood pressure readings, at least ten minutes apart, of 180mmHg or greater.

Patients were ineligible if they had specific contraindications to receiving either a beta blocker or a calcium channel blocker. Patients were also excluded if they met any of the following criteria: use of any investigational drug within 30 days, pregnant or breast-feeding, contraindications or allergy to beta-blockers and calcium channel blockers (per food and drug administration [FDA]-approved labeling for nicardipine and labetalol), advanced aortic stenosis, bronchial asthma, overt cardiac failure, greater than first-degree heart block, cardiogenic shock, severe bradycardia, obstructive airway disease, decompensated heart failure or a known left ventricular ejection fraction <35%, history of stroke within 30 days, known impaired hepatic function, suspected myocardial infarction (MI), suspected aortic dissection, suspected cocaine use as the cause of ED presentation, or if they were concurrently receiving any IV antihypertensive medication.

Protocol

After obtaining informed written consent, the treating physician was asked to define a target systolic blood pressure with a range of ± 20mmHg prior to patients being randomized to IV labetalol or nicardipine per set protocol.[8] Medications were initiated within 30 minutes after randomization. FDA recommendations regarding dosing of the drugs used in this study were provided to the treating physicians, and the physician determined the dosing and the frequency of titration for each drug. Labetalol was administered as bolus doses at varying amounts and nicardepine was administered as a continuous infusion, titrated as needed. Descriptive, historical, and investigational clinical data were collected as soon as possible after enrollment, but this step was not required prior to the initiation of study drug. Data collected included past medical history and available laboratory data. Medications taken one week prior to screening, and the assessment of baseline signs and symptoms, were documented. At discharge, adverse events were recorded. Intensive care unit or hospital stay, date and cause of any deaths (with autopsy data if available), were also recorded.

Measurements

Blood pressure recordings were taken with an automatic cuff every five minutes during the 30 minutes following initiation of treatment. Vital signs and adverse events were also monitored for six hours after initiation of IV antihypertensive or until discharge from the ED, whichever came first. The presence of end organ damage was also recorded. End organ damage was defined as having any one of the following symptoms suggestive of a hypertensive emergency at time of presentation: chest pain, shortness of breath, epigastric discomfort, syncope, dizziness, blurred

vision, diplopia, diminished level of consciousness, confusion, hematuria, or development of acute ischemic changes on a twelve lead electrocardiogram. Although not all of these symptoms are included in the traditional definition for hypertensive emergency, the study group wanted to ensure that it captured patients with atypical symptoms for acute coronary syndrome. For this subanalysis, patients who met the target blood pressure (BP) within 30 minutes were defined as responders and those who did not meet target BP were defined as non-responders.

Data Analysis

Categorical variables were compared by using Chi-square or Fisher's Exact test, and continuous variables by Student's T-test or Wilcoxon rank-sum test if the variable was not normally distributed. A multivariable logistic model to assess the risk factors for non-responders within 30 minutes, after controlling for site differences, was developed. Missing values were not imputed and only observed values were used for the multivariable analyses. All baseline variables with no more than 10% missing data points were considered for inclusion into the adjusted model. A stepwise elimination procedure was used to determine the final model. Risk factors with univariate p-value ≤ 0.10 were considered and included in the stepwise elimination procedure. All variables with a p-value <0.05 were included in the final model. The final multivariable logistic model included the variables of treatment drug, gender and no history of stroke. All statistical analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC).

RESULTS

A total of 226 patients were enrolled in the initial trial, 109 (49%) in the nicardipine group and 114 (51%) in the labetalol group (Figure 1). One patient in the nicardipine group withdrew and two patients from the labetalol group withdrew from the study, so 223 patients were included in the final endpoint analysis. Twenty-nine (13%) patients, 9 in the nicardipine group and 20 in the labetalol group, did not meet their target systolic blood pressure target. The overall population (n=223) had a mean age of 52.4 years, 105 (47.1%) were males, and 171 (77%) were African American (Table 1). Age, race and gender were similar between the responder and non-responder groups (Table 1). Characteristics comparing the nicardepine and labetalol groups were reported in Table 2 in the parent paper. Patients in the nicardepine group were more likely to be diabetic or have hyperlipidemia and patients in the labetalol group were more likely to have a social history of past or current smoking.

Presenting vital signs were similar throughout all subpopulations. The median (IQR) initial systolic blood pressure was 211mmHg (198, 206), 210 (200, 230), and 211mmHg (198,226), for the total, non-responder, and responder cohorts. Further, the minimum to maximum range of presenting systolic blood pressure was 163 to 275, 184 to 264, and 163 to 275mmHg for the total, non-responder, and responder populations. Finally, the mean initial presenting heart rate varied by approximately 1 beats per minute (bpm) for all cohorts (86±17, 85±16, and 86±17bpm, for the total, non-responder, and responder groups).

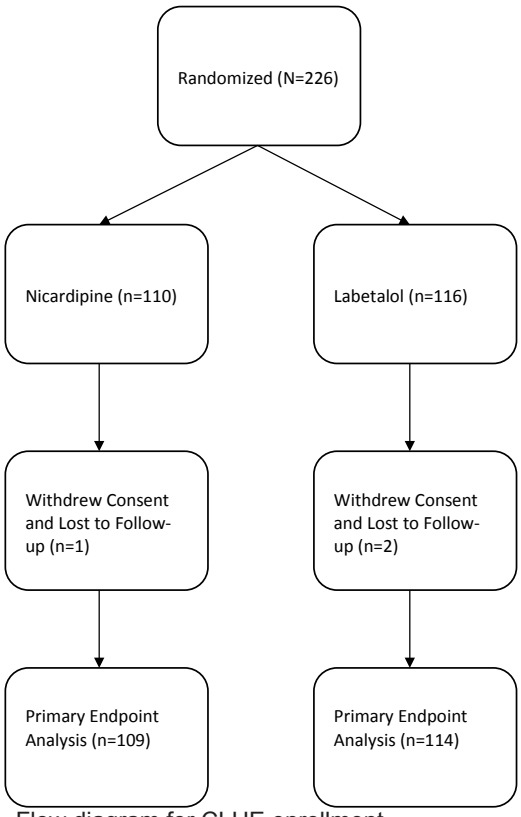

Figure 1. Flow diagram for CLUE enrollment.

Non-responders were more likely to be male. They were also more likely to have previous medical history of stroke. Further, being a non-responder was associated with an altered level of consciousness, epigastric discomfort or palpitations at presentation. Non-responders were less likely to be taking antiadrenergic medications (Table 2). An elevated serum creatinine at presentation was associated with non-response to IV antihypertensive therapy. However, only ¼ of the non-responders were dialysis dependent, and there was no difference in proportion of responders vs non-responders who were dialysis dependent (Table 1).

As expected, non-responders spent less time in the pre-specified target BP range than responders. In fact, non-responders clearly represented a cohort of extremely resistant hypertensive patients as none were noted to have a BP reading within the target range during the entire thirty minute period. This compared to responders who had a median of 4 out of 6 BP readings within the target range (Table 3). Only one-third of the non-responders fell within 5mmHg of target systolic blood pressure (Table 4).

Although responders and non-responders were noted to have medication titrated the same amount of times within the thirty minute study period, responders received

Table 1. Characteristics of patients by responder status.

	Met target SBP within 30 minutes		
	Total (n=223)	No (n=29)	Yes (n=194)
Randomization cohort			
Nicardipine, n (%)	109 (48.9)	9 (31.0)	100 (51.5)
Labetalol, n (%)	114 (51.1)	20 (69.0)	94 (48.5)
Demographics			
Age, years, mean ± SD	52.4 ± 14.5	52.0 ± 15.2	52.5 ± 14.4
Female, n (%)	118 (52.9)	9 (31.0)	109 (56.2)
African American, n (%)	171 (77.0)	23 (79.3)	148 (76.7)
White, n (%)	50 (22.5)	6 (20.7)	44 (22.8)
Hispanic/Latino, n (%)	12 (5.4)	2 (6.9)	10 (5.2)
Social history			
Prior smoking, n (%)	130 (58.3)	16 (55.2)	114 (58.8)
Prior stimulant use, n (%)	40 (17.9)	8 (27.6)	32 (16.5)
Past medical history			
Hypertension, n (%)	211 (95.1)	27 (93.1)	184 (95.3)
Previous admission for hypertensive crisis, n (%)	77 (37.2)	13 (48.2)	64 (35.6)
Hyperlipidemia, n (%)	75 (35.1)	7 (25.9)	68 (36.4)
Diabetes, n (%)	62 (27.9)	6 (20.7)	56 (29.0)
Coronary artery disease, n (%)	30 (13.6)	2 (7.1)	28 (14.6)
Dialysis, n (%)	28 (12.7)	7 (24.1)	21 (10.9)
Stroke, n (%)	16 (7.3)	5 (17.9)	11 (5.8)
Heart failure, n (%)	20 (9.1)	2 (7.1)	18 (9.4)
Myocardial infarction, n (%)	13 (5.9)	3 (10.3)	10 (5.2)
Baseline lab/ECG			
Creatinine, mg/dL, median (IQR)	1.2 (0.9, 2.4)	1.8 (1.0, 7.6)	1.1 (0.8, 2.0)
BNP, pg/dL, median (IQR)	346 (131, 2184)	1466 (520, 2184)	244 (131, 905)
Troponin I, ng/mL, mean ± SD	0.2 ± 0.9	0.3 ± 0.9	0.2 ± 0.9
Abnormal ECG, n (%)	52 (28.0)	8 (30.8)	44 (27.5)

SBP, systolic blood pressure; *ECG,* electrocardiogram*; BNP*, B-type natriuretic peptide

Table 2. Univariate analysis of factors associated with nonresponse to intravenous antihypertensives.

	Responders to therapy within 30 minutes		
Parameter	No (n=29)	Yes (n=194)	P-Value
Nicardipine treatment	9 (31%)	100 (51.5%)	
Labetalol treatment	20 (69%)	94 (48.5%)	
Female	9 (31%)	109 (56%)	0.011
Altered level of consciousness	4 (13.8%)	2 (1%)	0.003
Epigastric pain	7 (24.1%)	17 (8.8%)	0.022
Palpitations	4 (13.8%)	6 (3.1%)	0.028
Dialysis dependent	7 (24.1%)	21 (10.9%)	0.067
Prior stroke	5 (17.9%)	11 (5.8%)	0.038
Prior antiadrenergic use	6 (20.9%)	15 (7.7%)	0.038
Creatinine (mg/dL)	4.1 (± 5.0)	2.3 (± 2.9)	0.026

Table 3. Hemodynamic response to treatment in responders versus non-responders.

	Met target SBP within 30 minutes			
Parameter	Total (N=223)	No (N=29)	Yes (N=194)	p-value
Number of titrations, n (%)*				0.412
0	33 (14.8)	2 (6.9)	31 (16)	
1	62 (27.8)	7 (24.1)	55 (28.4)	
2	49 (22)	9 (31)	40 (20.6)	
>2	79 (35.4)	11 (37.9)	68 (35.1)	
Number of instances within TSBP range (Mean ± SD)	3.5 ± 2.0	0.0 ± 0.0	4.0 ± 1.6	<0.001
Total nicardipine dose (Mean ± SD) mg	3.6 ±1.5	5.2 ±2.0 (n=9)	3.4 ± 1.4 (n=100)	0.012
Total labetalol dose (Mean ± SD) mg	58.2 ± 39.2	77.0 ±39.6 (n=20)	54.1 ± 38.2 (n=94)	0.006
Patient SBP above target, n (%)	199 (89.2)	28 (96.6)	171 (88.1)	0.330
Patient SBP below target, n (%)	27 (12.1)	1 (3.4)	26 (13.4)	0.217
HR below 60, n (%)	23 (10.9)	4 (14.8)	19 (10.3)	0.507

SBP, systolic blood pressure; *TSBP,* target systolic blood pressure; *HR,* heart rate
*Number of titrations indicates number of doses for labetalol and number of titrations of the drip for nicardepine.

Table 4. Distribution of non-responders by distance outside target range.

	Number (%) of non-responders
0-5mmHg outside range	11 (37.9)
6-10mmHg outside range	5 (17.2)
11-15mmHg outside range	6 (20.7)
16-20mmHg outside range	3 (10.3)
>20mmHg outside range	4 (13.8)

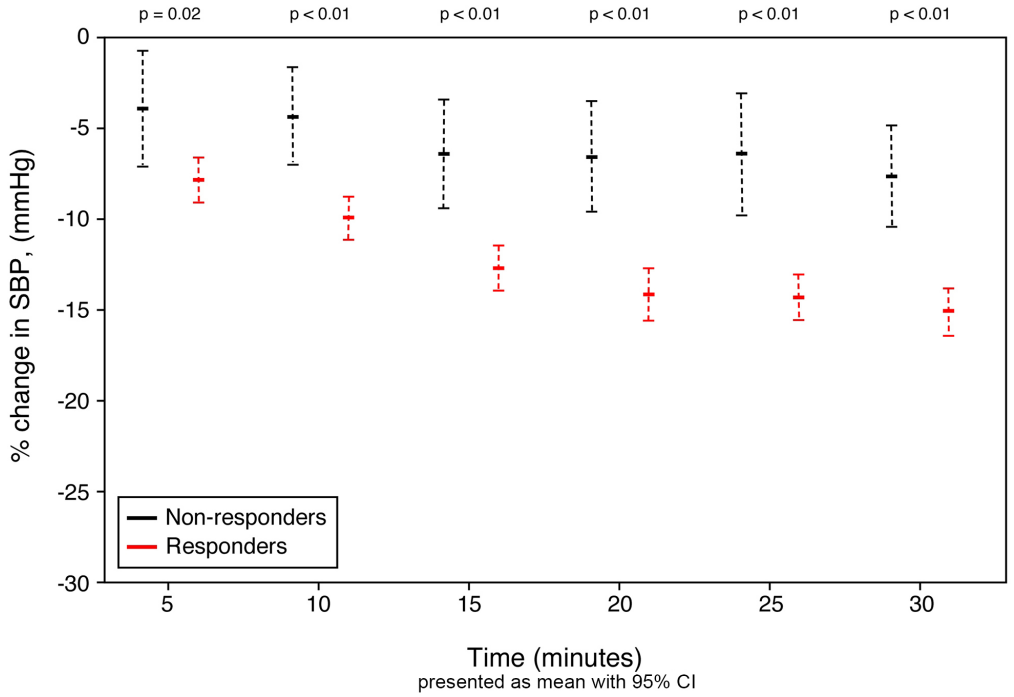

Figure 2. Change in systolic blood pressure measurements over time.
SBP, systolic blood pressure

less drug overall due to smaller doses required to achieve blood pressure control within 30 minutes. Despite higher overall doses, non-responders had a significantly lower percent change in systolic blood pressure when compared to responders (Figure 2).With regard to adverse events, there was no statistical difference between responders and non-responders, including bradycardic episodes, defined as a heart rate below 60bpm (Table 3).

After adjusting for significant baseline variables by multivariate logistic regression, including forcing the study site into the model, randomization to treatment with labetalol (OR 2.7, p-value=0.028, 95% CI [1.1-6.7]), having a past medical history of stroke (OR 5.4, p-value=0.008, 95% CI [1.6-18.5]), or being male (OR 3.3, p-value=0.008, 95% CI [1.4-8.1]) were independently associated with failure to achieve a systolic blood pressure in the target range within 30 minutes of the start of IV anti-hypertension therapy (C statistic for the model = 0.72, Pearson's goodness of fit test p-value=0.76).

DISCUSSION

The primary goal of the CLUE study was to determine whether there was a difference in achieving target blood pressure within thirty minutes using nicardipine vs. labetalol. To the best of our knowledge, patient characteristics that are associated with resistance to parenteral antihypertensives in the ED have not been previously described. If patients resistant to BP control can be identified at presentation, more aggressive ED therapy may prevent further complications. Early ED identification of patients who will predictably have a poor response to BP control interventions may also assist emergency physicians in making appropriate inpatient dispositions decisions. Our univariate analysis suggests that presenting with select symptoms suggestive of end organ damage, including altered level of consciousness, epigastric pain and palpitations, increases the likelihood that blood pressure will not be lowered to target level within thirty minutes of treatment initiation. Our multivariate analysis indicates that being male and having history of a previous stroke also increases that likelihood.

The overall prevalence of hypertension is relatively similar between men and women, although men have a higher prevalence below the age of 60, and women have the higher prevalence after age 60.[1] According to a recent analysis of the National Health and Nutrition Examination Survey (NHANES), women were more likely to be receiving medication for hypertension, but were less likely to have their blood pressure adequately controlled.[9] In this analysis of the CLUE trial, there were no differences between responders and non-responders with regards to prior antihypertensive treatment. Although NHANES revealed that women were more resistant to oral antihypertensives, we found them to be less resistant than males to IV antihypertensives in the ED.

Hayes and Taler reviewed the literature regarding gender differences in chronic HTN to determine if treatment options for women should be different than those for men.[10] Factors they considered to play a possible role in increased blood pressure in women included use of oral contraceptives and renal artery stenosis, which has a female predominance. It has been postulated that estrogen may be protective against end organ damage from hypertension,[11] although Reckelhoo[12] emphasized the role of the renin-angiotensin system (RAS) in blood pressure regulation. Studies on rats reveal that estrogen does not seem to affect the rates of hypertension, but that the lack of androgens is the key difference between males and females in blood pressure regulation.[12] Men are known to have higher levels of renin than females.[13] This may explain some of the difficulty in controlling blood pressure, since the CLUE trial used medications that did not target the RAS. Another study revealed that patients with difficult to control blood pressure, defined as lack of adequate response despite three oral agents, were found to have higher aldosterone levels. This elevation was most significant in men, despite correction for menopausal status of women.[14]

There are multiple physiologic differences between males and females that may contribute to development of hypertension, many of which disappear after menopause. These differences include higher cardiac index, higher HR and lower peripheral resistance and blood volume.[15] Males are also known to have greater left ventricular mass, despite correction for weight, height, body mass index, and inotropic state.[16] All of these factors may lead to differences in response to antihypertensives. Menopause status was not a recorded variable in this study, but the mean age of 52 suggests that many female patients were likely pre-menopausal.

History of a prior stroke is an intuitive factor affecting acute blood pressure control since the brain plays a key role in regulation of blood pressure. It has been shown that blood pressure rises in the first 24 hours after stroke to increase perfusion to the damaged area of the brain.[17] It is also noted that blood pressure will trend down over the next week, and then plateau. Just as previous stroke deficits can be exacerbated during acute illness, it is possible that the brain may reset the autoregulation curve for blood pressure control during times of acute stress, making it more difficult for antihypertensives to be effective.

End organ damage will also intuitively lead to difficulty controlling blood pressure, as injury to the brain and kidneys affect the regulation of blood pressure. Persistence of elevated blood pressure leads to endothelial damage, promoting platelet aggregation and fibrin deposition, which stimulates release of further inflammatory molecules and perpetuates cycle of damage.[18] Angiotensin II is thought to play a large role in the damage to organs associated with hypertension, so the medicines used in this study may have been ineffective in lowering blood pressure in the setting of end organ damage because they were targeting the wrong pathway.[18] There is suggestion of kidney injury present in the non-responders, as they did have higher creatinine levels, despite no difference in

rate of patients requiring dialysis between the responders and non-responders.

There are multiple studies to guide choice of IV antihypertensive in the setting of specific end organ damage such as stroke, MI, aortic dissection and end stage renal disease, but no recommendation for an IV antihypertensive that could be started based on suspicion alone of end organ damage.[19] We chose to define end organ damage based on presenting symptoms because emergency physicians are frequently faced with the decision to treat critically elevated blood pressure before the results of diagnostic testing are available.

LIMITATIONS

There are a number of limitations to our study. First, we used only two IV antihypertensives, so patients labeled as non-responders are not necessarily unresponsive to all IV antihypertensives. We chose a two medication study model because it allowed direct comparison of two of the most common classes of IV antihypertensives currently used in U.S. emergency departments and there is no gold standard medication for blood pressure control. The selected agents were relatively easy to titrate with a low side effect profile. However, there are differences in the method of administration between labetalol and nicardipine (bolus vs. infusion) that may account for our results, in that an infusion may inherently reach the target BP range faster than bolus therapy. Our study was not designed to determine the effects of administration method on time to BP control.

Secondly, the treating physicians had control over multiple variables. FDA recommendations are for titration of the nicardipine at intervals of 5 minutes, while the labetalol is re-dosed at 10 minute intervals. However, the actual titration intervals and dosing were left to the discretion of the treating physician, which may have biased the study. It is possible that more aggressive dosing of the medications might have altered results. Importantly, there were no differences in the number of times the two drugs were titrated, although there were more non-responders in the labetalol group. The treating physicians also set the goal blood pressure. Common recommendations for hypertensive emergency call for lowering the blood pressure by 25% over hours. However, there are individual patient characteristics that may affect the timing and degree of lowering. Allowing the treating physicians to set the blood pressure goal reflects real world practice.

Thirdly, as this was a randomized controlled trial, the groups were similar in terms of baseline characteristics. However, the treating physicians were not blinded to study drug and therefore bias may have been introduced with regard to the effect of allocated treatments. Due to the low number of patients that were defined as non-responders, there was a limited amount of covariates that could be analyzed and there may be further factors that are associated with nonresponse that we failed to identify.

Using systolic blood pressure alone may have failed to identify patients with isolated elevated diastolic blood pressure who may be at risk for hypertensive emergency. It is unclear if those patients would have a different response to medication therapy. It was acknowledged by JNC 7 that diastolic pressure levels out and may actually fall after the age of 50, making systolic blood pressure a more potent cardiovascular risk factor in patients over the age of 50.

Finally, CLUE only reported BP response within the first 30 minutes of antihypertensive use. It is unknown if those patients that were resistant within this time period continued to be resistant, or if it just took longer for them to respond. However, it can be argued that BP control requiring more than 30 minutes to attain is insufficient in the setting of hypertensive emergency. Labetalol has an onset of action of just five minutes and a peak effect is reached by thirty minutes. Nicardipine has an onset of action within 5-15 minutes, although the peak effect is not reached until about 45 minutes. This knowledge would suggest that a longer time period may be needed to assess non-response to nicardipine, but this study found more non-responders in the labetalol group.

CONCLUSION

In this secondary analysis from the CLUE study, we have identified patient characteristics associated with difficulty in the emergency department control of BP within 30 minutes of the initiation of therapy. These characteristics include being male and having a previous history of stroke.

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Long-term Neurological Outcomes in Adults with Traumatic Intracranial Hemorrhage Admitted to ICU versus Floor

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Introduction: The objective of this study was to compare long-term neurological outcomes in low-risk patients with traumatic intracranial hemorrhage (tICH) admitted to the ICU (intensive care unit) versus patients admitted to the floor.

Methods: This retrospective study was conducted at a Level 1 trauma center from October 1, 2008, to February 1, 2013. We defined low-risk patients as age less than 65 years, isolated head injury, normal admission mental status, and no shift or swelling on initial head CT (computed tomography). Clinical data were abstracted from a trauma registry and linked to a brain injury database. We compared the Extended Glasgow Outcome Scale (GOS-E) score at six months between patients admitted to the ICU and patients admitted to the floor. We did a risk-adjusted analysis of the influence of floor admission on a normal GOS-E.

Results: We identified 151 patients; 45 (30%) were admitted to the floor and 106 (70%) to the ICU. Twenty-three (51%; 95% CI [36-66%]) patients admitted to the floor and 55 (52%; 95% CI [42-62%]) patients admitted to the ICU had a normal GOS-E. On adjusted analysis; the odds ratio for floor admission was 0.77 (95% CI [0.36-1.64]) for a normal GOS-E at six months.

Conclusion: Long-term neurological outcomes in low-risk patients with tICH were not markedly different between patients admitted to the ICU and those admitted to the floor. However, we were unable to demonstrate non-inferiority on adjusted analysis. Future work aimed at a larger, prospective cohort may better evaluate the relative impacts of admission type on outcomes. [West J Emerg Med. 2015;16(2):284–290.]

INTRODUCTION

Each year traumatic brain injury (TBI) accounts for an estimated 1.4 million emergency department (ED) visits in the United States.[1] Approximately 95% of patients with TBI are categorized as mild.[2] In patients with mild TBI with intracranial hemorrhage, routine admission to the hospital for early detection of secondary brain injury is recommended.[2] Because most of these patients do not develop hemorrhage progression or require neurosurgical intervention, significant variation in ED disposition exists, including admission to the intensive care unit (ICU), admission to the hospital floor, or ED observation.[3-6] In one study, variability in ICU use among Western U.S. trauma centers ranged from 50% to 97% for patients with minor traumatic intracranial hemorrhage.[6]

We recently derived a clinical instrument that identified a subset of patients with mild TBI with intracranial hemorrhage who likely do not require ICU admission.[7] While this study demonstrated that low-risk patients are unlikely to require ICU resources during hospitalization, it is unknown whether ICU admission might impart indirect benefits reflected in long-term neurological outcomes.

The primary objective of this study was to compare long-term neurological outcomes with ICU versus floor admission among low-risk patients with traumatic intracranial hemorrhage (tICH). The secondary objective was to compare hospital length of stay. We hypothesized that floor admission was not inferior to admission to the ICU for a favorable neurological outcome at six months. Specifically, we tested the null hypothesis that in adjusted analysis, floor admission provided no more than half the odds of a favorable neurological outcome at six months as admission to the ICU.

METHODS

Study design and setting

We conducted this retrospective, registry-based cohort study at a Level 1 trauma center. The study was approved by the institutional review board at the study site. At the study site, low-risk patients with tICH are generally admitted to the ICU although admission status decisions are ultimately at the discretion of the admitting trauma surgeon. Patients with tICH admitted to the ICU typically have neurological checks every hour while patients admitted to the floor typically have neurological checks every two hours or greater. All patients with tICH are evaluated by the neurosurgery service. Patients with tICH are seen for cognitive evaluation and education by speech therapists prior to hospital discharge.

Selection of participants

Adult patients (18 years and older) with ED visits from October 1, 2008, to February 1, 2013, were identified from the hospital trauma registry using the International Classification of Diseases, 9th Revision, Clinical Modification codes specific for tICH (codes 851-854).We identified low-risk patients from this cohort based on our previously derived clinical decision instrument criteria: admission Glasgow Coma Scale (GCS) score of 15, isolated head injury (defined as abbreviated injury score [AIS] less than three in all non-head body regions), age less than 65 years old, and initial head computed tomography (CT) imaging without evidence of shift or mass effect.[7] To obtain long-term neurological outcomes, these low-risk patients were then linked to an institutional TBI database using medical record numbers and ED visit dates. Patients included in the TBI database met at least one of the following criteria that prompted neurosurgical consultation: (1) suspected TBI due to clinical history, clinical symptoms, or signs of neurological deficits on physical examination, or (2) traumatic findings on CT including any tICH. Long-term neurological outcomes were prospectively collected by trained research personnel using a standardized data collection form. Patients or their surrogates underwent a structured interview by trained research personnel at six months to assess global functioning using the Extended Glasgow Outcome Scale (GOS-E).[8]

Methods and Measurements

Data collection followed previously published guidelines on retrospective chart review.[9] Variables abstracted from the trauma registry included age, sex, mechanism of injury, initial ED GCS score, initial systolic blood pressure (SBP), heart rate, and respiratory rate, revised trauma score (physiological scoring system based on initial GCS, SBP, and respiratory rate),[10] blood alcohol level, initial hematocrit, AIS score and injury severity score (ISS) (anatomical scoring system),[11] ED disposition, hospital length of stay, in-hospital mortality, and hospital disposition. Variables abstracted from the TBI database included admission GCS score (GCS score at the time of admission), initial platelet count and international normalized ratio (INR), initial CT characteristics and prognostic score (Rotterdam CT score), [12] in-hospital neurosurgical interventions, and GOS-E score at six months.

Outcomes

Our primary outcome measure was a dichotomized GOS-E score at six months (8 [fully recovered] versus 1-7 [not fully recovered]). The GOS-E is the most commonly used measure of global functional performance after TBI and has been recommended as the criterion standard outcome measure for TBI studies.[13,14] It uses an 8-category score that is typically dichotomized between 8 and 1-7 for mild TBI to facilitate interpretation.[15] It has excellent interrater reliability and content validity.[8] We also conducted a sensitivity analysis adjusting the dichotomization at GOS-E 1-6 versus GOS-E 7 and 8. The secondary outcome measure was hospital length of stay (days in the hospital). Outcomes were collected independent of the knowledge of ED disposition.

Analysis

We conducted data formatting and recoding of variables ducted using STATA 11.0 statistical software (STATA Corp, College Station, TX). The study population was characterized using descriptive statistics. Non-normal interval data were reported with medians and interquartile ranges, and proportions were presented with 95% confidence intervals (CIs). We analyzed categorical data with chi-square test or Fischer's exact test in cases of small cell size. Continuous data were analyzed with Student's t-test if normally distributed. We used Wilcoxon rank-sum test for nonparametric data or ordinal data. Since inherent differences likely existed between low-risk patients admitted

to the ICU and those admitted to the floor we created boxplots to analyze the distribution of key independent variables (age, initial systolic blood pressure, AIS head and neck score, and Rotterdam CT score) by hospital admission location (floor versus ICU). Boxplots were also created to analyze outcome measures. Bivariate analyses on these variables and GOS-E score were also done to evaluate which variables may have influenced the GOS-E score. We then fit a logistic regression model with these variables using the dichotomized GOS-E score (8 versus <8) as the dependent variable and ED disposition as the independent variable of primary interest. A linear regression model was created to analyze hospital length of stay. To evaluate for missing data bias, we compared key characteristics between patients with and without GOS-E at six months.

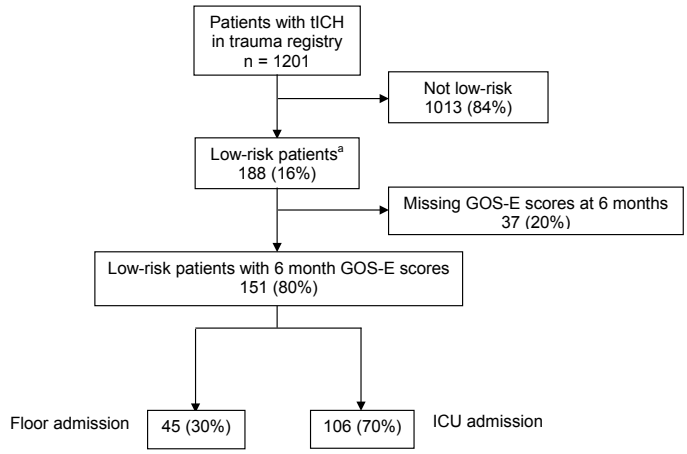

Figure 1. Flow of patients in the study.

tICH, traumatic intracranial hemorrhage; *GOS-E*, Glassgow Outcome Score Extended; *ICU*, intensive care unit
[a] Low-risk defined as admission Glasgow Coma Scale score of 15, isolated head injury (defined as Abbreviated Injury Score less than three in all non-head body regions), age less than 65 years old, and initial head computed tomography imaging without evidence of shift or mass effect.

RESULTS

Among 188 patients with tICH who met our inclusion criteria, 151 (80%) had complete data; 106 (70%) patients were admitted to the ICU and 45 (30%) to the floor (Figure 1). Median age in the cohort was 40 years (IQR 25-54 years) and 109 were male (72%). The most common mechanisms of injury were fall from standing (49 patients, 32%) and assault (48 patients, 32%). The most common head CT findings were subdural hematoma (56 patients, 37%) and subarachnoid hemorrhage (54 patients, 36%). One patient (admitted to ICU) required a neurosurgical intervention, which consisted of an elevation of skull fracture on hospital day 3. One patient died during hospitalization (hospital day 13) from hospital-acquired pneumonia and sepsis (see Table 1 for complete patient characteristics). Distributions of key independent variables are shown in Figure 2. The majority of patients had a GOS-E at six months of 8 (78; 52%) (Table 2). Patients with GOS-E at six months were more likely to have a higher AIS head and neck compared to patients with a missing GOS-E at six months (Table 3).

Distributions of GOS-E at six months and hospital length of stay by ED disposition are shown in Figure 3. On adjusted analysis, floor admission had an odds ratio of 0.77 (95% CI [0.36-1.64]) for a GOS-E score of 8 at six months. Given our tolerance margin of an odds ratio of 0.5, we failed to reject the null hypothesis of non-inferiority (Figure 4). Only age was significantly associated with a normal GOS-E at six months (Table 4a). No variable was significant on adjusted analysis of hospital length of stay (Table 4b). In the sensitivity analysis, no variable was associated with GOS-E scores 7 and 8.

DISCUSSION

This was a hypothesis-generating study evaluating the impact of floor and ICU admission on a clinical (neurological outcome) and system outcome (hospital length of stay) in patients with low-risk tICH. Based on the results of our study, we were unable to reject the null hypothesis of inferiority; that is, we were unable to prove that floor admission was not inferior to ICU admission by our threshold margin, because the relatively wide 95% confidence interval for the adjusted odds ratio (0.36 to 1.64) included the value 0.50. To reduce the confidence interval width in an otherwise similar study would require a larger sample size.

Our study cohort consisted of low-risk patients with tICH with the definition for "low-risk" based on a recently published derivation of a clinical decision instrument identifying patients who are unlikely to receive a critical care intervention within 48 hours of hospital admission and thus, may not require ICU admission.[7] While these low-risk criteria narrowed the study population to a relatively homogenous, well-appearing cohort of patients with tICH, it is likely that there was still some selection bias with sicker patients more likely to be admitted to the ICU. Our analysis demonstrated that the cohort of patients admitted to the ICU were older and had a higher AIS head and neck score compared to the cohort admitted to the floor.

GOS-E scores at six months were similar to other studies evaluating patients with mild TBI.[15,16] Prior studies have demonstrated that injury severity (e.g., GCS score), demographic factors including age, gender, pre-injury education and employment, as well as post-injury cognitive and social factors may influence long-term neurological outcome after TBI.[17] To our knowledge this is the first study to evaluate the potential influence of hospital admission location on neurological outcomes. It is possible that ICU admission in low- risk patients with tICH imparts benefits such as close monitoring of neurological decline or intensive cognitive

Table 1. Patient characteristics by hospital admission location.

Characteristic	Floor admission (n=45)	ICU admission (n=106)
Age (years), median (IQR)	31 (25-47)	44 (25-56)
Male, n (%)	34 (76)	75 (71)
Mechanism of injury, n (%)		
Assault	13 (29)	35 (33)
Motor vehicle collision	5 (11)	11 (10)
Fall from standing	16 (36)	33 (31)
Other	11 (24)	27 (26)
Initial systolic blood pressure (mmHg), mean (SD)	129 (18)	132 (23)
Initial pulse rate (beats/min), mean (SD)	86 (17)	87 (18)
Initial respiratory rate (breaths/min), mean (SD)	17 (2)	18 (2)
Revised trauma score, mean (SD)	7.84 (0)	7.83 (0.1)
Initial hematocrit (%), mean (SD)	40.7 (5.4)	40.1 (4.8)
Blood alcohol level 80 mg/dL or more, n (%)	18 (40)	48 (45)
Initial international normalized ratio, mean (SD)	1.04 (0.08)	1.15 (1.08)
Initial platelet count (1,000s/mcL), mean (SD)	205 (65)	221 (62)
Injury Severity Score, median (IQR) *	10 (9-16)	16 (10-17)
Abbreviated Injury Scale head and neck score, median (IQR) *	3 (3-4)	4 (3-4)
Computed tomography (CT) subtypes, n (%)		
Intraparenchymal contusion	10 (22)	19 (18)
Intraparenchymal hematoma	9 (20)	24 (23)
Subdural hematoma *	10 (22)	46 (43)
Epidural hematoma	1 (2)	8 (8)
Intraventricular hemorrhage	0 (0)	2 (2)
Subarachnoid hemorrhage	20 (44)	34 (32)
Rotterdam CT score, median (IQR)	2 (2-3)	2 (2-3)
In-hospital mortality, n (%)	0 (0)	1 (0.9)
Hospital disposition, n (%)		
Discharged home	40 (89)	94 (89)
Discharged to rehabilitation facility	0 (0)	0 (0)
Discharged to skilled nursing facility	0 (0)	1 (1)
Discharged to other acute care facility	2 (4)	8 (8)
Died	0 (0)	1 (1)
Left against medical advice	1 (2)	0 (0)
Discharged to psychiatric facility or jail	2 (4)	2 (2)
Length of stay in the hospital (days), median (IQR) *	2 (1-2)	2 (1-3)
Neurosurgical intervention, n (%)	0 (0)	1 (0.9)

ICU, intensive care unit; *CT,* computed tomography
*p<0.05

therapy that is reflected in long-term neurological function. However, the results of this study demonstrate there is no clear signal to suggest this.

LIMITATIONS

These results should be interpreted in the context of several limitations. This study was retrospective and subject to the limitations of the chart review. While we adjusted for some potential confounders, there may be a number of unmeasured variables such as comorbidities, post-injury neurological dysfunction, and social characteristics that may have influenced outcome measures. In addition,

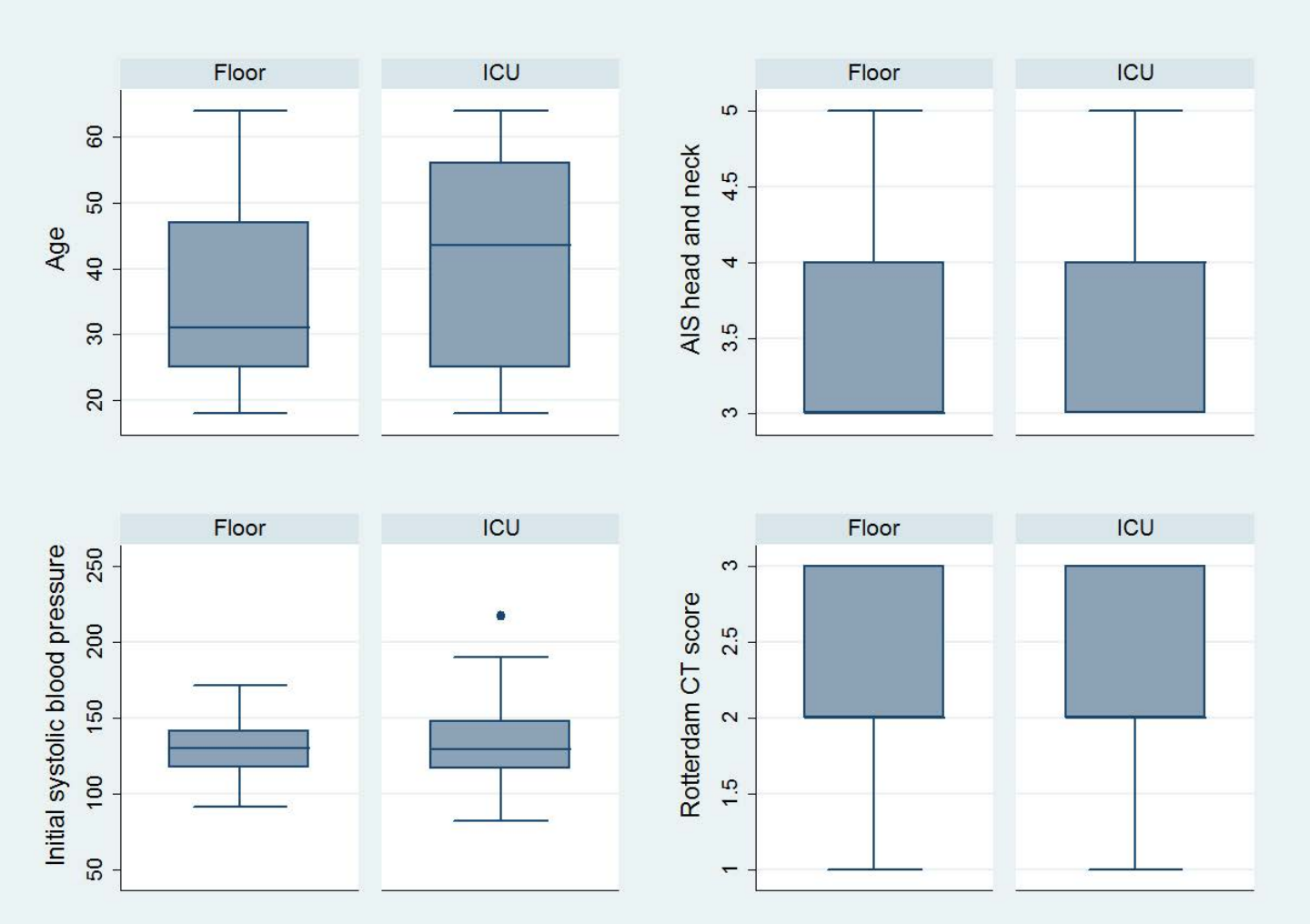

Figure 2. Distribution of independent variables by admission location.
ICU, intensive care unit; *CT*, computed tomography; *AIS*, abbreviated injury score

Table 2. Extended Glasgow Outcome Score (GOS-E) at 6 months.

GOS-E score	Floor admission, n(%) (n=45)	ICU admission, n(%) (n=106)
8 (upper good recovery)	23 (51.1)	55 (51.9)
7 (lower good recovery)	13 (28.9)	17 (16.0)
6 (upper moderate disability)	2 (4.4)	11 (10.4)
5 (lower moderate disability)	5 (11.1)	15 (14.2)
4 (upper severe disability)	2 (4.4)	4 (3.8)
3 (lower severe disability)	0 (0)	3 (2.8)
2 (vegetative state)	0 (0)	0 (0)
1 (dead)	0 (0)	1 (0.9)

ICU, intensive care unit

Table 3. Comparison of variables for patients with and without Extended Glasgow Outcome Score (GOS-E) at 6 months.

Characteristic	With GOS-E at six months (n=151)	Without GOS-E at six months (n=37)
Age, median (IQR)	40 (25-54)	35 (21-49)
AIS head and neck score, median (IQR)*	4 (3-4)	3 (3-4)
Initial systolic blood pressure, mean (SD)	132 (21)	131 (20)
Rotterdam CT Score, median (IQR)	2 (2-3)	2 (2-3)
Admission to the ICU, n (%)	106 (70)	27 (73)

AIS, abbreviated injury severity; *CT*, computed tomography; *ICU*, intensive care unit
*p<0.05.

this is a single center study, and the results may not be generalizable to other sites that have different resources or admission practices. Since these were low-risk patients with tICH, other outcome measures, such as neuropsychological impairment, psychiatric and psychological functioning

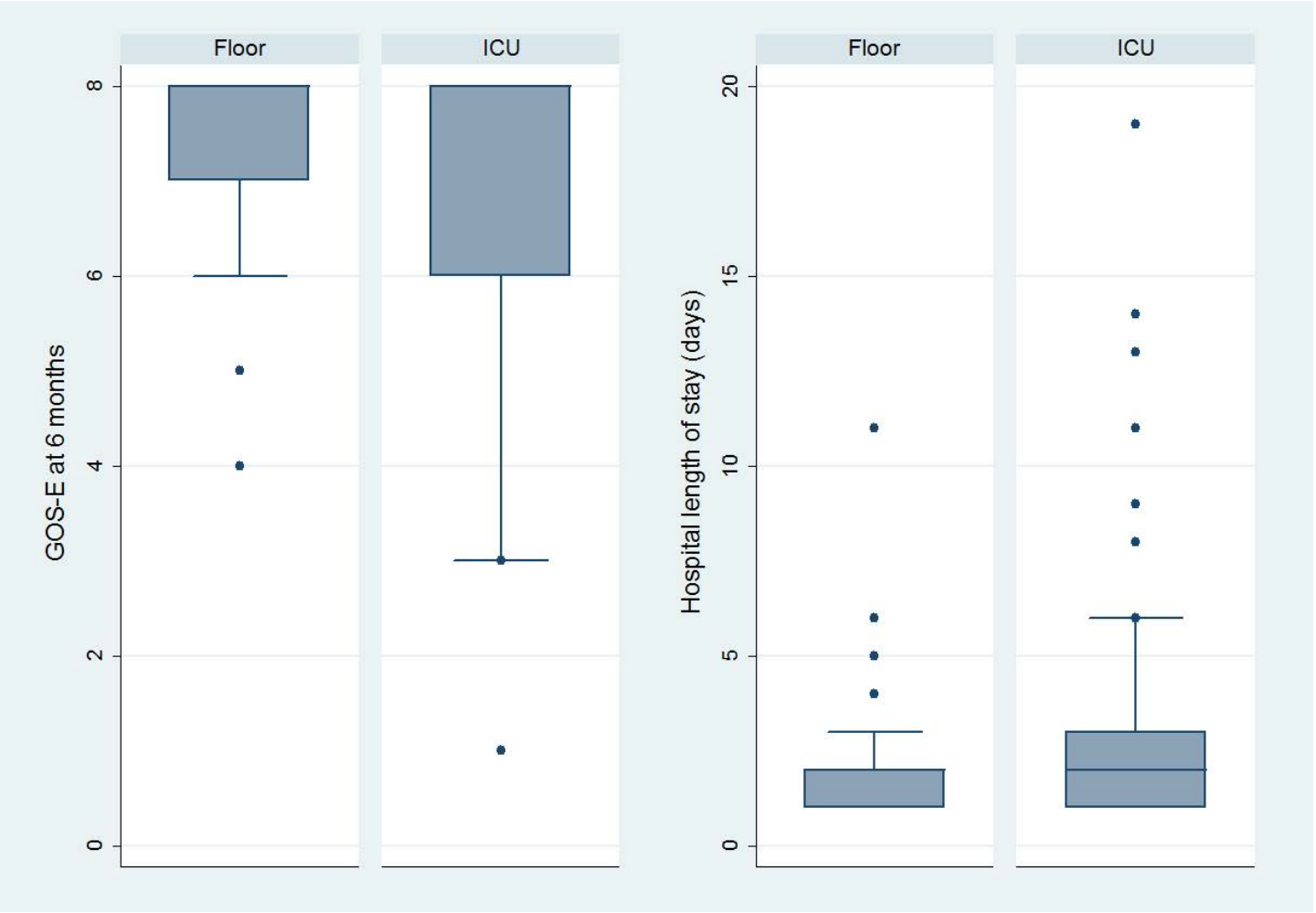

Figure 3. Distribution of outcome measures by admission location.
GOS-E, extended Glassgow Outcome Score; *ICU*, intensive care unit

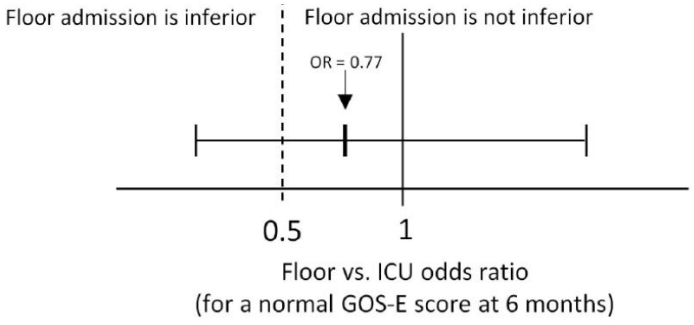

Figure 4. Adjusted odds ratio of floor admission on extended Glosgow Outcome Score (GOS-E) at six months (non-inferiority is not established).

Table 4a. Adjusted analysis for predicting outcome measures.**

Variable	Odds ratio (95% CI)
Age	0.98 (0.95-1.00)
AIS head and neck score	0.77 (0.39-1.52)
Initial systolic blood pressure	0.99 (0.98-1.01)
Rotterdam CT Score	0.90 (0.49-1.65)
Admission to the floor	0.77 (0.36-1.64)

GOS-E, extended Glassgow Outcome Score; *AIS*, abbreviated injury severity; *CT*, computed tomography
*p<0.05.
**Adjusted odds ratios for predicting GOS-E of 8 at six months.

and TBI-related symptoms, may be more sensitive to detect differences between management. While interrater reliability of the GOS-E has previously been shown to have acceptable agreement between trained raters, inter-rater reliability was not measured in this study.[8] Twenty percent of patients were missing the GOS-E at six months. Patients with missing GOS-E scores may have influenced the results of the study. We did evaluate key differences between patients with and without GOS-E and found that patients with GOS-E had higher AIS head and neck scores indicating more severe injuries compared to those with missing GOS-E scores. Finally, this study was underpowered to detect small but potentially clinically important differences in neurological outcomes.

Table 4b. Adjusted analysis for predicting outcome measures.*

Variable	Coefficient (95% CI)
Age	0.02 (-0.01 to 0.05)
AIS head and neck score	0.64 (-0.25 to 1.52)
Initial systolic blood pressure	0.00 (-0.02 to 0.02)
Rotterdam CT Score	-0.10 (-0.91 to 0.65)
Admission to the floor	-0.28 (-4.99 to 4.99)

AIS, abbreviated injury severity; *CT*, computed tomography
*Adjusted coefficients for predicting hospital length of stay.

CONCLUSION

In low-risk patients with tICH, six-month neurological outcomes were not markedly different between patients admitted to the ICU and those admitted to the floor. However, we were unable to demonstrate non-inferiority on adjusted analysis. Future work aimed at a larger, heterogeneous and prospective cohort may better evaluate the impact of ICU admission on outcomes in this patient population.

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Headache in Pregnancy: An Approach to Emergency Department Evaluation and Management

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Headache is a common presenting complaint in the emergency department. The differential diagnosis is broad and includes benign primary causes as well as ominous secondary causes. The diagnosis and management of headache in the pregnant patient presents several challenges. There are important unique considerations regarding the differential diagnosis, imaging options, and medical management. Physiologic changes induced by pregnancy increase the risk of cerebral venous thrombosis, dissection, and pituitary apoplexy. Preeclampsia, a serious condition unique to pregnancy, must also be considered. A high index of suspicion for carbon monoxide toxicity should be maintained. Primary headaches should be a diagnosis of exclusion. When advanced imaging is indicated, magnetic resonance imaging (MRI) should be used, if available, to reduce radiation exposure. Contrast agents should be avoided unless absolutely necessary. Medical therapy should be selected with careful consideration of adverse fetal effects. Herein, we present a review of the literature and discuss an approach to the evaluation and management of headache in pregnancy [West J Emerg Med. 2015;16(2):291–301.]

INTRODUCTION

A 30-year-old pregnant female at 10 weeks gestational age (GA) presented to the emergency department (ED) complaining of headache. The headache was sudden onset at maximal intensity and was described as left-sided pressure. There was associated lightheadedness, dizziness, blurred vision, and numbness and weakness of her right arm. There was no trauma or loss of consciousness, no slurred speech, and no other numbness or weakness. Approximately 90 minutes after headache onset, she reported spontaneous improvement in headache intensity from 10/10 to 6/10, resolution of the numbness and weakness of her right arm, and persistent blurred vision. She denied any prior similar episodes or history of migraine headache. She had no history of preeclampsia or other pregnancy-related complication. She had no associated fever, chills, or neck pain. A review of systems was otherwise negative. Past medical and surgical history was noncontributory. Medications included acetaminophen and prenatal vitamin. She smoked cigarettes, but denied alcohol or illicit drug use.

On examination she was awake, alert and oriented; Glasgow Coma Scale score was 15. She was afebrile with a blood pressure of 111/64mmHg and heart rate of 62 beats per minute. Cranial nerves were grossly intact, pupils were 3mm bilaterally and equally round and reactive to light, extraocular movements were intact, and no nystagmus was noted. She had a normal gait, 5/5 strength, and grossly intact sensation throughout the extremities. She had no cervical spinal tenderness and no meningismus. The remainder of her physical exam was unremarkable.

Laboratory studies revealed a leukocytosis of 13.6 x 10^9 white blood cells/L and normal electrolytes. A non-contrast computed tomography (CT) of the head was negative. Subarachnoid hemorrhage (SAH) was a diagnosis of consideration in this case. Recent studies suggest that a negative head CT obtained within six hours of headache onset is sufficient to rule out SAH.[1,2] Additionally, appropriate evaluation of cerebrospinal fluid (CSF) requires sufficient time for the development of xanthochromia.[3,4] As the patient presented only 90 minutes after headache onset, a lumbar puncture (LP) was not immediately indicated for further evaluation of SAH. As cerebral venous thrombosis was also a diagnosis of consideration, a magnetic resonance image (MRI)

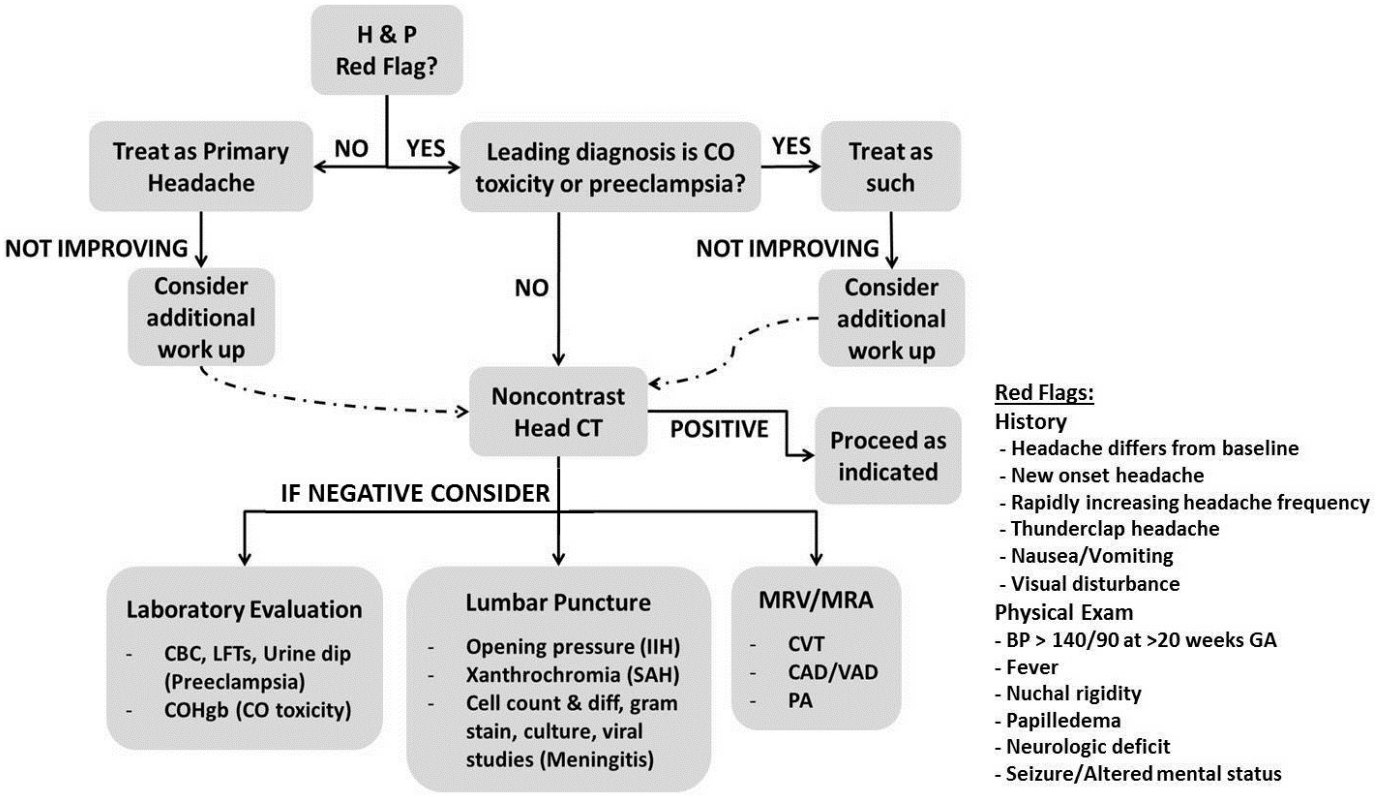

Figure. Suggested approach to evaluation of headache in a pregnant patient.

Leading differential diagnosis and/or availability of advanced imaging should determine the order of laboratory evaluation, lumbar puncture, and/or MRV/MRA. Additional laboratory studies may be obtained if indicated based on differential diagnosis.
H&P, history and physical; *COHgb*, carboxyhemoglobin; *CO*, carbon monoxide; *CT,* computed tomography; *CBC,* complete blood count; *LFT,* liver function test; *IIH*, idiopathic intracranial hypertension; *diff*, differential; *SAH*, subarachnoid hemorrhage; *MRV,* magnetic resonance venogram; *MRA*, magnetic resonance angiogram; *CVT*, cerebral venous thrombosis; *CAD,* carotid artery dissection; *VAD,* vertebral artery dissection; *PA*, pituitary apoplexy; *BP,* blood pressure; *GA,* gestational age

with arteriography and venography (MRA and MRV) of the head was then obtained. Because the patient was pregnant, the study was obtained without gadolinium contrast. This showed no evidence of cerebral venous thrombosis, aneurysm, or vascular malformation, but did reveal a five-millimeter hemorrhagic appearing pituitary lesion consistent with pituitary apoplexy.

Headache is a common presenting complaint in the ED. The differential diagnosis is broad and includes benign and ominous etiologies. When evaluating the pregnant patient with headache, there are important unique considerations regarding the differential diagnosis, imaging options, and medical management. Herein, we present a review of the literature and discuss an approach to the evaluation and management of headache in pregnancy.

ADVANCED IMAGING IN THE PREGNANT PATIENT

Advanced neuroimaging should be obtained for patients with sudden onset severe headache, rapidly increasing headache frequency or neurologic deficits, and should be considered for patients with new onset headache or headache that differs from baseline. Non-contrast head CT is the initial study of choice.

The estimated fetal radiation dose from a head CT is very low, <1 rad.[5-7] At eight to fifteen weeks GA, the fetus is at greatest risk for radiation-related injury. A fetal dose of 1-2 rad may increase the risk of leukemia to 1 in 2,000 children compared to 1 in 3,000 children for the general population. The risk of fetal anomalies, growth restriction, or abortion is not increased with radiation doses of <5 rad.[5,6] Most CT contrast agents contain iodine derivatives, which have not been formally studied in pregnancy. However, neonatal hypothyroidism has been associated with some iodinated agents taken in early pregnancy. Contrast should be avoided unless absolutely necessary.[5-8]

MRI involves no radiation and is safe in pregnancy.[5] MRI is recommended for adequate imaging of the posterior fossa, and MRA and MRV are recommended to rule out vascular events.[7] Gadolinium contrast crosses the placenta, and animal studies have demonstrated adverse fetal effects. Gadolinium should therefore be avoided unless absolutely necessary to confirm the diagnosis.[5,7,8] Although contrast MRA/MRV provides superior imaging, non-contrast MRA/MRV produces quality images and is typically sufficient for establishing a diagnosis.[9]

EVALUATION AND MANAGEMENT

Etiologies for which pregnancy increases risk

Preeclampsia

Preeclampsia is defined as hypertension (systolic blood pressure >140mmHg OR diastolic blood pressure >90mmHg) *and* proteinuria (>0.3g protein in a 24-hour urine collection) at >20 weeks GA in a woman who was known to be normotensive prior to pregnancy. It is considered severe at blood pressures >160/>110mmHg. Preeclampsia occurs in approximately 2-8% of healthy nulliparous pregnancies. The risk is higher in African American-women, women over age 35 years, multifetal gestations, and women with a history of preeclampsia, hypertension, diabetes, and obesity, among others. Patients may present with headache, visual disturbances, edema, and epigastric pain. Severe preeclamptics may present with multi-organ involvement (e.g., pulmonary edema, oliguria, thrombocytopenia, elevated liver enzymes, persistent severe headache, blurred vision, blindness, or altered mental status). Preeclamptics with new onset grand mal seizure are considered to have eclampsia.[10,11]

The evaluation for preeclampsia should include an evaluation for HELLP (hemolysis, elevated liver enzymes, low platelets) syndrome with complete blood count and liver function tests. A urine dip with 1+ protein is suggestive of preeclampsia but not diagnostic; a 24-hour urine collection should be arranged.[10,11]

Obstetrics should be consulted for all patients with mild to moderate preeclampsia as these patients require maternal/fetal monitoring. Severe preeclamptics should be hospitalized and the fetus monitored. Intravenous magnesium should be given to prevent seizure. Typical dosing consists of a 4-6g load infused over 15-20 minutes followed by 2g/hr infusion. Patients who are not actively seizing may not require loading.[10,11] Antihypertensives should also be given to maintain blood pressures of 140-155/90-105 mmHg. Recommended agents include hydralazine and labetalol. Hydralazine is given intravenously 5-10mg every 15-20 minutes as needed to achieve goal pressures. Labetalol is given intravenously in a 20mg bolus dose, followed by 40mg and then 80mg every 10 minutes to a maximum dose of 220mg.[10] Delivery of the fetus should be considered if the gestational age is appropriate or if cerebral symptoms or severe uncontrolled blood pressures persist despite maximum antihypertensive and magnesium therapy, regardless of gestational age. Corticosteroids can be given to accelerate fetal lung maturity if <34 weeks GA.[11]

Cerebral venous thrombosis

The risk of cerebral venous thrombosis (CVT) is increased in the prothrombotic pregnant state. Most pregnancy-related CVT occurs in the third trimester.[12,13] Common presenting complaints include headache, focal neurologic deficit, seizure, altered mental status, and signs of elevated intracranial pressure (ICP) such as papilledema. The headache is typically sub-acute, although thunderclap headache has been reported. Headache with focal neurologic findings or seizures should increase suspicion of CVT, particularly in the peripartum population.[12-15]

The diagnosis of CVT is based on neuroimaging. Classic non-contrast CT findings are the empty delta sign, dense triangle sign, or cord sign.[13-15] More often, CT will show nonspecific edema or infarction, but the imaging may be normal in up to 30% of cases, particularly if obtained within the first 5-10 days of symptom onset. MRI/MRV is the imaging modality of choice.[13-15] Non-contrast MRV is commonly used to evaluate for CVT; however, contrast CT venography or MRV may be required to detect acute thrombus (up to 5 days old).[9]

Anticoagulation is the standard of care for management of CVT. Low molecular weight heparin (LMWH) does not cross the placenta and is the first-line treatment for anticoagulation in pregnancy. Anticoagulation should be continued throughout the pregnancy and post-partum for a minimum of six weeks for a total minimum duration of therapy of three to six months. Although warfarin is contraindicated in pregnancy, post-partum patients may be safely transitioned to oral warfarin. Elevated ICP should be treated if present.[12-16]

Pituitary apoplexy

Pituitary apoplexy is caused by acute ischemic or hemorrhagic infarction as the pituitary gland expands and outgrows its blood supply or compresses the vessels against the sella.[12,17] It is most commonly seen in men over the age of 50 years and in a pre-existing pituitary adenoma.[17,18] Although rare, the massive hyperplasia of lactotrophs that occurs in pregnancy causes the pituitary gland to grow by as much as 130% putting pregnant patients at risk.[19-21] Patients will present most commonly with sudden onset severe headache and nausea and vomiting and less commonly with visual symptoms, altered mental status, or coma.[17-19,22] Secondary adrenal insufficiency can occur, causing severe hypotension and hyponatremia which can be life-threatening.[18]

In pituitary apoplexy, CT may demonstrate a recent bleed or hyperdense lesion in the pituitary. MRI is more sensitive for delineating the relationship between the pituitary and surrounding structures.[17,18]

Pituitary apoplexy patients with persistent visual symptoms, neurologic deficit, or altered mental status require urgent surgical decompression.[17,18,22] Secondary adrenal insufficiency should be treated immediately with fluid and electrolyte replacement and hydrocortisone.[17-19]

Subarachnoid hemorrhage

Subarachnoid hemorrhage occurs most commonly as the result of a ruptured aneurysm or arterial-venous malformation (AVM). In pregnancy, AVM rupture typically occurs early (15-20 weeks GA) and in younger women (20-25 years), while aneurysm rupture usually occurs later (30-40 weeks GA)

Table 1. Medications for treatment of secondary headache in pregnancy.

Disease	Treatment	Medication	Category* (1st/2nd/3rd)	Adverse effect(s)	Recommendation
Preeclampsia[10-11,66]	Antiepileptic	Magnesium	D/D/D	Neonatal respiratory or neuromuscular depression (transient)	Use with caution, Acceptable in some circumstances (i.e. preeclampsia)
	Antihypertensive	Hydralazine	C/C/C	Associated with increased rates of placental abruption and cesarean section, maternal headache, palpitations, hypotension, tachycardia	Use with caution
		Labetalol	C/C/C	Increased incidence of intrauterine growth restriction, rare cases of neonatal hypoglycemia, bradycardia, and hypotension	Use with caution
	Fetal lung maturity	Corticosteroids	C/C/C	Cleft lip and palate (first trimester use)	Not recommended in 1st trimester pregnancy
Cerebral venous thrombosis and arterial dissection[12-16,34,66]	Anticoagulation	Low molecular weight Heparin (LMWH)	B/B/B	Maternal heparin induced thrombocytopenia and/or osteoporosis; no documented increased fetal risk	Acceptable
		Unfractionated heparin	C/C/C	Maternal heparin induced thrombocytopenia and/or osteoporosis; no documented increased fetal risk	Acceptable
		Warfarin	X/X/X	"Warfarin embryopathy," intracranial hemorrhage, intrauterine fetal demise, pregnancy loss, maternal hemorrhage	Contraindicated
	Antiplatelet	Clopidogrel	B/B/B	Maternal bleeding; no documented increased fetal risk	Use with caution
		Aspirin	C/C/D	Premature closure of *ductus arteriosus*, oligohydramnios (especially 3rd trimester use)	Use with caution; not recommended in 3rd trimester

*Adapted from www.drugs.com/pregnancy.[46]

Table 1 continued. Medications for treatment of secondary headache in pregnancy.

Disease	Treatment	Medication	Category* (1st/2nd/3rd)	Adverse effect(s)	Recommendation
Pituitary Apoplexy[17-19,66]	Secondary adrenal insufficiency therapy	Fluid/Electrolyte replacement	--/--/--	No documented increased fetal risk	Acceptable
		Hydrocortisone	C/C/C	Cleft lip and palate (first trimester use)	Not recommended in 1st trimester
Subarachnoid Hemorrhage [51,66]	Analgesia	Acetaminophen	C/C/C	No documented increased fetal risk	Acceptable
		Opiates	C/C/C	Maternal respiratory depression, histamine release, nausea	Acceptable
Idiopathic Intracranial Hypertension [35,38,66]	Reduce intracranial pressure	Acetazolamide	C/C/C	No documented increased fetal risk	Acceptable
		Topiramate	D/D/D	Cleft lip and palate	Not recommended
		Furosemide	C/C/C	Maternal hypovolemia and decreased placental perfusion	Not recommended
		Thiazides	B/B/B	Maternal and neonatal hyponatremia, hypokalemia, hyperglycemia, thrombocytopenia; smooth muscle contraction and initiation of labor	Not recommended
		Steroids	C/C/C	Cleft lip and palate (first trimester use)	Not recommended in 1st trimester
Meningitis[39-40,42,66]	Antibiotic	3rd generation cephalosporin	B/B/B	No documented increased fetal risk	Acceptable
		Vancomycin	C/C/C	Potential neonatal ototoxicity and nephrotoxicity, No documented increased fetal risk	Acceptable
		Ampicillin	B/B/B	No documented increased fetal risk	Acceptable
	Antiviral	Acyclovir	B/B/B	No documented increased fetal risk	Acceptable
	Other	Dexamethasone	C/C/C	Cleft lip and palate (first trimester use)	Not recommended in 1st trimester
Carbon MonoxideToxicity[45-46,66]	Oxygen therapy	100% High flow oxygen	--/--/--	No documented increased fetal risk	Acceptable
		Hyperbaric Oxygen therapy (HBO)	--/--/--	No documented increased fetal risk	Acceptable

*Adapted from www.drugs.com/pregnancy.[46]

Table 2. Medications for treatment of primary headache in pregnancy.

Disease	Treatment	Medication	Category* (1st/2nd/3rd)	Adverse Effect(s)	Recommendation
Migraine Headache [7,52-56,60,66]	Analgesia	Ketorolac	C/C/D	Premature closure of *ductus arteriosus*, oligohydramnios (especially in 3rd trimester use)	Use with caution; not recommended in 3rd trimester
		Acetaminophen/ Aspirin/Caffeine	D/D/D	Neonatal hemorrhage, decreased birth weight, birth defects	Not Recommended
	Antiemetic	Metoclopramide	B/B/B	No documented increased fetal risk	Acceptable
		Ondansetron	B/B/B	Possible increased risk of cleft palate, risk of maternal prolonged QTc and arrhythmia	Use with caution
		Promethazine	C/C/C	No documented increased fetal risk	Acceptable
		Droperidol	C/C/C	No documented increased fetal risk, risk of maternal prolonged QTc and arrhythmia	Use with caution
		Prochlorperazine	C/C/C	Congenital heart defects, cleft palate	Not Recommended
	Other	Propofol	B/B/B	Neonatal hypotonia and sedation (us ually transient), maternal hypotension and respiratory depression	Acceptable
		Sumatriptan	C/C/C	Low birth weight, preterm delivery, minor fetal anomalies	Use with caution
		Dexamethasone	C/C/C	Cleft lip and palate (first trimester use)	Not recommended in 1st trimester
		Dihydroergotamine	X/X/X	Vasoconstriction, decreased uterine blood flow	Contraindicated
		Valproic acid	X/X/X	Spina bifida and other fetal anomalies	Contraindicated
Cluster Headache [61,63-64,66]	Other	High Flow Oxygen	--/--/--	No documented increased fetal risk	Acceptable
		Intranasal lidocaine	B/B/B	No documented increased fetal risk	Acceptable
		Sumatriptan	C/C/C	Low birth weight, preterm delivery, minor fetal anomalies	Use with caution
		Dihydroergotamine	X/X/X	Vasoconstriction, decreased uterine blood flow	Contraindicated
Tension Type Headache [51,66]	Analgesia	Acetaminophen	C/C/C	No documented increased fetal risk	Acceptable
		NSAIDs	C/C/D	Premature closure of *ductus arteriosus*, oligohydramnios (especially 3rd trimester use)	Use with caution; not recommended in 3rd trimester
		Salicylates	D/D/D	Neonatal hemorrhage, decreased birth weight, birth defects	Not Recommended

*Adapted from www.drugs.com/pregnancy.[46]

and in older women (30-35 years). A theoretical increased risk in pregnancy has been proposed. The cardiac output and blood volume peak of the third trimester is thought to increase the risk of aneurysm rupture.[23] However, other studies suggest there is no increased risk of SAH in pregnancy, labor, or delivery.[24-26] Patients will classically present with a thunderclap headache, but nausea and vomiting, stiff neck, photophobia, syncope, and focal neurologic deficit may also be seen. Patients with a preceding less severe headache episode should raise concern for a sentinel bleed.[26]

Evaluation of SAH should begin with a non-contrast head CT. If negative, a LP should be performed and the CSF examined for xanthrochromia. If necessary, CT angiogram (CTA) may localize the lesion (e.g. aneurysm, AVM) or document vasospasm.[26]

Patients with SAH should be hospitalized to facilitate early neurosurgical intervention with clipping or coiling to reduce the risk of rebleeding.[23,26]

Arterial dissection

Vertebral artery dissection (VAD) and carotid artery dissection (CAD) are common causes of cerebral vascular accident in young patients. Patients often present with unilateral headache or neck pain followed by signs of posterior circulation ischemia (e.g., Horner's syndrome, diplopia, delayed transient ischemic attack, and stroke).[27-29] In the general population, the incidence of spontaneous CAD is estimated at 2.5-3/100,000 and spontaneous VAD is estimated at 1-1.5/100,000.[29-31] Pregnancy theoretically increases the risk for spontaneous dissection. In pregnancy, high progesterone and/or decreased collagen synthesis is thought to weaken the arterial wall. This, together with increased sheer stress on the vessel wall caused by increased intravascular volume and cardiac output, is thought to increase the risk of dissection in the pregnant population.[27,32] However, the reported incidence of VAD (1.5/100,000) in the pregnant population is comparable to that of the general population; less is known about the incidence of CAD in pregnancy.[27,33]

Intra-arterial angiography is the gold standard for diagnosis of arterial dissection, typically revealing an intimal flap or double lumen, aneurysm, occlusion, or the classic "string sign."[29] Non-contrast MRA is the preferred modality in the pregnant patient, however.[27]

As in CVT, anticoagulation is the standard of care for management of arterial dissection. LMWH is again the first-line treatment and the duration of anticoagulation is the same as for CVT. Post-partum patients may be transitioned to oral warfarin. Elevated ICP should be treated if present.[12-16] Anticoagulation is contraindicated in patients with intracranial extension of the dissection, intracranial aneurysm, or infarction with hemorrhagic transformation or mass effect. Patients without ischemic symptoms may be treated with an antiplatelet agent only.[34] Aspirin (pregnancy category D) has been demonstrated safe and effective at low doses (< 100mg/day).[16] Patients with evidence of hemodynamic insufficiency due to severe stenosis or occlusion may require intervention to increase cerebral blood flow (e.g.; induced hypertension, volume expansion, or emergent endovascular repair or stenting).[29] Endovascular repair or stenting in stable patients should be reserved for those in whom anticoagulation is contraindicated.[34]

Other Secondary Headaches

Idiopathic Intracranial Hypertension

Idiopathic intracranial hypertension (IIH), formerly pseudotumor cerebri, is defined as an opening pressure of >250 mmH_2O with normal CSF. IIH classically affects obese women of childbearing age and is relatively rare, occurring in approximately 0.9 per 100,000 in the general population and 4-19 per 100,000 in obese women.[35] Occurrence rates are estimated at 5% in the pregnant population.[20] Outcomes of pregnant women with IIH are the same as those of non-pregnant women, and pregnancy outcome is unaffected.[35] Patients commonly present with headache (90%) and visual changes (e.g., transient visual obscurations, diplopia, and blindness). Papilledema is almost universally present and can occasionally be unilateral.[35-37] In patients without papilledema, a history of headache with visual disturbances, tinnitus, or sixth-nerve palsies is very suggestive of IIH.[37]

Evaluation for IIH begins with imaging to rule out other causes of intracranial hypertension with non-contrast head CT or MRI. It is important to consider that CVT also presents with headache and papilledema; a diagnosis of CVT should be excluded in these patients. A thorough review of the patient's medications may reveal one of a number of agents known to cause intracranial hypertension including vitamin A and nitrofurantoin.[35]

First-line therapy for IIH in pregnancy is diet and weight control.[35] Second-line therapies include serial LPs and/or acetazolamide (category C). Acetazolamide use in pregnancy has been limited because of teratogenic potential. However, Falardeau et al 2013[38] reviewed outcomes of pregnant women with IIH treated with acetazolamide and found no forelimb or axial skeletal abnormalities and no difference in the abortion rate, minor complication rate, or minor abnormality rate compared to a control group of pregnant women with IIH who did not use acetazolamide. These data suggest acetazolamide can be safely used in pregnancy; dosing starts at 0.5-1g/day in divided doses to a maximum of 2g/day. The use of other diuretics is controversial because of the potential for decreased placental blood flow.[35] Steroids (category C) are reserved for urgent short-term treatment in patients awaiting surgery. Surgical therapy is recommended for those with severe or progressive visual loss despite medical management. Optic nerve sheath fenestration creates a window in the optic nerve sheath allowing CSF to drain into the retrobulbar space, directly protecting the optic nerve. Lumboperitoneal or ventriculoperitoneal shunting is also an option however

over 50% become occluded, infected, or migrate requiring reoperation.[35] Visual outcomes for pregnant patients with IIH are the same as those in the nonpregnant IIH population.[35,36]

Meningitis

Meningitis in pregnancy presents similarly to that in the non-pregnant population with headache, fever, nausea, vomiting, nuchal rigidity, and/or altered mental status.[39-41] Otitis and sinusitis infection often precede meningitis in pregnancy.[40,42] *Streptococcus pneumoniae* and *Listeria monoctogenes* are the most common causative organisms and are associated with a very high mortality rate (28%). Miscarriages and neonatal death are also common consequences of meningitis in pregnancy.[42]

If meningitis is suspected, blood cultures and a LP should be obtained. A CT of the head should be done prior to the LP if there are any concerns for elevated ICP. Studies suggest that once antimicrobial therapy is started, sterilization of the CSF occurs within two hours for *N. meningitides* infections, and within four hours for *S. pneumoniae* infections; however, antibiotics should not be delayed if LP cannot be performed early.[39]

Empiric antimicrobial therapy for meningitis consists of a third-generation cephalosporin, such as cefotaxime or ceftriaxone (category B), and vancomycin (category C).[39,40,42] Because *Listeria* infection is common in pregnancy, ampicillin (category B) should also be given.[42] If viral causes are suspected, add acyclovir (category B). Studies suggest that prognosis in viral meningitis is directly related to the delay in empiric acyclovir administration.[43] Some data suggest adjunct therapy with steroids reduces mortality. Dexamethasone has few side effects in third trimester pregnancy (category C) and may also be used.[39,42]

Carbon Monoxide Toxicity

Carbon monoxide (CO) toxicity presents with non-specific signs and symptoms, but headache is present in the vast majority (approximately 84%). Other symptoms include weakness, nausea, confusion, and shortness of breath, among others.[44] In addition to maternal toxicity, fetal toxic effects include teratogenicity, neurological dysfunction, decreased birth weight, increased fetal death, and premature closure of the *ductus arteriosus*.[45] The fetal carboxyhemoglobin (COHbg) level cannot be accurately estimated from the maternal COHgb level. The fetal level is higher than the maternal level at baseline and rises faster and clears more slowly than the maternal level.[45,46] The fetal outcome is proportionate to the severity of maternal toxicity; the risk is very high when the mother shows signs of altered mental status.[46]

Because the presentation of CO toxicity is non-specific, a high index of suspicion should be maintained. Normal COHgb levels in a nonsmoker are <2% and in smokers are 5-13%. Pulse oxyimetry cannot distinguish between oxyhemoglobin and carboxyhemoglobin and so is not a reliable measure of CO toxicity.[44]

All patients with suspected CO toxicity should receive 100% high flow oxygen. This reduces the half-life of CO from five hours to one hour. Some recommend hyperbaric oxygen (HBO) therapy for pregnant women with any signs of acute poisoning or COHgb level >20%.[46] Others recommend HBO therapy for COHgb >20%, or neurologic effects or signs of fetal distress regardless of COHgb level.[45] Because the fetal half-life of COHgb is longer than the maternal half-life, the duration of HBO therapy in pregnant women should be longer than in non-pregnant women.[46] If HBO therapy is not available, give 100% high flow oxygen for five times as long as is needed to reduce the maternal COHgb level to normal. Repeat treatments should be considered if neurological symptoms or fetal distress persists 12 hours after the first treatment.[45]

Primary Headaches

Migraine Headache

Migraine headache (MH) typically presents with unilateral, pulsating headache that is aggravated by physical activity and associated with nausea and vomiting and/or photophobia or phonophobia. Some patients experience a preceding aura consisting of a reversible focal neurologic deficit.[47] Typically it is not the MH symptom complex, but the frequency and severity of attacks that changes in pregnancy. In general, 50 to 75% of women have a reduction in frequency of attacks during pregnancy. Migraine headache is known to be influenced by cyclical changes in reproductive hormones, and it is thought that the absence of hormonal fluctuation during pregnancy is responsible for the observed improvement. In contrast, approximately 8% of women experience increased frequency or intensity of MH during pregnancy.[48-50] None of these studies demonstrate a difference in incidence or course of MH between primigravid and multiparous women. New-onset MH can also occur in up to 16.5% of pregnant women and usually presents in the first trimester.[49]

Treatment of acute migraine headache is challenging. First-line therapy typically includes a non-narcotic analgesic and an antiemetic. Several of the common initial agents (acetaminophen/aspirin/caffeine, ketorlac, prochlorperazine) are contraindicated in pregnancy.[7,51,52] Prochlorperazine is associated with congenital heart defects and cleft palate and is contraindicated.[7] A recent study also demonstrates an increased risk of cleft palate with the use of ondansetron (category B).[53] Although studies investigating droperidol are few, there are no significant differences in major or minor birth defect rates compared to the general population.[54,55] Dihydroergotamine (DHE), valproic acid infusion and sumatriptan, are common second-line agents for migraine. In pregnancy, DHE is contraindicated because its vasoconstrictive effects decrease uterine blood flow.[7,52] Valproic acid is known to cause spina bifida and other fetal anomalies and is also contraindicated in pregnancy.[7,55,56] Some studies suggest that sumatriptan is associated with low

Table 3. U.S. Food and Drug Administration pregnancy categories.

Pregnancy category	Description
A	Adequate and well-controlled studies in pregnant women have failed to demonstrate a risk to the fetus in the first trimester of pregnancy (and there is no evidence of a risk in later trimesters)
B	Animal reproduction studies have failed to demonstrate a risk to the fetus and there are no adequate and well-controlled studies in pregnant women
C	Animal reproduction studies have shown an adverse effect on the fetus and there are no adequate and well-controlled studies in humans, but potential benefits may warrant use of the drug in pregnant women, despite potential risks
D	There is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience or studies in humans, but potential benefits may warrant use of the drug in pregnant women despite potential risks
X	Studies in animals or humans have demonstrated fetal abnormalities and/or there is positive evidence of human fetal risk based on adverse reaction data from investigational or marketing experience, and the risks involved in use of the drug in pregnant women clearly outweigh potential benefits

Adapted from www.drugs.com/pregnancy.[46]

birth weight, preterm delivery, and minor fetal anomalies while others suggest that there is no increased risk compared to the general population.[57-59] Propofol is an emerging treatment option for migraine and is pregnancy category B.[60] Dexamethasone has been used to prevent migraine recurrence, but is associated with increased risk of cleft lip and palate in first trimester exposures, so should not be used early in pregnancy.[53,54] Treatment options for migraine headache are summarized in Table 2. A combination of intravenous fluids and droperidol as initial therapy, followed by propofol or sumatriptan as second line agents, is a reasonable approach.

Cluster Headache

Cluster headache (CH) is described as a severe and unilateral, orbital, supraorbital, and/or temporal headache; attacks occur up to eight times daily and are associated with ipsilateral autonomic dysfunction (e.g., conjunctival injection, lacrimation, rhinorrhea, miosis, etc.).[47] Data regarding CH in pregnancy are limited and conflicting.[63-65]

First-line treatment for acute cluster headache (CH) attack in pregnancy remains high flow oxygen.[63,64] About 60% of all CH patients have significant reduction in pain after 30 minutes of oxygen therapy. Sumatriptan, effective in 2/3 of CH patients, is an option, although its safety profile in pregnancy is not clear, as previously discussed. Ipsilateral intranasal lidocaine (pregnancy category B) has been used with rapid relief and no significant general side effects and is effective in 1/3 of CH cases.[61] Again, DHE is contraindicated.[61,63]

Tension Type Headache

Tension type headache (TTH) is the most common and least well-studied primary headache. TTH is typically bilateral and of pressing or tightening quality. It is not exacerbated by routine physical activity and is not associated with nausea, but may be associated with photophobia or phonophobia.[47] Data about the incidence of TTH in pregnancy is limited, but some authors suggest that the majority of TTH sufferers are not affected by pregnancy.[48]

Tension type headache can be treated with over-the-counter (OTC) analgesics. Acetaminophen is safe during pregnancy and is the OTC analgesic of choice. Salicylates and non-steroidal anti-inflammatory agents are associated with adverse fetal effects and should be avoided.[7,51]

SUMMARY

The objective of the ED evaluation of headache is to rule out ominous secondary causes. The diagnosis and management of headache in the pregnant patient presents several challenges. Physiologic changes induced by pregnancy increase the risk of CVT, dissection, and pituitary apoplexy. Preeclampsia must also be considered. A high index of suspicion for CO toxicity should be maintained. Primary headaches should be a diagnosis of exclusion. When advanced imaging is indicated, MRI should be used whenever possible to reduce radiation exposure. If CT is necessary, imaging of the head rarely exceeds fetal radiation danger thresholds. Contrast agents do cause adverse fetal effects and should be avoided unless absolutely necessary for accurate diagnosis. An approach to the evaluation of the pregnant patient with headache is proposed (Figure). Medical therapy should be selected with careful consideration of adverse fetal effects. The management of secondary headache is tailored to the etiology (Table 1) as are treatment options for primary headache (Table 2).

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Diagnosis of Pneumoperitoneum with Bedside Ultrasound

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An 86-year-old female was brought in by ambulance for severe abdominal and back pain. She was hypotensive en route and appeared to be in distress upon arrival to the emergency department. Her abdomen was tense and distended with diffuse tenderness to palpation present. A bedside abdominal ultrasound (US) was done immediately, which raised concern for free air. A portable upright chest x-ray was obtained, which confirmed the diagnosis of pneumoperitoneum (Video).

Pneumoperitoneum due to perforated viscus is an emergent diagnosis that requires immediate surgical consultation and intervention. US is a useful tool that can be done at the bedside to rapidly make the diagnosis. Both low- and high-frequency transducers may be used to detect intraperitoneal free air. With the patient in a supine position, the perihepatic space should be evaluated. The patient may also be turned to the left lateral decubitus position to facilitate the rise of free air to the RUQ.[1] Findings may also be seen from the anterior abdominal wall when the patient is supine. Pneumoperitoneum can be detected on US by the enhanced peritoneal stripe sign (EPSS) in conjunction with reverberation artifacts, which have the appearance of repeating linear lines extending at equidistant distances posteriorly from the peritoneal lining.[2] Comet tail artifact may also be appreciated from the peritoneal stripe. The "scissors maneuver" can increase sensitivity of US in detecting intraperitoneal free air.[3] Indirect signs may also be seen on US, including thickened bowel loops or air bubbles in peritoneal free fluid.[4]

US has been shown to have a sensitivity of 85% and a specificity of 100% for pneumoperitoneum. It has been shown by some to have a higher sensitivity for this diagnosis as compared to plain radiography.[5] Although computed tomography imaging is still the gold standard for pneumoperitoneum, US is a helpful initial diagnostic tool that can be done rapidly at the bedside.

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Video. Pneumoperitoneum.

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Jaguar Attack on a Child: Case Report and Literature Review

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Jaguar attacks on humans rarely occur in the wild. When they do, they are often fatal. We describe a jaguar attack on a three-year-old girl near her home deep in a remote area of the Guyanese jungle. The patient had a complex but, relatively, rapid transport to a medical treatment facility for her life-threatening injuries. The child, who suffered typical jaguar-inflicted injury patterns and survived, is highlighted. We review jaguar anatomy, environmental status, hunting and killing behaviors, and discuss optimal medical management, given the resource-limited treatment environment of this international emergency medicine case. [West J Emerg Med. 2015;16(2):303–309.]

INTRODUCTION

Worldwide, hundreds of deaths are caused by large cat attacks annually.[1] Reported attacks are rare in the Western Hemisphere or Europe, and usually occur in zoos and circuses, or are caused by "exotic" pets,[2] especially where local laws and regulations are more lenient.[3] Attacks on humans remain common in Africa and Asia, where significant wild populations of large cats still exist. They have become especially prevalent in areas where expansion of urban centers and agricultural zones have decreased these animals' habitat size, reduced their natural prey, and forced them to hunt outside of their protected areas.[4]

Jaguars (*Panthera onca*) are the third largest felid (cat) after the tiger and the lion (Figures 1A and 1B). They exist only in the Western Hemisphere, with the Amazon regions of South America, particularly Brazil, having the highest concentration. An apex predator (no natural enemies), jaguar survival is threatened only when humans intentionally kill them or decrease their ability to feed by destroying or encroaching on their habitat. In some areas, their fear of humans has decreased due to ecotourism and intentional feeding. As in the following case of an unprovoked attack on a three-year-old Amerindian girl in Guyana, the cats may be more prone to attack humans as prey.

Case Report

A three-year-old Amerindian girl presented without warning to our emergency department (ED) in the country's only tertiary care hospital, after being attacked by a jaguar in the remote Isseneru Village, Cuyuni-Mazaruni (Region 7), Guyana. This village is located near the large Mazaruni River, amid dense jungle about 40 air miles from the Venezuelan border. When attacked, she was with her mother at the Mazaruni River, as they were every morning, to bathe and wash clothes.

Her mother says that she turned away from the child to tend to the clothes when she heard "screams and then saw the jaguar ripping away at her" (personal communication from Dr. Sagon, the area general medical officer, who visits that area every 2 to 3 months). The large adult jaguar apparently pounced on the girl from the bushes and, with its jaws clamped on her head, dragged the 24kg child about 60 feet into nearby bushes. It released her only after other residents, who had heard her screams, forced the jaguar to drop the child and then shot the animal.[5]

Although jaguar sightings in the region are rare, the child's grandmother had witnessed that same jaguar attack the girl one month previously when they were at the river, "the animal jumped on her and scraped her on her foot. But I hit it and it got away."[5]

The second attack, which caused grievous injuries, occurred at about 10:30am, and relatives rushed the child to the local health center by speedboat, about 10 minutes away. Thinking that the child was already dead, the family left her

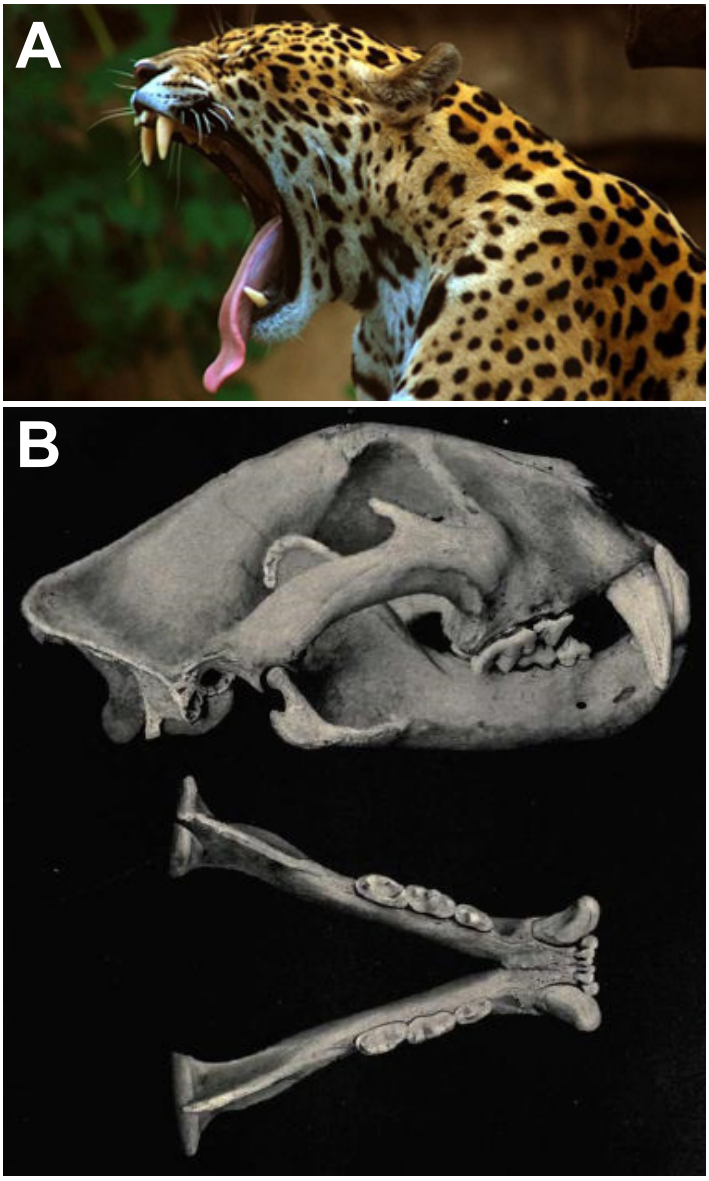

Figure 1. *A*, Jaguar (used by permission; *Panthera onca*, jaguar © MarcusObal, Creative Commons Attribution-Share Alike 3.0 Unported. Available at: http://www.nhm.ac.uk/nature-online/species-of-the-day/biodiversity/endangered-species/panthera-onca/biology/index.html. Accessed 6 July 2014.)

B, Jaguar Skull (Public domain. Originally from Elliot DG. *The land and sea mammals of Middle America and the West Indies*. Chicago:Field Colombian Museum, 1904. Available at: http://commons.wikimedia.org/wiki/File:Jaguarskull. jpg#mediaviewer/File:Jaguarskull.jpg. Accessed 6 July 2014.)

at the river bank and ran to get the health center nurse. When the nurse got to the child, she found a pulse, so the relatives waited about 10 minutes for a river boat to take them to the nearest radio so they could call a medical evacuation plane. The village and surrounding area has no phone service. Meanwhile, the nurse administered 200mL Ringers Lactate and 500mg metronidazole intravenously (IV) and dressed the wounds, although shortly thereafter, the agitated child pulled out her IV line and pulled off her dressings. The flight was quickly arranged, but it took about an hour to transport the child, via speedboat, to the airstrip. The child then had a 1½ hour flight to Georgetown, followed by a 15 minute ambulance transfer to our hospital.

The child arrived at our ED approximately five hours following the attack. Adhering as closely as possible to the optimal treatment regimen given the available resources (Figure 2), the patient was immediately taken to the ED critical treatment area, where her vital signs were blood pressure 62/42mmHg, pulse 102/minute, temperature 99.3°F axillary, and respiratory rate 18/minute. Her random blood sugar was 258mg/dL. The pulse oximeter was not functioning that day.

The ED staff performed a rapid physical exam, quickly placed the child in a cervical collar, cleaned and dressed her wounds, and started two peripheral IV lines (Figure 3). They administered ceftriaxone 1 gram, metronidazole 180mg, and 2 liters of Ringers Lactate. Laboratory results on admission were hemoglobin (Hgb) 5.0g/dL, white blood cell (WBC) 16,500/mm^3 (Polys 73%, Lymphs 25%, Eos 1%, Bands 1%), platelets 364,000/μL, Na 139mEq/L, K 3.6mEq/L, Cl 108mEq/L.

Physical examination showed an awake, alert and cooperative child with multiple deep lacerations over her scalp, face, and torso. A puncture of the skull was observed within a scalp laceration. A portable chest radiograph and an eFAST exam demonstrated no abnormalities. At that point, general, orthopedic, and neurosurgery consults were obtained. Ophthalmology became involved near the end of the patient's hospital stay.

A computed tomography (CT) without contrast was performed at a hospital 10 minutes away because the local CT scanner was inoperative. It demonstrated fractures along the left frontal bone involving the superior border of the left orbit, small areas of pneumocephalus in the cortical and interhemispheric regions, non-hemorrhagic contusion/edema in the left frontal lobe, and soft-tissue swelling of the scalp and face.

About four hours post-arrival and nine hours post-injury, her vital signs were blood pressure 100/62mmHg, pulse 100/minute, temperature 99.8°F axillary, and respiratory rate 32/minute. At that point she was taken to the operating room. They found an open fracture to the left fronto-temporal region, a depressed fracture to the left middle parietal bone, and boney defects in the left frontal zygomatic arch and left frontal bone. A depressed fracture of the left posterior parietal bone with a 5cm dural tear was flushed with normal saline and the edges debrided and skin closed (Figure 4). An open fracture to left angle of mandible was washed and closed, and a laceration to the left nostril extending onto the left side of the face was repaired.

Post-operatively, the child was sent to the intensive care unit on a ventilator. She received two units of packed erythrocytes—one intra-operatively and one post-operatively. Post-operative laboratory results were: Hgb 9.3g/dl, WBC: 11,500/mm^3 (polys 62%, lymphs 30%, bands

IMMEDIATELY
1. Safely remove human victim from felid's proximity and keep others away from the area.
2. Check and optimize patient's airway and breathing.
3. Control bleeding with direct pressure.
4. Immobilize the spine if the head, neck, or back are injured.
5. Splint large wounds and suspected fractures.
6. Expeditiously transport the patient to the local healthcare facility.

AT LOCAL HEALTHCARE FACILITY
1. Reassess ABCs and intervene, when possible.
2. Arrange timely transport to the best available healthcare facility.
3. If available, place intravenous lines and give normal saline and available antibiotics.
4. Clean and vigorously irrigate wounds using potable water and regular soap, if no other option exists. If a virucidal agent (e.g., povidone-iodine solution) is available, use it to irrigate the wounds, especially if rabies immunization will not occur. Gently remove foreign material.
5. After cleaning, cover wounds with a clean, dry dressing.

AT HIGHER LEVEL HEALTHCARE FACILITY
1. Evaluate ABCDE and treat accordingly.
2. Perform a careful secondary physical exam.
3. Place cervical collar.
4. Do an eFAST exam.
5. Give normal saline through two large-bore intravenous lines (appropriate dose for body mass). Begin a massive transfusion protocol if indicated (i.e., shock, thromboelastometry, shock index).
6. Obtain baseline laboratory tests, including type and crossing for transfusion, if needed.
7. Perform additional imaging, including CT scans, as soon as the patient is stable.
8. Administer antibiotics as early as possible. Generally, this will be a broad-spectrum antibiotic such as a beta-lactam/beta-lactamase inhibitor combination (e.g., amoxicillin-clavulanate). Alternatively, administer a penicillin and a first-generation cephalosporin, or a second-generation cephalosporin, or clindamycin and a fluoroquinolone.
9. If needed, administer tetanus prophylaxis (booster or entire initial series). If tetanus immune globulin is available and the patient has not had primary immunization series, administer TIG with the first dose of tetanus toxoid.
10. If available, administer rabies post-exposure prophylaxis treatment.
11. Perform surgical repair of injuries, including stabilization of fractures and exploration of wounds with meticulous debridement and surgical wound closure.

Figure 2. Optimal actions, evaluation and treatment for large felid injuries.[1,3,16,21]
eFAST, extended focused assessment with sonography for trauma; *ABC;* Airway,Breathing, Circulation; *ABCDE*, Airway, Breathing, Circulation, Disability, Exposure; *CT*, computed tomography; *TIG*, tetanus immune globin

Figure 3. Child in the emergency department.

8%), platelets 171,000/μL, Na 136mEq/L, K 4.4mEq/L, Cl 109mEq/L, BUN 12mg/dL, creatinine 0.6 μmol/L. Post-operatively, she received metronidazole, amoxicillin/clavulanate, and gentamycin. The child self-extubated on the third day and was discharged the next day to the pediatric surgical ward. She was discharged from the hospital 22 days after arrival (Figure 5).

The child returned home to normal activities. Her only deficits are healing wounds with some scarring across her face and a left ptosis, most probably from local nerve injury.

DISCUSSION

This case describes a severe life-threatening attack of a non-captive jaguar on a human child in South America, which has been rarely described in the medical literature.[1] The jaguar evolved in Europe or Asia at least 1.8–2.0 million years ago and colonized the Americas via the Bering Strait and the Panama (Darien) Isthmus. Although it looks much like a leopard (*felis pardis*), DNA studies indicate that it is more closely related to the lion (*P. leo*) or the snow leopard (*P. uncial*).[6] The word "jaguar" comes from one of the Tupi–Guarani languages, and means all carnivorous beasts. Their specific word for jaguar is *jaguareté*, with the suffix *-eté* meaning "true."[7]

Figure 4. Child in the operating room.

Figure 5. Child in the clinic prior to discharge (published with written parental permission).

Geographical Distribution

Jaguars currently inhabit a region from northern Argentina to as far north as southern Arizona, a ranging area that has contracted approximately 46% over the past century.[8] The child in this case lives within the Guyana-Montane Forest, where the numbers of jaguars have decreased over the last decade.[9,10] While the jaguar prefers dense rainforest, it will range across a variety of forested and open terrains. It is strongly associated with the presence of water and is notable, along with the tiger, as a feline that enjoys swimming.[11] The child in this case was attacked adjacent to a major waterway.

Population Decline and Protection

A jaguar's typical lifespan in the wild is around 12 to 15 years; in captivity they live up to 23 years.[11] Human population growth inevitably leads to jaguar population decline and eventual local extinction. This stems from deforestation and fragmentation of their habitat with barriers.[6] Both are occurring in the region in which this attack occurred. Jaguars also are killed by ranchers and farmers to protect their livestock or out of fear, and by professional hunters for their skin and other body parts.[6] The jaguar is considered "near threatened"[12] or "endangered,"[13] and all commercial trade is prohibited.[14]

Anatomy

The jaguar has a short and sturdy physique that makes it adept at climbing, crawling, and swimming.[11] It normally weighs 56 to 96kg (124 to 211lb), with larger males weighing as much as 160kg (350lb) (roughly matching a tigress or lioness). Females are typically 10% to 20% smaller than males.[15] Further north, its size diminishes. In Guyana, specimens up to 200lb have been seen, while in the forests of Paraguay, Southern Brazil and Bolivia, jaguars weigh up to 300lbs. The jaguar is more powerfully and heavily built than the leopard, standing 63 to 76cm (25 to 30in) tall at the shoulders. Their length, from the nose to the base of the tail, varies from 1.2 to 1.95m (3.9 to 6.4ft).[15]

Jaguars have sharp, strong, retractile claws, which they use to grasp prey and puncture its spine, cervical soft tissues, and skull. Deep lacerations and tissue loss from their claws also often occur. Wounds have included extensive deep lacerations of cervical structures, including transection of the trachea, and lacerations of the jugular vein, carotid artery and cervical nerves. Some of these injuries were only discovered during operative exploration.[16] In other cases, cervical spine dislocations and spinal cord transections were only discovered at autopsy.[1,17] Most of this patient's injuries were from clawing, rather than from bites, although her potentially lethal wound was the bite through her skull.

Jaguars generally have a tawny yellow coat, but it can range from reddish-brown to black. The dorsal coat is covered in rosettes for camouflage and its ventral area is white. The spots vary over individual coats and between individual jaguars: rosettes may include one or several dots, and the shapes of the dots vary. The spots on the head and neck are generally solid, as are those on the tail, where they may merge to form a band.[11] The rosettes on a jaguar's coat are larger, fewer in number, usually darker, and have thicker lines than the leopard, as well as small spots in the middle that the

leopard lacks. About 6% of jaguars are black (melanistic) "panthers," a designation that stems from polymorphism rather than denoting a separate species.[11] They reside, among other locations, along the Guyana–Venezuelan border, where the described attack occurred.[6]

Hunting

Jaguars are opportunistic killers, walking until they encounter prey and eating what is available. Jaguars' hunting activity varies with prey availability, which means it hunts mostly at night. They have very large (males 28–40km;^{2} females ≥10km^2) non-overlapping hunting ranges, often changing the specific hunting area within their range every two weeks.[18] That makes two attacks in the same area on the same child within a month extremely unusual. On average, a jaguar kills a large- or medium-sized prey every four days, although they typically do not consume an entire large carcass.[6] In captivity, a 76kg jaguar typically consumes the equivalent of 1.4kg/day (34g/day/kg cat).[19]

The jaguar tends to take larger prey, usually over 22kg (49lb), and often weighing 10%–80% of its own body mass.[19] Their preferred natural prey includes capybara (*Hydrochoerus hydrochaeris*, a large aquatic rodent weighing ~25kg), peccaries (*Pecari tajacu* and *Tayassu peccary*), tapirs (*Tapirus terrestris*), and caimans (Alligatoridae family).[1] When it encroaches on domestic animals, "it is by no means an unusual feat for a 150lb jaguar to kill a 1,000lb steer, and drag the carcass for a hundred yards to the seclusion of some thicket and there to dine in comfort."[15]

Children as Prey

Since the size of their prey influences large cats, children make especially likely targets for attacks.[3] In the United States, the majority of big cat attacks involve children.[3] The child in this case closely matched the physical characteristics of a jaguar's typical prey. Not only the child's size and weight (24kg), but also her head size was very similar to that of capybara (average skull length 18–20cm).[20]

Killing Behavior

Jaguars stalk and ambush, rather than chase their prey, attacking from nearby cover and quickly pouncing from a target's blind spot—sometimes from a tree.[15] With bigger prey they may jump over them, biting the nape of their neck and dragging them down.[6] The ambush may include leaping into the water after its prey or, as in one reported case, knocking its human victim out of a boat, since a jaguar is quite capable of carrying a large kill while swimming.[1]

The jaguar skull is robust and massive, supporting a powerful jaw with very long and massive canines. Among mammals, the jaguar has the third most powerful bite, estimated at 74% of a *P. leo* (lion) bite force and 84% of a *P. tigris* (tiger)—both of which have an estimated biting force of more than 1,000lb/square inch.[21,22] This allows it to pierce the shells of armored reptiles and to directly bite through a turtle's shell or a tapir or cow's skull, penetrating its brain.[6] According to one scientific observer, "The jaguar seems to take the head into its mouth and with an opposing set of canines bite one or more times until the teeth penetrate the brain."[20] That was the most serious injury our patient received.

EVALUATION AND TREATMENT

This patient's evaluation and treatment reflects other cases described in resource-limited settings. It parallels, but does not exactly replicate, recommended optimal treatment for these injuries (Figure 2). After the child was attacked in a remote area at the margin of the Amazon Basin, relatives and neighbors forced the jaguar to drop the child and then killed the animal. They then transported the child to the local nurse-staffed health center, where the nurse administered the most appropriate medications she had available and washed the wounds with water and applied moist dressings, most of which the child removed. She wanted to use povidone-iodine as a potential antiviral agent against rabies, but none was available.[23] The possibility of rabies existed after this unprovoked attack by a wild mammal that has been known to carry rabies.[24] She assumed (correctly) that the child had received primary tetanus immunizations and so did not administer it.

The child's relatively short transport time from an almost inaccessible jungle area to the country's main hospital was a remarkable feat. The child's village is located eight hours (by jetboat) and two weeks (by motorboat) up river from the nearest town (Bartica, Essequibo). The ready availability of medical evacuation is in part due to the Guyanese government guaranteeing payment for such flights.

The child arrived at the ED unannounced, since no mechanism exists for contacting hospitals from remote regions—either for guidance or to inform them about arriving patients. No telephone service exists anywhere near the child's village. She was transported on her mother's lap via a small fixed-wing plane, since no other means were available. A cervical collar was applied only upon her arrival at our ED. After arrival in the tertiary care facility ED, the evaluation and treatment closely followed the steps in Figure 2.

A careful primary and secondary trauma-oriented exam demonstrated that the neck and torso wounds were not deep enough to have caused structural damage, while the facial wounds communicated with bony fractures and the scalp wound contained an obvious (when examined carefully) puncture wound of the skull. We started IV lines with 0.9% normal saline, drew bloods for baseline laboratory tests and type and cross-match, further cleaned the wounds and administered antibiotics.

Since the child appeared clinically stable—and neurologically normal – and our chest radiograph and eFAST exam were negative, we agreed with the consulting surgeons that it was safe to send the child to a nearby institution for a

CT of her head and cervical spine, since the scanner associated with the hospital (but which still would have required a short ambulance transfer) was temporarily inoperable. We discussed administering rabies post-exposure prophylaxis for this unprovoked attack of a mammal in a rabies-endemic area; however, none was available.

Given the extent of soft tissue and intracranial damage, the child was taken to the operating room for a craniotomy and facial bone and soft tissue debridement and repair. While mammalian bite wounds carry an infection rate of 10%–20%, all her wounds were closed primarily, since most were on her face and scalp, they were highly vascular and she appeared to have few of the major risk factors for infection: 1) devitalized or low-vascularity areas; 2) deep punctures, macerated or crushed tissue; 3) tissue loss or avulsion; or 4) patients >50 years old who have chronic diseases or are immunocompromised.[1,25]

The patient received transfusions to bring her Hgb levels above 8g/dL. Her antibiotics were changed to match the polymicrobial organisms anticipated from these injuries. Mechanical ventilation continued until self-extubation, an unfortunate but relatively common occurrence in ICUs with limited staff. After discharge from the hospital, she and her relatives stayed in an Amerindian housing unit supplied by the government. During her subsequent clinic visit, she appeared to be doing well, so she and her family returned to the jungle. Arrangements were made for her to be seen at our hospital again in several months, at which time she again would be transported by a government-arranged plane.

CONCLUSION

Jaguar attacks on humans have increased as their habitat and available prey decreases and humans come in close contact with them more frequently. Clinicians assessing and treating these injuries must be aware of three critical and possibly occult injuries: disruption of the cervical spine, which may cause immediate death; intracranial tooth penetration; and laceration of the large cervical vessels. Awareness of these injuries, especially occult intracranial penetration, may help clinicians better manage these patients. In the remote areas where these attacks often occur, however, evaluation and treatment must succumb to optimizing the available resources.

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Die Another Day

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A 22-year-old healthy male university student presented to the emergency department (ED) complaining of syncope. He had five episodes of loss of consciousness from 10 to 40 seconds in length, with loss of postural tone and full recovery without intervention in the last month. Witnesses to these events denied tonic-clonic activity, and he had no sphincter tone loss. On the index ED visit the patient was in good condition, without distress. Primary survey was normal, he denied chest pain, dyspnea or headache. He had no history of tobacco or illicit drug use, and was a moderate social drinker. Secondary survey was unremarkable.

An electrocardiogram (ECG) was ordered during the ED visit. During the performance of the test the patient collapsed, and the ECG showed he had degenerated from sinus rhythm to ventricular fibrillation (VF) (Figure 1). Cardiopulmonary resuscitation with chest compressions were commenced immediately. He was defibrillated with 200 J biphasic shock, which returned him to sinus rhythm. He recovered consciousness after the shock and remained hemodynamically stable. A second ECG post defibrillation showed sinus rhythm with a right bundle branch block pattern and ST segment elevation in V1-V4 leads, compatible with a type 1 Brugada syndrome. The patient was

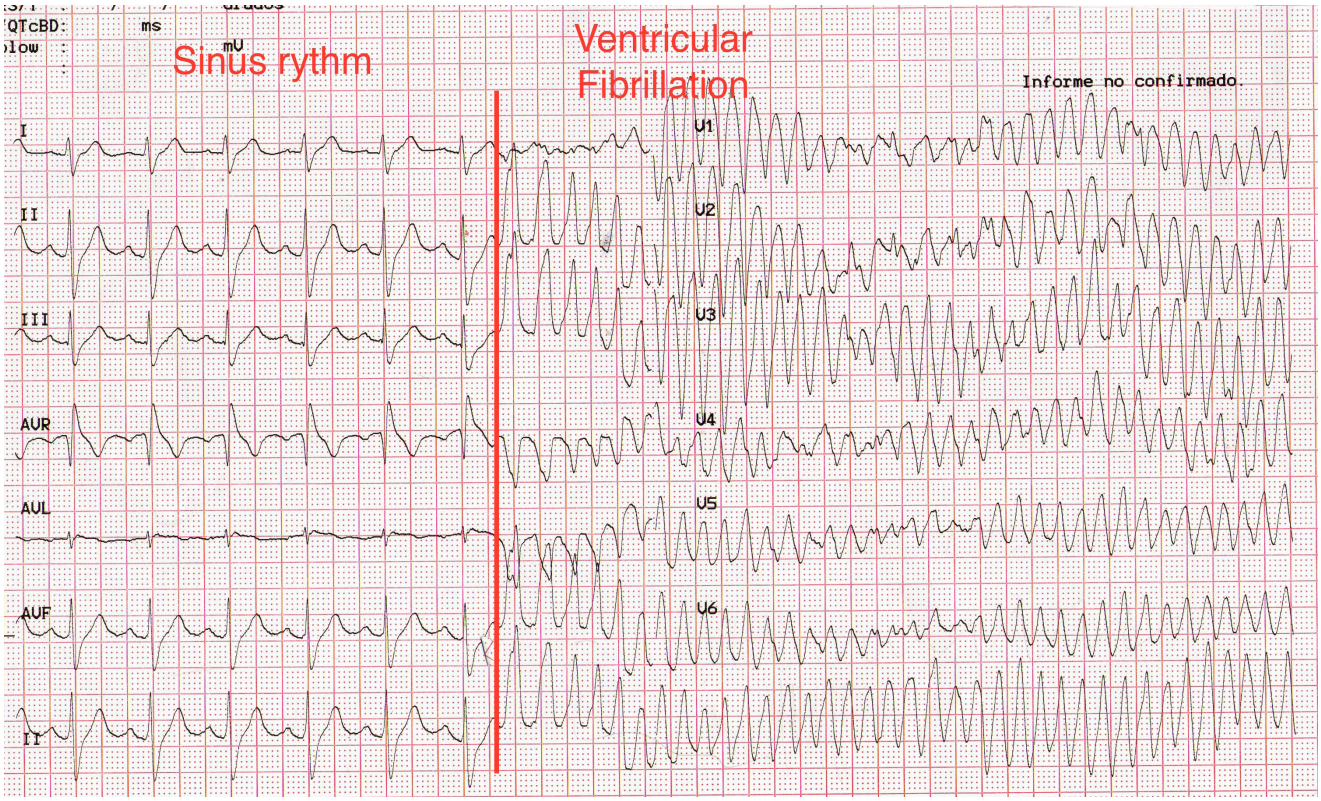

Figure 1. Twelve-lead electrocardiogram showing the degeneration from sinus rhythm to ventricular fibrillation.

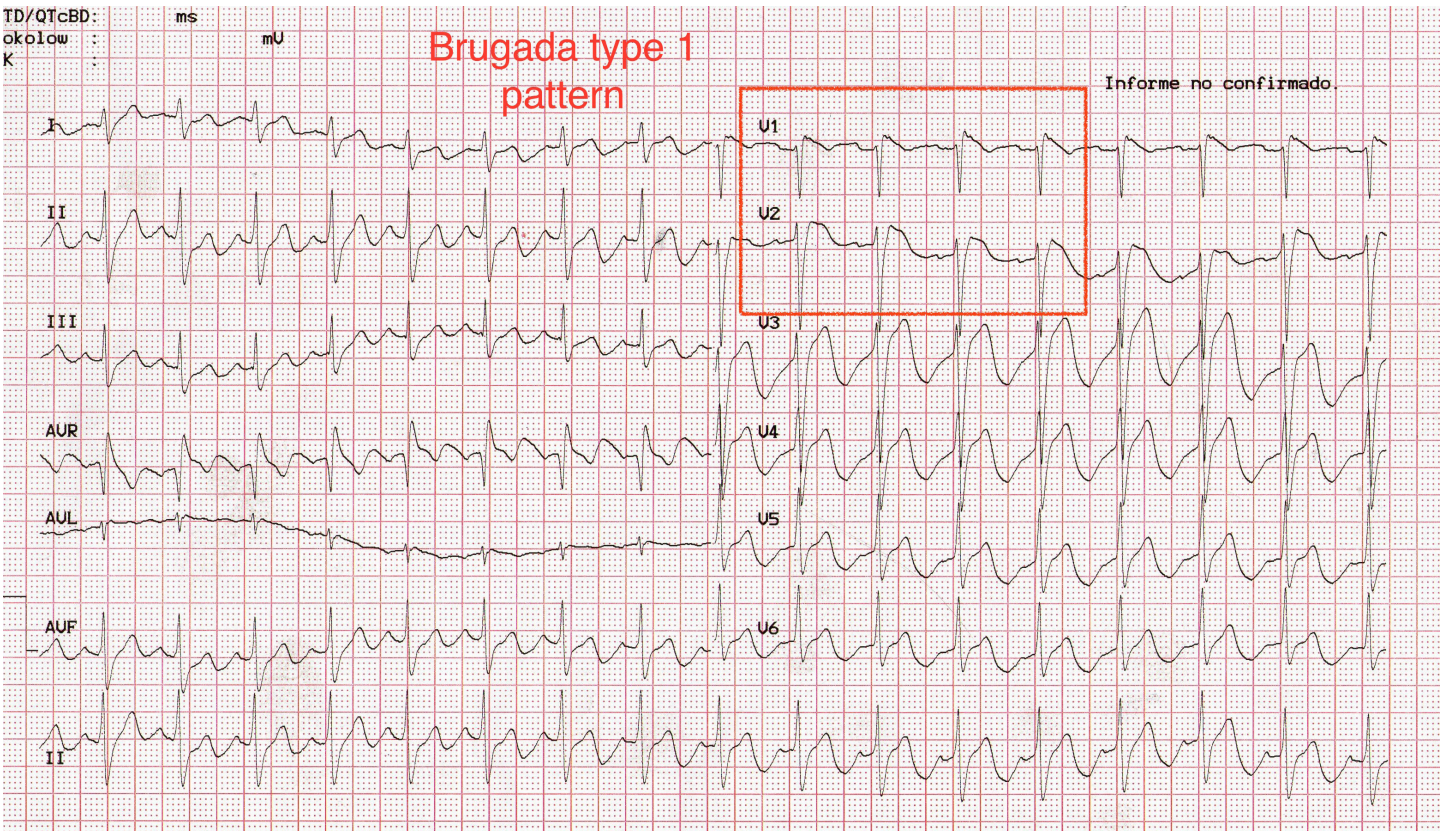

Figure 2. Twelve-lead electrocardiogram after successful defibrillation. Notice the Brugada type I pattern on the anterior leads.

admitted to the coronary critical care unit, and was evaluated by the electrophysiologist who confirmed the diagnosis. The patient had an automated implantable cardiac defibrillator inserted as an inpatient. He subsequently had no more episodes of VF in hospital and was discharged.

DISCUSSION

Brugada syndrome is a well-described cause of sudden death in young patients.[1] The resting ECG of these patients classically shows a characteristic incomplete or complete right bundle branch block pattern with ST-segment elevation in leads V1-V2 (Figure 2).

This is a unique case because an episode of spontaneous ventricular fibrillation was caught during the performance of a routine screening ECG. The ECG shows the dramatic transition from sinus rhythm to coarse ventricular fibrillation in a torsade de pointes-like pattern.

Definitive testing for Brugada syndrome should be done in the electrophysiology laboratory. If the diagnosis is confirmed, an automated implantable cardioverter-defibrillator (AICD) should be considered and placed.

This case is a reminder for emergency practitioners to look for the signs of Brugada syndrome on ECG in all patients who present with a history of syncope, since AICD placement is an effective and life-saving treatment. Baseline mortality in patients with Brugada syndrome can be as high as 10% per year, and this is essentially reduced to zero with AICD placement.[2] In this case the ECG morphology was consistent with a type 1 or coved-type Brugada syndrome. Type 1 Brugada syndrome is the most clinically important as it has the highest rate of spontaneous degeneration to ventricular fibrillation.[3]

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Descending Necrotizing Mediastinitis in an Infant

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CASE

A nine-month-old girl was brought to the emergency department because of right neck swelling. She had recently been discharged from the same hospital after a brief admission for pneumonia that had followed influenza.

The mother denied noticing increased drooling, dyspnea, or stridor. Pooled oral secretions were present on physical exam, but the patient was calm with normal vital signs (Figure 1). Computed tomography (CT) of the neck revealed a large retropharyngeal abscess tracking caudally into the posterior mediastinum (Figure 2). The infection extended into the adjacent right carotid sheath, producing a dramatic "Lincoln's Highway" sign (Figure 3).

DISCUSSION

Descending necrotizing mediastinitis (DNM) is a rare complication of retropharyngeal abscess (RA). The retropharyngeal space is bounded in the anteroposterior axis by the buccopharyngeal and prevertebral fascia, and extends from the base of the skull to the posterior mediastinum.[1] Most cases of nontraumatic RA occur in children <5 years old, whose retropharyngeal lymph nodes have not yet involuted, predisposing to abscess formation.[2,3]

In DNM, caudal spread of the infection (by mixed flora) is facilitated by gravity and negative intrathroacic pressure.[4] Recent reports suggest that RA and DNM are on the rise, which may be due to the increasing role of aggressive

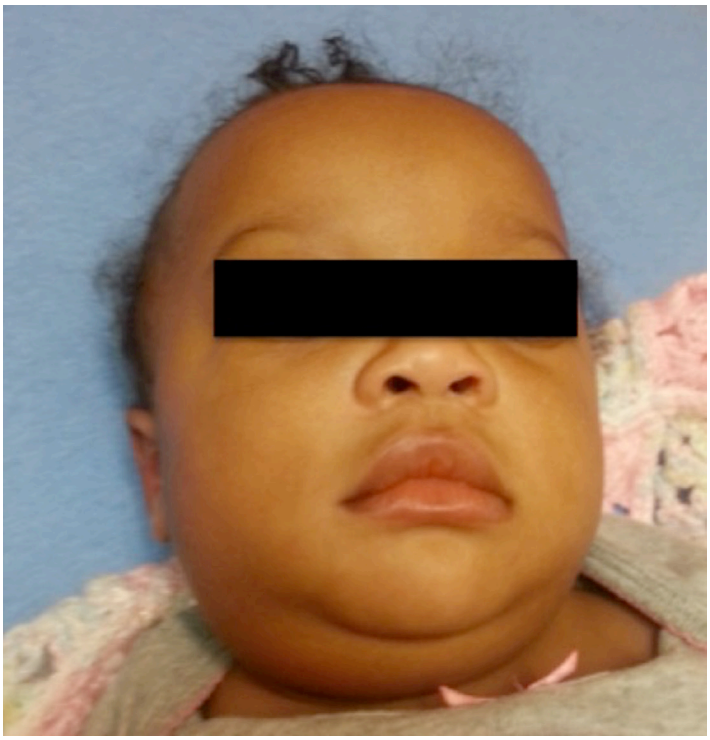

Figure 1. Notable swelling of the patient's right neck.

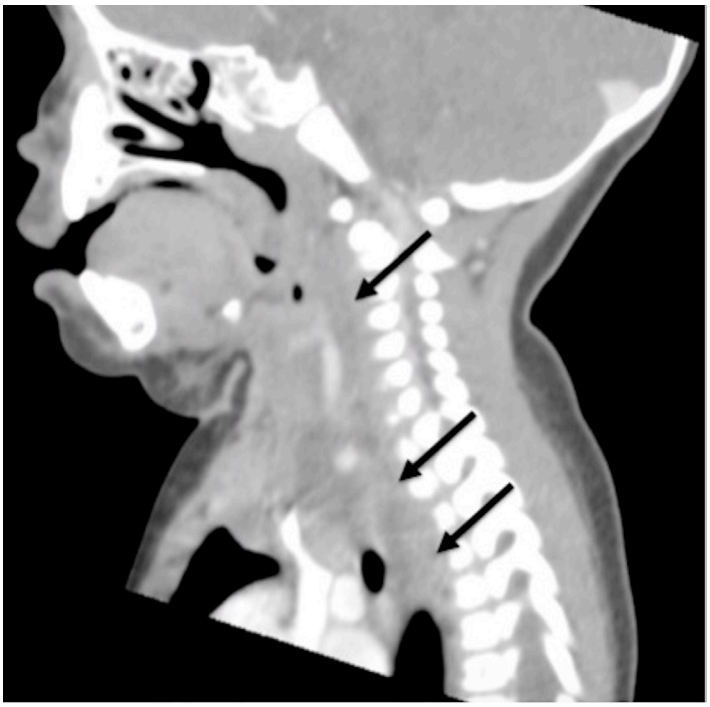

Figure 2. Hypointense retropharyngeal abscess tracking inferiorly into the mediastinum (arrows).

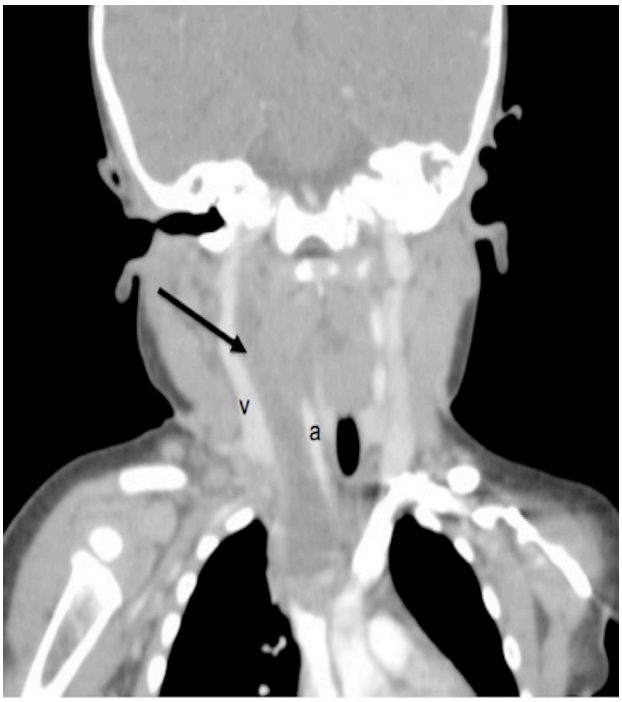

Figure 3. In the coronal view, the abscess (arrow) can be seen within the carotid sheath, separating the jugular vein (v) from the carotid artery (a).

bacteria such as community-acquired methicilin-resistant staphalococcus aureus (MRSA) in their pathogenesis.[5,6]

Children typically present with irritability, neck pain, and increased secretions; stridor is infrequently observed. Lateral neck radiographs demonstrate widening of the prevertebral soft tissue, defined as a diameter equal or larger to that of the contiguous vertebral body.[7] DNM is suggested by widening of the mediastinum seen on chest radiograph, but contrast-enhanced CT remains the imaging modality of choice.[8] After airway assessment, all patients should be started on intravenous clindamycin and consulted to otolaryngology or interventional radiology to evaluate for possible abscess drainage.[3,9]

The patient was given one dose of IV clindamycin in the emergency department. Her airway remained patent, and she was transferred to a pediatric hospital for drainage of the abscess. She did well and was discharged home on oral antibiotics on postoperative day 5.

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Left Flank Pain

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An 18-year-old female presented to the emergency department with three days of worsening left flank pain. Past medical history included asymptomatic bacteriuria. She denied prior similar episodes or inciting events, and was currently being treated with trimethoprim sulfamethoxazole by an urgent care center for a urinary tract infection, although she denied having any urinary symptoms. Upon evaluation, she was found to be in severe pain, refractory to multiple doses of opioids. Her examination revealed fever, mild tachycardia and tachypnea, and clear lungs, with significant tenderness to palpation on her left flank. Initial laboratory evaluation showed a leukocytosis and bacteriuria.

A computed tomography of the abdomen and pelvis was ordered with intravenous contrast to rule out pyelonephritis and infected renal calculus. It revealed Figure 1, which shows an inflamed pulmonary sequestration in the posteromedial left lung base, with a surrounding pleural effusion. An independent arterial blood supply branching off of the descending thoracic aorta was later confirmed with angiography, shown in Figure 2, which further revealed infarction secondary to torsion.

A pulmonary sequestration is a congenital malformation of independent, nonfunctioning, pulmonary tissue that does not communicate with the tracheobronchial tree and often has its own independent systemic blood supply.[1-4] Both the location and associated effusion in this image indicate an extralobular pulmonary sequestration, which is defined by the presence of its own pleura.[1,2,5] Presentation can occur at various ages and can include recurrent pneumonia, hemoptysis and pain, and persistent or severe symptoms may indicate surgical resection.[5,6]

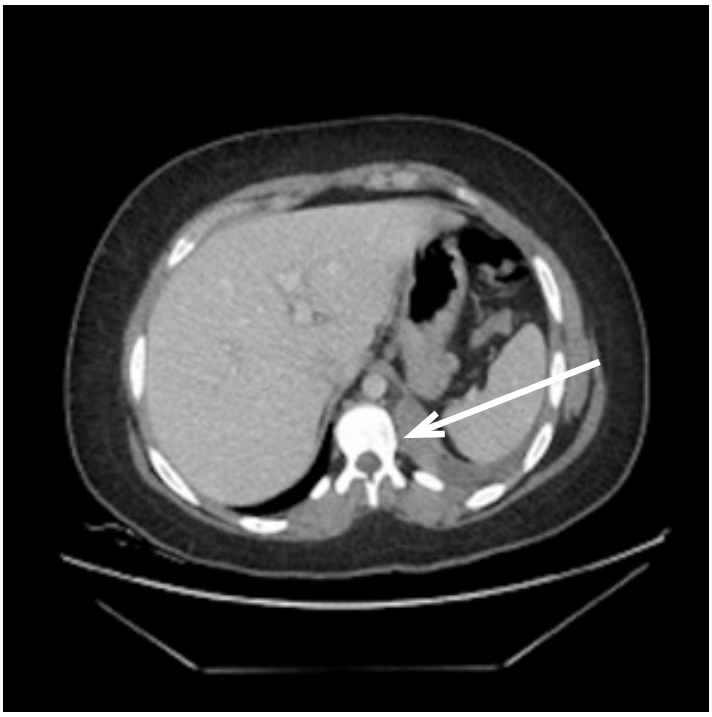

Figure 1. Computed tomography image of thorax with pulmonary sequestration present at left base.

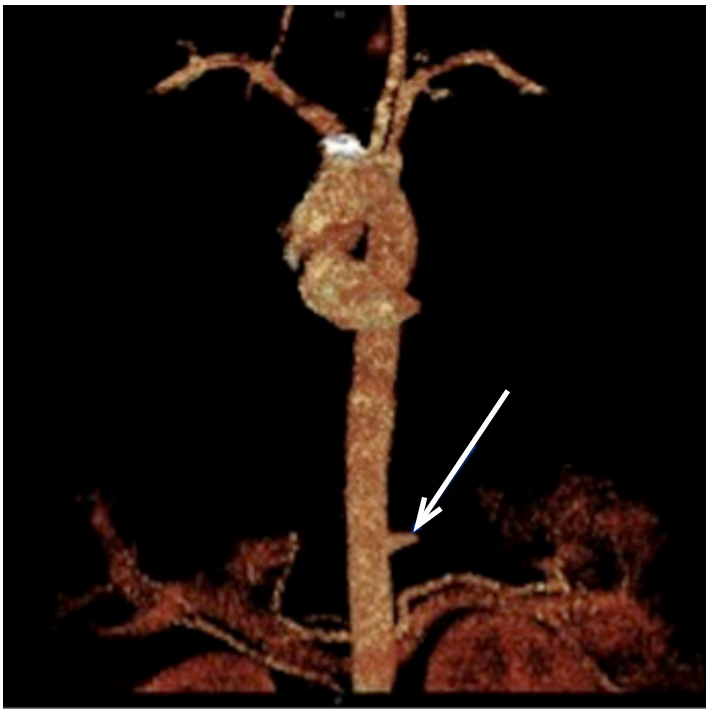

Figure 2. Angiography showing arterial blood supply to pulmonary sequestration with abrupt lack of flow due to torsion.

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Cecal Diverticulitis: A Diagnostic Conundrum

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We report an unusual presentation of a 63-year-old female who presented with a five-day history of right-sided loin to groin pain. On assessment she was afebrile and her observations were stable. She had right iliac fossa pain and tenderness in the right renal angle. Urine dip was positive for blood only. A routine set of bloods revealed normal inflammatory markers and renal function. A differential diagnosis of renal colic was made as a cause for her symptoms, and after analgesia and intravenous (IV) fluids her symptoms settled and the patient was discharged with an urgent outpatient CT urogram the next day. She was readmitted two days later with recurrent symptoms and raised inflammatory markers. The CT from the previous day illustrated cecal diverticulitis (Figure 1 and Figure 2). The patient received 24 hours of IV antibiotics, and she was discharged on oral antibiotics the following day with a colonoscopy request to complete the assessment.

Cecal diverticulitis is a rare entity in Western countries. Its incidence is reported at 1-2% in Europe and the United States.[1] Right-sided diverticulae of the colon involve all layers of the colon making them true diverticulae, whereas left-sided diverticulae are false.

Clinical diagnosis is problematic, and the most common misdiagnosis is appendicitis resulting in surgical exploration. CT imaging has a sensitivity and specificity of 98% for appendicitis and has also the benefit of confirming or excluding alternative diagnoses such as renal colic.

CT has been shown to be cost effective in comparison to direct surgical exploration.[3]

The diagnosis of cecal diverticulitis is based on clinical judgment and radiological diagnosis. The management of the condition can be conservative if malignancy has been excluded or surgical. Surgical options include an isolated resection or when cecal adenocarcinoma cannot be excluded by a formal right hemicolectomy.[1,2]

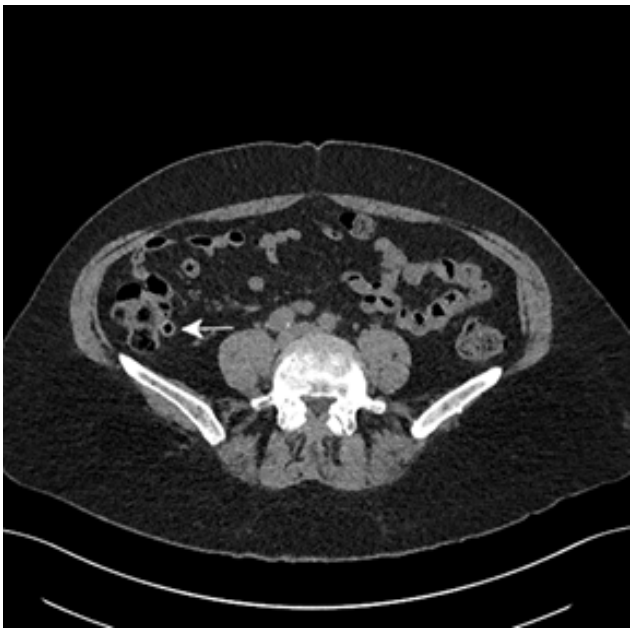

Figure 1. Axial view of the caecum with multiple diverticulae, one of which has a dense wall (white arrow).

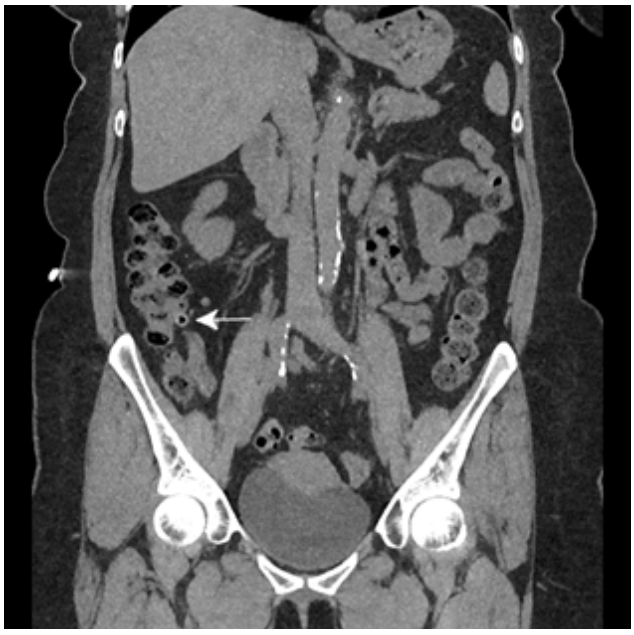

Figure 2. Coronal view of the caecum with multiple diverticulae, one of which has a dense wall (white arrow).

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Silent Killer: Case Report of Acute Gastrostomy Tube Erosion

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An 87-year-old male with multiple medical problems and percutaneous endoscopic gastrostomy (PEG) tube placement presented to the emergency department for recurrent dysphagia, constipation, and concern for stool appearing in his PEG tube. The patient denied PEG tube complications over the past year. The patient's vitals were within normal limits, and the exam was notable for a soft, non-tender, non-distended abdomen without masses or pain, with fecal contents observed in the PEG tube. Lab studies were unremarkable, and acute abdominal series films showed no evidence of obstruction or free air. A chest tomography (CT) of the abdomen and pelvis with contrast was performed, showing the gastrostomy tube linking the anterior aspect of the middle stomach with a portion within the transverse colon (Figures 1 and 2). The patient was admitted to the general surgery service for removal of the migrated PEG tube that eroded into the viscera.

Migration of PEG tubes into the colon is a rare complication of PEG tube insertion occurring in only 0.8% of patients in a seven-year clinical study.[1] While uncommon, it is considered a major complication requiring hospital admission and specialty consultation, due to risk for further migration, peritonitis, or sepsis. Presenting symptoms of a colonic PEG migration include the onset of copious diarrhea and cramping

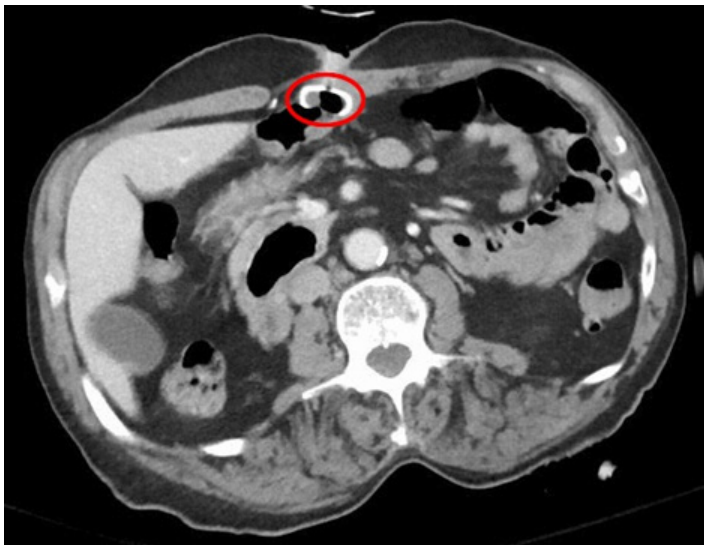

Figure 1. Cross section showing erosion into bowel wall (circle).

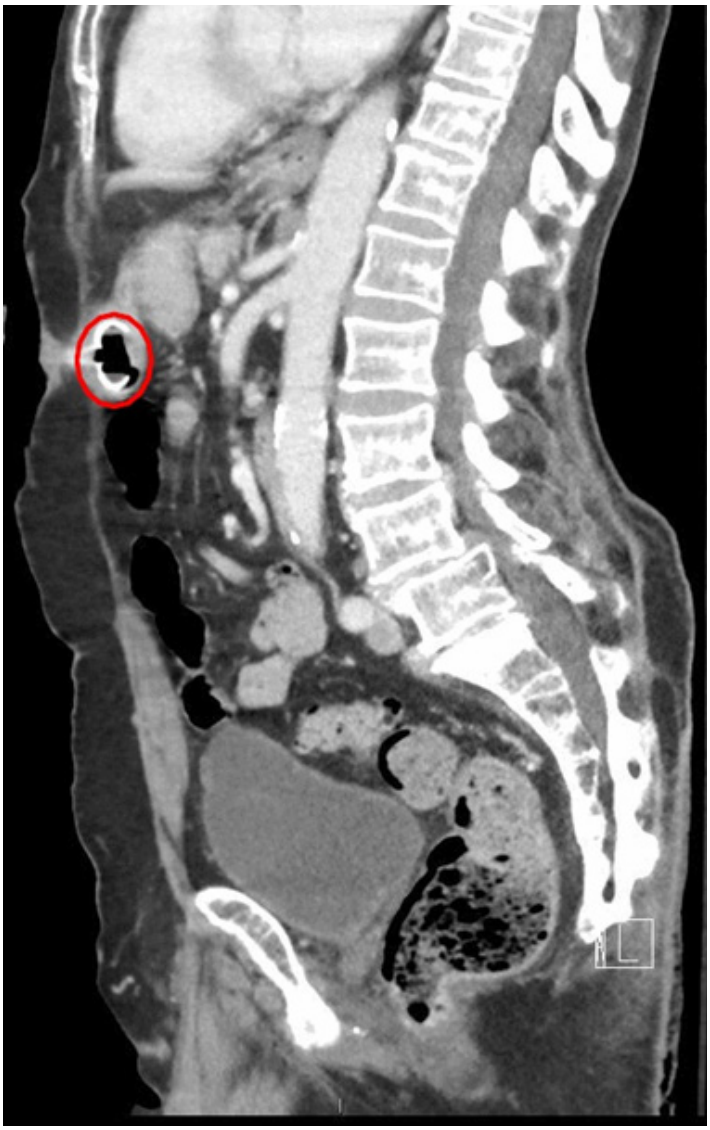

Figure 2. Sagittal section showing erosion into bowel wall (circle).

(50%), often after tube feeding, fecal leakage (39%), or odorous fecal exudates from the stoma.[2] Risk factors for migration and fistula formation include previous abdominal surgery, post-surgical adhesions, and a superiorly displaced transverse colon.

Assessment may be delayed due to overlying medical co-morbidities and otherwise unremarkable physical examination, which can delay accurate evaluation and surgical intervention. Of note, patients with neurological injuries may have limited perception of pain, resulting in reduced clinical flags potentially masking serious complications.[3] Thus, close attention to vague abdominal or referred symptoms in this patient population is critical to timely diagnosis and treatment.

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Penile Foreskin Avulsion from Parrot Fish Bite

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A healthy, uncircumcised 34-year-old male presented to an emergency department (ED) in Tinian (Commonwealth of the Northern Mariana Islands) after a parrot fish bite. The patient was spearfishing in the Philippine Sea and impaled a 15-pound parrot fish. As the patient was attempting to grasp the speared fish it bit him in the groin exterior to his swimming trunks. He experienced immediate penile pain and swam back to shore. Upon removal of his intact swimming trunks, the patient noticed a two-centimeter foreskin avulsion at the proximal penile shaft (picture). He presented to the ED where extensive irrigation of the wound with normal saline was initiated, followed by administration of local anesthesia and laceration repair with sutures. The patient was offered systemic analgesics but declined. He received tetanus toxoid immunization and was discharged with an antibiotic prescription for skin and marine flora with instructions to follow up in one week. The patient was contacted 10 weeks later for follow-up and stated that the avulsion healed well with good comesis and he has had no infections or issues with urination or erections.

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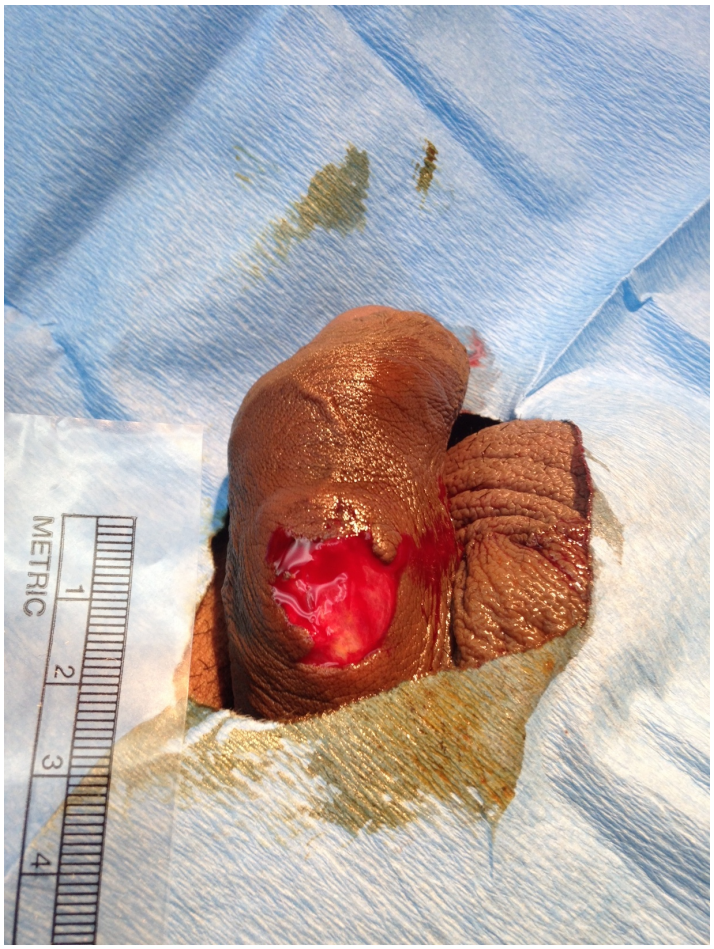

Figure. Penile foreskin avulsion from parrot fish bite.

Spontaneous Pneumomediastinum on Bedside Ultrasound: Case Report and Review of the Literature

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Spontaneous pneumomediastinum is a rare disease process with no clear etiology, although it is thought to be related to changes in intrathoracic pressure causing chest pain and dyspnea. We present a case of a 17-year-old male with acute chest pain evaluated initially by bedside ultrasound, which showed normal lung sliding but poor visualization of the parasternal and apical cardiac views due to significant air artifact, representing air in the thoracic cavity. The diagnosis was later verified by chest radiograph. We present a case report on ultrasound-diagnosed pneumomediastinum, and we review the diagnostic modalities to date. [West J Emerg Med. 2015;16(2):321–324.]

INTRODUCTION

Pneumomediastinum is defined as free air in the mediastinal cavity. It is considered spontaneous when there is no definite etiology, as opposed to secondary pneumomediastinum, which occurs with a clear causative factor. Spontaneous pneumomediastinum (SPM) is a rare condition with an incidence of less than 1:44,000.[1] The pathogenesis of SPM is thought to involve a change in intrathoracic pressure that causes an alveolar leak that leads to a dissection of air along bronchovascular sheaths and eventually into the mediastinum.[2] Patients often present with chest pain and dyspnea, which are nonspecific complaints and can be associated with an array of cardiopulmonary pathology presenting a challenge for the physician.

We report a case of SPM that was initially suspected by history and physical examination with supportive ultrasound findings, subsequently confirmed on chest radiograph. We then review the presentation, causes, and methods of diagnosis of pneumomediastinum, including a review of the literature of bedside ultrasound as a method of rapid evaluation.

CASE REPORT

A 17-year-old male with no prior medical history presented to the emergency department (ED) with acute chest pain. The patient had been at work as a restaurant server when he noticed a sudden onset of substernal chest pain. The pain began while at rest without associated trauma, coughing, or sneezing. During initial examination in the ED, the patient was in significant pain and distress. He described the pain as pleuritic, substernal, positional, nonexertional, and worse with leaning forward. It was associated with shortness of breath. Additionally, he complained of a "crunching" sound in the right ear. He denied fevers, recent illness, cough, vomiting, leg swelling, drug use, alcohol use, and smoking.

The patient had a heart rate of 79 beats per minute, oral temperature of 36.9 degrees Celsius, respiratory rate of 16 breaths per minute, oxygen saturation of 99% on room air, and was initially noted to be hypertensive at 150/72mmHg. He was found to have a precordial crunching sound that was synchronous with the heartbeat audible on cardiovascular exam. His pulmonary exam was limited secondary to his inability to take deep breaths due to pain with inspiration. He had palpable crepitus on the right side of his neck. His initial electrocardiogram (EKG) showed small inferior and lateral q waves and was otherwise unremarkable. No prior EKG was available for comparison.

A bedside point-of-care ultrasound was performed (Figure 1, Video 1). The presence of bilateral lung sliding was confirmed with a linear transducer in the 2nd intercostal spaces, thus decreasing the likelihood for a spontaneous

pneumothorax. Using the phased array probe, the subxiphoid view demonstrated normal cardiac contractility, normal chamber size, and lack of pericardial effusion. However, parasternal long, parasternal short, and apical views of the heart were of poor quality with diffuse A lines, suggesting air artifact. These views were not visualized despite changes in patient positioning from supine to left lateral decubitus. At this point, concern was greatest for a pneumomediastinum with air dissecting anterior to the heart, causing poor sonographic windows. Pneumomediastinum was favored over pneumopericardium given the subxiphoid window remained clear and anatomy not obscured, suggesting the diaphragm, pericardium, and myocardium were still in contact and not separated by air. A chest radiograph was obtained and confirmed the diagnosis of pneumomediastinum, based upon the presence of air dissecting along the mediastinum and bilaterally into the neck and left axilla. (Figure 2) Given the patient's findings, he was treated conservatively with oxygen by nasal cannula and admitted for observation with an unremarkable hospital course without requiring further intervention or imaging.

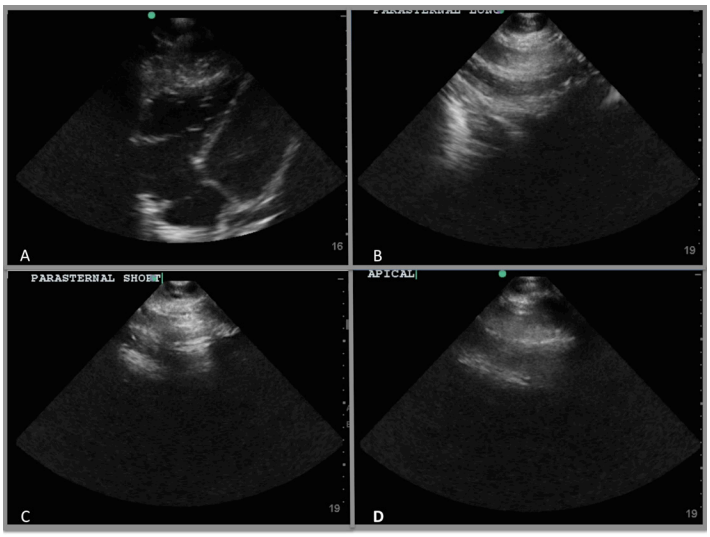

Figure 1. Bedside ultrasound images of patient with pneumomediastinum. (A) The subxiphoid view demonstrated normal cardiac contractility, normal chamber size, and lack of pericardial effusion. The parasternal long (B), parasternal short (C), and apical views of the heart were of poor quality with diffuse A lines (D), suggesting air artifact. These findings were suggestive of the presence of a pneumomediastinum.

DISCUSSION

The most common etiology of pneumomediastinum is trauma. Nontraumatic pneumomediastinum is spontaneous in approximately half of the cases in adult patients, more commonly in men.[3] A recent retrospective chart review of pediatric patients with pneumomediastinum demonstrates that idiopathic primary pneumomediastinum is the most common etiology, seen most often in adolescent males.[4] Younger children less than six years of age in this study were found to have secondary pneumomediastinum related to asthma, lower respiratory tract infection or pneumonia, foreign bodies, or croup.[4]

Chest pain is the most common presenting symptom in SPM, occurring in 72-75% of all patients with SPM, and up to 93% of pediatric patients. Other symptoms, such as dyspnea (48-59%) and cough (25-36%), were present less often. SPM has no known predisposing factors while secondary pneumomediastinum does, including smoking or tobacco use, asthma/chronic obstructive pulmonary disease (COPD), and interstitial lung disease or upper respiratory illnesses. Secondary pneumomediastinum can also be caused by increased intrathoracic pressure due to processes such as vomiting, strenuous activity, coughing, and childbirth.[2-4]

Subcutaneous emphysema or crepitus is a common finding noted on physical exam in up to 58% of patients. Hamman's sign, or the crunching or bubbling sound over the mediastinum synchronous with the heart sounds, although nearly pathognomonic for pneumomediastinum and present in our patient, is present only in a minority of cases (18%).[2]

Pneumomediastinum is most commonly diagnosed with chest radiographs (CXR), demonstrating free air tracking along the mediastinum or subcutaneous air in the shoulders or neck. Other radiological signs on CXR include the spinnaker sail sign or "angel wing sign," more commonly seen in the pediatric population, due to the dissecting air elevating the thymus; the ring sign, due to air surrounding the pulmonary artery or its main branches; and the Naclieros V sign, due to a hyperlucent V shape between the descending aorta and the left hemidiaphragm.[2,5]

CXR reportedly misses or underestimates the severity of the SPM in 10-30% of cases.[6-8] When CXR is equivocal but SPM is clinically suspected, computer tomography (CT) is generally considered the diagnostic standard to detect even small amounts of air in the mediastinum or subcutaneous tissues.[2,4,7,8] In one retrospective review, lateral neck radiograph proved to be diagnostic in patients who had normal frontal CXRs, demonstrating pneumomediastinum in 9 out of those 10 cases. Overall, out of 21 neck radiographs performed, 20 detected subcutaneous emphysema or prevertebral air collection.[4] However with national attempts to minimize radiation exposure, particularly in young patients, the utility of ultrasound has grown in many pulmonary applications; the identification of SPM by ultrasound is becoming increasingly common but is still in its early stages.[9,10]

Sonographic evaluation of pneumomediastinum was first described in 1983 as the "air gap sign," described as a broad band of echoes during held respiration due to accumulating air obscuring normal cardiac structures, with drop out of echoes posteriorly. This sign was notable for appearing cyclically with the cardiac cycle.[11] This sign was demonstrated in both pneumomediastinum and pneumopericardium. In 1994, a proposed mechanism to differentiate the two was

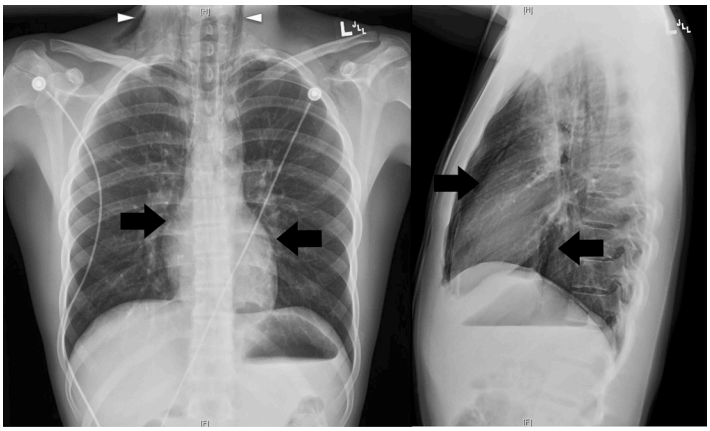

Figure 2. Chest radiograph, PA and lateral views.
PA, posterior-anterior
The patient's pneumomediastinum was confirmed on chest x-ray, based on the presence of air dissecting along the mediastinum (arrows) and into the lower neck region bilaterally (arrow heads).

described by the inability to see the heart with ultrasound in the subxiphoid view in pneumopericardium, as pericardial air extends inferiorly to the posterior reflection of the pericardium and scattering sound waves. However, in pneumomediastinum, the heart is well visualized in the subxiphoid view as it is in contact with diaphragm without obstructing air artifact.[12] This was evident in our patient who had normal subxiphoid views but with difficult visualization of parasternal and apical views.

Other diagnoses to consider on the differential for air on the parasternal and apical windows include pneumothorax, severe COPD, pediatric causes of obstructive diseases such as alpha 1 anti-trypsin disease, or severe bullous diseases such as advanced tuberculosis. These processes will cause air-filled lung to move into position between the probe and the parasternal and apical cardiac windows. However, the subcostal view in these patients will be unaffected, as in this case of SPM.

In 1992, ultrasound was used to help delineate the diagnosis on a neonate with a CXR ambivalent for a medial pneumothorax and a pneumomediastinum. Ultrasound demonstrated a "fluorescent white" echogenic rim of air outlining the cardiac shadow on the left and the right at the subxiphoid view, along with a thin sliver of air outlining the left hemidiaphragm, thus confirming spontaneous pneumomediastinum.[13]

Other cases of SPM have been reported with results similar to ours, with parasternal and apical views not obtainable due to air artifact, with an associated normal subxiphoid view.[6,14] SPM has been noted to be initially suspected due to ultrasound of the neck demonstrating both bullous hyperechoic artifacts around nerve sheaths extending along the aortic arch contour and "comet tails" or vertical gas artifacts in the anterolateral cervical region.[5,15] Ultrasound has even identified a thin anechoic band identified as air, separating the pericardium from the pleural line.[5]

A recent study evaluated the use of ultrasound to evaluate for pneumomediastinum in neonates with abnormal mediastinal radiolucency on CXR. The study demonstrated not only the ability to detect the pneumomediastinum, but also identifies the location of air collection, which is most commonly the anterior margin of the thymus. This correlates with the raised thymus causing the spinnaker sail signs present on CXR.[16]

Management of SPM may include hospital admission for observation, especially for patients who are in distress, febrile, having worsening symptoms, or if secondary pneumomediastinum cannot be ruled out. Well-appearing patients with no concerning signs and symptoms may be treated with ambulatory care. Treatment generally consists of oxygen administration, pain control, and possible prophylactic antibiotics. More invasive intervention is rarely required and depends on the severity of symptoms or development of complications such as a tension pneumothorax.[8,17]

In conclusion, we have presented a case of spontaneous pneumomediastinum, which supports the use of bedside ultrasonography to aid in the diagnosis and rapid recognition of this less common cause of chest pain. When evaluating chest pain, SPM should be suspected when bedside echo demonstrates poor visualization of the heart with diffuse A lines in the parasternal and apical views in conjunction with normal visibility from the subxiphoid view. We can foresee in the future that ultrasound will be used more commonly to quickly evaluate for SPM in clinical practice, as well as more accurately diagnosed when evaluating for other thoracic disorders such as pneumothorax.

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Video. Spontaneous pneumomediastinum on bedside ultrasound.

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Disaster Response Team FAST Skills Training with a Portable Ultrasound Simulator Compared to Traditional Training: Pilot Study

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Introduction: Pre-hospital focused assessment with sonography in trauma (FAST) has been effectively used to improve patient care in multiple mass casualty events throughout the world. Although requisite FAST knowledge may now be learned remotely by disaster response team members, traditional live instructor and model hands-on FAST skills training remains logistically challenging. The objective of this pilot study was to compare the effectiveness of a novel portable ultrasound (US) simulator with traditional FAST skills training for a deployed mixed provider disaster response team.

Methods: We randomized participants into one of three training groups stratified by provider role: Group A. Traditional Skills Training, Group B. US Simulator Skills Training, and Group C. Traditional Skills Training Plus US Simulator Skills Training. After skills training, we measured participants' FAST image acquisition and interpretation skills using a standardized direct observation tool (SDOT) with healthy models and review of FAST patient images. Pre- and post-course US and FAST knowledge were also assessed using a previously validated multiple-choice evaluation. We used the ANOVA procedure to determine the statistical significance of differences between the means of each group's skills scores. Paired sample t-tests were used to determine the statistical significance of pre- and post-course mean knowledge scores within groups.

Results: We enrolled 36 participants, 12 randomized to each training group. Randomization resulted in similar distribution of participants between training groups with respect to provider role, age, sex, and prior US training. For the FAST SDOT image acquisition and interpretation mean skills scores, there was no statistically significant difference between training groups. For US and FAST mean knowledge scores, there was a statistically significant improvement between pre- and post-course scores within each group, but again there was not a statistically significant difference between training groups.

Conclusion: This pilot study of a deployed mixed-provider disaster response team suggests that a novel portable US simulator may provide equivalent skills training in comparison to traditional live instructor and model training. Further studies with a larger sample size and other measures of short- and long-term clinical performance are warranted. [West J Emerg Med. 2015;16(2):325–330.]

INTRODUCTION

Pre-hospital focused assessment with sonography in trauma (FAST) has been reported to be accurate and effective for triage and early diagnosis during numerous mass casualty events throughout the world.[1–9] As with any clinical task, proper knowledge and skills training is essential to ensure appropriate healthcare provider utilization and optimal clinical outcomes. Traditional FAST training requires didactic training and on-site expert live instructor skills training using healthy models with significant logistical challenges and cost.

Recently a portable ultrasound (US) simulator, the SonoSim laptop training solution, was developed specifically to rapidly train healthcare providers in the knowledge and skills of FAST. Review of narrated screencasts teaches the required knowledge. Deliberate practice obtaining patient US images with the SonoSim gyrometer probe and real-time simulator feedback teaches the necessary hands-on skills of image acquisition and interpretation.

A recent systematic review of 14 US simulation training studies reported a wide variability in research design and called for further investigation prior to widespread use.[10] Most studies have used medical students and other novice ultrasonographers. However, no study has described the effectiveness of a portable US simulator for skills training in comparison to traditional skills training for a mixed provider disaster response team.

The primary objective of this pilot study was to describe the effectiveness of novel portable US simulators in teaching the skills of the FAST examination in comparison to traditional training for a deployed mixed-provider disaster response team.

METHODS

We conducted a prospective randomized blinded trial of SonoSim versus traditional FAST skills training. The study was conducted at a satellite institution, Provident Hospital of Cook County, during the May 2012 Chicago North Atlantic Treaty Organization (NATO) Summit. Disaster response team members from Colorado and California were stationed at the hospital in the event of a crisis situation. As part of standard deployment training, a four-hour FAST US course was conducted by the Department of Emergency Medicine, Division of Emergency US, John H. Stroger, Jr. Hospital of Cook County.

The initial idea for this pilot investigation, study objective, methodology, and analysis were developed and conducted in collaboration between the Division of Emergency US and the Division of Emergency US and the Cook County Simulation program without industry involvement. US equipment (Sonosite TITAN, Bothell, WA) for the course was provided by Sonosite, Inc. Portable US simulators (SonoSim Ultrasound Training Solution, Point of Care Edition, Santa Monica, CA) were provided for the course by SonoSim, Inc.. No financial support was provided. Local institutional review acknowledgment was obtained for this exempt educational study of de-identified trainees.

The combined Colorado and California disaster response team was comprised of 36 mixed provider team members. Participation in this research project was strictly voluntary. After discussion of the educational course and research project, all disaster response team members agreed to participate and signed an informed consent.

At the start of the course, all participants first completed a pre-course US and FAST knowledge test previously developed by experts at the University of California at Irvine.[11] The 74-item multiple-choice test was validated in an earlier medical student examination of SonoSim by the Center for Research on Evaluation, Standards, and Student Testing.[11] The test assessed key content contained in SonoSim's narrated screencast didactics; specifically knowledge of anatomy, indications, contraindications, image acquisition, image interpretation, and clinical integration of US findings.

To learn the required FAST knowledge, all participants then reviewed US simulator-based narrated screencast didactics covering US physics, machine use, and FAST for 90 minutes. These didactics were created by national experts consulting with SonoSim, and reviewed by local investigators independently to ensure quality and absence of industry bias. No skills training was provided during this knowledge learning session.

Next, disaster response team members were stratified by provider role into physicians, nurses, paramedics, and other clinicians. The participants were then randomly assigned to one of three training groups: Group A. Traditional Skills Training, Group B. US Simulator Skills Training and Group C: Traditional Skills Trainings plus US simulator Skills Training. See Figure 1 for course and research study flowchart. For each participant we recorded basic demographic information including age, gender, provider role (physician, nurse, or paramedic), and prior US experience.

To learn the required FAST skills, participants then completed skills training based on group randomization. Each group was divided into three subgroups to create a 1:4 instructor/simulator to participant ratio. Skills training sessions lasted one hour during which all four participants in the subgroups received approximately 15 minutes of hands-on time. Group A and B received one hour of skills training while Group C received two hours of skills training.

After the skills training, to measure post-intervention skill in image acquisition, all participants individually completed a FAST standardized direct observation tool (SDOT) on a live healthy model. Evaluators were blinded to participant's provider role and prior US experience. Participants were asked to obtain each of the four FAST views and press freeze in less than one minute per view. Images were rated by the evaluator on a 1-5 scale (1 – no useful information provided

by the image, 3 – adequate image quality and visualization of relevant anatomy to make a clinical decision, 5 – textbook quality image). Evaluators were all US faculty, US fellows, or senior emergency medicine (EM) residents with US case totals above the American College of Emergency Physician's minimum benchmark of 150 emergency US exams. For the research project, evaluators were specifically given detailed instructions and provided with examples of all FIVE ratings in each FAST view during a two-hour faculty-only walk through session prior to the course.

To measure post-training skills in image interpretation, all participants individually completed a FAST image interpretation assessment comprised of a review of FAST images from four actual trauma cases. Participants identified the anatomical location of the obtained image as well as whether the image was normal or revealed free fluid. Lastly, all participants completed the same post-course US and FAST knowledge test.

Primary endpoints included FAST image acquisition and interpretation skills assessment scores. Secondary endpoints included pre-course and post-course US and FAST knowledge test scores.

The research project, including the administration and collection of study related forms, was completed by a team of four volunteer research assistants under the supervision of an experienced clinical research coordinator (EC). Two emergency US fellowship directors (JB and KC), coordinated logistics of the educational course and ensured that all participants benefitted from the learning experience.

We used the ANOVA procedure to determine the significance of group differences in FAST image acquisition and interpretation skills assessment scores. Two-tailed paired t-tests were conducted for each group to assess pre-course and post-course differences on the US and FAST knowledge test scores. We also used the ANOVA procedure to determine if any significant differences existed among groups on the knowledge test scores. We performed statistical analysis using SPSS version 21.0 (IBM Corp., Armonk, NY).

RESULTS

All 36 disaster response team members participated in the course and research project. The demographic data and baseline characteristics of study participants are summarized in Table. In each group, four of the twelve participants had received prior US training.

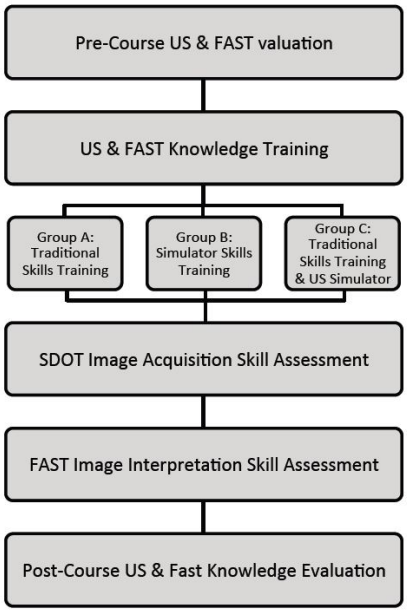

Figure 1. Study design.
US, ultrasound; *FAST*, focused assessment of sonography in trauma; *SDOT*, standardized direct observation

The primary endpoints of FAST image acquisition assessment scores between training groups are depicted in Figure 2. In each group, the mean image acquisition skills score was above 3 - acceptable to make a clinical decision. An additional ordinal and dependent analysis of image acquisition scores using a Krukal-Wallis test confirmed similarity between all groups. Likewise, mean image interpretation skills score was similar across groups. The mean (± SD) image interpretation score by group was; Group A. 76 ± 6%, Group B. 77 ± 6%, and Group C. 81 ± 6%. The ANOVA procedure did not demonstrate any statistically significant differences between the training groups' FAST image acquisition or image interpretation skills scores.

Table. Baseline characteristics of participants in FAST training.

	Traditional training n=12	US simulator n=12	Traditional training + US simulator n=12
Mean age (years)	50 ± 11	43 ± 13	43 ± 9
Sex			
Male	7 (58)	10 (83)	7 (58)
Female	5 (42)	2 (17)	5 (42)
Occupation			
Nurse	3 (25)	3 (25)	3 (25)
Physician	5 (42)	5 (42)	4 (33)
Paramedic/EMT	4 (33)	4 (33)	5 (42)

Data are reported as n (%) or mean ± SD. No significant differences between groups (p>0.05).
FAST, focused assessment with sonography in trauma; *US*, ultrasound; *EMT*, emergency medical technician

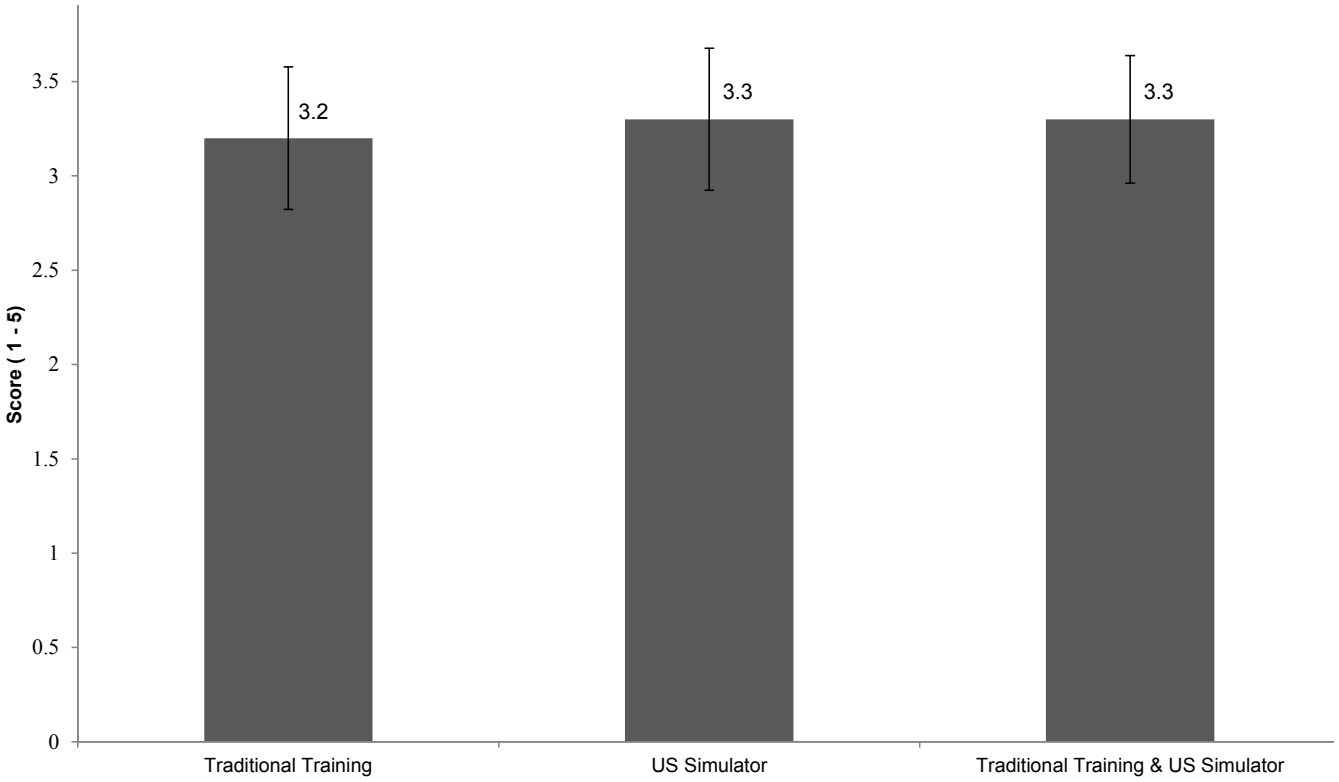

Figure 2. SDOT image acquisition scores across groups.
SDOT, standardized direct observation tool; *US*, ultrasound
Data are reported as mean with 95% CI. Images were rated by the evaluator on a 1-5 scale (1 – No information provided by the image, 3 – Adequate image to make a clinical decision, 5 – Textbook quality image).

The secondary endpoint of pre- and post-course US and FAST knowledge test scores are shown in Figure 3. Within each training group, there was a statistically significant improvement in the mean pre- and post-course knowledge test scores ($p<0.001$ in each group). The ANOVA procedure again did not reveal any significant differences between the three training groups' pre- and post-course knowledge gains ($p>0.05$).

DISCUSSION

FAST has been demonstrated to be an invaluable primary triage and diagnostic tool in multiple disasters even in remote locations.[1–6,9] Effective utilization of FAST by disaster response teams requires proper training. However, FAST training for disaster response team members has numerous logistical challenges. Although FAST knowledge may be effectively learned with narrated didactics, traditional skills training requires numerous US machines, instructors, models, and time.[12,13] Fortunately, over the last decade US simulators have been developed to quickly teach these skills.

Our results are similar to earlier work describing the utility of US simulators.[10] In a prospective randomized controlled trial, Girzadas et al. reported improvements in both EM resident learning and the evaluation using a pelvic US simulator.[14] Likewise, in a prospective study, Lee et al. demonstrated improved EM resident performance and confidence with a central venous insertion US simulator.[15] Outside of EM, Burden et al. reported that both novices and experts were able to adequately obtain images and specific measurements in a prospective cross-sectional comparative study utilizing an obstetric US simulator.[16] Similarly, Platts et al. demonstrated effective use of computer-based transthoracic and transesophageal echocardiogram simulators in acquiring images.[17]

Our pilot study is the first to compare traditional FAST skills training to a novel portable US simulator for members of a deployed disaster response team. Training with the US simulator appears to result in equivalent disaster response team member skill performance in both image acquisition and interpretation when compared to traditional FAST skills training. Furthermore, the provision of both types of training did not result in a statistically significant improvement over either alone, suggesting that the US simulator alone may be sufficient for FAST skills training.

Additionally, these initial results suggest that FAST skills may be easily taught to disaster response team members with non-physician healthcare providers. Similarly, Heegaard et al. reported that paramedics undergoing two training sessions

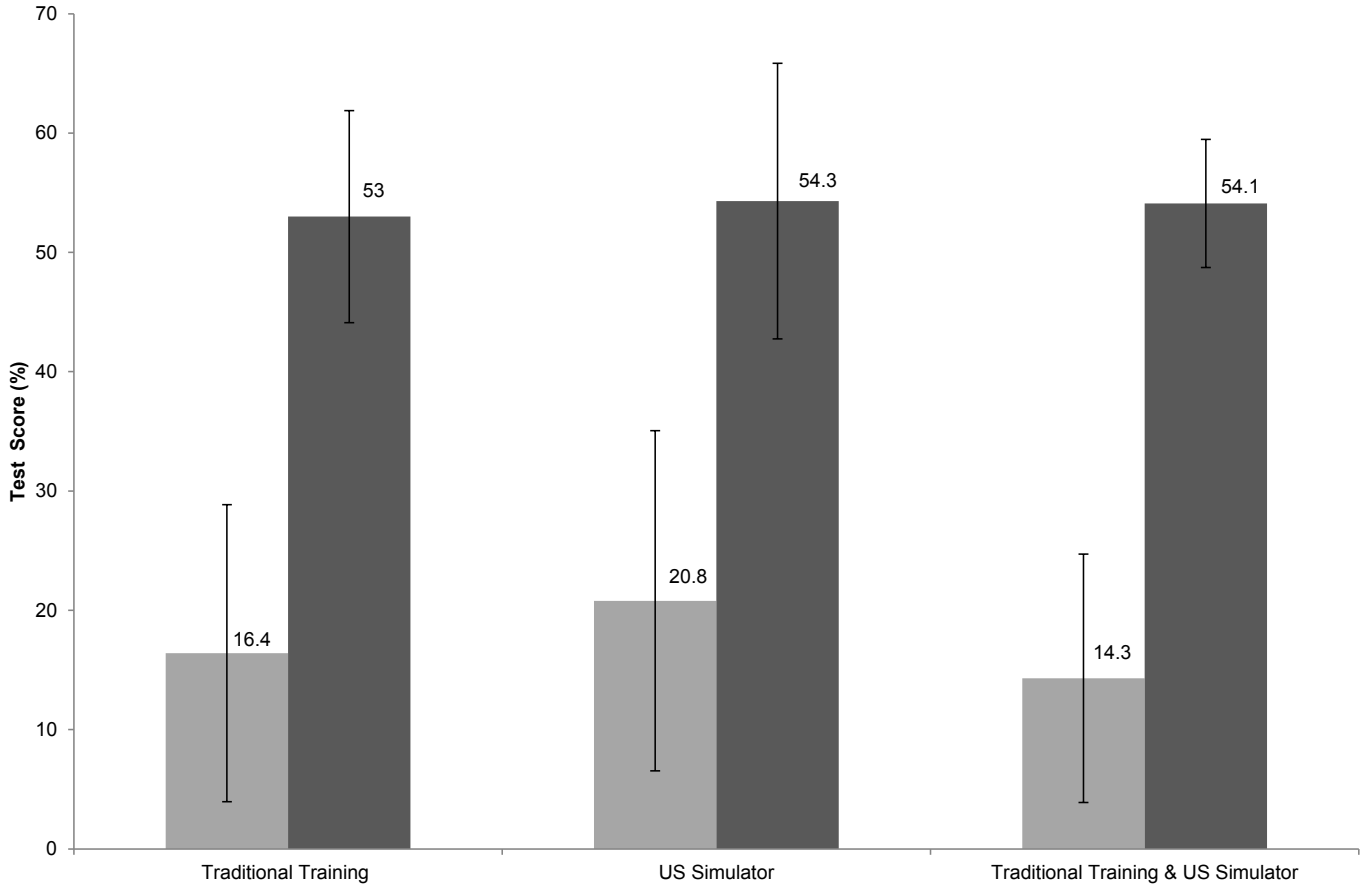

Figure 3. US and FAST knowledge pre- and post-evaluation scores.
US, ultrasound; *FAST*, focused assessment of sonography in trauma
Data are reported as mean with 95% CI. Lighter grey designates pre-course examination scores, darker grey designated post-course examination.

were able to adequately perform and interpret pre-hospital FAST and abdominal aorta US exams.[4] This cross-role training and familiarity with performing and interpreting FAST may be essential in mass casualty events.

LIMITATIONS

Our pilot study has several limitations. The sample size was fixed by the number of disaster response team members deployed at Provident Hospital of Cook County during the 2012 NATO Summit. The majority of the evaluators were emergency attending US faculty or fellows. EM residents conducted two of the six evaluation stations. These two EM residents were PGY4 resident members of our EM US Resident College (a resident scholarly tract), each with over 300 total exams completed during residency that was finishing the next month (June 2012). To ensure examiner reliability, a course and study walk through was conducted the day before for all evaluators and repeated the morning of the course. Scores did not appear to vary significantly between evaluation stations (unpublished data). Although we evaluated pre- and post-course US and FAST knowledge only post-course FAST skills were evaluated due to educational course logistics. However, most trainees had no prior US training prior to this course. Furthermore, the lengthy US and FAST knowledge test was designed specifically for medical student learners. This resulted in lower than expected pre- and post-course scores among our mixed providers but similar overall improvement versus prior studies.[11] Future larger prospective, randomized, blinded studies will continue to compare different learning modalities for rapidly developing short and long term US knowledge and skills among disaster response team members.

CONCLUSION

For deployed mixed provider disaster response team members with limited training time and resources, a portable US simulator appears to provide equivalent skills training in comparison to traditional live instructor and model training in this initial pilot study. Future work will focus on evaluating larger teams of mixed providers as well as long and short-term clinical performance of FAST skills.

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Conflicts of Interest: By the *West*JEM article submission agreement, all authors are required to disclose all affiliations, funding sources and financial or management relationships that could be perceived as potential sources of bias. The manufacturer of the Sonosim device had no role in the design and implementation of presentation of this study.

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Asking for a Commitment: Violations during the 2007 Match and the Effect on Applicant Rank Lists

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Introduction: Applicants to residency face a number of difficult questions during the interview process, one of which is when a program asks for a commitment to rank the program highly. The regulations governing the National Resident Matching Program (NRMP) match explicitly forbid any residency programs asking for a commitment.

Methods: We conducted a cross-sectional survey of applicants from U.S. medical schools to five specialties during the 2006-2007 interview season using the Electronic Residency Application Service of the Association of American Medical Colleges. Applicants were asked to recall being asked to provide any sort of commitment (verbal or otherwise) to rank a program highly. Surveys were sent after rank lists were submitted, but before match day. We analyzed data using descriptive statistics and logistic regression.

Results: There were 7,028 unique responses out of 11,983 surveys sent for a response rate of 58.6%. Of those who identified their specialty (emergency medicine, internal medicine, obstetrics and gynecology [OBGYN], general surgery and orthopedics), there were 6,303 unique responders. Overall 19.6% (1380/7028) of all respondents were asked to commit to a program. Orthopedics had the highest overall prevalence at 28.9% (372/474), followed by OBGYN (23.7%; 180/759), general surgery (21.7%; 190/876), internal medicine (18.3%; 601/3278), and finally, emergency medicine (15.4%; 141/916). Of those responding, 38.4% stated such questions made them less likely to rank the program.

Conclusion: Applicants to residencies are being asked questions expressly forbidden by the NRMP. Among the five specialties surveyed, orthopedics and OBGYN had the highest incidence of this violation. Asking for a commitment makes applicants less likely to rank a program highly. [West J Emerg Med. 2015;16(2):331-335.]

INTRODUCTION

The residency interview process creates much anxiety among senior medical students and residency programs each year. The National Resident Matching Program (NRMP) was created in 1952, to help medical students navigate the process and in part mitigate some of the high-pressure tactics of recruiting that were common in that era. Prior to the NRMP, students often were forced to accept appointments as early as the second year of medical school, even prior to any clinical clerkship.[1] The NRMP allowed applicants to make decisions on a uniform schedule, ostensibly without pressure from residency programs. At the center of the NRMP was the Match Participation Agreement (MPA), which outlined restrictions on persuasion.[2] Per the MPA, applicants and programs may not

solicit either a verbal or written commitment or suggest that ranking is contingent upon a commitment. However, anecdotal accounts and published studies suggest programs violate this rule. In 1998, senior medical students from three medical schools reported a 34% rate of inappropriate commitment requests from programs.[3] Emergency medicine applicants in 2005 and 2006 reported an 8% rate though the survey response rate was 28%.[4]

The current literature suggests that both applicants and residency program directors feel that the application process retains inherent dishonesty. Applicants feel uncomfortable and forced to lie about ranking a program while program directors distrust the information they receive from applicants.[3,5-7] When multiple programs request a commitment – either overt or subtle – the applicant may have less incentive to report an individual program, considering commitment requests commonplace.[7] We performed a national, multi-specialty survey to describe the prevalence and burden of commitment violations during the 2006-2007 interview season.

METHODS

We surveyed applicants in the 2006-2007 NRMP in five specialties: emergency medicine, internal medicine, general surgery, obstetrics and gynecology (OBGYN), and orthopedic Surgery on various topics as part of a larger project understanding the residency match milieu.[8] We solicited information from residency match subjects on NRMP match rule violations.

The survey instrument was developed in conjunction with a survey design and protocol specialist at UC Berkeley, School of Public Health. The instrument was piloted among residents (a population close in age and experience to our survey population) and faculty for clarity. The pilot and revisions were in accordance with survey design methodology to maximize validity and reliability.

We included both categorical and preliminary applicants for medicine and surgery specialties; however, we collapsed them into their respective specialty for analysis. Study participants were recruited through an electronic mail message sent by the Electronic Residency Application Service (ERAS) in February of 2007. ERAS is a centralized service that transmits medical student residency applications to residency program directors. ERAS referred the residency applicants to a public instrument for study enrollment. The instrument was located on a public website (www.surveymonkey.com) and all data remained anonymous with a custom ID generated by ERAS and securely encrypted. Study participants were informed on the survey that the information would remain confidential and only study investigators would have access to their anonymous responses. The electronic message was sent twice (one week apart) after residency rank lists were submitted by applicants and programs but before match results were known. All data analyzed were received within two weeks of the initial email. We discarded data received after match results were public.

Applicants were asked to recall if, during the course of their interviews, they were asked to provide a commitment, verbal or otherwise, that they would rank a program highly. The survey also asked what effect such questions had on their decisions to rank that program. Respondents were asked to characterize how many programs solicited a commitment. The survey also collected demographic information including age, gender, marital status, number of children, race/ethnicity and religious affiliation. Participants also described the specialty they were applying to, number of interviews offered, and number of interviews completed by the applicant.

Surveys were imported into a Microsoft Excel spreadsheet (Redmond WA). We calculated frequencies for all survey variables. The primary outcome was solicitation of commitment by a residency program. Commitment request was stratified by the covariate variables. We calculated differences using chi square analysis for categorical variables and t-test for univariate variables. Statistical analysis was completed using both STATA (Version 10.1, STATA Corporation, College Station, Texas) and SAS (Version 9.2, Cary NC).

The Institutional Review Board at our home institution approved the instrument and protocol prior to distribution.

RESULTS

Overall Prevalence

Questionnaires were sent to 11,983 applicants and 7,028 replied, resulting in a response rate of 58.6%. Overall, 1,380 or 19.6% of applicants (1380/7028) were asked for a commitment (verbal or otherwise) to rank a program highly. Of those who were asked for a commitment, 540 (39.1%) were asked by one program, 333 (24.1%) by two programs, 187 (13.6%) by three, and 112 (8.1%) by four.

Specialty and Demographic Differences

Among those respondents who indicated their specialty, orthopedics had the highest overall prevalence at 28.9% (372/474) followed by OBGYN (23.7%; 180/759), general surgery (21.7%; 190/876), internal medicine (18.3%; 601/3278), and finally, emergency medicine (15.4%; 141/916) (Table 1).

Women were more likely to be asked for a commitment. Almost 23% of women (732/3194; 22.9%) were asked for a commitment while only 18.2% of men (612/3358) were solicited. This difference was shown to be statistically significant with $p<0.001$. There was no statistically significant difference in proportion of applicants asked for commitment by age, race/ethnicity, marital status, number of children, and religious status.

Comfort Level and Rank List Effect

Of the applicants asked to provide a commitment, 1,030 (74.6%) felt either uncomfortable or very uncomfortable sharing this information (Table 2). Furthermore, applicants

Table 1. Specialty distribution of commitment questions (N=912).

Answer	General surgery	Prelim surgery	Internal medicine	Prelim medicine	Emergency medicine	Obstetrics/ gynecology	Orthopedic surgery	Total
Yes (%)	171 (22.53)	19 (19.00)	339 (16.78)	262 (23.04)	141 (15.86)	180 (24.10)	137(29.53%)	1,249
No (%)	588 (77.47)	81 (81.00)	1,681 (83.22)	875 (76.96)	748 (84.14)	567 (75.90)	327 (70.47)	4,867
Total	759	100	2,020	1,137	889	747	464	6,116

N, total number of responses

Table 2. Applicant comfort level of sharing information.

	Frequency	Percent
Very uncomfortable	424	30.72%
Somewhat uncomfortable	606	43.91%
Neither comfortable or uncomfortable	156	11.30%
Somewhat comfortable	119	8.62%
Very comfortable	62	4.49%
No response	13	0.94%

Table 3. Applicant effect on ranking.

	Frequency	Percent
Much more likely to rank it highly	38	2.75%
More likely to rank it highly	148	10.72%
No effect	647	46.88%
Less likely to rank it highly	388	28.12%
Much less likely to rank it highly	142	10.29%
No response	17	1.23%

solicited for a commitment were less likely to rank the program. Among applicants approached for committal, 388 of 1,380 (28.1%) stated they were 'less likely' to rank the program and 142 of 1,380 (10.3%) were 'much less likely' to rank the program. Fewer than half the respondents said commitment solicitation had no effect on their decision to rank the program (46.9%; 647/1380) (Table 3).

Among those applicants asked for a commitment, OBGYN applicants felt the most uncomfortable – 142 of 179 (79.3%) respondents were either somewhat or very uncomfortable sharing this information. This was followed by orthopedics at 75.5% (102/135), emergency medicine 75% (105/140), internal medicine 74.5% (445/597), and surgery 70.7% (133/188) (Table 4).

When asked if questions of commitment affected their ultimate rank lists, emergency medicine residents stated it would affect them the most. Almost half of emergency medicine residents were less likely to rank a program based on this question (44.6%; 62/139). Lower percentages were given by applicants in OBGYN (42.5%; 76/179), internal medicine (39.4%; 234/594), orthopedics (33.6%; 45/134), and surgery (32.8%; 62/189) (Table 5).

DISCUSSION

Results of our national survey suggest that residency applicants routinely experience questions of residency commitment. Almost one in five respondents in the surveyed specialties reported facing a direct question asking for a commitment. This is a direct and clear material breach of the MPA set forth by the NRMP. In addition, almost three-quarters of those who received such a question felt somewhat or very uncomfortable answering this question. Applicants also said the effect on their decision to rank a program soliciting a commitment was significant. Over 38% of applicants who received such a request were less likely to rank the program on their rank lists. This information is powerful for residency programs. Knowing that questions on commitment directly lower a program on the applicant's rank list should encourage program directors to educate their interviewers that such questions are not only a direct violation but can significantly jeopardize recruiting efforts. Program directors could both improve compliance with the MPA and improve their recruiting and retention of highly qualified applicants by taking this information into account.

These results may be surprising to medical educators and program directors, but they are not to applicants. Medical student applicants share stories of commitment solicitation during the actual interview as well as post-interview communication between applicants and programs.[7] Oftentimes, applicants feel a high degree of gamesmanship played on both sides of the residency application process. Anecdotally, medical students are contacted by programs to subtly, or not so subtly, gauge interest. In addition, programs who do not participate in post-match resident contact appear to be at a disadvantage. One program who explicitly chose not to participate in post-interview communication found on a post-match survey that if they had contacted applicants after interviews, the program may have done better in the match.[9] While post-interview communication is important, program directors must be cognizant that compliance with the MPA can be beneficial to success in the match.

For program directors, a response might be one of clearly outlining to all interviewers what can and cannot be asked during a residency interview. It is imperative that residency programs have clearly stated policies about post-match contact.

Table 4. Specialty choice by comfort level.

	Comfort level of sharing information					
Specialty	Very uncomfortable	Somewhat uncomfortable	Neither comfortable or uncomfortable	Somewhat comfortable	Very comfortable	Total
Surgery (%)	53 (28.19)	80 (42.55)	26 (13.83)	17 (9.04)	12 (6.38)	188
Medicine (%)	178 (29.82)	267 (44.72)	76 (12.73)	53 (8.88)	23 (3.85)	597
Emergency medicine (%)	46 (32.86)	59 (42.14)	15 (10.71)	16 (11.43)	4 (2.86)	140
OBGYN (%)	55 (30.73)	87 (48.60)	13 (7.26)	16 (8.94)	8 (4.47)	179
Orthopedic surgery (%)	44 (32.59)	58 (42.96)	15 (11.11)	10 (7.41)	8 (5.93)	135
Total	376	551	145	112	55	1,239

OBGYN, obstetrics and gynecology
N = 141 was the frequency missing.

	Affect on decision to rank the program					
	Much more likely to rank it highly	More likely to rank it highly	No effect	Less likely to rank it highly	Much less likely to rank it highly	Total
Surgery (%)	8 (4.23)	29 (15.34)	90 (47.62)	45 (23.81)	17 (8.99)	189
Medicine (%)	15 (2.53)	54 (9.09)	291 (48.99)	171 (28.79)	63 (10.61)	594
Emergency medicine	4 (2.88)	12 (8.63)	61 (43.88)	45 (32.37)	17 (12.23)	139
OBGYN (%)	4 (2.23)	18 (10.06)	81 (45.25)	59 (32.96)	17 (9.50)	179
Orthopedic surgery (%)	4 (2.99)	21 (15.67)	64 (47.76)	31 (23.13)	14 (10.45)	134
Total	35	134	587	351	128	1,235

OBGYN, obstetrics and gynecology
No Response = 145.

One such stance, which might limit the 'gamesmanship,' would be that such contact is 'voluntary and has no bearing on an applicant's standing.' It is only once the process becomes more transparent that applicants' anxiety and unethical behavior on the part of the residency programs can be lessened. The inherent mistrust on both sides has eroded the application process and created an atmosphere where code words and innuendos often lead to disappointment from both sides on Match Day.

LIMITATIONS

This study shares limitations inherent in survey-based research projects. Completed potentially months after the interviews, the results were dependent on the memory of respondents. All responses were returned within 2 weeks of electronic mail and therefore, prior to match results being announced.

The response rate was 58.6%. The percentage of illegal interview experiences may be artificially increased as respondents who identified illegal or inappropriate questions may be more inclined to return the survey as a means of catharsis.

Survey results were based on the applicants' interpretation of questions rather than actual questions asked. While there is no way to monitor all interviews for commitment questions, asking applicants immediately after the interview season offers a reasonable alternative. This would allow for the applicant to reflect on all of their interviews but may limit exact recall of specific questions.

In addition, recall bias may also play a role. An applicant may recall a request for commitment because they remember an uncomfortable interview better than a comfortable experience. This systematic bias might artificially increase the rate of these types of questions.

CONCLUSION

Almost one in five respondents among the five major specialties surveyed were asked to commit to a program during the 2006-2007 residency interview season, often by multiple programs. This is an explicit violation of NRMP match rules. Program directors must realize such questions have a negative impact on their matched applicant list, a finding that may influence them to change their interview practices. Graduate medical education should consider educational outreach and information to both applicants and programs regarding acceptable interview procedures and guidelines. A formal "Interview Code of Conduct" might address a potentially flawed process for selecting future practitioners and medical educators.

AUTHORS' CONTRIBUTIONS

Dr. Hern conceived and implemented the study design, data acquisition, analysis and writing of the manuscript. Dr. Alter and Johnson assisted with data analysis and editing. Drs. Wills, Snoey, and Simon assisted with original conception and editing of the manuscript.

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Virtual Alternative to the Oral Examination for Emergency Medicine Residents

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Introduction: The oral examination is a traditional method for assessing the developing physician's medical knowledge, clinical reasoning and interpersonal skills. The typical oral examination is a face-to-face encounter in which examiners quiz examinees on how they would confront a patient case. The advantage of the oral exam is that the examiner can adapt questions to the examinee's response. The disadvantage is the potential for examiner bias and intimidation. Computer-based virtual simulation technology has been widely used in the gaming industry. We wondered whether virtual simulation could serve as a practical format for delivery of an oral examination. For this project, we compared the attitudes and performance of emergency medicine (EM) residents who took our traditional oral exam to those who took the exam using virtual simulation.

Methods: EM residents (n=35) were randomized to a traditional oral examination format (n=17) or a simulated virtual examination format (n=18) conducted within an immersive learning environment, Second Life (SL). Proctors scored residents using the American Board of Emergency Medicine oral examination assessment instruments, which included execution of critical actions and ratings on eight competency categories (1-8 scale). Study participants were also surveyed about their oral examination experience.

Results: We observed no differences between virtual and traditional groups on critical action scores or scores on eight competency categories. However, we noted moderate effect sizes favoring the Second Life group on the clinical competence score. Examinees from both groups thought that their assessment was realistic, fair, objective, and efficient. Examinees from the virtual group reported a preference for the virtual format and felt that the format was less intimidating.

Conclusion: The virtual simulated oral examination was shown to be a feasible alternative to the traditional oral examination format for assessing EM residents. Virtual environments for oral examinations should continue to be explored, particularly since they offer an inexpensive, more comfortable, yet equally rigorous alternative. [West J Emerg Med. 2015;16(2):336–343.]

INTRODUCTION

Simulation-based education and assessment strategies have become increasingly popular in medical education. Healthcare simulations are being used in individual and group settings for both formative and summative assessments.[1,2] The use of immersive learning environments (ILE) for education provides learners with a sense of being immersed in the simulated environment while experiencing it as real. Partial immersive environments involve a virtual world that consists of three dimensions (3-D) displayed on a two-dimensional (2-D) computer screen.[3,4] Educational research using 3-D virtual worlds and their effect on learning outcomes is limited.[5] With a predicted paradigm shift in medical education where immersive environments continue to expand in the personal and professional lives of learners, it is imperative to explore and understand the implications and limitations of these ILEs.[6]

A number of ILEs have been developed in the past ten years with varying rates of adoption by the education community. Second Life (SL) is a virtual 3-D platform that allows individuals from any geographic location to interact in a virtual environment. Accordingly, SL provides opportunities for remote virtual simulation experiences.[5,7] In SL, users are represented in a virtual world by their avatars. An avatar is an online, self-created, animated characterization of the user that can act in any role (doctor, patient, nurse, or teacher) and perform programmed tasks (Figure 1). SL has been successfully used in medical and public health education.[7,8] Specifically, the platform has been used to model doctor-patient relationships, teach clinical diagnosis, train for disasters, virtually tour the human anatomy, and to conduct physical examinations.[4,8-11]

The American Board of Emergency Medicine (ABEM) administers an oral board examination semiannually to residency-trained emergency medicine (EM) physicians. Passage of the oral board examination is required for EM board certification.[12] The purpose of the oral board examination is to assess the candidates' medical knowledge, clinical reasoning, and interpersonal skills. In the current format, candidates travel to a central assessment venue to take the oral board examination. The examination requires the candidate to verbally explain how they would handle various patient cases to an examiner. Many residency programs offer "mock" or practice oral examinations to prepare residents for the ABEM oral boards. Residents at this academic EM residency program participate in an annual mock oral examination, which is conducted in the traditional format, a face-to-face interaction with an examiner. The purpose of this study was to assess the feasibility of using immersive virtual simulation technology to administer oral examinations to EM residents and to evaluate the potential of this platform as an alternative to the traditional face-to-face oral examination.

Figure 1. Avatar patient in an emergency department examination bay.

METHODS

We used a prospective, stratified-random control group study design to evaluate two methods of administering an oral examination: the traditional face-to-face method and the immersive virtual simulation method. To create a virtual environment we used SL (Second Life 2.0 Viewer, Linden Research, Inc. (Linden Lab), San Francisco, CA). Second Life Viewer is free, open-access computer software; however, fees are required to purchase virtual real estate or to construct virtual environments. We constructed a virtual emergency department (ED) for this study on virtual real estate purchased by one of the authors for another project. Both real estate and building costs were covered by internal institutional grants. The study was conducted at an American, university-based, three-year EM residency training program. Residents at all three levels, program years (PGY) 1-3 were included.

EM residents (n=35) were randomly assigned to one of two groups using a stratified approach to ensure that each group had an equal number of residents from each of three levels of training (PGY1-3). The first group was administered the oral examination using the immersive virtual interface with the examiner at a different physical location than the examinee (Figure 1). The second group served as a control and was administered the oral examination using the traditional format: a face-to-face patient case scenario that was managed with the examiner present in the same room as the examinee. Both groups were administered the same case scenario in which the examinee was expected to diagnose and manage a patient with ST-elevation acute myocardial infarction and resuscitate the patient after cardiac arrest. The study was reviewed and approved by our institution's behavioral sciences institutional review board.

In the immersive virtual condition, the examinee managed the patient case using the physician avatar to play the role of the physician (Figure 2). The faculty proctor played the role of the patient using the patient avatar. The examinee and proctor were in remote physical locations and communicated via headset and computer. Resident-examinees verbally interviewed the patient-proctor for historical details and physical exam findings. A collection of pertinent diagnostic data was created in PowerPoint and subsequently loaded into an image viewer in the immersive virtual environment. The faculty proctor controlled the image viewer, allowing diagnostic data (initial and repeat vital signs, laboratory reports, and diagnostic imaging) to be displayed in the virtual examination room in real time when requested by the examinee or at appropriate times during the case (Figure 2). Identical images were printed on paper and offered in similar sequence for the traditional oral exam format. Two faculty proctors administered all virtual examinations and two other faculty proctors administered all traditional oral exams. Access to a video demonstration of the virtual examination can be found at http://vimeo.com/user29472626/videos (Password = OSUEMSL2, case sensitive).

We used the ABEM instruments for scoring resident performance and documenting execution of "critical actions" on both the virtual and traditional oral examination conditions. Using this instrumentation, proctors scored examinees on eight performance items using an 8-point rating scale. The items on the instrument represent the eight ABEM competency categories. Proctors also used the ABEM checklist to document whether the examinee executed 10 "critical actions" during their work on the case. Traditional and virtual groups were compared on: the number of critical actions they executed, their original scores on the eight performance items, and on passage of the performance items as defined by ABEM. The ABEM standard for passing is a composite score greater than or equal to 5.75 on the 8-point scale. For our purposes, all performance items were dichotomized into pass-fail variables to compare groups on pass-rates across each competency category.

Participants were surveyed regarding their opinions about the oral examination experience. The immersive virtual group received a survey comprised of 13 items that used a 5-point Likert response set (from 1=Strongly Disagree to 5= Strongly Agree). Questions inquired about past experiences with the format, any difficulties encountered during the exams, and format preference for the virtual group. Questions further elicited the level of perceived realism, objectivity, efficiency and intimidation during the examinations. The traditional oral examination group received a shorter 6-item survey comprised of questions designed to compare their experience with that of the virtual group.

We used Fisher's exact tests for analyzing 2 x 2 tables to compare the groups on number of critical actions executed and on pass rates for each of the eight examination items (ABEM competencies and overall clinical competence). Independent t-tests were used to compare the groups on mean item scores for each of the eight items. We used Bonferroni corrections to control for family-wise Type 1 error rates for each set of multiple comparisons (critical action and pass-fail comparisons, and comparisons between competency category scores).[13]

RESULTS

Fisher's exact test showed no significant differences between traditional and virtual examinees in the number of critical actions executed (Table 1) and showed no significant

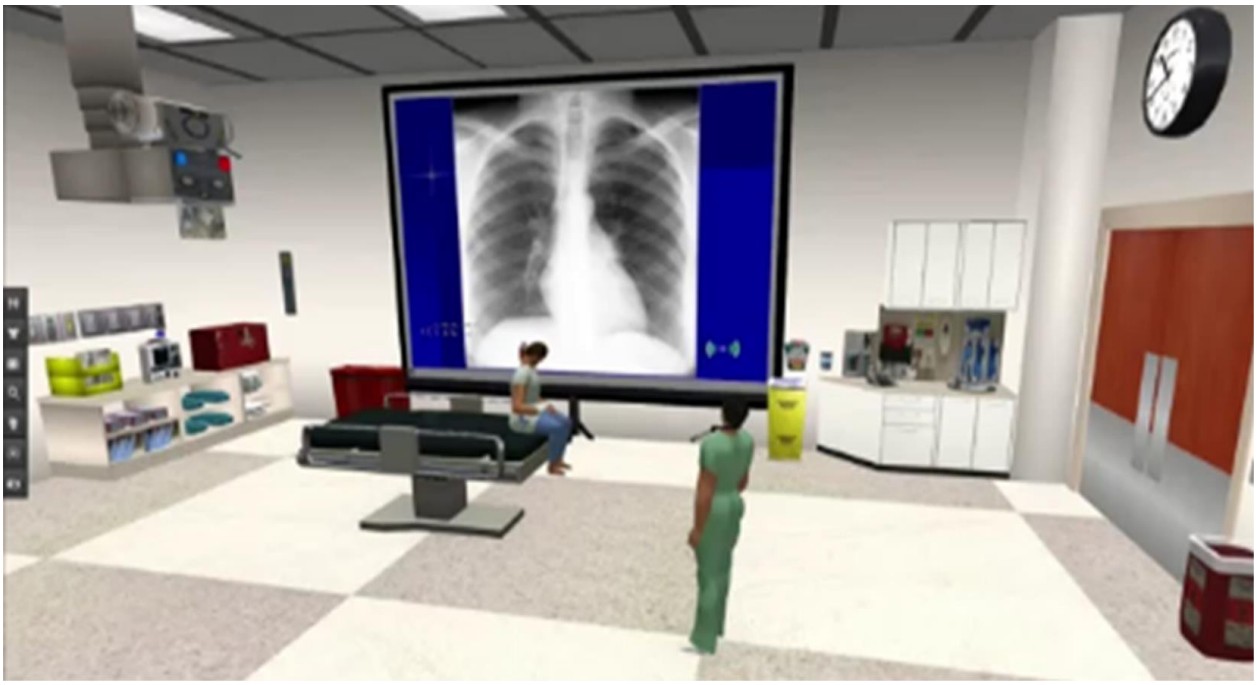

Figure 2. Physician (examinee) avatar examining a patient in an emergency department examination bay after requesting chest radiograph.

Table 1. Frequencies, (percentages), and Fisher's exact test value for 17 Traditional Oral Exam Group residents and 18 Immersive Virtual Exam Group residents on execution of 10 critical actions during an oral examination case.

Critical action	Group	Resident results		Fisher's exact test
		Missed (%)	Completed (%)	
Check bedside blood glucose	Traditional	10 (58.8)	7 (41.2)	1.00
	Virtual	11 (61.1)	7 (38.9)	
Initiate cardiac monitoring	Traditional	0 (0)	17 (100)	Constant
	Virtual	0 (0)	18 (100)	
Identify inferior wall myocardial infarction	Traditional	0 (0)	17 (100)	Constant
	Virtual	0 (0)	18 (100)	
Administer antiplatelet agent	Traditional	0 (0)	17 (100)	1.00
	Virtual	1 (5.6)	17 (94.4)	
Administer anticoagulation	Traditional	3 (17.6)	14 (82.4)	0.10
	Virtual	0 (0)	18 (100)	
Arrange for emergent cardiac catheterization	Traditional	0 (0)	17 (100)	Constant
	Virtual	0 (0)	18 (100)	
Administer chest compressions/CPR	Traditional	0 (0)	17 (100)	0.49
	Virtual	2 (11.1)	16 (88.9)	
Administer epinephrine or vasopressin	Traditional	0 (0)	17 (100)	0.49
	Virtual	2 (11.1)	16 (88.9)	
Defibrillate pulseless Vtach/Vfib	Traditional	0 (0)	17 (100)	1.00
	Virtual	1 (5.6)	17 (94.4)	
Administer antiarrhythmic medication	Traditional	4 (23.5)	13 (76.5)	0.18
	Virtual	1 (5.6)	17 (94.4)	

CPR, cardiopulmonary resuscitation; *Vtach*, ventricular tachycardia; *Vfib*, ventricular fibrillation
*A family-wise Bonferroni correction was used to control for Type I error rates (finding significant differences by chance). The corrected p-value considered for statistical significance is equal to 0.005.
**Critical actions were documented by the proctors using a checklist during the examination.

difference in pass rates between traditional and virtual examinees (Table 2). We compared groups on examination scores for the ABEM's individual competency categories and found no significant differences (Table 3). However, moderate effect sizes were observed for many of the ABEM competency categories, with all but two mean differences favoring the virtual examination group (data acquisition and interpersonal relations competencies). The assessment results observed during this study were consistent with results of mock oral examinations administered in prior years.

The mock oral examination is a program requirement for our residency program. Accordingly, all examinees, regardless of training level, had experience with the traditional face-to-face oral examination format prior to this study. Most of the examinees (57%) had never used SL prior to the examination. Examinees reported that both formats were realistic (Traditional 80% vs. Virtual 86%). All examinees perceived the examinations to be fair, objective, and efficient in either format. None of the examinees in the virtual group found the examination to be intimidating (Traditional 40% vs. Virtual 0%), and many reported that the virtual format was less intimidating than traditional oral exams that they had experienced in the past (77%). Most of the virtual examinees reported a preference for the virtual examination (79% agree and 21% neutral) over the traditional format (Table 4).

DISCUSSION

Criticisms of the traditional oral examination process have been raised by EM residents, including recent residency graduates preparing for the ABEM oral examination.[14] These criticisms can be classified into three domains or issues; fidelity, validity, and logistics.

The first issue has to do with the oral examination fidelity. While the goal of the ABEM oral examination has been to replicate a realistic ED encounter; the traditional oral examination format, with its face-to-face questioning process, remains somewhat artificial. Also related to fidelity is the manner in which the patient information is communicated to the examinee. Until recently, ABEM examinees have been unable to visualize their patient during the test. Additionally, physical examination findings and

Table 2. Frequencies, (percentages), and Fisher's exact test value for 17 Traditional Oral Exam Group residents and 18 Immersive Virtual Exam Group residents on passing or failing 8 American Board of Emergency Medicine competency categories.

		Resident pass-fail results		
Competency category	Group	Passed (>5.75) (%)	Failed (<5.75) (%)	Fisher's exact test
Data acquisition	Traditional	15 (88.2)	2 (11.8)	0.23
	Virtual	12 (66.7)	6 (33.3)	
Problem solving	Traditional	9 (52.9)	8 (47.1)	0.31
	Virtual	13 (72.2)	5 (27.8)	
Patient management	Traditional	9 (52.9)	8 (47.1)	0.74
	Virtual	11 (61.1)	7 (38.9)	
Resource utilization	Traditional	14 (82.4)	3 (17.6)	0.66
	Virtual	16 (88.9)	2 (11.1)	
Health care provided	Traditional	10 (58.8)	7 (41.2)	0.73
	Virtual	12 (66.7)	6 (33.3)	
Interpersonal relations	Traditional	11 (64.7)	6 (35.3)	1.00
	Virtual	11 (61.1)	7 (38.9)	
Comprehension of pathophysiology	Traditional	10 (58.8)	7 (41.2)	0.29
	Virtual	14 (77.8)	4 (22.2)	
Clinical competence	Traditional	10 (58.8)	7 (41.2)	0.29
	Virtual	14 (77.8)	4 (22.2)	

*A family-wise Bonferroni correction was used to control for Type I error rates (finding significant differences by chance). The corrected p-value considered for statistical significance is equal to 0.006.
**A score of 5.75 or greater was required for passing each competency category.

Table 3. Means, (standard deviations), independent t-test results, and effect sizes for 17 Traditional Oral Exam Group residents and 18 Immersive Virtual Exam Group residents on 8 American Board of Emergency Medicine competency category scores.

	Group				
Competency category	Traditional	Virtual	t	df	Effect size
Data acquisition	6.18 (0.64)	5.94 (1.30)	0.67	25	-0.23
Problem solving	5.59 (0.94)	6.17 (0.92)	1.84	33	0.60
Patient management	5.18 (1.13)	5.89 (1.37)	1.67	33	0.55
Resource utilization	6.06 (0.66)	6.50 (0.86)	1.70	33	0.56
Health care provided	5.53 (1.07)	6.28 (1.07)	2.07	33	0.67
Interpersonal relations	5.76 (0.83)	5.72 (0.83)	0.15	33	-0.05
Comprehension of pathophysiology	5.94 (0.90)	6.28 (1.02)	1.03	33	0.35
Clinical competence	5.59 (1.00)	6.28 (1.02)	2.02	33	0.65

*A family-wise Bonferroni correction was used to control for Type I error rates (finding significant differences by chance). The corrected p-value considered for statistical significance is equal to 0.006.
**Scores were assigned by proctors using a standard ABEM 1-8 scale.

diagnostic imaging were presented on paper, rather than in the medium in which it would be encountered in a real ED. To address this issue, ABEM has recently committed to incorporating some computer-based images into their oral examination (eOrals); however, the specific details of this change have yet to be revealed.[12]

A second issue involves the validity of the oral examination format. Threats to validity involve both the effects of performance anxiety and examiner bias. Performance anxiety can occur when an examinee is confronted with an unfamiliar examiner during a face-to-face encounter in an unfamiliar environment. Furthermore, despite formal scoring systems and examiner training, examiner bias also remains a threat to the validity of the traditional oral exam format.[15] The literature suggests that bias is common towards candidates with good interpersonal skills, good communication skills, and those who are physically attractive.[16] Finally, a third issue with

Table 4. Means, (standard deviations), independent t-test results, and effect sizes for 10 Traditional Oral Exam Group residents and 14 Immersive Virtual Exam Group residents on six post-examination evaluation items over the interface they experienced: Immersive Environment or Traditional Face-to-Face interface with a proctor.

	Group				
Evaluation item	Traditional	Virtual	t	df	Effect size
Comfort: I felt comfortable communicating with the interface (SL or proctor) during the exam	4.60 (0.52)	4.43 (0.65)	0.69	22	0.29
Realism: The interface provided a realistic patient encounter	4.20 (1.03)	4.36 (0.75)	-0.43	22	-0.18
Intimidation: The interface was intimidating	2.60 (1.27)	1.79 (0.58)	1.90	11.7	0.82
Fairness: The interface was fair and objective	4.40 (0.52)	4.43 (0.51)	-0.13	22	-0.06
Efficient: The interface is an efficient way to complete mock oral examinations	4.30 (0.48)	4.29 (0.61)	0.61	22	0.02
Preference: I would prefer to complete more of my oral examination requirements using this interface	3.50 (1.18)	4.29 (0.83)	-1.93	22	-0.77

*A family-wise Bonferroni correction was used to control for Type I error rates (finding significant differences by chance). The corrected p-value considered for statistical significance is equal to 0.006.
**Option key: 1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5= Strongly Agree.

the traditional ABEM oral examination format involves logistics, such as the expense of preparation and travel to the testing site.[15]

The virtual examination offers many potential benefits to address the issues involved with the traditional oral examination. The virtual examination offers higher fidelity realism than the traditional oral exam by immersing the examinee in a setting resembling one in which actual patient care is delivered. The virtual examination involves dynamic interaction between the examinee as physician and the examiner as patient. Patient information, such as vital signs and diagnostic imaging results, are presented in a more authentic manner in the virtual environment.

Threats to examination validity are also minimized in the virtual examination format. The potential for anxiety produced by a one-on-one encounter with a stranger is alleviated by the virtual world encounter. Examiner biases resulting from the personal encounter with the examinee are also minimized.[3] Finally, because the virtual examination can be administered through the electronic medium of the world-wide web, logistic concerns can be addressed. Delivering the oral exam through a virtual reality platform eliminates the need for examinees and examiners to travel, providing economic and time savings.

The results of this study offer confirmation that virtual examination results are comparable to those of the traditional oral examinations for assessing EM residents. In fact, we observed moderate effect sizes favoring the SL group, even with relatively small samples, on five of the eight ABEM competencies; suggesting that with bigger samples we might have demonstrated significantly better performance on these competencies through the virtual examination platform.

One can envision the application of advanced virtual simulation technology as a way to alleviate some of the barriers encountered in the current process. In addition to reported ease of use and perception by many that this was a more realistic experience, the virtual examination format is adaptable. The virtual oral examination could be administered from any remote location with computer access, at any time of day. Thus, oral examinations could be completed while on away rotations, while travelling, at home rather than in an office setting, or at a remote testing site.

The implementation of virtual technology in resident assessment required a time commitment for brief training of faculty to use the system to administer the examinations. Direct costs included purchasing space in the virtual world and costs for building the desired assessment environment.[17] Examiners of the immersive virtual oral examination required 2-3 hours of training in order to develop and monitor the data display. Communication via microphone and computer did not require specific training for the faculty or residents participating in the examinations. Some examinees reported feedback or echoing in the headset. Such impediments can be eliminated through use of higher quality microphones, headsets and computer systems.

Resident feedback regarding the use of the immersive environment for the oral examination in EM was overwhelmingly positive. Many examinees expressed an interest in even more advanced capability to interact with the virtual patient and within the examination room. With currently available animation and programming capabilities, items in the room can be made more interactive. The examinee might click on the patient-avatar's body to perform physical examination skills or a virtual IV pole to order IV fluids. They might also instruct a nurse avatar to perform programmed tasks. The virtual environment could be expanded to a multi-case format, requiring concurrent care of multiple patients requiring the examinee-physician avatar to transition between patient rooms. More complex immersive assessment environments may offer higher fidelity assessment potential without additional cost or

barriers to ease of use. Transition to an automated scenario, without a real-life examiner, could be achieved through application of artificial intelligence. The Unity 3-D platform is an example of another immersive environment that is ideally suited to support the virtual assessment format as it offers higher levels of fidelity and is reported to be easier to use by both examinees and proctors.[18] In addition, it can be highly customized and configured to provide secure examinations without requiring the type of third party support which is necessary with platforms such as Second Life.

LIMITATIONS

This study was conducted at a single academic training site and therefore the number of assessment subjects was not large. Our intent was to evaluate the feasibility and value of the virtual examination; however, because each resident experienced only one examination format, they were unable to preference one format over the other. Prior experience with the traditional face-to-face oral examination made it possible for the immersive exam participants to contrast the virtual with the traditional oral exam experience. As voices were not modified in this virtual examination, there is the potential for bias to be introduced based on voice recognition of the examinee or examiner. This is a bias that could be avoided in a larger-scale examination format using anonymous proctors, technology to modify or standardize the proctor's voice, or creation of an automated case using artificial intelligence. Because only one examiner evaluated each examinee, inter-rater reliability was not evaluated; therefore, inter-rater reliability remains an issue to be studied in future research. Other aspects of testing via virtual simulation require additional exploration before such technology is more broadly adopted for general use in a high-stakes oral board examination. Further research is needed to study faculty perceptions about the virtual examination experience or evaluate the reproducibility of results using this platform.

CONCLUSION

The virtual simulated oral examination is a feasible alternative to the traditional oral examination format for EM residents. This study used Second Life as a platform for the virtual examination; however, we believe that other immersive learning environments should be evaluated. Future studies should focus on identifying and developing the most user-friendly platforms for virtual oral examination and continue to assess applications of virtual examination in other areas of medical education.

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Structured Communication: Teaching Delivery of Difficult News with Simulated Resuscitations in an Emergency Medicine Clerkship

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Introduction: The objective is to describe the implementation and outcomes of a structured communication module used to supplement case-based simulated resuscitation training in an emergency medicine (EM) clerkship.

Methods: We supplemented two case-based simulated resuscitation scenarios (cardiac arrest and blunt trauma) with role-play in order to teach medical students how to deliver news of death and poor prognosis to family of the critically ill or injured simulated patient. Quantitative outcomes were assessed with pre and post-clerkship surveys. Secondarily, students completed a written self-reflection (things that went well and why; things that did not go well and why) to further explore learner experiences with communication around resuscitation. Qualitative analysis identified themes from written self-reflections.

Results: A total of 120 medical students completed the pre and post-clerkship surveys. Majority of respondents reported that they had witnessed or role-played the delivery of difficult news, but only few had real-life experience of delivering news of death (20/120, 17%) and poor prognosis (34/120, 29%). This communication module led to statistically significant increased scores for comfort, confidence, and knowledge with communicating difficult news of death and poor prognosis. Pre-post scores increased for those agreeing with statements (somewhat/very much) for delivery of news of poor prognosis: comfort 69% to 81%, confidence 66% to 81% and knowledge 76% to 90% as well as for statements regarding delivery of news of death: comfort 52% to 68%, confidence 57% to 76% and knowledge 76% to 90%. Respondents report that patient resuscitations (simulated and/or real) generated a variety of strong emotional responses such as anxiety, stress, grief and feelings of loss and failure.

Conclusion: A structured communication module supplements simulated resuscitation training in an EM clerkship and leads to a self-reported increase in knowledge, comfort, and competence in communicating difficult news of death and poor prognosis to family. Educators may need to seek ways to address the strong emotions generated in learners with real and simulated patient resuscitations. [West J Emerg Med. 2015;16(2):344–352.]

INTRODUCTION

Optimal care for the critically ill or injured patient includes caring, compassionate communication and support for the family during and after patient resuscitation.[1] In the emergency department (ED), resuscitation events often end in patient death or uncertain and poor outcomes.[2-5] Traditionally, for both graduate and undergraduate trainees in emergency medicine (EM), the main focus is on acquiring the *technical* resuscitation skills, as exemplified by the Advanced Cardiac Life Support (ACLS) and Advanced Trauma Life Support (ATLS) courses.[6-9] Little, if any, attention is directed towards teaching trainees how to deliver news of uncertain prognosis or patient death after the resuscitation efforts.[8-10] Trainees are also rarely debriefed after an intense, emotional resuscitation or taught the skills of self-reflection as a means of addressing their emotions or coping with patient death. As a result, many trainees may feel unprepared to deal with the stress and emotions that may result from these highly charged resuscitation encounters.[8,10] To address this gap, the EM resuscitation curriculum would benefit from the addition of opportunities for trainees to practice delivering difficult news and to provide support for the family.[11-14]

Simulation is increasingly used to teach critical skills, including communication, since it provides a safe and realistic environment for active learning by allowing for trial and error.[15-18] Appropriate feedback to learners in the simulated setting may help shape future trainee to patient/family conversations.[18-22] The principles of adult learning and Kolb's experiential learning theories also support the use of simulation in education.

Our project is designed to teach skills of effective communication in high-stress situations that surround ED resuscitations. We use a hybrid simulation curriculum where case-based simulated resuscitation scenarios are supplemented with a structured communication that immediately follows the technical training. Our overall goal is to teach medical students in the EM clerkship how to compassionately communicate with families of critically ill and dying patients. We describe here the curriculum implementation. The main outcomes are pre-post self-assessments by learners to rate their knowledge, competence, and comfort with delivering difficult news to family. The secondary aims of our project are to 1) encourage students to use written reflective inquiry for communication skills development and 2) analyze these written learner experiences with the goal to inform future case scenario and curriculum design.

METHODS

Study Setting and Target Population

The educational project was conducted in a large academic, urban, tertiary care teaching hospital with approximately 100,000 ED patient visits per year. The study period was from July 2011 through May 2012. The target population consisted of fourth-year medical students on a four-week mandatory EM clerkship. The faculty facilitators were EM board certified and one facilitator was also certified in Hospice and Palliative Medicine. The institutional review board approved the study. The curriculum design and implementation was supported by the Y.C. Ho/Helen and Michael Chiang Foundation administered and guided by the expert faculty at the Harvard Medical School Center for Palliative Care.

Description of 'communication and self-reflection' learning activities

The curriculum is grounded in Kolb's experiential theory in which the learner 'touches all the bases' of thinking, experiencing, acting and reflecting (Figure 1). Concrete experiences activate prior knowledge; observations are translated into concepts; the student can then actively test new concepts; this enables experiences and reflections that in turn promulgate the cycle.[23]

The communication and self-reflection educational module supplements pre-existing technical resuscitation training in the clerkship. The technical component consisted of two case-based simulated resuscitation scenarios (one addresses ACLS and the other ATLS skills). Trainees practice on a high-fidelity human adult simulation mannequin. Both simulation case scenarios with objectives as well as step-by-step outlines and competencies are available via MedEd portal.[16] The communication skills addressed included reinforcement of closed-loop communication during simulated resuscitation. The simulated resuscitation training (ATLS and ACLS skills) was followed by the students role-playing as physician and family members to deliver news of uncertain or poor prognosis and/or death of simulated patient. Students took turns to play the role of the physician delivering difficult news and then received feedback from faculty and peer observers. Figure 1 outlines the overall goals, objectives, methods, assessment and Accreditation Council on Graduate Medical education (ACGME) competencies addressed with the learning activities for the communication module. The students were also asked to provide a written self-reflection based on a challenging communication event regarding resuscitation that they witnessed in the ED setting (real) or in the simulated encounter. They were asked to describe at least one thing that went well and one thing that did not go well. Students reflected on their emotional responses and considered an action plan to address a similar challenging situation in the future. Detailed descriptions of each learning activity, outlines and scripts for the role-play activity as well as tools for faculty development and student self and peer assessment/feedback and an outline of the self-reflection exercise are also available via the MedEd portal.[16]

Survey Development and Content

We developed a pre- and post-clerkship survey. Pre-clerkship questions asked the student about their experiences

Learning Activity	Goals and Objectives	Methods	Assessment
1. Case based simulated resuscitation *Communication skills addressed:* *Healthcare worker to healthcare worker communication during simulated resuscitation*	**Goal 1:** Student will reinforce their knowledge of ACLS and ATLS protocols, while practicing closed-loop team communication in a simulated environment. **Objective:** Student will be able to demonstrate clear and direct closed-loop communication while conducting a simulated patient resuscitation.	1) Students work in groups (5 to 7), alternating roles and responsibilities, to care for a simulated patient requiring application of ACLS and ATLS skills - ACLS scenario is patient with myocardial infarction that has a cardiac arrest resulting in patient death - ATLS scenario is a motor vehicle accident with massive blunt trauma resulting in uncertain/poor prognosis 2) Students are prompted, if needed, to use closed-loop communication with team members. 3) Students are prompted, if needed, to engage team for suggestions and process oriented inputs, as per ACLS/ ATLS guidelines.	Primarily experiential. Students are debriefed and provided formative feedback regarding; - Participation and roles / responsibilities - Application of technical ACLS/ATLS skills - Communication aspects during session *(ACGME competencies: MK, PBLI, P, ICS, SBP)*
2. Role Play of crucial conversations around patient resuscitation: *Communication skills addressed: Healthcare worker to Family*	**Goal 2:** Student will enhance skills in conducting difficult conversations with family of patients who undergo ED resuscitation. **Objective:** Students will be able to describe and practice the appropriate behaviors of responding to emotion, comforting someone in emotional shock when breaking bad news, and when delivering news of death to family survivors.	1) Discussion of key concepts to physician-family communication. Outline mnemonic aids such as SPIKES/ ASCEND 2) Highlight family-centered communication skills, including active listening, empathic statements, use of silence, exploration of emotions, and appropriate non-verbal behaviors (sit down, eye contact, warning shot, responding to emotion, silence when appropriate etc.). 3) Students role-play as physicians and family in a patient death and in an uncertain/poor prognosis post-resuscitation scenario	Faculty and Peer observers complete a 'learner feedback' form Role players self-assess using same feedback form *(ACGME competencies: PC, MK, PBLI, P, ICS)*
3. Self-reflection *Transformative learning*	**Goal 3:** Student will gain additional insight in how self-reflection can be used to identify processes for improvement and to identify their emotional responses. **Objective:** Student will be able to provide a written self-reflection based on a challenging communication event regarding resuscitation that they witnessed in the ED during the clerkship rotation (either real or simulated)	A minimum of one page written self-reflection, based on the communication around a resuscitation event. Specifically, students will reflect on; - Communication [things that went well (and why) and those that did not (and why)] - Emotions as related to the resuscitation event	1) Completion of assignment. 2) At least one thing that went well described, and expound upon why they thought it went well. 3) At least one thing that did not go well described, and expound upon why they thought it did not go well. 4) Self-reflection on emotional response 5) Action plan for future *(ACGME competencies: PBLI, ICS)*

Figure 1. Communication and self-reflection educational module related learning activities.
ACLS, advanced cardiac life support; *ATLS,* advanced trauma life support; *ACGME,* accreditation council for graduate medical education; *MK*, medical knowledge; *PBLI,* practice-based learning and improvement; *P,* professionalism; *ICS,* interpersonal and communication skills; *SBP*, systems based practice; *ED,* emergency department; *SPIKES*, setting, patient perception, invitation, emotions/empathy, strategy/summary; *ASCEND,* anticipation, summary, concerns elicited, exploration/explanation, next steps, documentation; *PC*, patient care

in prior clinical rotations with delivering difficult news of death and/or poor prognosis (whether they had witnessed, role-played, or performed communication skill). In addition, the pre-clerkship survey asked students to rate their baseline knowledge, comfort, and confidence with communicating difficult news of death and poor prognosis on a scale of 1-4 (1=not at all to 4=very much).

The post-clerkship survey asked learners to rate their knowledge, comfort, and confidence regarding delivery of difficult news after completion of the simulation and communication role-play learning activity.

Since our secondary aims were to encourage reflective inquiry and to explore learner needs/experiences via written self-reflection we also added questions to address this in the pre-post surveys. We asked for the pre-EM clerkship medical student experiences with written self-reflection and its perceived value. The students were then also asked their perception of value of a written self-reflection after completion of the exercise.

The questions were piloted for readability, clarity, and content with a small group of the EM faculty as well as medical students. The comments from the pilot were reviewed and final survey was determined by author consensus.

Survey Administration

Anonymous pre-clerkship surveys were administered to all senior medical students during orientation on the first day of the EM clerkship as a paper and pencil survey. Students placed the completed pre-clerkship survey (with no student identifiers) into an envelope, sealed it, and wrote a self-assigned, easy to remember number on the envelope. Post-clerkship surveys were similarly administered on the last day of rotation. The students identified and opened their sealed envelope and returned the stapled completed pre- and post-clerkship surveys together. We randomly assigned the returned surveys a study number and entered corresponding data into an Excel spreadsheet. Every third survey was audited (RN) to ensure accuracy of data entry. No research incentives were provided to participants.

Data Analysis

Descriptive statistics, such as percentages, means, and medians, are provided below. We compared pre- post-clerkship dichotomous data using McNemar chi-square tests. We analyzed comparisons of pre- and post-clerkship Likert like scale ratings with Wilcoxon signed-ranks tests. P-values for comparisons of means and medians were obtained via paired-samples t-tests.

We performed qualitative analyses on experiences reported by students via the written reflections.[24] Based on a review of 10 written self-reflections, three authors identified categories that included: "things that went well and why;" " things that did not go well and why;" and the student's emotional responses. We reviewed 110 written self-reflections and extracted content into categories. Subsequently recurring themes were identified within categories. Any discrepancies or conflicts were resolved by author consensus.[25,26]

RESULTS

Out of the 160 senior medical students completing their fourth-year at our institution, 120 answered both the pre- and post-clerkship surveys on their EM clerkship rotations (Table 1). Eighteen students in the June rotation were not offered the survey as data collection began in July. Twenty-two students completed the pre-survey only and this data is comparable to those we included in our analyses. Students reported using e-mail as the most common means to communicate to others "what went well" or "what did not go well" with a patient encounter (76/120, 64% and 73/120, 61% respectively).

Few students (17/120, 15%) reported receiving specific training on closed-loop communication. A vast majority recalled witnessing and/or role-playing communication of difficult news of death and poor prognosis. However, few students reported personally delivering difficult news of death (20/120, 17%) and poor prognosis (34/120, 28%).

After completion of the simulation and communication

Table 1. Emergency medicine pre-clerkship survey responses.

Questions	n=120 (%)
Self-reflection Have you received specific training on self-refleciton?	12 (10)
Have you ever used the following to discuss what went well in a patient encounter?	
Blog	21 (18)
Social	38 (33)
Diary	37 (32)
Email	76 (64)
Have you ever used the following to discuss things that did *not* go well?	
Blog	16 (64)
Social	27 (23)
Diary	34 (29)
Email	73 (61)
Communication training	
Specific training for closed-loop?	17 (15)
Is self-reflection a valuable tool for?	
Personal growth	108 (91)
Improvement in clinical practice	90 (75)
Lifelong learning	95 (80)
CDN of death	
Witnessed	96 (80)
Performed self	20 (17)
Role-played	104 (87)
CDN of poor prognosis	
Witnessed	109 (92)
Performed self	34 (29)
Role-played	110 (92)

CDN, communicating difficult news

role-play learning activity, there was a statistically significant increase in scores related to comfort, confidence, and knowledge regarding communicating difficult news of poor prognosis and patient death (Figures 2 and 3). The largest increase was seen in the knowledge scores (Figures 2 and 3).

Of the 119 student respondents, a majority (111/119, 93%) felt that the clinical ED faculty served as either somewhat or very positive role models for communicating difficult news (Likert like scale of 1-4 with mean score of 3.26).

Prior to starting the EM clerkship an overwhelming majority of respondents (100/120, 90%) stated that they had not received specific training on written self-reflection. Similarly, a majority of students (108/120, 91%) perceived self-reflection to be a valuable tool for personal growth. Comparisons of pre- and post-clerkship survey responses revealed a statistically significant decrease in the perceived value of written self-reflection (Table 2).

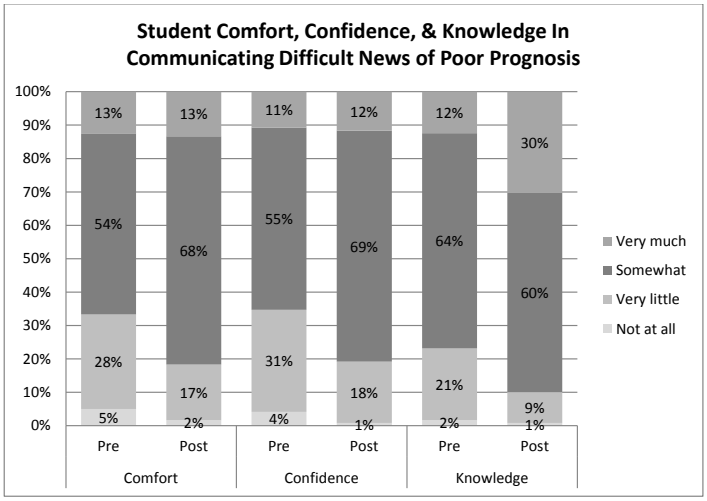

Figure 2. Emergency Medicine Clerkship students' self-reported pre and post clerkship responses regarding breaking bad news of poor prognosis.

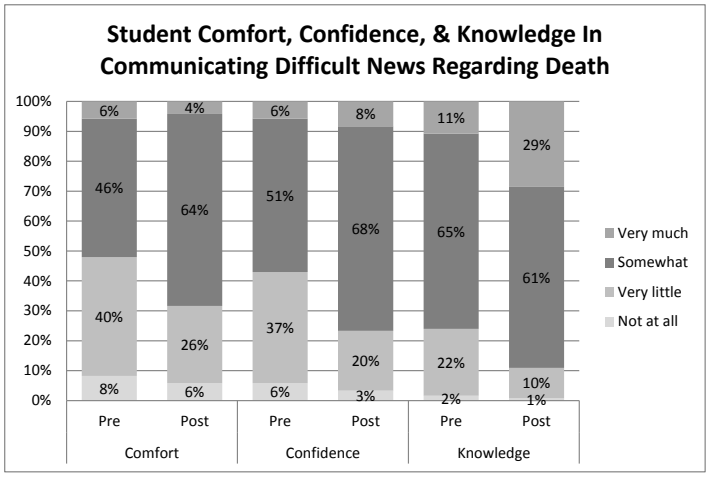

Figure 3. Emergency Medicine Clerkship students' self-reported pre and post clerkship responses regarding breaking bad news of death.

Learner experience-related themes from written self-reflections

Of the 110 written self-reflections analyzed, we explored themes expressed for real and/or simulated resuscitations under three main categories: "things that went well and why;" "things that did not go well and why;" and finally any student emotional responses identified. In general, among "things that went well," students had positive comments about the simulation and described ED resuscitations as good role models to learn team organization and efficiency; "ED codes run as a well-oiled machine;" "ED team knew their roles well;" and "Everyone worked well together." Students also listed that the observed ED clinician to family communication interactions were positive experiences; "Took time to explain, prompt effort to contact family." However, among "things that did not go well," the chaotic resuscitation setting, negative emotions, and some of the negative healthcare worker to healthcare worker communication interactions during resuscitations were cited.

Students listed strong emotional responses to both real and/or simulated resuscitation encounters:
Anxiety and stress around the overwhelming nature of resuscitation; "….the day when the responsibility will fall on me;" Feelings of a personal sense of loss, grief and of own mortality; "I am that age…that could have been me"
Sense of failure when patient died after resuscitation attempt; "You work to save a life and failed"
Feelings of worthlessness and abandonment; "I felt….lost,…. overlooked,….useless."

DISCUSSION

Teaching the essential communication skills of how to deliver difficult news of poor prognosis and death to family can be accomplished by including role-play communication exercises with simulated resuscitation scenarios. Role-play can be incorporated without a significant impact on session time and faculty resources. Major outcomes of our study included the following: 1) Most medical students reported limited real-life experiences with communicating difficult news; 2) The communication learning activities increased knowledge, comfort and confidence with communicating news of death and poor prognosis. When we explored student written self-reflections with intent to inform future curricula we found as a secondary outcome that resuscitations (both real and/or simulated) generated a variety of strong emotional responses in student learners.

Communication skills are taught in the pre-clerkship years to prepare students for clinical encounters in all undergraduate medical school curricula. However, these skills may decline by graduation if not reinforced.[27,28] Real-life opportunities to deliver difficult news will vary from

Table 2. Comparison of pre and post emergency clerkship survey responses.

Questions	Pre	Post	p-value*
Is self reflection a valuable tool for?[1]			
Personal growth	90.8%	73.9%	<0.001
Improvement in clinical practice	80.5%	65.3%	0.005
Lifelong learning	80.5%	67.8%	0.011
Comfort with CDN[2]			
Death	Median 3.0	Median 3.0	0.006
	Mean 2.5	Mean 2.7	0.010
Poor prognosis	Median 3.0	Median 3.0	0.003
	Mean 2.7	Mean 2.9	0.005
Confident with CDN			
Death	Median 3.0	Median 3.0	<0.001
	Mean 2.6	Mean 2.8	<0.001
Poor prognosis	Median 3.0	Median 3.0	0.002
	Mean 2.7	Mean 2.9	0.001
Knowledge of CDN			
Death	Median 3.0	Median 3.0	<0.001
	Mean 2.8	Mean 3.2	<0.001
Poor prognosis	Median 3.0	Median 3.0	<0.001
	Mean 2.9	Mean 3.2	<0.001

CDN, communicating difficult news

[1]p-values obtained via McNemar Chi-Square tests.

[2]p-values for comparisons of medians obtained via Wilcoxon signed ranks tests; p-values for comparisons of means obtained via paired-samples t-tests.

student to student, regardless of institution. Therefore, it is important for educators to create and provide opportunities with simulated scenarios so students can practice delivering news of death and poor prognosis, for example simulated resuscitations.[8,18,20-22,29-32] Post-module, the levels of knowledge, comfort and confidence with delivering news of death and poor prognosis improved. Knowledge levels increased the most as compared to comfort and confidence.[8,33-35] This may be due to the fact that unlike a gain in knowledge, comfort, and confidence in skills may take longer to build and require repeated practice over time. For some students the role-play exercise may actually serve to highlight the fact that these discussions may be much more difficult and complex than previously perceived.

The secondary aims of our project were to 1) encourage students to use written reflective inquiry for communication skills development and 2) explore these written learner experiences with the goal to inform future case scenario and curriculum design. Self-reflection exercises have also been shown to foster development of reflective capacity and enhance life-long learning and professionalism when used appropriately.[36-42] Though we asked students to write on difficult communication, many however chose to express concern and lack of comfort with resuscitation experiences (both real and simulated). Therefore, the themes analysis has additionally provided valuable information about learner experiences and emotions during real and simulated resuscitations that may have implications for the school curriculum as well as the ED learning environment. This information may assist educators designing similar educational modules. In our institution, written self-reflection exercises occur in the early pre-clerkship years. However, based on student report it is clear that the current curriculum does not adequately reinforce the practice of written self-reflection, especially in the clerkship years. Students were initially overwhelmingly positive about the value of written self-reflections. However, the perceived value of written self-reflections declined after completing the exercise. We speculate that students may have 1) viewed this exercise as 'added' busy work for a clinical clerkship, 2) realized that writing about personal feelings may be more difficult than initially perceived, and 3) lacked validation of expressed emotions. Our study, as well as work by Dyrbye et al., also suggests that e-mail could be a useful modality to consider when offering formative feedback on clinical events/experiences that went well or did not go well and for self-reflective exercises.[28,43]

Patient resuscitations (both real and simulated) generated an emotional response in the learner. Frequently expressed learner emotions included anxiety, grief, sense of loss, and sense of failure. The emotions of professional failure and other personal reactions related to death and

dying have been previously described.[9,11,18,30,31,33,44-49] Many students also expressed ambivalence regarding 'moving on to the next patient' after a patient death. Some were unsettled by this routine ED practice whereas others felt it helped them cope with recent patient death. Clinicians also report that patient resuscitations are particularly stressful, especially those that end with patient death.[11] The ED setting may present additional challenges to effective communication around resuscitation that include chaotic setting, time constraints, and no prior doctor-patient relationship.[8,45] Stressful resuscitations may sometimes lead to unprofessional communications among healthcare workers and this was cited by many of our students under "things that did not go well." In addition, in the ED setting students often reported feelings of worthlessness and abandonment while they acknowledged the well-organized efforts of the ED team in general. A suggestion to provide a sense of value as well as actively engage students in real resuscitations may therefore be to assign them simple tasks such as chest compressions.

In summary, we propose that communication modules should ideally routinely supplement ACLS and ATLS simulation resuscitation scenarios. We feel that this is an opportune time to closely integrate and reinforce communication skills with family members and encourage trainee self-reflection.[5,18,36,50] Based on our learner self-reflection responses, we suggest that educators also explore ways to 1) address and validate the emotions felt by students and 2) address any negative role-modeling/communication that may occur during real and/or simulated resuscitation events.

LIMITATIONS

Limitations of our study include the use of survey tools that were not previously validated, but internally developed by experts in EM and palliative care. Though the project was conducted at a single institution, the educational module is feasible to implement and adaptable across other settings. We target learners in a mandatory clerkship and results may differ with students on electives who may have a special interest in resuscitation or communication skills. We only evaluate pre-clerkship and post-clerkship self-report data (four weeks later). This self-report methodology is dependent on student perception and does not allow for objective measurement of knowledge and skills acquisition. Since the graduating senior students were not followed as they went on to the various residencies (with varied emphasis on communication skills training by discipline) we are unable to provide long-term data. As stated above, we did not provide one-on-one feedback to the learners on their written self-reflections and this may have led to the decline in scores related to the perceived value of the written exercise. This specific self-reflection format therefore may not have been constructed to provide maximal benefit to students.

CONCLUSION

Simulated resuscitation case-based scenarios present an opportunity to closely integrate teaching of communication and self-reflection skills. A communication module with role-play increased trainee knowledge, comfort, and competence regarding communication of difficult news of poor prognosis and death after resuscitation. Educators may need to seek ways to address the strong emotions generated in learners with real and simulated patient resuscitations.

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Residency Applicants Prefer Online System for Scheduling Interviews

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Introduction: Residency coordinators may be overwhelmed when scheduling residency interviews. Applicants often have to coordinate interviews with multiple programs at once, and relying on verbal or email confirmation may delay the process. Our objective was to determine applicant mean time to schedule and satisfaction using online scheduling.

Methods: This pilot study is a retrospective analysis performed on a sample of applicants offered interviews at an urban county emergency medicine residency. Applicants were asked their estimated time to schedule with the online system compared to their average time using other methods. In addition, they were asked on a five-point anchored scale to rate their satisfaction.

Results: Of 171 applicants, 121 completed the survey (70.8%). Applicants were scheduling an average of 13.3 interviews. Applicants reported scheduling interviews using the online system in mean of 46.2 minutes (median 10, range 1-1800) from the interview offer as compared with a mean of 320.2 minutes (median 60, range 3-2880) for other programs not using this system. This difference was statistically significant. In addition, applicants were more likely to rate their satisfaction using the online system as "satisfied" (83.5% vs 16.5%). Applicants were also more likely to state that they preferred scheduling their interviews using the online system rather than the way other programs scheduled interviews (74.2% vs 4.1%) and that the online system aided them coordinating travel arrangements (52.1% vs 4.1%).

Conclusion: An online interview scheduling system is associated with higher satisfaction among applicants both in coordinating travel arrangements and in overall satisfaction. [West J Emerg Med. 2015;16(2):352-354.]

INTRODUCTION

Residency applicants have to coordinate interviews at different programs even though interview offers may not be extended concomitantly. Residency administration may also be overwhelmed with scheduling residency interviews. Additionally, applicants are often doing rotations during "business hours," which might prevent them from calling or reaching program coordinators in a timely fashion. We estimated scheduling and rescheduling interviews took 40hrs of administrator time the first week and 10hrs each subsequent week for the next three weeks each year.

A commercial online scheduling system that was available at all hours of the day might make the interview scheduling process easier for applicants and be a significant resource-saving investment for programs. An ideal system would allow both initial scheduling and would also allow changing/rescheduling of interviews later. Such a system might improve the experience for both applicants and for program coordinators. A prior study of a university-based, custom single site scheduling system, showed a 77% preference for scheduling interviews online.[1]

Our study objective was to determine applicant mean time to schedule and satisfaction using a commercially available Internet scheduling program. A secondary objective was to calculate the return on investment. We

implemented this online program for the 2010-2011 residency interview season. Our program was one of four emergency medicine (EM) programs who used the system that year, the first year it was offered. We paid a fee of $2 per applicant for the use of this system and have no financial interest in it (www.Interviewbroker.com).

METHODS

This pilot study is a retrospective analysis of applicants at an urban county EM residency. They received an anonymous survey asking about their experiences with the online interview scheduling system as compared with other programs. The survey was sent after interview offers were granted but before any interview occurred. Applicants were asked to provide the estimated time to schedule with the online system compared to the average time to schedule using other methods. They were asked to rate their satisfaction on a five-point anchored scale.

Our survey was developed and then piloted with departmental faculty with residency leadership experience. The survey and revisions were piloted with residents within our own program and in accordance with survey design methodology to maximize validity and reliability.[2]

Data analysis followed the assumption that questions regarding subjects' experiences with and without the software should be treated as non-independent observations, and that the modified Likert scale should not be treated as an interval variable. With these assumptions, we analyzed Likert distributions using the Wilcoxon signed rank sum test. We also dichotomized the scale to "Satisfied" and "Less than satisfied," which we analyzed with McNemar's test for non-independent observations. The study instrument and protocol were approved by the institutional review board at our institution.

RESULTS

Of 171 applicants, 121 completed the survey (70.8%). Applicants were scheduling an average of 13.3 interviews. Based on their responses, applicants estimated scheduling interviews using the online system took a mean of 46.2 minutes (median 10, range 1-1800) from the interview offer as compared with a mean of 320.2 minutes (median 60, range 3-2880) for other programs not using this system. This difference was statistically significant. In addition, applicants were more likely to rate their satisfaction using the online system as "satisfied" – 101 (83.5%) or "somewhat satisfied" – 16 (13.2%), as compared to "neither satisfied or unsatisfied" – 1 (0.8%) or "somewhat unsatisfied" – 2 (1.7%) or "unsatisfied" – 1 (0.8%).

Among applicants who had to change interview dates, 35 of 40 (90%) were "satisfied" in their ability to change their date. Among applicants not using the online system, 16 of 90 (17.6%) were satisfied and 35 of 90 (38.8%) described themselves as "slightly unsatisfied" or "unsatisfied."

Overall, when asked if applicants preferred self scheduling using the online system, 105 of the 120 (87.5%) responding stating they "agree" or "somewhat agree." When asked if they preferred the non-online system only 13 of 121 (10.7%) stated they "agree" or "somewhat agree." In fact, 75 of the 121 (62%) responding to this question stated they "disagreed" or "somewhat disagreed."

In terms of travel, 84 of 119 (70.6%) applicants "agreed" or "somewhat agreed" to the statement that the online system made making their travel arrangements easier. When applicants did not use the online system, only 11 of 121 (9.1%) stated they "agreed" or "somewhat agreed" in the statement that the non-online systems made making their travel arrangements easier. Fifty-one of the 121 (42.1%) respondents stated they "disagreed" or "somewhat disagreed."

DISCUSSION

The results of this pilot study show that applicants prefer online systems. This result is consistent with a prior study showing high satisfaction with online interview scheduling.[1] While we did not study this, we assume applicants prefer online scheduling because it conforms to their schedules and their access to technology. An online system can allow them to schedule or change interviews 24 hours a day. For this technologically adept cohort, an online system may be more convenient or familiar than emails and phone calls. Similarly, the online system allows applicants to rapidly change interview dates electronically to coordinate interviews at other programs. What was surprising and unexpected in our results was the time to schedule an interview with half of applicants reporting scheduling interviews within 10 minutes.

Our initial cost was $342 plus about three hours of set-up time. Based on an estimated $35/hr salary for program coordinators, our investment was $447. We estimate that prior to this system, our program coordinator spent approximately 70 hours coordinating, scheduling, and rescheduling interviews. We saved $2,450 (70hrs x $35/hr) or $5.48 for every dollar invested. We did not attempt to quantify increased satisfaction as a measure of return on investment. There may be significant variation among programs for cost savings. Some programs may have a lower cost for program coordinator salary which might lower their cost savings and return on investment.

This online system, or others similar, may substantially change the scheduling of interviews and free up program coordinator and program director time. We assumed that there was increased accuracy with the online system and there was no information 'lost in translation' over the phone but did not study this outcome.

The study was completed in the 2010-2011 interview season. During the 2010 interview season, the authors' residency was one of only four EM programs using such a system based on information from the company. In addition, it was the first year the company offered the system.[3] It is not

clear how many programs are currently using online interview tools as the number of commercially available products has increased. A larger multi-center study is currently underway.

LIMITATIONS

Of the total applicants surveyed, only 121 (or 70.8%) responded. The ones who responded may have been more pleased with the system and have been more likely to answer the survey.

Additionally, those responded knew the survey was coming from our program. The survey was conducted prior to submission of the rank lists. The unblended aspect of the survey might have biased responders into responding favorably in the hope that it might affect their position on the rank list. (The survey was anonymous and the consent stated so.)

There was no way to accurately gauge the actual time spent on task for the applicants. They did not keep a time diary. Their recall of the time spent on task may not be accurate as it may have been 1-3 weeks after they received their interview offers. We chose to not wait until after match day as the time passed since the interviews were scheduled would have been over five months.

We also acknowledge that there are frequently follow-up phone calls or emails that require program coordinator time. We feel this likely happens with any system. Our initial time savings were based on calculations for the initial scheduling and rescheduling tasks that Interview Broker automated.

Responders might inherently prefer online systems because of their facility with technology. The survey may have confounders inherent in that it was merely measuring preferences for computer- based administrative systems rather than human based systems for simple administrative tasks.

CONCLUSION

In this pilot study, an online scheduling system was associated with higher satisfaction among applicants, including satisfaction for changing interview dates and making travel plans. We found a significant return on investment in terms of increased available administrator time.

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Emergency Medicine Residency Boot Camp Curriculum: A Pilot Study

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Introduction: Establishing a boot camp curriculum is pertinent for emergency medicine (EM) residents in order to develop proficiency in a large scope of procedures and leadership skills. In this article, we describe our program's EM boot camp curriculum as well as measure the confidence levels of resident physicians through a pre- and post-boot camp survey.

Methods: We designed a one-month boot camp curriculum with the intention of improving the confidence, procedural performance, leadership, communication and resource management of EM interns. Our curriculum consisted of 12 hours of initial training and culminated in a two-day boot camp. The initial day consisted of clinical skill training and the second day included code drill scenarios followed by interprofessional debriefing.

Results: Twelve EM interns entered residency with an overall confidence score of 3.2 (1-5 scale) across all surveyed skills. Interns reported the highest pre-survey confidence scores in suturing (4.3) and genitourinary exams (3.9). The lowest pre-survey confidence score was in thoracostomy (2.4). Following the capstone experience, overall confidence scores increased to 4.0. Confidence increased the most in defibrillation and thoracostomy. Additionally, all interns reported post-survey confidence scores of at least 3.0 in all skills, representing an internal anchor of "moderately confident/need guidance at times to perform procedure."

Conclusion: At the completion of the boot camp curriculum, EM interns had improvement in self-reported confidence across all surveyed skills and procedures. The described EM boot camp curriculum was effective, feasible and provided a foundation to our trainees during their first month of residency. [West J Emerg Med. 2015;16(2):356–361.]

INTRODUCTION

As medical students graduate and enroll into their respective residency programs, many realize there is a disconnect between their academic knowledge of medicine and its clinical application in team-based settings.[1] This disconnect also creates a steep learning curve for interns performing various procedural skills. With the advent and increasing prevalence of simulation training across healthcare institutions, first- year residents are able to better assimilate into their programs and treat patients with a consistent standard of care, decreasing the "July Effect."[2] Healthcare systems, recognizing the integral role of simulation training, have begun organizing "boot camps," curricula that involve a series of training sessions and debriefings with the intent of

not only increasing the confidence of resident physicians, but also standardizing a level of competency and performance across various procedures. Even though the integral role of boot camps has been understood in resident training, barriers exist nationally when it comes to implementing them. Boot camps are still a transitioning aspect of medical training.[3] Great ambiguity exists in defining and implementing boot camp curricula.

Emergency medicine (EM) residents, who are responsible for triaging, diagnosing and stabilizing patients, must be proficient in a large scope of procedures, ranging from airway management to lumbar puncture. They must also develop the ability to lead interprofessional teams during high acuity resuscitations. Therefore, establishing a boot camp curriculum for these residents is of paramount importance.

In this article, we describe the development of a broad-based EM boot camp curriculum. This includes the various materials and methodology used and measures the confidence of interns through a pre and post survey.[4] Ultimately, we aim to provide a framework through which other EM residencies can implement boot camp programs of their own.

METHODS

Study and Boot Camp Curriculum Design

We designed a one-month boot camp curriculum with the intention of improving the confidence, procedural performance, leadership, communication and resource management of EM interns. Our comprehensive curriculum consisted of approximately 12 hours of initial training and culminated with a two-day, 16-hour capstone experience (Figure 1). Initial training required approximately eight hours for set up and breakdown of equipment, printing and grading of checklists, and remediation testing. Prior to executing the capstone boot camp experience, 20 to 24 hours of initial preparation from seasoned simulation faculty was necessary for curriculum development including goals and objectives, simulation case development, and retrieval of multimedia images. After initial preparation was completed, a walk through and rehearsal was performed by simulation faculty and key staff to ensure cases ran as planned and necessary equipment was available for each scenario (four to six hours). In total, approximately 32-38 hours of preparation were required to execute this curriculum.

Initial Training

During orientation and prior to their initial simulation training, each intern received a CD-ROM containing reading materials, videos and internally developed competency checklists on six procedures (Figure 1). Interns were required to complete the appropriate readings and score a minimum of 80% on an online multiple choice test for each procedure as well as a formal summative evaluation to demonstrate procedural competence on the simulator. Residents had to correctly perform the procedure with a minimum of 80% of all competency checklist items including all items designated as critical actions. Initial training included two four-hour sessions of hands-on

Residents receive competency CD-ROM on 6 procedures:

- -Thoracostomy
- Femoral Line Insertion
- Internal Jugular Line Insertion
- Lumbar Puncture
- Orotracheal Intubation
- Subclavian Line Insertion

Initial Training

Session 1: 4 hours, Lumbar Puncture and Airway Management
Session 2: 4 hours, Thoracostomy and Central Line Insertion
Session 3: 4 hours, Optional Training
Session 4: 4 hours, Formal Testing
Remediation: Provided for those who are unsuccessful at any one procedure on an individual basis

2-Day Boot Camp

Day 1: 08:00 – 11:00 Skills Training Stations (45 minute rotations); Genitourinary Exam, Defibrillator/Monitor, Intubation, Central Line Insertion
11:00 – 12:00 Lunch
12:00 – 15:00 Skills Training Stations (45 minute rotations); Slit Lamp, Suture Techniques, Thoracostomy, Lumbar Puncture, Arterial Line Insertion, Arterial Blood Gas, Intraosseous Access
15:00 – 16:00 Wrap Up

Day 2:
08:00 – Introduction
08:15 – Scenario 1
09:15 – Scenario 2
10:15 – Break
10:30 – Scenario 3
11:45 – Lunch
12:15 – Scenario 4
13:15 – Scenario 5
14:30 – Break
14:45 – Scenario 6
16:00 – Scenario 7 & 8 (Dual Trauma)
17:30 – Concluding Remarks/Survey
18:00 – END

Figure 1. Boot camp curriculum overview.

instruction, four hours of optional training, and four hours of formal testing (Figure 1).

Two-Day Capstone Experience

Day 1 - 8 hours of instruction

Two weeks after initial training, twelve EM interns participated in the two-day capstone experience. During the first day, four groups of three residents rotated through eight skills stations at 45- minute intervals (Figure 2). At each station, a physician or a simulation team member demonstrated the designated procedure(s). Each intern was provided time to practice and received individualized feedback in a deliberate practice fashion.[5]

Day 2 – 9 hours of instruction

At the beginning of day two, interns received an orientation to the high-fidelity simulators, resuscitation bay, ancillary equipment and staff available. They were informed that the

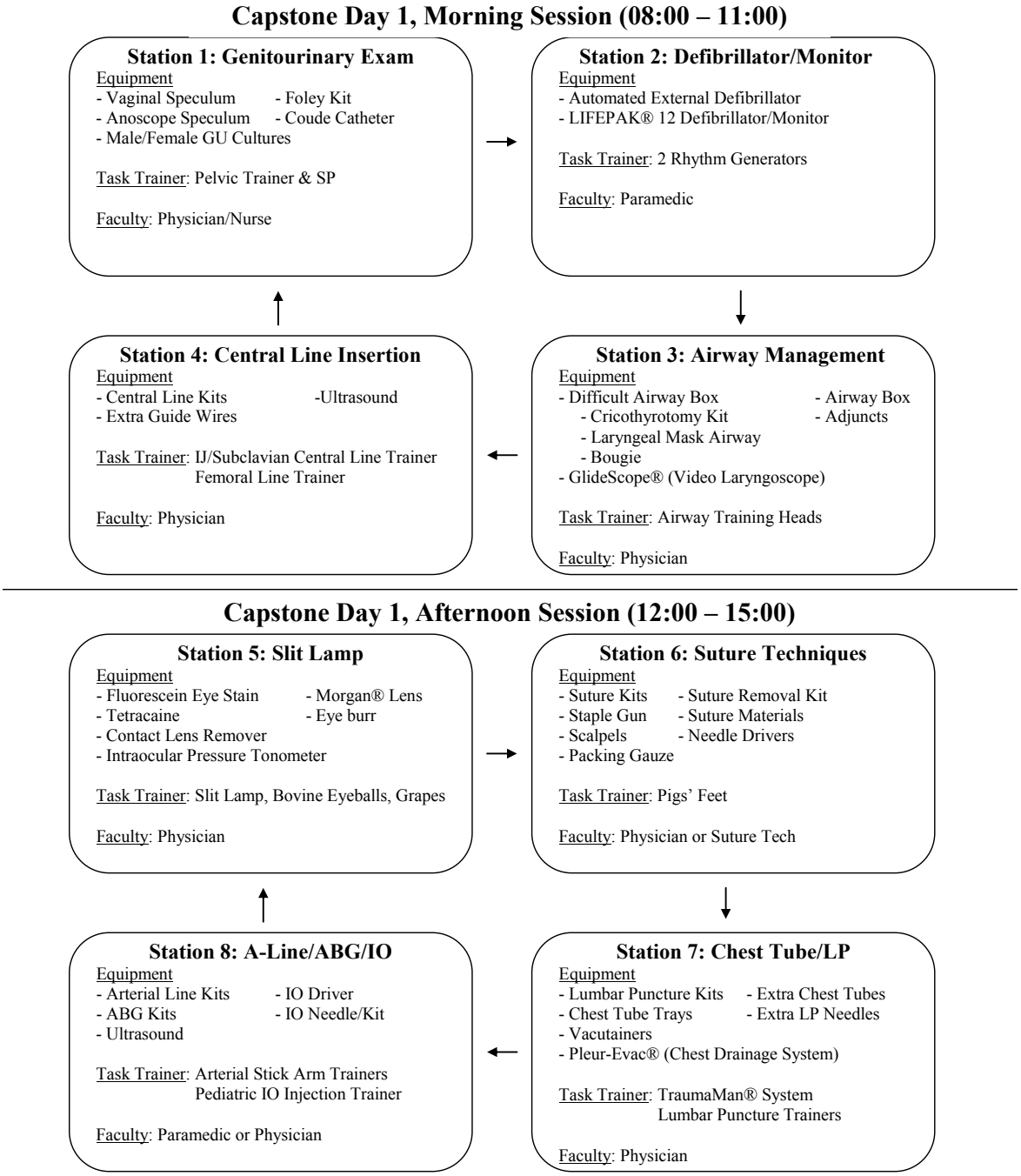

Figure 2. SKill Stations and required equipment for capstone experience day 1.
GU, genitourinary, *SP*, standardized patient; *IJ*, internal jugular, *A-line,* arterial line; *ABG*, arterial blood gas; *IO*, intraosseous access; *LP,* lumbar puncture

simulation site functions as a learning environment and were encouraged to treat the simulation as realistically as possible. For the duration of the second day, six code scenarios and a final dual trauma were simulated, which required participants to apply several of the skills learned from the previous training (Figure 3).

In preparation for day two, materials were gathered including possible test results such as digital x-rays, electrocardiograms, ultrasound images and computed tomography scans to enhance the fidelity of the simulation. Each resuscitation bay was stocked with a crash cart, the appropriate trainers and equipment. This included an airway box, central line kit and trainer, thoracostomy tray with thoracostomy tubes, cricothyrotomy kit, tourniquet and pelvic binder. Most materials used during the code drills were recycled or expired to both save on costs and mirror the equipment residents would typically encounter in actual clinical environments. Each of the first six scenarios required four residents, two confederate nurses, a confederate paramedic and a high-fidelity adult simulator to mimic clinical conditions.[6] The dual trauma scenario provided a final resuscitation opportunity in which the interns begin the scenario managing one critically injured geriatric trauma patient but are then confronted with another critical accident victim (Figure 3). After each scenario, the interns were debriefed using advanced debriefing strategies.[7] The goals and objectives listed in Figure 3 were addressed in a formative nature during the debriefing process by several of the EM core faculty observing the simulations.

Goals:

1) Demonstrate effective closed-loop communication with team members.
2) Apply appropriate medical and procedural knowledge to clinical scenarios.
3) Demonstrate principles of crisis resource management.
4) Participate in interprofessional debriefing.

Description of simulation cases with objectives:

1) Pulseless electrical activity (PEA)—patient found unresponsive in hospital bed
   a) Follow correct ACLS protocol
   b) Perform appropriate airway management
   c) Demonstrate effective teamwork and closed-loop communication
   d) Develop shared mental model (discuss "H's and T's")
2) Supraventricular Tachycardia (SVT)—patient presents via EMS with normal vitals
   a) Follow correct ACLS protocol
   b) Perform synchronized cardioversion secondary to hypotension
   c) Perform appropriate airway management
   d) Demonstrate effective teamwork and closed-loop communication
3) Chest pain- patient presents via EMS with hypotension
   a) Proper interpretation of EKG (STEMI)
   b) Recognize rhythm change (ventricular tachycardia)
   c) Shock appropriately
   d) Perform appropriate airway management
   e) Follow correct ACLS protocol
   f) Obtain timely and appropriate consult (cardiology)
4) Symptomatic bradycardia- patient presents via EMS with hypotension
   a) Recognize symptomatic bradycardia/ 3rd Degree heart block (EKG)
   b) Treat hypotension
   c) Follow correct ACLS protocol
   d) Initiate transcutaneous pacing
   e) Obtain timely and appropriate consult (cardiology)
5) Asystole- patient found unresponsive in hospital bed
   a) Follow correct ACLS protocol
   b) Perform appropriate airway management (difficult airway)
   c) Recognize rhythm change (torsades)
   d) Defibrillate appropriately
6) Apnea, CHF- patient arrives via EMS with hypotension on BiPAP
   a) Confirm BiPAP settings/determine BiPAP appropriateness
   b) Obtain ABG
   c) Recognize change in mental status and need for intubation
   d) Perform surgical airway
   e) Perform Central line placement
   f) Provide fluids, appropriate pressors
7) Dual Trauma: Motorcycle struck by vehicle presents via EMS to rural ED
   Pt #1: Motorcycle driver
   a) Perform primary survey
   b) Perform intubation with cervical spine precautions
   c) Obtain two large bore IV's with fluid boluses
   d) Recognize unstable pelvis and apply pelvic binder
   e) Obtain FAST exam (positive)
   f) Order O negative blood
   g) Apply principles of crisis resource management with arrival of 2nd patient
   h) Transfer to trauma center

   Pt #2: Motorcycle passenger
   a) Perform primary survey
   b) Provide immediate pressure to extremity hemorrhage
   c) Obtain two large bore IV's with fluid boluses
   d) Recognize need for and application of tourniquet
   e) Order O negative blood
   f) Apply principles of crisis resource management

Figure 3. Goals and outline of capstone experience day 2.

Survey Questionnaire

Pre and post surveys were administered in order to gauge interns' confidence levels and areas of weakness. In addition, we sought to identify specific areas in need of improvement within our boot camp curriculum. The pre survey was comprised of two sets of 12 questions aimed at outlining interns' confidence levels and prior experience. The post survey consisted of 15 questions, 12 of which were repeat questions from the pre survey, along with three additional open-ended questions to identify strengths and weaknesses of the boot camp curriculum. This was a quality assurance project and did not meet the definition of human subject research and was therefore exempt from institutional review board review.

RESULTS

This pilot study demonstrated that interns enter residency with an overall confidence score of 3.2 (1-5 scale) across all surveyed skills (Table 1). Interns reported the highest pre-survey confidence scores in suturing (4.3) and genitourinary exams (3.9). The lowest pre-survey confidence score was in thoracostomy (2.4). Following the capstone experience, overall confidence scores increased to 4.0. There was a significant improvement in confidence across eight procedures (Table 1). Confidence increased the most in defibrillation and thoracostomy (Table 1). Additionally, all interns reported post-survey confidence scores of at least 3.0 in all skills, representing an internal anchor of "moderately confident/need guidance at times to perform procedure." Approximately 80% of interns had fewer than five simulation and five clinical experiences across all surveyed skills preceding the capstone event (Table 2).

DISCUSSION

Our boot camp curriculum provided both a procedural component and a scenario-based component. The first day of the capstone experience emphasized fundamental procedural skills. The second day focused on the creation of a broad differential diagnosis, recognition of the correct procedure(s)

Table 1. Pre- and post-survey confidence scores of interns participating in an emergency medicine boot camp.

Clinical skills	Pre survey confidence mean (standard deviation) 1-5 scale	Post survey confidence mean (standard deviation) 1-5 scale	p-value (significant <0.05)*
Genitourinary exam	3.9 (0.9)	4.4 (0.5)	0.11
Defibrillation	3.0 (1.3)	4.3 (0.5)	0.0059*
Intubation	3.7 (0.9)	4.0 (0.6)	0.35
Central lines	3.3 (1.0)	3.8 (0.6)	0.15
Slit lamp	2.7 (1.1)	3.8 (0.6)	0.0074*
Suturing	4.3 (0.7)	4.4 (0.5)	0.69
Thoracostomy	2.4 (1.2)	3.7 (0.7)	0.0046*
Lumbar puncture	3.0 (1.1)	3.8 (0.7)	0.045*
Arterial line	2.7 (1.2)	3.7 (0.8)	0.025*
Arterial blood gas	3.1 (1.2)	4.2 (0.9)	0.019*
Intraosseus	3.3 (1.1)	4.4 (0.7)	0.0079*
Code team leader	2.7 (1.2)	3.8 (0.6)	0.0095*
Overall	3.2 (0.56)	4.0 (0.29)	0.00012*

Table 2. Pre-survey frequency of clinical skills.

	Simulation			Clinically		
Clinical skills	<5 Times	5-10 Times	>10 Times	<5 Times	5-10 Times	>10 Times
Genitourinary exam	9/12 (0.75)	2/12 (0.17)	1/12 (0.083)	1/12 (0.083)	4/12 (0.33)	7/12 (0.58)
Defibrillation	6/12 (0.50)	4/12 (0.33)	2/12 (0.17)	8/12 (0.66)	3/12 (0.25)	1/12 (0.083)
Intubation	3/12 (0.25)	1/12 (0.083)	8/12 (0.67)	8/12 (0.66)	2/12 (0.17)	2/12 (0.17)
Central line	7/12 (0.58)	4/12 (0.33)	1/12 (0.083)	10/12 (0.83)	2/12 (0.17)	0/12 (0.00)
Slit lamp	12/12 (1.00)	0/12 (0.00)	0/12 (0.00)	10/12 (0.83)	0/12 (0.00)	2/12 (0.17)
Suturing	6/12 (0.50)	4/12 (0.33)	2/12 (0.17)	0/12 (0.00)	1/12 (0.083)	11/12 (0.92)
Thoracostomy	10/12 (0.83)	2/12 (0.17)	0/12 (0.00)	11/12 (0.92)	1/12 (0.083)	0/12 (0.00)
Lumbar puncture	8/12 (0.67)	4/12 (0.33)	0/12 (0.00)	12/12 (1.00)	0/12 (0.00)	0/12 (0.00)
Arterial line	11/12 (0.92)	1/12 (0.083)	0/12 (0.00)	9/12 (0.75)	3/12 (0.25)	0/12 (0.00)
Arterial blood gas	11/12 (0.92)	1/12 (0.083)	0/12 (0.00)	8/12 (0.66)	4/12 (0.33)	0/12 (0.00)
Intraosseus	9/12 (0.75)	2/12 (0.17)	1/12 (0.083)	12/12 (1.00)	0/12 (0.00)	0/12 (0.00)
Code team leader	8/12(0.66)	2/12 (0.17)	2/12 (0.17)	11/12 (0.92)	1/12 (0.083)	0/12 (0.00)

to perform and use of stress mitigation strategies.[8] Teamwork and leadership are critical components of diagnosing and providing care for patients with a wide range of high acuity illnesses. The diverse series of eight scenarios highlighted the value of each team member in terms of their knowledge and troubleshooting ability. Rotating the leadership position in each scenario provided interns with the opportunity to better envision role dynamics typical in clinical settings. Additionally, it emphasized the concept of closed-loop communication between interns, ultimately empowering the team to safely delegate responsibilities, stabilize patients and focus on different aspects of patient care.[9] The end result of closed-loop communication, knowledge sharing and task delegation is to minimize the chance of complications due to miscommunication and system failure.[10]

Prior to the capstone experience, interns reported the highest confidence scores in suturing and genitourinary exams. This high level of confidence may be attributed to prior exposure during the course of their medical education, including practical experience on clinical rotations (Table 2). The low level of confidence in thoracostomy was likely due to the limited clinical exposure and opportunity to perform the procedure. Following the capstone experience, the significant rise in intern confidence scores suggests the effectiveness of our boot camp curriculum.

In addition to our quantitative results, interns' written responses provided a framework through which the boot camp curriculum's strengths and weaknesses could be evaluated. An appreciated aspect was the small group sizes. This allowed for

greater access to faculty and more opportunities for individuals to practice their learned skills in a deliberate practice approach.[5] Interns valued the hands on approach to the complex cases and the manner in which they were debriefed. They appreciated the constructive, team-based approach in addressing prospective clinical errors, highlighting the importance of having skilled debriefers. This concentrated, simulation-based curriculum aims to improve both procedural and leadership skills in a safe and effective learning environment.

LIMITATIONS

This study has several limitations. First, the sample size was small and consisted of interns from one institution over one year. Second, we used a non-validated survey tool and confidence scores provide subjective data. While confidence scores may prospectively predict clinical performance, future studies should use more concrete assessment tools to objectively measure interns' progress.[3] Finally, many goals and objectives listed were not objectively evaluated with an instrument and were addressed during formative post-simulation debriefing sessions.

CONCLUSION

At the conclusion of the EM boot camp curriculum, the interns had an improvement in self-reported confidence across all surveyed procedures and skills. The described EM boot camp curriculum was effective, feasible and provided a foundation to our trainees during their first month of residency. Our boot camp curriculum offers educators a framework from which they can implement their own training programs with coordinated effort, relatively inexpensive materials and dedicated faculty.

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

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This article corrects: "Correlation of the NBME Advanced Clinical Examination in EM and the National EM M4 exams"

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In the Original Research article entitled "Correlation of the National Board of Medical Examiners Advanced Clinical Examination in Emergency Medicine and the National Emergency Medicine M4 Exams," published in the January 2015 issue of the *Western Journal of Emergency Medicine* (2015;16(1):138-142. DOI: 10.5811/westjem.2014.11.24189), there were the following errors in the published article:

1. On page 138, the 1st line of the results section of the abstract should read: 305 students took the EM-ACE and versions 1 (V1) or 2 (V2) of the EM M4 exams (281 and 24, respectively).

2. On page 138, the 2nd line of the results section of the abstract should read: The mean percent correct for the exams were as follows: EM-ACE 74.9 (SD-9.82), V1 83.0 (SD-6.39), V2 78.5 (SD-7.70).

3. On page 138, the 3rd line of the results section of the abstract should read: Pearson's correlation coefficient for the V1/EM-ACE was 0.53 (0.43 scaled) and for the V2/EM-ACE was 0.58 (0.41 scaled).

4. On page 138, the 4th line of the results section of the abstract should read: The coefficient of determination for V1/EM-ACE was 0.73 and for V2/EM-ACE 0.71 (0.65 and .49 for scaled scores) [ERRATUM]. The R-squared values were 0.28 and 0.30 (0.18 and 0.13 scaled), respectively.

5. On page 140, the 1st line of the results section should read: Five institutions administered both the NBME EM-ACE and one version of the EM M4 exam to 305 fourth-year students at the end of their EM rotation. V1 of the EM M4 was administered to 281 students, and V2 to 24 students.

6. On page 140, the fifth sentence of the results section should read: The mean NBME scaled score for the entire cohort was 68.3 (SD-9.66).

7. On page 141 in the table, the Pearson's Correlation coefficient for "NBME (raw) V1 EM M4" should be 0.53 and "NBME (scaled) V1 EM M4" 0.43.

8. On page 141 in the table, the R-squared value for "NBME (raw) V1 EM M4" should be 0.28.

9. The correct Figures for "Figure 1" and Figure 2" on page 140 are shown on the following page:

We apologize for this error.

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

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1. Hiller K, Miller ES, Lawson L, et al. Correlation of the NBME Advanced Clinical Examination in EM and the National EM M4 exams. *West J Emerg Med*. 2015 Jan;16(1):138-42.

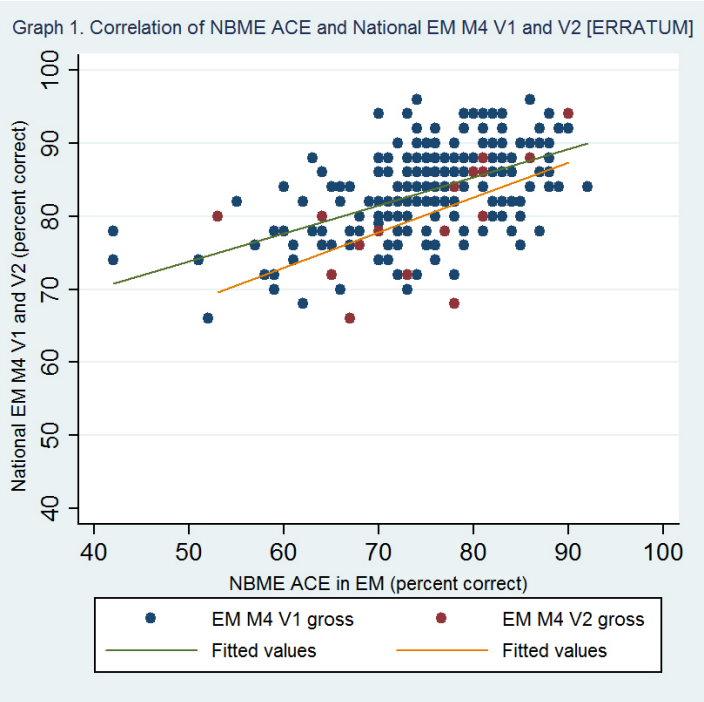


Figure 1. Correlation of NBME EM-ACE and National EM M4 V1 and V2.
EM, emergency medicine; *V1,* first version; V2, second version; *NBME,* National Board of Medical Examiners; *EM-ACE,* Advanced Clinical Exam in Emergency Medicine

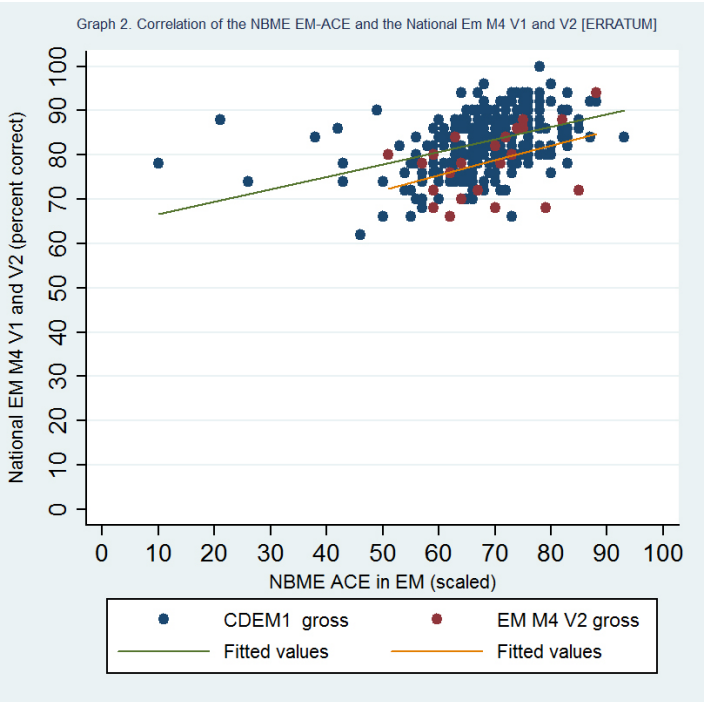
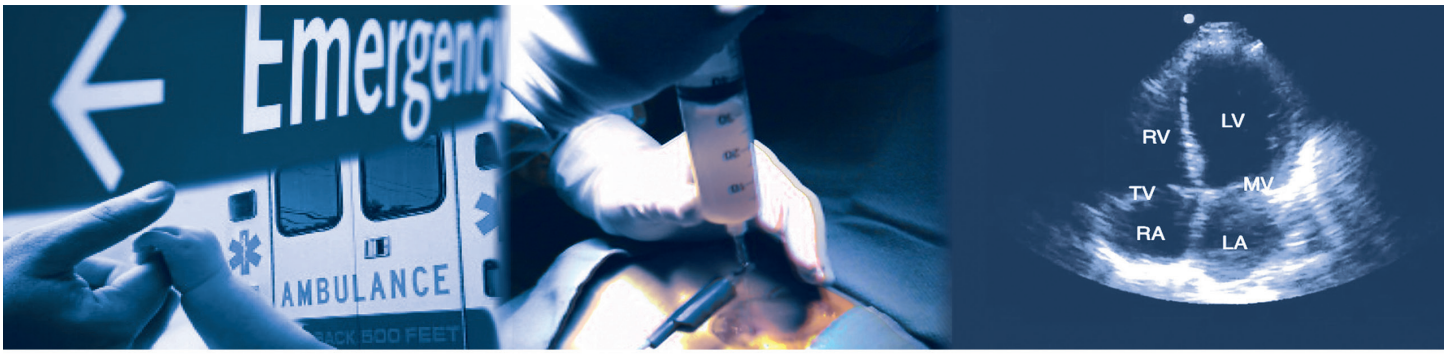


Figure 2. Correlation of NBME EM-ACE and National EM M4 V1 and V2.
EM, emergency medicine; *V1,* first version; V2, second version; *NBME,* National Board of Medical Examiners; *EM-ACE,* Advanced Clinical Exam in Emergency Medicine



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The VIII[th] MEMC is jointly organized by the American Academy of Emergency Medicine (AAEM), the Global Research on Acute Conditions Team (GREAT) Network & the Mediterranean Academy of Emergency Medicine (MAEM).
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Call for Papers
2015 *Academic Emergency Medicine* Consensus Conference

Diagnostic Imaging in the Emergency Department:
A Research Agenda to Optimize Utilization

The 2015 *Academic Emergency Medicine* (*AEM*) consensus conference, **Diagnostic imaging in the emergency department: A research agenda to optimize utilization** will be held on May 12, 2015, immediately preceding the SAEM Annual Meeting in San Diego, CA. Original papers on this topic, if accepted, will be published together with the conference proceedings in the December 2015 issue of *AEM*.

Diagnostic imaging is integral and beneficial to the practice of emergency medicine. Over the last several decades, emergency department (ED) diagnostic imaging has increased without a commensurate rise in identified pathology or improvement in patient-centered outcomes. Unnecessary imaging results in increased resource use and significant exposure risks. ED diagnostic imaging has become the focus of many stakeholders, including patients and various regulatory agencies. This multidisciplinary consensus conference represents the first coordinated effort to further our evidence-based knowledge of ED diagnostic imaging. This consensus conference will formulate the research priorities for emergency diagnostic imaging, initiate a collaborative dialogue between stakeholders, and align this research agenda with that of federal funding agencies.

Consensus Goal:
The overall mission of the 2015 *AEM* consensus conference will be to create a prioritized research agenda in emergency diagnostic imaging for the next decade and beyond. The consensus conference will feature expert keynote speakers, panel discussions including nationally recognized experts, and facilitated breakout group sessions to develop consensus on research agendas by topic. Optimizing diagnostic imaging in the ED is a timely topic that is relevant to all who practice emergency medicine. Furthermore, the conference content spans many other specialties (e.g. radiology, pediatrics, cardiology, surgery, internal medicine), all of which will be invited to participate in the conference to optimize the agenda and for future collaboration in order to improve emergency diagnostic imaging use.

Consensus Objectives:
1. Understand the current state of evidence regarding diagnostic imaging utilization in the ED and identify opportunities, limitations, and gaps in knowledge of previous study designs and methodology
2. Develop a consensus statement that emphasizes the priorities and opportunities for research in emergency diagnostic imaging that will result in practice changes, and the most effective methodologic approaches to emergency diagnostic imaging research
3. Explore and improve knowledge of specific funding mechanisms available to perform research in emergency diagnostic imaging

Accepted manuscripts will present original, high-quality research in emergency diagnostic imaging in areas such as clinical decision rules, shared decision making, knowledge translation, comparative effectiveness research, and multidisciplinary collaboration. They may include work in clinical/translational, health systems, policy, or basic sciences research. Papers will be considered for publication in the December 2015 issue of *AEM* if received by April 17, 2015. All submissions will undergo peer review and publication cannot be guaranteed.

For queries, please contact Jennifer R. Marin, MD, MSc (jennifer.marin@chp.edu) or Angela M. Mills, MD (millsa@uphs.upenn.edu) the 2015 consensus conference co-chairs. Information and updates will be regularly posted in *AEM*, the SAEM Newsletter, and the journal and SAEM websites.

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