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Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

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

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Mumps Virus: Modification of the Identify-Isolate-Inform Tool for Frontline Healthcare Providers

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Mumps is a highly contagious viral infection that became rare in most industrialized countries following the introduction of measles-mumps-rubella (MMR) vaccine in 1967. The disease, however, has been re-emerging with several outbreaks over the past decade. Many clinicians have never seen a case of mumps. To assist frontline healthcare providers with detecting potential cases and initiating critical actions, investigators modified the "Identify-Isolate-Inform" tool for mumps infection. The tool is applicable to regions with rare incidences or local outbreaks, especially seen in college students, as well as globally in areas where vaccination is less common. Mumps begins with a prodrome of low-grade fever, myalgias and malaise/anorexia, followed by development of nonsuppurative parotitis, which is the pathognomonic finding associated with acute mumps infection. Orchitis and meningitis are the two most common serious complications, with hearing loss and infertility occurring rarely. Providers should consider mumps in patients with exposure to a known case or international travel to endemic regions who present with consistent signs and symptoms. If mumps is suspected, healthcare providers must immediately implement standard and droplet precautions and notify the local health department and hospital infection control personnel. [West J Emerg Med. 2016;17(5)490-496.]

INTRODUCTION

Several international public health crises have emerged in recent years, including Ebola, Middle East respiratory syndrome (MERS), and Zika virus. In addition to these novel threats, there has been a resurgence of previously nearly eradicated infectious diseases, including mumps. In recent years, the numbers of mumps cases in the United States has fluctuated from hundreds to thousands of cases per year. In 2006, a multi-state mumps outbreak in the Midwest consisted of over 6,500 cases. In 2009-2010, two large outbreaks occurred in New York City and Guam, affecting about 3,000 and 500 persons respectively. In 2011-2013, there were smaller outbreaks in several states.[1] Many of the outbreaks occurred among college students. There was also a large outbreak in late 2014 among professional hockey players involving at least five teams in the National Hockey League (NHL), which began with players on the Anaheim Ducks. In March 2016, California public health officials issued an advisory noting that five college students at the University of San Diego had been diagnosed with mumps; this was followed by a subsequent advisory identifying three additional mumps cases in college students diagnosed in Orange County, California.[2,3] In April 2016, a high profile outbreak reported at Harvard University and surrounding areas resulted in more than 40 cases of mumps in less than two months. As of May 5, 2016, nearly 80 cases were reported in the state of Massachusetts with 50 cases at Harvard.[4] Over a 5-year period from 2011 to 2016, mumps cases reported to the Centers for Disease Control and Prevention (CDC) have been steadily increasing, from 370 in 2011 to 1,148 as of May 21, 2016.[5] These cases and outbreaks as well as the potential decrease in measles-mumps-rubella (MMR) vaccination

uptake due to parental refusal underscore the importance of the emergency department (ED) as a primary location for identification and containment of public health threats. Patients frequently present to the ED with undifferentiated chief complaints, making rapid and accurate diagnosis challenging. Most contagious diseases that manifest with nonspecific influenza-like illness symptoms and signs will not ultimately be determined to be rare and deadly diseases like Ebola or MERS; however, they may be contagious and require immediate isolation. This underscores the need for emergency physicians to have the necessary information and tools to rapidly identify potential public health threats. While the mumps virus is typically mild and self-limited, it is highly contagious for susceptible patients when proper isolation and containment measures are not rapidly initiated; a single case can result in up to 12 secondary cases in a susceptible population.[6] Infection can occur despite vaccination, and most cases seen in college outbreaks have occurred in fully vaccinated patients. Further, the mumps virus can sometimes have serious long-term sequelae including infertility/subfertility, central nervous system (CNS) infection, deafness, and severe pancreatitis. In rare cases, these complications can be fatal.[7]

Given the highly contagious nature of the virus, it is paramount that frontline providers be aware of how to identify the clinical manifestations of mumps virus and understand how to properly isolate potentially infected patients and rapidly inform necessary authorities of a potential case. This paper provides a comprehensive review of mumps infection followed by a brief discussion of the novel 3I tool, initially developed for Ebola virus and subsequently for measles, MERS and Zika virus,[8-11] as adapted for use by healthcare providers in the initial detection and management of mumps.

CLINICAL PRESENTATION

Mumps typically begins with a prodrome of low-grade fever, myalgias, anorexia, malaise and headache. Over the next 1-3 days, the patient develops earache and tenderness over the parotid gland, which becomes noticeably enlarged and painful (Figure 1). Parotitis is typically seen in 31-65% (with some authoritative texts citing 60-70%) of cases of mumps infection. In about three quarters of patients, the other parotid gland becomes involved.[12,13] The parotitis is nonsuppurative and typically progresses for about three days and lasts for approximately one week.[13] Patients often have trismus and have difficulty chewing and speaking. In about 10% of cases, other salivary glands, especially the submandibular gland, can become involved and can mimic anterior cervical lymphadenopathy.

RISK FACTORS

In the post-vaccination era, populations at greatest risk for mumps infection are adolescents and adults. The clinical course of mumps also tends to be more severe in adolescents/adults when compared to the clinical course in younger children.[6] Other at-risk populations include unvaccinated individuals who are exposed to the virus – this includes children whose parents opted against vaccination and those with contraindications to vaccination including anaphylactic/severe allergic reactions to vaccine components or neomycin, and immunocompromised children.[12] Risk of mumps for travelers is high in many countries, including industrialized countries. For example, the United Kingdom has had several outbreaks since 2004, and Japan does not routinely vaccinate against mumps. The disease is only contracted and spread by humans; there is no animal host.

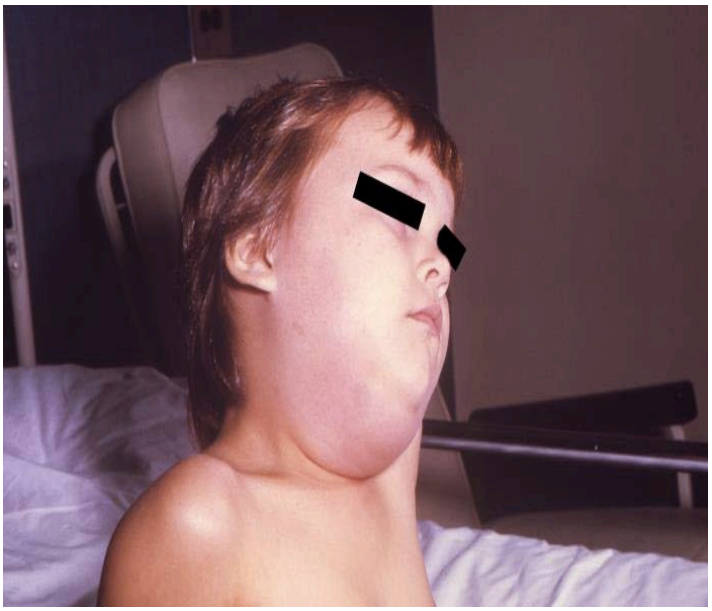

Figure 1. Child with mumps parotitis, the pathognomonic finding of acute mumps infection.

DIAGNOSIS

Mumps is a clinical diagnosis that is made based on a history of exposure, prodromal constitutional symptoms and parotitis. Serologic/polymerase chain reaction (PCR) testing to confirm diagnosis is also available. Mumps virus can be isolated from saliva, urine, blood, nasopharyngeal secretions, and seminal fluid.[14, 15] The preferred definitive diagnostic test is a swab of the buccal mucosa using a viral culture swab for RT-PCR testing. Collection of the specimen in the first three days of parotitis is optimal, but virus can still be detected in some cases up to nine days after onset of parotitis. Clinicians should contact local or state public health authorities to arrange for testing, as testing at commercial laboratories may be unreliable. Serologic diagnosis of acute mumps infection by testing for IgM and IgG antibodies may be unreliable, as the IgM response may be attenuated or absent in vaccinated persons, and persons with detectable IgG titers can still develop mumps.[16]

COMPLICATIONS AND SPECIAL POPULATIONS

In post-pubertal males, the most common complication of mumps infection is orchitis. In the era prior to the advent of the MMR vaccine, orchitis occurred in between 12% to 66% of post-pubertal males with mumps. In the post-vaccination era, orchitis has been reported in 15% to 40% of post-pubertal males.[12] Orchitis typically occurs about 10 days after the onset of parotitis, although it can be seen up to six weeks later. Orchitis is typically unilateral, but bilateral orchitis manifests in 15-30% of cases.[13] Orchitis may be accompanied by epididymitis up to 85% of the time.[17]

Mumps orchitis can lead to a range of testicular complications. True infertility following mumps orchitis is rare but subfertility has been seen in up to 13% of patients. Subfertility can occur even without accompanying testicular atrophy.[7, 18-20] Testicular atrophy (any reduction in testicular size) occurs in 30-50% of patients with orchitis.[6] Abnormalities of spermatogenesis have been observed to occur in up to half of patients for up to three months after recovery from the acute illness.[20] Mumps orchitis and subsequent testicular atrophy have been weakly associated with the development of testicular tumors, including cancer, with an incidence of 0.5%.[7, 21, 22]

Other complications of mumps infection include meningitis, which may occur in up to 10% of cases. When meningitis does occur, it is typically seen 3-4 days after the onset of parotitis.[6]Acute encephalitis and encephalomyelitis are rare. When acute encephalitis due to mumps occurs, it is typically self-limiting. Acute encephalomyelitis, on the other hand, tends to be much more severe. Case fatality rates for acute encephalomyelitis due to mumps virus are up to 10%, while the overall case fatality rate due to CNS complications from mumps virus has been reported to be about 1%.[23]

Sensorineural hearing loss is another CNS complication of mumps infection. Permanent unilateral hearing loss has been reported to occur in 1 of every 20,000 cases. Bilateral hearing loss is much less frequent. Other rare CNS complications include Guillain Barre Syndrome, transverse myelitis, facial palsy, cerebellar ataxia and flaccid paralysis.[7]

Oophoritis (ovarian inflammation) has been reported to occur in 5% of post-pubertal females. Symptoms of oophoritis may include lower abdominal pain, vomiting and fever. Long-term sequelae of oophoritis, while rare, may include infertility or premature menopause. Mastitis (breast inflammation) has also been reported as a complication of mumps infection in post-pubertal females.[7] In some studies, mumps infection in early pregnancy has been linked with spontaneous abortion, with one study identifying a 27% rate of fetal death after first trimester mumps infection compared with 13% in a control group.[7, 24] A second, more recent study has not shown the same association between spontaneous abortion and mumps infection in early pregnancy.[25] As of early 2016, there is no reported association between perinatal mumps infection and significant congenital malformations.[7]

Other rare complications associated with mumps infection include pancreatitis (with rare reported cases of severe hemorrhagic pancreatitis), ECG abnormalities (depressed ST segments, prolonged PR intervals and inverted T waves), myocarditis, polyarthritis, abnormal renal function (with rare reports of severe or fatal nephritis), hepatitis, acalculous cholecystitis, kerato-uveitis, hemophagocytic syndrome and thrombocytopenia.[7] (Table)

TRANSMISSION AND PERSONAL PROTECTIVE EQUIPMENT

Mumps is a moderately to highly contagious infection that is typically transmitted via direct contact, droplet transmission and through spread from contaminated

Table. Complications associated with mumps infection.

Complication	Frequency
Orchitis	15–40% of postpubertal males with infection
Epididymitis	Accompanies up to 85% of cases of orchitis
Bilateral orchitis	15–30% of epididymitis or orchitis cases
Subfertility	Up to 13% of male patients
Testicular atrophy	30-50% of patients with orchitis
Testicular tumors	0.5% of cases of mumps orchitis or testicular atrophy
Oophoritis	5% of postpubertal females with infection
Meningitis	1–10% of infections
Encephalitis	0.1% of infections
Death due to CNS complications of mumps	1 to 1.5% of cases with CNS complications
Permanent unilateral hearing loss	0.005% of infections
Spontaneous abortion	27% of pregnancies with mumps infection in the first trimester
Pancreatitis	4% of infections

CNS, central nervous system

fomites. It is considered to be less contagious than measles or varicella. About one-third of cases are subclinical and these persons are also contagious. The incubation period of mumps virus averages 16-18 days (range 12 to 25 days) and infected patients are most contagious at 1 to 2 days *prior* to symptom onset.[7, 26, 27] As of 2008, CDC, the American Academy of Pediatrics (AAP), and the Healthcare Infection Control Practices Advisory Committee (HICPAC) recommend a 5-day period of isolation after the onset of parotitis. Isolation measures should include standard as well as droplet precautions.[28]

DIFFERENTIAL DIAGNOSIS

The differential diagnosis for mumps includes other causes of parotitis such as Epstein Barr virus, parainfluenza virus types 1 and 3, influenza A virus, coxsackie virus, adenovirus, parvovirus B19, lymphocytic choriomeningitis virus, human immunodeficiency virus (HIV), human herpesvirus 6, and suppurative infection caused by Staphylococcus aureus, gram-negative bacteria and atypical mycobacteria. Non-infectious causes for parotid swelling include starch ingestion, drugs (phenylbutazone, thiouracil, iodides, phenothiazines), malnutrition, tumors, cysts, salivary stones, metabolic disorders (diabetes, cirrhosis, uremia) and rare disorders such as Mikulicz's, Parinaud's and Sjogren's syndromes. Differential diagnosis for mumps orchitis/epididymitis includes bacterial infection and testicular torsion.[13]

TREATMENT

Mumps virus is typically self-limiting with treatment primarily directed towards supportive care including antipyretics and analgesics. Supportive treatment of mumps orchitis includes bed rest, scrotal support, heat and cold packs as well as antipyretics and analgesics. Antibiotics are also commonly prescribed both because it can be difficult to distinguish mumps orchitis from bacterial infection and to prevent superimposed bacterial infection.[29, 30]

Treatment with mumps intramuscular immunoglobulin has been shown to have no benefit in mumps epidemics, although the immunoglobulin may have some benefit in early infection in a limited number of cases.[31, 32] Although intravenous immunoglobulin may reduce some complications of mumps, there is no universal recommendation for its use.[7]

Historically, various methods to reduce intratesticular pressure, including interferon therapy,[33-35] treatment with oxyphenbutazone[36] and surgical management including aspiration[37, 38] have been described. Results of these treatments have been variable with unclear impact on the development of long-term testicular atrophy and other complications. Accordingly, there is no universal recommendation in favor of these measures and they are not commonly used in clinical practice.[13]

PREVENTION

The primary method of prevention of mumps infection is via vaccination. Current vaccination recommendations are for a two-dose vaccination series for all children with the MMR vaccine. The first dose of the vaccine should be administered at age 12-15 months and the second dose of the vaccine should be given at 4-6 years of age. Previously unvaccinated school-aged children/post high school students, international travelers and healthcare providers should also receive two doses of the MMR vaccine while other unvaccinated adults should receive one dose of the vaccine. CDC estimates that about 90% of people are protected after two MMR doses. Like other live virus vaccines, the MMR vaccine should not be administered to pregnant women, persons on immunosuppressive therapy, those with congenital or acquired immunodeficiency disorders, persons with severe febrile illnesses, advanced malignancies, or those persons with advanced HIV disease. Other prevention methods include isolation of cases as detailed previously as well as use of respiratory hygiene/cough etiquette.[28]

DISPOSITION

Hospital admission is not typically indicated for mumps infection except for cases of serious neurologic and other CNS sequelae, other severe complications, or in cases where patients meet standard hospital admission criteria for other conditions, or require aggressive supportive care measures. In practice, hospitalization for mumps is uncommon.[28]

IDENTITY-ISOLATE-INFORM

The Identify-Isolate-Inform (3I) tool initially developed for Ebola virus disease[8] can be modified for ED evaluation and management of patients under investigation for mumps (Figure 2). The 3I tool was conceived during the 2014 Ebola virus disease outbreak as a concise method to identify and manage patients presenting to the ED who might have Ebola. The first step was to identify patients with an epidemiologic risk factor (potential exposure to a symptomatic Ebola patient) coupled with symptoms of disease. Once identified as a "patient under investigation," isolation had to be immediately implemented and both public health and hospital infection prevention authorities notified of the case. The 3I tool was conceived by Koenig, approved by the American College of Emergency Physicians Expert Ebola Panel and adopted and distributed to EDs nationwide by the CDC. Subsequently the 3I tool was modified for use in MERS, measles, and Zika viruses, in each case considering disease characteristics (e.g., contagious prior to or only after symptom onset, incubation periods, epidemiologic risk factors, types of isolation necessary).

As with any patient presenting to the ED, the "vital sign zero" concept should be applied immediately to determine whether the patient is a potential threat to healthcare providers or other patients.[39] This means that prior to touching a

Identify, Isolate, Inform

Emergency Department Evaluation and Management of Patients Under Investigation (PUIs) for Mumps Virus

First image courtesy of: Centers for Disease Control and Prevention's Public Health Image Library, ID # 130
http://phil.cdc.gov/phil/details.asp?pid=130

IDENTIFY

SYMPTOMATIC SIGNS AND SYMPTOMS*

*Incubation period average 16-18 days (range 12-25)

PRODROME
- Low Grade Fever
- Malaise/Anorexia
- Myalgias
- Headache

FOLLOWED BY
- Parotitis (pathognomonic)
- Orchitis/Oophoritis

ASYMPTOMATIC EXPOSURE HISTORY

INQUIRE
- Exposure
- Immunization Status
- Immunosuppression

- Infected patients are most contagious 1 to 2 days *prior* to symptom onset
- 15-27% of infected persons are asymptomatic
- Post exposure MMR vaccine/IG does not prevent clinical severity
- Implement Public Health monitoring for signs and symptoms

ISOLATE

- Initiate droplet and standard precautions
- Fomite transmission possible
- Continue for 5 days after onset of parotid gland swelling
- Obtain PCR testing of buccal mucosa swab and serum antibody testing for laboratory confirmation

INFORM

*Insert local contact information below

Report immediately to
- Local Health Department
- Hospital Infection Control

The Identify-Isolate-Inform tool was conceived by Dr. Kristi L Koenig, Director, Center for Disaster Medical Sciences, UC Irvine

Figure 2. Identify-Isolate-Inform Tool adapted for mumps virus.

patient to measure the traditional vital signs, triage nurses must consider whether the patient may be contagious (or contaminated with a risk of contaminating others) and don disease/contaminant-characteristic specific personal protective equipment (PPE) and initiate appropriate isolation measures to protect healthcare providers and other patients/visitors from contagion/contaminant. While the specific diagnosis may often be unknown at initial presentation, certain epidemiologic risk factors (e.g., recent travel to West Africa for Ebola virus disease) or other risk factors (e.g., close contact with a known asymptomatic infected patient in the case of measles) coupled with clinical features (e.g., parotid swelling in the case of mumps) should lead to the immediate placement of a person into the "patients under investigation" category.

The majority of patients with mumps infection will likely present to the ED with symptoms; however, it is also possible that asymptomatic patients will present during an outbreak due to concerns about potential exposure to the virus. Accordingly, the first branch of the algorithm involves determination of whether the patient is symptomatic or asymptomatic. For asymptomatic patients, exposure history must be elicited as mumps can be transmitted 1-2 days prior to symptom onset. For patients with a history of exposure to the mumps virus, there is no clear evidence to support reduction of clinical disease severity through post-exposure MMR vaccination or immunoglobulin administration.[7] Public health monitoring of asymptomatic patients for development of signs and symptoms is recommended. Each prior 3I tool (e.g., for Ebola, MERS, measles, and Zika) considered specific disease characteristics, and the algorithms were modified accordingly. For example, Ebola is not contagious from person to person prior to symptom onset, and therefore, no PPE or isolation would be indicated in an asymptomatic person.

In the case of mumps, symptomatic patients who exhibit either the viral prodrome (low grade fever, myalgias, anorexia, headache) after a known exposure to mumps or the hallmark finding of parotitis, should immediately be masked and isolated using droplet and standard precautions.[28] Healthcare providers should elicit exposure history, vaccination status and medical history to determine whether the affected patient is immunocompromised. All healthcare providers, regardless of vaccination status, should wear a gown, gloves and a mask when caring for these patients. Isolation precautions should be continued for five days after the onset of parotid gland swelling to minimize risk of disease transmission. Laboratory specimens (serum, urine, nasopharyngeal secretions, semen) should be sent for confirmatory PCR and serologic testing.

Healthcare providers should promptly notify public health authorities about suspected mumps cases or suspected cases of asymptomatic exposure. Providers should also inform hospital infection control of the suspected case and/or exposure.

LIMITATIONS

While strengths of the tool include that it is concise and can be made readily available, frontline clinicians must suspect mumps so that they can then apply the tool. This may be particularly challenging since viral prodromes are a common presentation in ED patients and resources are insufficient to isolate all such patients. Hence, inquiring about exposure as appropriate (e.g., during a known outbreak) and being aware of the classic clinical appearance of parotid swelling (even without a known outbreak) is crucial.

This study is further limited in that it represents the derivation of the mumps 3I tool and the tool has not been widely validated under real-time conditions. In addition, the 3I tool is generic and we recommend that it be populated with the local 24/7 contact numbers for public health and hospital infection prevention as it may not be simple to rapidly identify contact information, particularly in the off hours.

CONCLUSION

Mumps is a highly contagious viral disease that became rare following implementation of the MMR vaccination but has been reemerging in the last decade with multiple outbreaks of hundreds to thousands of cases per year, often in college students living under crowded conditions. Undifferentiated patients presenting to the ED with influenza-like illness may have a myriad of diseases with variable characteristics; parotid swelling is pathognomic for mumps. Mumps is a viral illness that is contagious from person to person prior to symptom onset and can be readily transmitted if not identified so that proper precautions can be initiated. Identify-Isolate-Inform is a useful tool for emergency physicians to apply in the evaluation and management of patients with possible mumps infection who present to the ED.

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Discriminating Between Legitimate and Predatory Open Access Journals: Report from the International Federation for Emergency Medicine Research Committee

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Introduction: Open access (OA) medical publishing is growing rapidly. While subscription-based publishing does not charge the author, OA does. This opens the door for "predatory" publishers who take authors' money but provide no substantial peer review or indexing to truly disseminate research findings. Discriminating between predatory and legitimate OA publishers is difficult.

Methods: We searched a number of library indexing databases that were available to us through the University of California, Irvine Libraries for journals in the field of emergency medicine (EM). Using criteria from Jeffrey Beall, University of Colorado librarian and an expert on predatory publishing, and the Research Committee of the International Federation for EM, we categorized EM journals as legitimate or likely predatory.

Results: We identified 150 journal titles related to EM from all sources, 55 of which met our criteria for OA (37%, the rest subscription based). Of these 55, 25 (45%) were likely to be predatory. We present lists of clearly legitimate OA journals, and, conversely, likely predatory ones. We present criteria a researcher can use to discriminate between the two. We present the indexing profiles of legitimate EM OA journals, to inform the researcher about degree of dissemination of research findings by journal.

Conclusion: OA journals are proliferating rapidly. About half in EM are legitimate. The rest take substantial money from unsuspecting, usually junior, researchers and provide no value for true dissemination of findings. Researchers should be educated and aware of scam journals. [West J Emerg Med. 2016;17(5)497-507.]

INTRODUCTION

Dissemination of findings is the very core of every research endeavor. Publication through peer-reviewed literature educates the research community. It is also used to quantify the impact of individuals during career progression. In fact, publishing in high-quality peer-reviewed journals remains the prime metric of success for academicians, especially early career researchers focused on promotion and tenure.

Publication of research without proper scientific review is a detriment to society,[1] can lead to unsafe/non-beneficial clinical practice, and in some cases may reward the conduct of unethical/unscientific conduct such as plagiarism, falsified data, and image manipulation.[2-3] Predatory journals are motivated by financial gain, and are corrupting the communication of science.[4] Furthermore, their main victims are primarily institutions and researchers in low- and middle-income countries (LMICs).

Predatory publishing is often confused with open access

(OA), though they are distinctly different. Legitimate OA publishing benefits scientific communication, especially in LMICs, where researchers lack institutional support for access to literature.[5] Conversely, predatory publishing upholds few if any of the best practices, yet demands payment for publishing, even from those most unable to pay.

One might argue that more OA data and research dissemination serves the public good. Furthermore, OA journals, even predatory ones, may provide an outlet for publication of papers not deemed especially timely or interesting, or showing significant positive effects. In a *British Medical Journal* (*BMJ*) editorial, Jocalyn Clark and Richard Smith argue for firm action to address predatory publishers and educate researchers of the pitfalls of predatory publishing.[5]

In 2013, John Bohannon conducted a "sting" operation, to expose the lack of peer review in predatory OA journals, and published his story in the journal *Science*.[6] He created a fictitious paper from made-up authors from non-existent African universities that purported to identify a new chemical that inhibited cancer cell growth. The paper was purposely fundamentally flawed such that any level of peer review would result in rejection from a legitimate journal. He sent the paper to 304 OA journals drawn from both the "predatory" scientific journal list of Beall (see below), and the Directory of Open Access Journals (presumably legitimate). Ultimately 157 (52%) accepted, 98 (32%) rejected it and the rest did not respond. Average time to acceptance was 40 days, and to rejection 24. He reported that 60% of those that were accepted or rejected showed no signs of peer review for content.

There is little in the peer-reviewed literature on the topic of OA publishing and submission processes.[7] Determining whether a journal is truly predatory is difficult. One might mislabel small or nascent OA publishers lacking societal support or financial infrastructure as predatory because of their fees.

Jeffrey Beall, a librarian at the University of Colorado in Denver, has long enlightened the scientific community about predatory publishing.[8] This paper brings disparate sources together to provide a cogent tutorial for researchers. We present examples and strategies to discriminate between legitimate and predatory OA journals. In addition, we provide guidance from the International Federation for Emergency Medicine (IFEM) Research Committee report of 2015 to educate EM researchers to avoid predatory publishers and journals.

METHODS

A researcher from the IFEM Research Committee (BH), a journal editor (ML) and a university medical librarian (LM) collaborated to summarize the current state of potential indexing for OA journals, as well as collecting web resources to discriminate between legitimate and predatory OA journals. We defined as OA a journal that did all of the following:

1. The authors retained their own copyright to the material published.
2. The entire content of the journal was available free of charge to consumers wishing to read the articles.
3. The journal used a form of Creative Commons License.

We conducted searches between January 1 and June 10, 2016 from these directories, indexes, databases, and publishers including the US National Library of Medicine (NLM) Catalog: journals referenced in the NCBI (National Center for Biotechnology Information) Database, PubMed Central®, Google, Scimago Journal and Country Rank (SJR), Directory of Open Access Journals (DOAJ), Thomson Reuter's Web of Science, and EBSCOhost title lists. We are confident that we identified all the world's OA journal titles in the EM subject discipline. We used search terms: (emergencies OR emergency OR ER) AND (open access OR OA OR PMC) to pare these down to only OA EM-related journals.

Google works with publishers to index articles, theses, preprints, book chapters, abstracts, and technical reports from all research disciplines and make them searchable on Google Scholar. However, while these services readily retrieve individual papers, it is challenging to retrieve EM journal titles. We performed a comprehensive Google search, and then pared results to identify a list of OA EM journals. We then removed duplicates, included only journals that are 100% OA, and publish in English. We excluded any partial OA (a stated embargo period during which readers would need to pay for access) or inactive titles.

We then scrutinized the journals, searching their websites and applying Beall's criteria to identify and clarify which were likely to be "predatory" journals.[8] We drew on collective experience in medical publishing and journal editing to identify features and characteristics that suggested that journals were primarily interested in profit over science, and lacked features inherent in legitimate journals in the field. A journal was categorized as likely predatory when it was not included in any recognized medical library indexing services (beyond Google), and did not have features on its website of legitimate OA journals. We present the journal titles and their website links as aides to authors who wish to further scrutinize the characteristics of a journal before submission.

As this paper did not involve human subjects, approval was not obtained.

RESULTS

We present our comprehensive findings of OA journals that relate to EM, and are likely to be either legitimate or predatory. We first divide our results by each index we searched to identify OA EM journal titles. We then present journal titles (Table 1) from Beall's list of predatory OA journals that relate to EM. Next, we present indexing services where legitimate open access journals may be found, and the number of journals indexed with the word "emergency", "emergencies" or "ER" in the title, and notation of how many are OA (Table 2).

Next, we present a list of OA journals with the word "emergency" in the title that are archived in PubMed Central with full paper deposition and no or one-month embargo period (Table 3). These are clearly legitimate by virtue of their inclusion in PubMed.

Then, we present a list of legitimate OA journals in EM, along with the well-recognized indexing services in which they are contained (Table 4). By virtue of their inclusion in indexing services, they are legitimate OA journals. Finally, we present a list of likely predatory OA journals in EM (Table 5) that are not included in any reputable index. Therefore, Tables 1 and 5 are likely predatory OA journals, while Tables 3 and 4 list legitimate EM OA titles.

The three authors agreed with the designation of OA journal in all cases. After scrutiny of the websites, this became very clear by the description, copyright agreement and Creative Commons licenses. The authors also were entirely in agreement regarding the titles listed in Tables 3 (PubMed Central indexed) and 4 that these were legitimate OA journals. All others were highly suspected of being predatory.

NLM Catalog Search for OA Journals in EM

The United States (US) NLM Catalog includes journals in all NLM collections and databases (e.g., PubMed, PubMed Central, MEDLINE, Nucleotide, Protein, etc). We found 127 titles in PubMed, PubMed Central, and MEDLINE, but only 17 are fully OA and contain the word "emergency," "emergencies," or "ER" in their title. See Table 2.

PubMed Central Journal list in EM

PubMed Central is a US NLM repository and archive of OA full-text (not just abstract) scholarly articles. Our search identified 17 journals that are in "full participation" of OA. One title, "*California Journal of Emergency Medicine*" changed its name to "*Western Journal of Emergency Medicine*" and has remained fully OA. Two titles dropped their names and merged with a new name (*Emergency Medicine Journal* or *EMJ*). Since then, only a few selected articles are open access (Table 2), leaving 14 of the 17 journals that are truly OA. These journals must meet rigid scientific quality standards (http://www.ncbi.nlm.nih.gov/pmc/pub/addjournal/) to be included in PubMed Central. Therefore, they are all clearly legitimate and not predatory journals.

SJR (Scimago Journal & Country Rank) Journal Subject Category Search

The SJR is a mathematical analysis designed to measure the relative impact of journal articles by their citation frequency and importance, and then to rank the journals themselves within scientific fields. In the SJR website (http://www.scimagojr.com/journalrank.php?area=2700&category=2711), we selected "Medicine" as the subject area and "Emergency Medicine" as the subject categories in all regions and countries for 2015 journals. The results returned 72 journals. We then selected the "Display only Open Access Journals" box, yielding 17 titles, but only 12 were fully OA journals that met our inclusion criteria (Table 2).

Directory of Open Access Journal (DOAJ) Search

In the DOAJ homepage, we deselected "articles" and searched only for journal titles with a truncation search for emergenc***.** The results returned 46 OA journals that contained the word "emergency" or "emergencies" in the title, but only 19 met our inclusion criteria as fully OA (Table 2).

Thomson Reuters Master Journal List Search

Thomson Reuters is a major multinational mass media and information firm headquartered in Toronto and New York. Its business is to select, index and sell access to scholarly works to university libraries. The company includes select journals in its indexes upon application, but rejects many titles that do not meet its standards. The Thomson Reuters Master Journal List includes all journals indexed in their propriety product called "Web of Science." This includes the Emerging Sources Citation Index, created in 2015 (http://wokinfo.com/products_tools/multidisciplinary/esci/). With our truncated search for title word, "emergenc*," we located 33 titles in EM, with 11 of them fully OA (Table 2).

EBSCOhost Title Lists Search

EBSCO, headquartered in Ipswich, Massachusetts, is a private company that indexes and sells access to scholarly works to academic and medical libraries (and many other products) through 375 databases. EBSCOhost houses titles by subject category. We reviewed and included only two relevant EBSCO databases, CINAHL (Cumulative Index to Nursing and Allied Health Literature) and Academic Search Complete that would most likely index EM titles. Our reviews identified 63 journals that contain the word "emergency" or "emergencies" in the title, but only 10 qualified as completely OA (Table 2).

Google Search for OA Journals in EM

In Google, we searched for "Open Access Emergency Medicine Journal" (without the quotation marks) and examined the first 15 pages of results. These contained 150 sites that were linked to library journal directories, publishers and independent journal websites. After thorough review, we identified 57 (38%) initially determined to be OA journals. Two were excluded (leaving 55, or 37% OA) as known EM magazines (*EM World* and *EM Resident*) that would not be expected to achieve indexing or undergo formal peer review. These were then compared with titles from established indexing services worldwide described above (Table 2).

One of the major markers of a predatory OA journal is the absence of indexing in any recognized reference index. Twenty-five of these 55 titles (45%, Table 5) were not included in any index, and therefore are highly suspicious

of being predatory. Alternatively, they could be very early in their development and therefore cannot offer wide discovery in established search services. For example, we identified two journals that, while not included in any of the indexes we searched, nevertheless are legitimate and OA according to examination of their websites (*Japanese Journal of Trauma and Emergency Medicine,* an inactive title last published was in 2012, and *Emergency Medicine and Health Care).*

Beall's Predatory OA list

We found that the most recent list of predatory OA journals from Beall updated January 7, 2016, contains 923 publishers from all scientific fields, each of which publishes multiple (3-30+) journals (33% increase over 2015) and 882 stand-alone journals (74% increase over 2015).[8] Fortunately, none of the 923 publishers contain the word "emergency" or "medicine" in their titles, and none of the 882 stand-alone journals contain the stem, "emerg" (except for the word "emerging" in many journal titles).

We did identify 16 "medical" journals among the 882 stand-alones. Table 1 provides a short list of journals that may appear related enough for a novice researcher to be fooled into submitting an EM article (taken from the large list by one of the authors, ML). For perspective, the largest of the biomedical research legitimate journal databases (HINARI Program from the World Health Organization) lists 14,964 journal titles worldwide, so these "predatory" journals amount to 12-50% of the legitimate titles (calculating 1-7 journals per predatory publisher, which appears to be the case from Beall's list).

Indexing Services

The major biomedical indexing services identified by the authors are listed in Table 2, with the number of journals (OA/total including subscription) with the word "emergency,"

Table 1. Journal titles on Beall's Predatory Open Access list, 2015, containing the word, "medicine" in the title that may appear related enough to submit an emergency medicine article.

1	Global Journal of Medicine and Public Health
2	Hygeia: Journal for Drugs and Medicines
3	Internal Medicine Review (has not published any articles)
4	International Journal of Collaborative Research on Internal Medicine & Public Health (IJCRIMPH)
5	International Journal of Medicine and Biosciences
6	Journal of Advances in Internal Medicine
7	Journal of Coastal Life Medicine
8	Journal of Evidence Based Medicine and Healthcare (JEBMH)
9	Translational Medicine and Biotechnology (TMB)

Table 2. Indexing services where legitimate open access journals may be found, and the number of journals indexed with the word "emergency", "emergencies" or "emerg*" in the title, with denominators representing total number of journal titles, including subscription journals. Numerator = OA.

Index name	Website link	Number of OA journals with "emergency" "emergencies" or "emerg*" in title
The NLM Catalog	http://www.ncbi.nlm.nih.gov/nlmcatalog/journals	17/127
PMC Journal List	http://www.ncbi.nlm.nih.gov/pmc/journals/	14/17
EBSCOhost Title Lists	https://www.ebscohost.com/title-lists This list includes titles from CINAHL and Academic search complete	10/63
SJR	http://www.scimagojr.com/journalrank.php This list includes Scopus and EMBASE titles.	12/72
DOAJ (Directory of Open Access Journals)	https://doaj.org/search	19/46
Thompson Reuters Web of Science Master Journal Lists	http://ip-science.thomsonreuters.com/mjl/	11/33
Google search	https://www.google.com/	55/150

NLM, National Library of Medicine; *PMC*, PubMed Central; *EBSCOhost*, Elton B. Stephens Company; *SJR,* Scimago Journal Rank; *DOAJ*, Director of Open Access Journals; *EMBASE*, Excerpta Medica Database
Scopus has no abbreviation.

"emergencies" or "emerg*" in their titles.

DISCUSSION

Given this disturbing trend in OA publishing, the IFEM Research Committee sought to provide guidelines to identify potential predatory journals, and summarize Beall's criteria for determining predatory OA publishers. We present the report here:

Overall Approach to Choosing the Journal

1. Choose to submit your research to journals that you would normally find interesting and relevant. Although these may be among the most discriminating, if successful, this will increase the chance that your research will be disseminated to the community you want to reach. This may result in changes to practice or policy, providing the most impact for your work.
2. Reach out to colleagues and mentors to see in which journals your body of work will best fit. Mentors have an understanding of historical trends in the scientific community in general, and EM specifically. The university librarian can be a valuable resource to find legitimate impact factors of the journals you are considering, and the distribution of these journals to academic communities. Beware, however, that

Table 3. List of open access journals with the word "emergency" in the title that are indexed in PubMed Central with full paper deposition and no or one-month embargo period.

ISSN	Title	Latest	First	Free Access	Participation Level
0264-4924	Archives of Emergency Medicine — now published as Emergency Medicine Journal : EMJ	v.10(4) Dec 1993	v.1 1984	Immediate	Full
1471-227X	BMC Emergency Medicine	v.16 2016	v.1 2001	Immediate	Full
2322-2522	Bulletin of Emergency & Trauma	v.4(2) Apr 2016	v.1 2013	Immediate	Full
1948-3384	The California Journal of Emergency Medicine — now published as Western Journal of Emergency Medicine	v.8(2) May 2007	v.1 2000	Immediate	Full
2090-648X	Case Reports in Emergency Medicine	v.2015 2015	v.2011 2011	Immediate	Full
2345-4563	Emergency	v.3(4) Autumn 2015	v.1 2013	Immediate	Full
2090-2840	Emergency Medicine International	v.2015 2015	v.2010 2010	Immediate	Full
1472-0205	Emergency Medicine Journal : EMJ (v.1;1984)	v.24(12) Dec 2007	v.18 2001		Now Select only (Full)
1865-1372	International Journal of Emergency Medicine	v.8 2015	v.1 2008	Immediate	Full
1351-0622	Journal of Accident & Emergency Medicine — now published as Emergency Medicine Journal : EMJ	v.17(6) Nov 2000	v.11 1994	Immediate	Full
0974-2700	Journal of Emergencies, Trauma, and Shock	v.9(2) Apr-Jun 2016	v.1 2008	Immediate	Full
1179-1500	Open Access Emergency Medicine : OAEM	v.8 2016	v.1 2009	Immediate	Full
1757-7241	Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine	v.24 2016	v.16 2008	Immediate	Full
2452-2473	Turkish Journal of Emergency Medicine	v.16(1) Mar 2016	v.14 2014	Immediate	Full
1936-900X	Western Journal of Emergency Medicine (v.1;2000)	v.17(1) Jan 2016	v.8 2007	Immediate	Full
1920-8642	World Journal of Emergency Medicine	v.6(4) 2015	v.1 2010	1 month	Full
1749-7922	World Journal of Emergency Surgery : WJES	v.11 2016	v.1 2006	Immediate	Full

ISSN, International Standard Serial Number; *v*, volume

Table 4. Open access emergency medicine journals that have achieved indexing in recognized services and are therefore legitimate rather than predatory.

	Journal Title and Weblink	NLM Catalog	PubMed Central	SJR	DOAJ	EBSCO-host	WS
1	Advances in Emergency Medicine from Hindawi http://www.hindawi.com/journals/aem/contents/				X		
2	African Journal of Emergency Medicine http://www.afjem.org/	X	X	X	X		X
3	BMC Emergency Medicine https://bmcemergmed.biomedcentral.com/	X	X	X	X	X	X
4	Bulletin of Emergency & Trauma http://www.beat-journal.com/BEATJournal/index.php/BEAT	X	X		X		
5	Case Reports in Emergency Medicine from Hindawi Publishing Corporation http://www.hindawi.com/journals/	X	X		X		
6	EAJEM: Eurasian Journal of Emergency Medicine http://www.akademi-kaciltip.com/eng/Anasayfa						X
7	Emergency: An Academic Emergency Medicine Journal http://journals.sbmu.ac.ir/emergency	X	X		X		
8	Emergency Care Journal http://www.pagepressjournals.org/index.php/ecj				X		X
9	Emergency Medicine International from Hindawi Publishing Corporation http://www.hindawi.com/journals/emi/	X	X		X	X	X
10	Emergency Medicine: Open Access* http://www.omicsgroup.org/journals/emergency-medicine.php	X					
11	Hong Kong Journal of Emergency Medicine http://www.hkjem.com/			X			X
13	International Journal of Emergency Medicine from Springer Open https://intjem.springeropen.com/	X	X	X	X	X	X
14	International journal of Emergency Mental Health and Human Resilience http://www.omicsonline.com/open-access/international-journal-of-emergency-mental-health-and-human-resilience.php	X		X			X
15	Iranian Journal of Emergency Medicine http://www.journals.sbmu.ac.ir/en-iranjem				X		
18	ISRN Emergency Medicine http://www.hindawi.com/journals/isrn/contents/emergency.medicine/				X	X	
19	Journal of Cardiovascular Emergencies http://www.degruyter.com/view/j/jce				X		
20	Journal of Emergencies, Trauma, and Shock http://www.onlinejets.org/	X	X	X	X	X	
21	Journal of Emergency Medicine, Trauma and Acute Care from Qscience.com http://www.qscience.com/loi/jemtac			X	X		
22	Journal of Emergency Practice and Trauma http://jept.ir/				X		
23	Journal of Trauma Management and Outcome https://traumamanagement.biomedcentral.com/			X			
24	Open Access Emergency Medicine from Dovepress https://www.dovepress.com/open-access-emergency-medicine-journal	X	X	X	X	X	X
25	Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine http://sjtrem.biomedcentral.com/	X	X	X	X		X
26	Turkish Journal of Emergency Medicine http://www.trjemergmed.com/	X	X				X
27	Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health http://escholarship.org/uc/uciem_westjem	X	X	X	X	X	X
28	World Journal of Emergency Medicine http://www.wjem.org/	X	X				
29	World Journal of Emergency Surgery http://wjes.biomedcentral.com/	X	X	X	X		

NLM, National Library of Medicine; *SJR*, Scimago Journal Rank; *DOAJ,* Director of Open Access Journals; *WS*, Thomson Reuters Web of Science.

Emergency Medicine: Open Access is not indexed in PubMed. Only one citation was found in PubMed.

Table 5. Emergency medicine journals that have not achieved indexing in any recognized service and are therefore likely predatory.

	Journal Title and Weblink
1	Archives of Emergency Medicine and Critical care http://www.jscimedcentral.com/EmergencyMedicine/
2	Austin Emergency Medicine http://austinpublishinggroup.com/emergency-medicine/
3	Australian Journal of Emergency Management https://ajem.infoservices.com.au/items/AJEM-31-02
4	Clinical Experimental Emergency Medicine http://ceemjournal.org/about/index.php
5	Edorium Journal of Emergency Medicine http://www.edoriumjournalofemergencymedicine.com/about-us/about-us.php
6	Emergency Medicine and Health Care from HOAJ (Herbert Open Access Journal) http://www.hoajonline.com/emergmedhealthcare http://www.hoajonline.com/)
7	Emergency Medicine Open Journal from Openventio Publishers http://openventio.org/OpenJournal/EmergencyMedicine.html http://openventio.org/index.php
8	Frontiers in Public Health | Disaster and Emergency Medicine http://journal.frontiersin.org/journal/public-health/section/disaster-and-emergency-medicine
9	Gavin Journal of Emergency Medicine (journal has not published any issues) http://gavinpublishers.org/index.php/emergency-medicine
10	Henry Journal of Emergency Medicine, Trauma & Surgical Care (journal has not published any issues) http://www.henrypublishinggroup.com/index.php/emergencymedicine/about
11	HSOA Journal of Emergency Medicine, Trauma & Surgical Care http://www.heraldopenaccess.us/journals/Emergency-Medicine-Trauma-&-Surgical-Care/
12	International Journal of Critical Care and Emergency Medicine http://clinmedjournals.org/International-Journal-of-Critical-Care-and-Emergency-Medicine.php
13	Internet Journal of Emergency Medicine http://ispub.com/IJEM from Internet Scientific Publications.
14	Journal of Emergency Medicine & Critical Care from Avens Publishing Group Inviting Innovations http://www.avensonline.org/medical/emergency-medicine-and-critical-care/home-5/
15	Journal of Emergency Medicine and Intensive Care http://elynsgroup.com/journal/journal-of-emergency-medicine-and-intensive-care
16	Journal of General and Emergency Medicine http://scientonline.org/journals/general-emergency-medicine/31
17	Journal of Intensive Care and Emergency Medicine http://www.signavitae.com/
18	Mathews Journal of Emergency Medicine http://www.mathewsopenaccess.com/EMedicine.html
19	OA Emergency Medicine http://www.oapublishinglondon.com/oa-emergency-medicine
20	Open Emergency Medicine (latest content is 2013) http://benthamopen.com/toemj/home
21	Open Journal of Emergency Medicine from Scientific Research An Academic Publisher http://www.scirp.org/journal/ojem/
22	Pediatric Emergency Care and Medicine: Open Access http://pediatric-emergency-care.imedpub.com/
23	The Scientific Pages of Emergency Medicine http://thescientificpages.org/page/general-medicine/scientific-pages-of-emergency-medicine.php
24	SM Emergency Medicine and Critical Care (SMEM) http://smjournals.com/emergency-medicine/
25	Trauma and Emergency Care (TEC) from OAT (Open Access Text) http://oatext.com/Trauma-and-Emergency-Care-TEC.php

impact factors (as well as peer-review processes) can be fabricated. Beall published a new list in 2015 of 38 "Misleading Metrics" companies that purport to gauge a journal's impact factor, and provide scholarly metrics at the researcher and article level.[10]

3. Be honest about the methodological flaws of your own work. It is unlikely that good reviewers will not identify them. If the reviewers do not see the same limitations as you have, this is a red flag that you have sent your work to a predatory journal. Be concerned if you do not receive any critical feedback and your article is accepted, as this rarely happens with legitimate peer review.
4. Look up the journal title in the NLM Catalog: Journals referenced in the NCBI Databases.[11] If the journal is found there, you can review the detail record where it provides information about the journal and whether the journal is indexed in any of the NCBI databases such as MEDLINE, PubMed, or PubMed Central. PubMed Central is a free digital repository that archives publicly accessible full-text scholarly articles that have been published within the biomedical and life sciences journal literature. Journal acceptance to PubMed Central went through a vetting process. These journals may also be indexed in MEDLINE, though this index is substantially more discriminating. However, OA journals whose content is listed in PubMed Central (full papers) automatically have their abstracts migrated to the PubMed.

However, this does not guarantee legitimacy of the journal. In the present study separate from the IFEM Research Committee guidance, we found the journal, *Emergency Medicine: Open Access*, in the NLM Catalog. It further shows that the journal was found in PubMed and PubMed Central. However, after thorough review, we found only one citation in PubMed (PMID: 25035816) as well as PubMed Central (PMC: 4098070) for the entire journal. This occurred when the authors of the paper from Taiwan chose to deposit the article to PubMed Central.

5. If claiming to be an OA journal, is it in the Directory of Open Access Journals (DOAJ)? This is a sort of "whitelist" of legitimate journals that must meet specific criteria for inclusion.[12]
6. Is the journal transparent and following best practice in editorial and peer-review processes, governance, and ownership? The best way to discern this is by reviewing the journal documents and governance, likely available online at the website, or reaching out to the journal leadership. Legitimate journals should have a robust list of policies and procedures on their website, including human and animal subject policies, OA license type (something like Creative Commons Attribution License 4.0), conflict of interest and informed consent.
7. Read the articles in the journal before submitting an article. Warning signs include grammar errors, poor quality science, poorly maintained website with prominent misspellings and grammatical errors.
8. Is the name of the journal incongruent with the journal's mission? Is the name of the journal excessively broad? Does the name of the journal make sense?
9. Are there clear policies on plagiarism, authorship, and copyright on the website?
10. Is the impact factor clearly stated? Is it too good to be true (> 2)? If not readily available, journal impact factors can be found in the ISI Thomson Reuters Journal Citation Reports (JCR),[13] which requires institutional subscription, and the Scimago Journal & Country Rank[9] which is free.
11. Is the journal found in PubMed Central? PubMed Central allows publishers to deposit their OA journal contents for permanent archival without cost upon application and fulfilling features of legitimate and respectable journals for two years of publishing.[11]

The Publisher

Identify if the publisher is genuine. This requires some research evaluating the publisher's content practices and websites. Below are some of the aspects of the journal that may provide clues to a predatory publishing journal.

1. Submit work to publishers with enlightened copyright policies. Determine whether you can post and share your work once published. One of the main advantages of OA publishing is that the author maintains their own copyright, and therefore ability to use the material in other scholarly works. SHERPA/RoMEO[14] collects information on default copyright and self-archiving policies for both publishers and individual journals.
2. Complete an analysis of the publisher's content, practices, and websites according to ethical standards established by membership organizations. Numerous organizations have provided comprehensive ethical standards for publishers. Three are listed below.
   A. Open Access Scholarly Publishers Association (OASPA)[15]
   B. Committee on Publication Ethics (COPE)[16]
   C. International Association of Scientific, Technical & Medical Publishers (STM). [17]

Consider asking the following questions when reviewing the publisher's website.

1. Does the journal clearly identify an editor-in-chief and an editorial board?

2. Do the editors/editorial review board have academic affiliations and appropriate credentials for the journal scope and topic?
3. Does it provide specific and detailed instructions and guidelines for authors?
4. Are policies and practices fully stated?
5. Are author fees reasonable and are they clearly stated up front? OA fees to the author range from $300 to more than $4,000 USD. Wolters Kluwer, a legitimate publisher, openly lists fees for hundreds of their journals on their website.[18]
6. Do they offer discount or waiver for junior authors or authors from LMICs who can't afford to pay the author fee?
7. Can you find the publication fee easily identified on the website, or is it hidden many screens back with obscure navigation?
8. Does the publisher ask the corresponding author for suggested reviewers? This is, in general, a negative feature of a journal, and implies it does not have enough legitimately qualified and dedicated reviewers to perform this important scientific service to the profession or specialty.
9. Does the publisher engage in excessive use of spam emails to submit manuscripts? Specific targeted requests for papers to an established author are legitimate, and they come one at a time from the editor. Conversely, blanket solicitations addressed to "esteemed author" and similar salutations are markers of predatory OA journals.
10. Do the publisher's officers use email addresses that end in .gmail.com, .yahoo.com, or some other free email supplier?
11. Does the publisher have excessive advertising on the website?
12. Does the publisher have no membership or industry association? In particular, legitimate journals have membership in multiple indexes.

In truth, it can be difficult to distinguish between legitimate and non-legitimate journals. Beall has written about predatory open access journals since at least 2011. His website now has a section on "Hijacked Journals," which lists predatory/fake journals meant to look and sound like the titles of legitimate ones.[19] In our findings, two journals related to EM have apparently been hijacked. "*Emergencias,*" the Spanish language legitimate journal has a fake journal by the same name. A predatory journal, *OA Emergency Medicine* imitates a legitimate journal, *Open Access Emergency Medicine* from Dovepress. "Hijacked" journals are further challenging to decipher given their ability to mimic legitimate peer-review outlets.[7, 20-21]

Within Beall's list in 2015, we identified only nine journal titles from medicine that might tempt an EM author to submit (Table 1). However, the number of predatory journals and publishers is expanding weekly, so additional titles are now just as problematic. With difficulty and the guidance of a medical librarian, we identified multiple sources and indexes that contain EM journals, both subscription and OA. Of 150 titles, we found that about a third were OA, and of these half were predatory. However, per Beall, the number of predatory publishers and individual journal titles is proliferating exponentially in all scientific fields, from 18 publishers in 2011 to 923 listed in 2016, and from 126 stand-alone journals in 2013 to 882 in 2016. Clearly, lists are insufficient to guide authors. Only an understanding of the practices and markers of legitimate and predatory OA publishers will allow the researcher to keep pace with danger.

Tables 1 and 5 present likely predatory OA journals, while Table 3 presents clearly legitimate OA journals indexed in PubMed, which requires a high standard application from publishers. Table 4 shows legitimate OA journals and allows the reader of this piece to determine how widely an EM OA journal is indexed. This, in turn, determines how easy it would be for a reader or researcher interested in this subject to find their work.

Even with the guidance contained in the IFEM Research Committee report, and the list of likely predatory journals above, it can be difficult to identify predatory OA journals. Increasing numbers of "predatory publishers" take advantage of the "pay to publish" model used by legitimate OA publishers such as BioMed Central (https://www.biomedcentral.com/) and PLoS (https://www.plos.org/ Public Library of Science). Legitimate OA publishers charge authors to cover operational costs and management of peer review. These predatory OA publishers request high fees in exchange for quick, OA publication online, without robust editorial and publishing services or widespread indexing. Peer review is cursory at best, or sham at worst. Unfortunately, junior scholars at even well-resourced universities and scientists/institutions in LMIC are most at risk for these practices. These researchers may unknowingly submit to predatory journals, only then receive an invoice after the paper is "accepted," and not have the means to pay the fee.

Traditionally, librarians were the sophisticated gatekeepers to scientific information and advised researchers regarding mainstream journals. But with search engines such as Google Scholar©, researchers may find it difficult to distinguish between reputable and predatory publishers. All are found there, whether or not there has been any quality control. Nevertheless, consultation with a medical or science librarian, when in doubt, can clarify the status of an OA journal.

An additional negative feature of predatory publishers is that they can refuse to retract articles at author request, when their true nature is discovered. In the *BMJ* editorial and blogs, Clark stresses that, once a paper is published in one of these predatory journals, they are not cooperative with attempts to "retract," protesting that theirs is a legitimate outlet for

science.[22] She therefore advocates that institutions create "acceptable journals lists" to distinguish the differences. The medical librarian at each institution can play a major role in creating such a list. She also advises authors to stick with journals in the specialty that are more widely known.[23]

LIMITATIONS

We did not include words such as "trauma" and "disaster" and their variations in our searches. As a result, our study did not include possible predatory/hijacked journals that contain those words in the journal titles, e.g., *Austin Journal of Trauma and Treatment* (https://scholarlyoa.com/2016/03/03/a-true-predator-austin-publishing-group/). In addition, future research is needed to determine the true nature (legitimacy) of each non-indexed OA journal that we identified in Table 5. In addition, we may have included legitimate journals that are simply not indexed in any of the databases we searched. For example, we know that *Emergency Medicine and Health Care* (http://www.hoajonline.com/includes/homepages/search.php?searchtype=&searchtext=emergency+medicnie+and+health+care&journal%5B%5D=22&articletype=&PageSize=10&search=search) and the *Japanese Journal of Trauma and Emergency Medicine* (https://www.jstage.jst.go.jp/browse/jjtem) are legitimate, reputable journals that were found in our Google search, but were not indexed in any of the databases/directories that we selected for review. The landscape of publishing changes weekly, so there may be new legitimate and OA journals. Finally, we only searched for journals in English.

CONCLUSION

The novice scholar in EM should be cautious when submitting work to OA journals. This article educates and enables discrimination between legitimate and predatory OA journals. Legitimate ones disclose publishing fees freely, perform meaningful peer review, and then disseminate scholarship to the world without cost to the reader. Predatory OA journals hide fees, disclose them after acceptance, perform sham peer review or none at all, accept (nearly) all submissions to generate revenue, do not cooperate with publication retractions, and are not indexed sufficiently to allow other researchers to find the work. The number of these predatory journals and publishers is expanding rapidly, and threatens the integrity of scientific research and publishing.

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Getting Found: Indexing and the Independent Open Access Journal

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Running an independent journal takes much effort, even if only focusing on managing the process of moving articles through the process of submission, review, and publication. Yet publishing an article is not the only goal. Even a great article has little impact unless it can easily be discovered for people to read and cite. Without visibility, even a journal with a terrific editorial board will not get the high quality submissions its editors seek.

The *Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health* (*West*JEM) gets ten times the submissions as a decade ago, and has seen its readership climb. In 2008, *West*JEM averaged 2,907 combined article views and downloads per month. In 2015, the monthly average was 130,000 [Figure]. Without the support of a large publisher, and charging a $400 article processing fee, the journal's resources are limited. So what has led to the journal's success? The journal fills a need in an active and growing field, and its editorial board pursues savvy strategies to build strong and sustainable relationships with professional organizations and academic departments.

One crucial piece according to Mark Langdorf, Editor-in-Chief and UC Irvine Professor of Clinical Emergency Medicine, is getting the journal indexed in all major medical databases, and finding sufficient resources.

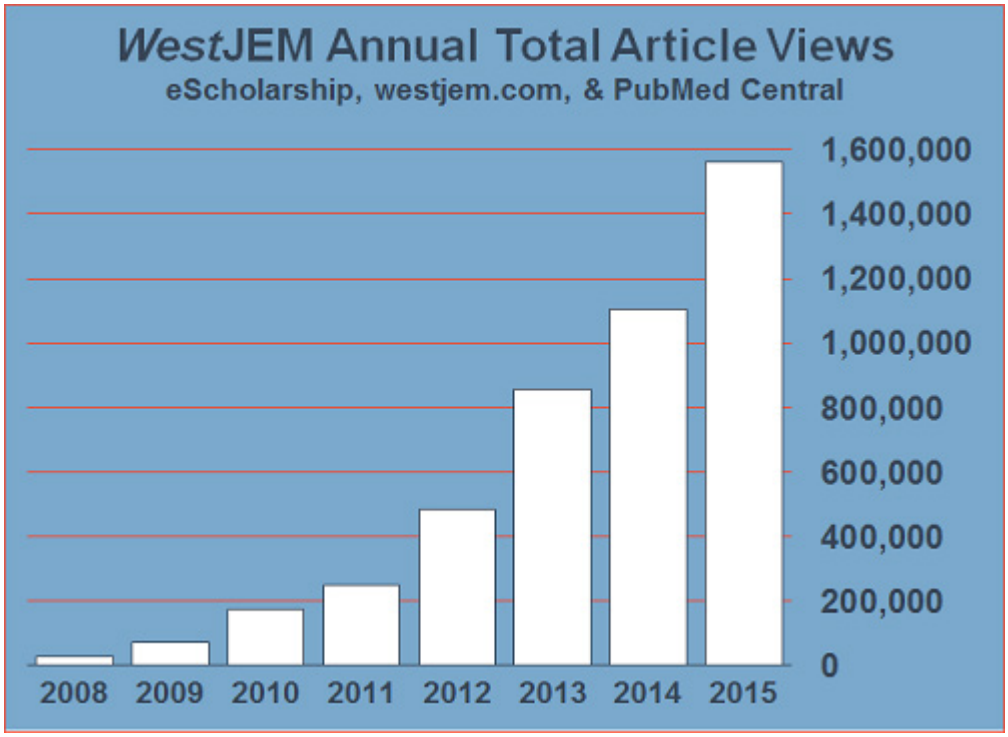

Figure. *Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health* (*West*JEM) annual total article page views and downloads since 2008.

Bibliographic databases/citation indexes are compilations of descriptive information about books, conference proceedings, reports, journals and the articles they contain. Some are discipline-specific and others cover a broad range of topics. If a journal is well indexed, readers are more likely to discover its content regardless of whether or not the journal itself is known to them.

However, getting a journal indexed can be difficult. While most citation indexes make their journal selection criteria publicly available, those criteria may be hard to meet. Citation indexes compete for users—and usually paid subscribers—the same way journals compete for readers. Most claim that they include more journals than their competitors and offer the *top-tier* journals. Thus, it is in their interest to vet publications carefully. Even if a journal seems eligible for inclusion, it can be labor intensive to bring the journal to the evaluators' attention and make the case that it should be added to the citation index. *West*JEM applied to be indexed in MEDLINE, the major bibliographic database of the U.S. National Library of Medicine, three times over five years before it was accepted.

Unsurprisingly, working with citation indexes can be a challenge for the journal editorial board. For *West*JEM, its board includes one unusual member: UC Irvine Health Sciences Librarian Linda Murphy. Librarians spend a great deal of time working with citation indexes and often get asked which ones are the best to use and why. They compare the features, scope, and coverage of citation indexes before deciding which to recommend to users engaged in education, research, or patient care. With increasingly tight budgets, librarians have to determine which indexes provide the most cost-effective usage. Because of this multifaceted customer/recommender/user role, librarians are more likely to be able to get the attention of citation indexes and speak their language. Murphy, says Langdorf, has played an essential role in *West*JEM's indexing success. It is not uncommon for indexing services to ignore messages from the editor and managing associate editor, only to respond when the librarian inquires.

For her part, Murphy says she's learned much, both from her fellow board members and from the indexing evaluation process. She offers these tips for journal editors who are getting their journal ready for the index submission process:

- Start by identifying relevant databases to be considered for indexing. These are frequently discipline specific.
- Review the citation index's requirements and its journal evaluation and selection criteria. Each has a publicly available description of their criteria with links to their journal suggestion submission form. Some forms demand more details and are more rigorous, or allow more space to justify inclusion, e.g., MEDLINE Review Application (comprehensive) vs. Thomson Reuters Electronic Journal submission form (limited) vs. Embase Journal Selection Procedures.
- Be persistent, even after a first rejection. Expect the acceptance process to take time. Reconsideration cycles for indexes are measured in years, not months.
- Citation indexes vary in journal coverage and base their selection decisions on a wide variety of criteria. Some focus only on article quality, and require journals to submit issues for them to review. Some want to see international representation on an editorial board, e.g., MEDLINE Journal Selection and Thomson Reuters Journal Selection Process. Scientific journals must also include comprehensive policies on peer-review process, full disclosure of conflicts of interest, and human and animal subjects treatment, among others.
- Establishing an open dialogue with the index editor is crucial. It helps to clarify questions and reasons for rejections and/or reconsideration.
- Sometimes a journal will be required to adjust the way it operates if its goal is to be accepted to a major citation index. For instance, the *West*JEM editorial board was told by both MEDLINE and Web of Science evaluators that the journal had insufficient international focus and submissions by non-U.S. authors. To address this requirement while maintaining writing quality for authors whose first language is not English, *West*JEM has partnered with international emergency medicine organizations to improve the quality of international submissions. MEDLINE also found the journal title too broad, and claimed it already had sufficient journal titles from emergency medicine. So *West*JEM added a subtitle that clarified its niche: "*Integrating Emergency Care with Population Health,*" to set it apart from other specialty journals. Its third MEDLINE application specifically highlighted this population health niche with purposely placed articles demonstrating the journal's unique role within the larger specialty.
- Journals may get frustrating rejections they might not be able to remedy, e.g., the journal contents are subjects already well represented in the citation index. This is an issue *West*JEM continues to discuss with Thomson Reuters regarding their Science Citation Index. *West*JEM has recently been accepted to a new citation index in the Web of Science Core Collection, *Emerging Sources Citation Index,* and currently is being reconsidered for the Science Citation Index. Inclusion in major indexes is a requirement for some submitting authors, whose university promotions are only supported by publishing in such completely indexed, peer-review journals.
- Being an open access (OA) journal may help. Many citation indexes consider OA journals to be desirable. It is easier to review the journal's content for quality and has the potential to reach a larger audience

> worldwide, especially in developing countries that lack resources for expensive subscriptions or per-article purchases. There is also evidence that OA journals garner citations more quickly and broadly than traditional subscription publications, especially in the developing world. Access generates citation.

*West*JEM's inclusion in MEDLINE (covering issues from 2014 onward) follows its indexing in Scopus (2011), CINAHL (2010), and PubMed (2007), among others. Langdorf and Murphy say the long hours invested have been worth it. What started as a four-page newsletter in 1999, and then became a regional journal, is now a well-established peer-reviewed international journal of some repute. *West*JEM is one of the only three 100% open access MEDLINE indexed emergency medicine journals in the world. The other two are the *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* and *BMC Emergency Medicine*. The quantity and quality of submissions is climbing along with their pageviews (on their independent site westjem.com, in eScholarship, and especially on PubMed Central). So are citations to *West*JEM articles. Having achieved inclusion in major citation indexes, the editors are exploring new opportunities such as interactive issues and partnering with Altmetric, a company that provides "*alt*ernative" "social media" *met*rics that scour the Internet to capture article-level activity and immediate impact in blogs, tweets, reader services and news outlets. For an example, see how Altmetric provides data of attention for a recent *West*JEM article, "The San Bernardino, California, Terror Attack: Two Emergency Departments' Response," published in January 2016.

One thing has remained constant during this long decade of growth: The journal remains focused on serving the emergency medicine community. Part of that focus is a commitment to the OA model that ensures everyone working in the field—a specialty that deals with social injustice, health and economic disparities, violence, substance abuse, and disaster preparedness and response—can read the articles. *West*JEM publicly shares and tries to minimize its acceptance-to-publication time so it can spread new knowledge quickly. It maintains a rigorous peer-review process and ethical standards as marked by membership in the Open Access Scholarly Publishers' Association (OASPA). *West*JEM also waives its article processing fee for authors from low-income countries, and for faculty of departments that support the journal through a membership/print subscription program.

eScholarship, the institutional repository of the University of California system, "*provides a suite of open access, scholarly publishing services and research tools that enable departments, research units, publishing programs, and individual scholars associated with the University of California to have direct control over the creation and dissemination of the full range of their scholarship*." According to Langdorf, hosting *West*JEM with eScholarship was crucial, especially during early implementation. As the UC Institutional Repository, eScholarship provides valuable support and free services to *West*JEM. These include the peer-review platform, key to *West*JEM's initial success. Without eScholarship, *West*JEM would never have been started, or continue to grow in the arena of OA publishing.

Many independent journals share similar dedication and willingness to adapt, despite staff turnover, financial constraints, and technology barriers. Nonetheless, the most daunting hurdle can be building the community of authors, reviewers, and readers necessary to establish a strong journal. Perhaps some impressive new technology will come along to solve that problem. In the meantime, indexing—and working with a university librarian—is certainly a wise strategy.

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Emergency Medicine Scholarship in the Digital Age

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How do scholars communicate in 2016 and beyond? Is the traditional journal being marginalized by digital communication? How many of us get the majority of our information from a paper page?

When an emergency medicine (EM) scholar has an idea, an innovation, or an important synthesis of existing information, is it appropriate to disseminate this several months later in a traditional print journal? In the digital age, when ideas flow around the world in minutes or hours, should scholarship flow so slowly? And yet, what is the role of peer review in attempting to assure that the ideas, innovations, and syntheses are generalizable, presented clearly, and (as best we can tell at the time) true?

What is the balance between digital communication and peer review?

As the editor of *WestJEM*, I consider this quandary frequently. The journal has grown substantially over the past eight years, with a current push circulation of 19,000 recipients and 4,500 paper copies per issue. Yet our digital exposure was 1.6 million pageviews and downloads last year, 12-fold greater than what we pushed to the academic world.

This switch from paper to digital information reminds me of the story of the buggy whip. As the world of 1920 changed from horse and buggy to the automobile, even the very best buggy whip maker in the world was doomed to go out of business. The transition took probably 30 years, but the outcome was inevitable. There would come a time when there was no need for buggy whips.

To cope with this transition, *West*JEM is partnering with the premier digital resource in academic EM, Academic Life in Emergency Medicine, or ALiEM. The journal embraces the concept that digital communication can and should be peer reviewed, and that the authors should get "traditional" academic credit proportional to their effort. This doesn't mean that an educational blog post written over the weekend should get as much credit as a 5-year funded original research project published in a discriminating journal. Yet it deserves some credit, as the pace of innovation and dissemination accelerate.

Therefore we inaugurate *West*JEM: ALiEM "PROMPT". PROMPT stands for Peer-Reviewed Online Media and Pedagogical approaches using Technologies. Although admittedly a mouthful, the title speaks to the immediacy of digital communication coupled with concepts of required peer-review and educational focus.

ALiEM (www.aliem.com) was originally a single-author educational blog focusing on clinical topics in emergency medicine (EM) in 2009. Since then it has evolved beyond a standard blog website into an innovative organization focusing on EM, health professions education, and digital scholarship. The organization's efforts are focused on developing, sustaining, and growing four domains.

The first is the ALiEM blog itself, which garners an annual 1 million page views globally, and continues to publish such topics as clinical Tricks of the Trade, pocket Paucis Verbis cards, clinical reviews supplemented by expert peer reviews, book club discussions, and faculty development debates.

The second domain, in contrast to the blog creating a worldwide virtual community of practice, focuses on establishing smaller mentored communities through our Chief Resident, Fellowship, and Faculty Incubator models. As an example, our Chief Resident Incubator virtually mentors approximately 200 U.S. chief residents year-round.

The third domain is curriculum development. With so many different blogs and podcasts available in EM, our focus has partly shifted towards a more structured, curricular approach to education in the form of ALiEM University (ALiEMU, www.aliemu.com). This digital learning management system allows educators to track learner progress and to generate custom reports, while also allowing trainees to track their own personal learning progress. To date, existing ALiEMU e-courses include the CAPSULES series, which focuses on EM pharmacology; the Approved Instructional Resources (AIR) series, which is a monthly curated list of recent, high-quality blog posts and podcasts as vetted by an expert panel of EM educators; and the AIR-Professional series, which is a bi-monthly, expert-crowdsourced list of social media resources focusing on advanced clinical concepts.

And the fourth pillar is digital scholarship. With many academic educators and scholars on the ALiEM team, it was a natural evolution of our mission. Our team is comprised of a diverse, international group of primarily educator-scholars and academic leaders in medical institutions. Unlikely traditional organizations, the team also includes residents, medical students, and even pre-medical students, providing a diverse spectrum of ideas, perspectives, and skill sets. In total, we have over 100 volunteers who dedicate their time towards advancing health professions education and digital scholarship in the realm of EM and beyond. Collectively, the organization and its team members have published over 20 peer-reviewed publications about social media and digital scholarship in journals such as

Western Journal of Emergency Medicine, *Annals of Emergency Medicine*, *Canadian Journal of Emergency Medicine*, *Journal of Graduate Medical Education*, *Academic Medicine*, and *Postgraduate Medical Journal*. Furthermore, the organization has partnered with various organizations and companies, such as the American College of Emergency Physicians, Council of EM Residency Directors, American Academy of Emergency Medicine, EBSCO Health, Call9, The Teaching Course, and AgileMD, to work on collaborative initiatives.

We, as readers, generators, and curators of academic scholarship, continue the journey toward digitalization together. I believe you will benefit from this unique cross-media partnership, and from the information published in these and subsequent issues of *WestJEM*'s ALiEM PROMPT.

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Blog and Podcast Watch: Pediatric Emergency Medicine

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Introduction: By critically appraising open access, educational blogs and podcasts in emergency medicine (EM) using an objective scoring instrument, this installment of the ALiEM (Academic Life in Emergency Medicine) Blog and Podcast Watch series curated and scored relevant posts in the specific areas of pediatric EM.

Methods: The Approved Instructional Resources – Professional (AIR-Pro) series is a continuously building curriculum covering a new subject area every two months. For each area, six EM chief residents identify 3-5 advanced clinical questions. Using FOAMsearch.net to search blogs and podcasts, relevant posts are scored by eight reviewers from the AIR-Pro Board, which is comprised of EM faculty and chief residents at various institutions. The scoring instrument contains five measurement outcomes based on 7-point Likert scales: recency, accuracy, educational utility, evidence based, and references. The AIR-Pro label is awarded to posts with a score of ≥26 (out of 35) points. An "Honorable Mention" label is awarded if Board members collectively felt that the posts were valuable and the scores were > 20.

Results: We included a total of 41 blog posts and podcasts. Key educational pearls from the 10 high quality AIR-Pro posts and four Honorable Mentions are summarized.

Conclusion: The *WestJEM* ALiEM Blog and Podcast Watch series is based on the AIR and AIR-Pro series, which attempts to identify high quality educational content on open-access blogs and podcasts. Until more objective quality indicators are developed for learners and educators, this series provides an expert-based, crowdsourced approach towards critically appraising educational social media content for EM clinicians. [West J Emerg Med. 2016;17(5)513-518.]

BACKGROUND

With the rapid rise in the number of social media educational content on blogs and podcasts, especially in emergency medicine (EM),[1] there has only been preliminary progress in helping educators and learners identify quality resources.[2-4] In 2008, the Accreditation Council for Graduate Medical Education endorsed a decrease in synchronous conference experiences for EM residency programs by up to 20% in exchange for asynchronous learning termed Individualized Interactive Instruction (III).[5] Residency programs, however, were often unsure how to identify quality online resources specifically for asynchronous learning and III credit.

To address this need, the Approved Instructional Resources (AIR) Series[6] and AIR-Pro Series were created in 2014 and 2015, respectively, by Academic Life in Emergency Medicine (ALiEM) to help EM residency programs identify quality online content specifically on social media. Using an expert-based, crowdsourced approach, these two programs

identify trustworthy, high-quality, educational blog and podcast content. The intended audience for the AIR series is EM junior residents, and the AIR-Pro Series is geared toward the EM advanced practitioner. This ALiEM Blog and Podcast Watch series on *WestJEM* presents annotated summaries from the AIR and AIR-Pro Series.

This installment from the AIR-Pro Series summarizes the best scoring social media educational resources on specific topics within pediatric EM.

METHODS

Question Identification

The AIR-Pro series is a continuously building curriculum covering a new subject area every two months. For each area, six EM chief residents from different U.S. residency programs on the ALiEM-Pro Editorial Board identify 3-5 focused, advanced-level clinical queries within the featured subject area. The topics for this installment included the following:

1. Pediatric arrhythmias
2. Procedural sedation in pediatrics
3. The neonate in distress
4. Toddlers with a limp
5. Pediatric syncope

Inclusion and exclusion criteria

A broad range of resources were identified using the custom EM search engine FOAMsearch.net, which extracts content from >300 blogs/podcasts relevant to EM as of February 2014.[7] We included blog posts and podcasts written in English and identified by key search terms for our scoring by our expert panel. We excluded journal articles from the list.

Scoring

Extracted posts were scored by eight reviewers from the AIR-Pro Editorial Board, which is comprised of EM core faculty and chief residents from various U.S. institutions. The eight reviewers included five chief residents from the AIR-Pro Editorial Board as well as three EM faculty educators, which included one board-certified pediatric EM educator and one pediatric EM fellow.

The scoring instrument contains five measurement outcomes using 7-point Likert scales: recency, accuracy, educational utility, evidence based, and references (Table). The scores for each post were evenly averaged over the eight reviewers. There were minimal disagreements regarding the scores, and the total for the five measured outcomes were tallied together to determine a final score out of 35 total points. We have sought to optimize content and response process validity of the scoring tool and assessment quizzes by expert development, review, and pilot testing. Although the inter-rater reliability of the scoring tool has not been performed, the tool was constructed to be simple and unambiguous similar to that of the AIR series this was modeled after.[6]

Data Analysis

An AIR-Pro endorsement is given to posts with a score of ≥26 (out of 35) points. Depending on the redundancy of the highest scoring posts, the best of these are then selected to address each preselected topic. An "Honorable Mention" label is also given to posts specifically felt to be worthwhile, accurate, unbiased, and educationally valuable for advanced clinicians by consensus of the AIR-Pro Board members. These posts must have scored ≥20 (out of 35) points.

RESULTS

We initially included a total of 41 blog posts and podcasts. Key educational pearls from the 10 high quality AIR-Pro posts and four Honorable Mentions are summarized.

AIR-Pro Content

1. Greene A, Patel S. ECGs: Long QT and Brugada. PEM Academy. (Sept 18, 2014)
http://www.pemacademy.com/ecgs-long-qt-and-brugada/

This 10-minute video presentation by Gopwani, Patel, Greene, and Chapman from the Pediatric EM Academy blog covers the pathologies related to Long QT Syndrome (exercise, stress, electrolyte abnormalities, etc) and Brugada Syndrome. Case-based content frames the discussion regarding the various pathologies, emergency department (ED) management, and patient disposition.

Long QT Syndrome take-home points: Pediatric patients with a QTc >470 msec should be seen emergently by a cardiologist in the ED. Long QT syndrome is typically either caused by a congenital abnormality or it is acquired (e.g. electrolyte and substance induced). Consider long QT syndrome as an etiology when exertion or emotional stress precedes syncope or seizures.

Brugada Syndrome take-home points: The electrocardiogram (ECG) in Brugada Type 1 appears as a "pseudo" right bundle branch block, coupled with ST segment elevation in V1, V2, and V3. The ECG in Brugada Types 2 and 3 has a saddleback-shaped pattern with a positive or biphasic T wave seen in V1, V2, and V3. The difference between Brugada type 2 and 3 is the amount of ST elevation with Type 2 having ≥1 mm of elevation and Type 3 having <1 mm of elevation.

2. Fox S. Brugada in Children. *Pediatric EM Morsels*. (Sept 11, 2015)
http://pedemmorsels.com/brugada-in-children/

This blog discusses the diagnosis and management of Brugada Syndrome. It focuses on the special considerations of Brugada Syndrome in the pediatric population.

Take-home points: Febrile illnesses can trigger arrhythmias in pediatric patients with underlying Brugada Syndrome. Children with Brugada Syndrome are more likely to present with complications of monomorphic ventricular tachycardia in comparison to older patients who present with

Table. Approved Instructional Resources – Professional (AIR-Pro) series scoring instrument for blog and podcast content in pediatric emergency medicine (maximum score = 35 points).

Tier 1: Recency	Score	Tier 2: Content accuracy	Score	Tier 3: Educational Utility	Score	Tier 4: Evidence Based Medicine	Score	Tier 5: Referenced	Score
When was the blog post or podcast published?		Do you have any concerns about the accuracy of the data presented or conclusions of this article?		Are there useful educational pearls in this article for senior residents?		Does this article reflect evidence based medicine (EBM) and thus lack bias?		Are the authors and literature clearly cited?	
≥6 years ago or unknown	1	Yes, many concerns from many inaccuracies	1	Low value: No valuable pearls	1	Not EBM based, only expert opinion	1	No	1
5-6 years ago	2		2		2		2		2
4-5 years ago	3	Yes, a major concern about few inaccuracies	3	Yes, but there are only a few (1-2) valuable or multiple (>=3) less-valuable educational pearls	3	Minimally EBM based	3		3
3-4 years ago	4		4		4		4	Yes, authors and general references are listed (but no in-line references)	4
2-3 years ago	5	Minimal concerns over minor inaccuracies	5	Yes, there are several (>=3) valuable educational pearls, or a few (1-2) KEY educational pearls that every resident should know before graduating	5	Mostly EBM based	5		5
1-2 years ago	6		6		6		6		6
<1 year ago	7	No concerns over inaccuracies	7	Yes, there are multiple KEY educational pearls that residents should know before graduating	7	Yes exclusively EBM based (unbiased)	7	Yes, authors and in-line references are provided	7

ventricular fibrillation. Although the best available treatment option is an automatic implantable cardioverter-defibrillator (AICD), the decision to place one requires a careful risk-benefit discussion because there is a higher rate of AICD complications in children.

3. Forbes E. Syncope Sunday 4: Syncope ECGs. Don't Forget the Bubbles. (March 15, 2015) http://dontforgetthebubbles.com/syncope-ecgs/

This post discusses the cardiac causes of syncope in pediatric patients including hypertrophic obstructive cardiomyopathy (HOCM), arrhythmogenic right ventricular dysplasia (ARVD), Wolff-Parkinson-White syndrome, Brugada syndrome, long QTc, and catecholaminergic polymorphic ventricular tachycardia (CPTV). A classic ECG

is provided for each syndrome, except CPTV.

Take-home points: The clinician must maintain a high index of suspicion for subtle ECG findings in the setting of syncope in children. Because HOCM is the leading cause of sudden death in young athletes, look for high left ventricular voltage, Q waves in the inferior-lateral leads, and left atrial enlargement in the setting of a concerning story. ARVD is the second most common cause of sudden death in young athletes. Look for the epsilon waves, T wave inversions in V1-V3, and prolonged S-wave upstroke.

4. Tat S. ECGs: Heart Block and Sick Sinus. PEM Academy. (July 17, 2014)
http://www.pemacademy.com/ecgs-heart-block-and-sick-sinus/

This is a 12-minute video presentation covering heart block and sick sinus syndrome created by Gopwani, Patel, Greene, and Chapman. Heart blocks and sick sinus conditions are discussed through real-life cases discussing possible patient presentations, acute management, and appropriate disposition for these patients.

Take-home points: Reading the ECG using the same methodical approach every time will aid in identifying subtle atrioventricular (AV) blocks. Second-degree AV blocks typically happen in a set pattern such as 4:3 and 3:2. All patients with a third-degree AV block require an immediate cardiology consultation. In contrast, only symptomatic patients with a second-degree AV block require cardiology consultation in the ED.

5. Fox S. Ketamine for Analgesia. *Pediatric EM Morsels*. (April 11, 2014)
http://pedemmorsels.com/ketamine-analgesia/

This blog post highlights current practices using ketamine as a primary pain medication in the pediatric population. Discussion points include indications, dosages, and barriers to use.

Take-home points: Ketamine should be considered as a core medication in basic healthcare systems. Ketamine is safe and effective, has a rapid onset, low risk for respiratory depression, and requires little monitoring when administered at analgesic doses (0.1–0.3 mg/kg IV or 0.5–1 mg/kg IM).

6. Sobo B. Ketamine. *PEM Currents*. (July 24, 2013)
http://www.pemcincinnati.com/podcasts/?p=60

This 8-minute podcast covers the basics of ketamine use in the pediatric population. It focuses on the benefits of ketamine including rapid onset, low side-effect profile, and ease of administration. Discussion points also include parental education regarding tachycardia and hypertension, as well as factors that increase a child's risk of adverse reactions.

Take-home points: Ketamine provides both amnestic and analgesic properties safely and efficiently. Younger patients metabolize ketamine at a faster rate and so may require more frequent re-dosing. Skillfully educating families of the possible effects prior to its use will decrease parental anxiety.

7. Radwine Z. The Sick Neonate. *EmDocs*. (Aug 12, 2014)
http://www.emdocs.net/sick-neonate/

This blog post reviews the initial approach to the evaluation, management, and resuscitation of the sick neonate. The post covers the topics of sepsis, congenital heart diseases, and metabolic disturbances. It includes a stepwise approach to the history and physical exam, as well as a mnemonic to help remember the differential diagnosis for a ill-appearing neonate.

Take-home points: The differential diagnosis for the ill-appearing neonate can be remembered using the mnemonic THE MISFITS and NEO SECRETS. Neonates in extremis without a fever have a congenital heart disease until proven otherwise. A pink baby in shock needs prostaglandin (PGE1) and milrinone. In contrast, a cyanotic baby in shock needs epinephrine or norepinephrine.

8. Partyka C. A Knackered Neonate… *The Blunt Dissection* (July 20, 2013)
http://thebluntdissection.org/2013/07/a-knackered-neonate/

This blog post covers an initial approach to the evaluation and management of an ill-appearing neonate. The case unfolds as you read with scaffolded questions for you to consider before revealing the answers. In this case, a hypoxic newborn presents with worsening respiratory distress despite being on nasal CPAP. The differential diagnosis is discussed, as well as neonatal intubation and troubleshooting the ventilator.

Take-home points: Neonates will become hypothermia very quickly, especially during the prolonged exposure times of endotracheal intubation. Ensure adequate external heating during the resuscitation. Troubleshooting the ventilator can be remembered using the DOPE mnemonic, which stands for Displacement of tubing, Obstruction, Pneumothorax, and Equipment failure.

9. Orman R. Pediatric Limp - Podcast: 28:22. *ER CAST*. (Feb 2, 2010)
http://blog.ercast.org/pediatric-limp/

This 28-minute podcast discusses the workup for a child with a limp as well as a decision rule for distinguishing toxic synovitis from a septic arthritis of the hip. A pediatric orthopedist Dr. Adam Barmada is curbsided for a consultation to give additional pearls for dealing with a limping child.

Take-home points: Examine the entire leg of the limping child, especially a joint above and below the subjectively painful area because, for instance, knee pain may be from hip pathology (and vice versa). The Kocher Criteria for risk stratifying septic hip arthritis includes non-weight bearing status, temperature >38.5°C (101.3°F), erythrocyte sedimentation rate> 40 mm/hr, and serum white blood cell count >12 cells/mm^3. The risk for septic arthritis is 0.2% (0 risk factors) and 97% (all four risks factors).

10. Fox S. Toddler's Fracture. *Pediatric EM Morsels*. (Feb 1, 2013)
http://pedemmorsels.com/toddlers-fracture

This blog post covers an initial approach to the evaluation and management of a toddler's fracture. It also reviews management strategies for challenging cases, such as children with a normal workup but continue to have symptoms.

Take-home points: Toddler's fractures are non-displaced spiral or oblique fractures of the tibia and may not be visible on initial radiographs in 13-43% of cases. Other areas that may also be initially normal on radiographs include the base of first metatarsal bone, cuboid, and calcaneus and so should be carefully palpated in toddlers with undifferentiated leg pain. A limping pediatric patient is more likely to have a fracture than a ligamentous strain even with a negative radiograph.

Honorable Mention Content:

1. Orman R. The Toxic Neonate. *ER CAST*. (May 26, 2010) http://blog.ercast.org/the-toxic-neonate/

This 37-minute podcast features an interview with Dr. Tim Horeczko, who was then a pediatric EM fellow. It was chosen as an honorable mention as it gives listeners useful information on the toxic neonate as well as a clear set of clinical priorities to work with for medical decision-making. It was determined to be a must-know resource for evaluating a sick neonate. Topics covered included the pediatric assessment triangle, hypoglycemia, intravenous fluid management, heart disease, and inborn errors of metabolism.

Take-home points: With a sick neonate, remember the pediatric assessment triangle (appearance, work of breathing, circulation) and to continue to reassess after interventions. Always check blood sugar and replete appropriately based on the different age groups: 10% dextrose 5-10 cc/kg (0-1 year old), 25% dextrose 2-4 cc/kg (1-8 years old), and 50% dextrose 1-2 cc/kg (>8 years old). In a "crashing infant" in its first month of life, if your interventions are not working, consider PGE, and if administering PGE, they will likely require intubation due to the risk for apnea.

2. Helman A. Episode 35: Pediatric Orthopedics Pearls and Pitfalls. *Emergency Medicine Cases*. (August 8, 2013) http://emergencymedicinecases.com/episdode-35-pediatric-orthopedics/

This 140-minute podcast was chosen as an honorable mention due to the careful explanation of the injuries they discussed. While a lengthy podcast, it discusses a broad spectrum of pediatric orthopedic conditions. Dr. Sanjay Mehta and Dr. Jonathan Pirie, both Canadian pediatric EM physicians, discuss septic arthritis, toddler's fracture, tillaux fracture, supracondylar fractures, anterior cruciate ligament tears, non-accidental trauma, pediatric orthopedic pain management, and more.

Take-home points: Remember that in children their ligaments are stronger than their bones, making fractures more likely than sprains. To determine the difference between septic arthritis and transient synovitis, the Kocher criteria (inability to weight bear, ESR >40 mm/hr, fever, serum white cell count >12 cells/mm^3), C-reactive protein, or ultrasound can be used. Ultimately one must use clinical judgment to differentiate the two conditions, because no one measure is perfect. Remember the CRITOE mnemonic (Capitellum, Radial head, Internal (medial) epicondyle, Trochlea, Olecranon, External (lateral) epicondyle) to avoid mistaking an ossification center for an avulsion fracture or vice versa. Comparison of the asymptomatic side is also useful to determine if there is an abnormality.

3. Radwine Z. Pediatric Syncope. *EmDocs*. (July 7, 2014) http://www.emdocs.net/pediatric-syncope/

This blog post was chosen as an honorable mention because of the practical and well-outlined list of pearls on pediatric syncope. The post discusses red flag considerations, cardiovascular causes, and concerning ECG findings.

Take-home points: Remember the 6 P's when obtaining you syncope history in children: prodrome activities and prodrome symptoms, predisposing and precipitating factors, passerby/witness, and post-ictal phase. Cautionary red flag signs and symptoms include a history of congenital heart disease, no prodromal symptoms, syncope while supine or during exertion, family history of sudden cardiac death, a pathologic heart murmur, and chest pain.

4. Burns E, Nickson C, Mattu A. Hypertrophic Cardiomyopathy. *Life in the Fastlane*. (July 30, 2012) http://lifeinthefastlane.com/ecg-library/hcm/

This blog post was chosen as an honorable mention because of its in-depth review of hypertrophic cardiomyopathy (HOCM). It reviews the background, pathophysiology, and various ECG abnormalities seen with HCOM. Additionally, it includes a link to a 17-minute video presentation by Dr. Amal Mattu on the early recognition and treatments of HOCM as well as multiple brief videos from Dr. Sanjay Sharma discussing classic and subtle ECG findings in HOCM.

Take-home points: The chief abnormality associated with HOCM is left ventricular hypertrophy (LVH), occurring in the absence of any inciting stimulus such as hypertension or aortic stenosis.

Additional ECG findings are deep, narrow (dagger-like) q waves in both lateral (V5-6, I, aVL) and inferior (II, II, aVF) leads. These q waves are <40 msec (compared to those related to a myocardial infarction which are typically >40 msec). HOCM can present with arrhythmias including Wolff-Parkinson-White, atrial fibrillation, supraventricular tachycardia, premature atrial contractions, premature ventricular contractions, and ventricular tachycardia.

CONCLUSION

Until more objective quality indicators are developed, the *WestJEM* ALiEM Blog and Podcast Watch series serves to identify educational quality blogs and podcasts for EM clinicians through an expert panel using an objective scoring instrument. These social media resources are currently curated in the ALiEM AIR and AIR-Pro Series, originally created to address EM residency needs. These resources are herein shared and summarized to help EM clinicians filter the multitude of blog posts and podcasts that are constantly being published at a rapid rate. Limitations include the fact that the search engine FOAMSearch.net may have omitted valuable websites, and the

scoring instrument has not been validated. While these lists are by no means a comprehensive analysis of the entire web for these topics, this series provides a crowdsourced, expert-panel approach towards identifying some high quality, educational social media content for the EM clinician.

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Academic Primer Series: Five Key Papers Fostering Educational Scholarship in Junior Academic Faculty

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Introduction: Scholarship is an essential part of academic success. Junior faculty members are often unfamiliar with the grounding literature that defines educational scholarship. In this article, the authors aim to summarize five key papers which outline education scholarship in the setting of academic contributions for emerging clinician educators.

Methods: The authors conducted a consensus-building process to generate a list of key papers that describe the importance and significance of academic scholarship, informed by social media sources. They then used a three-round voting methodology, akin to a Delphi study, to determine the most useful papers.

Results: A summary of the five most important papers on the topic of academic scholarship, as determined by this mixed group of junior faculty members and faculty developers, is presented in this paper. These authors subsequently wrote a summary of these five papers and discussed their relevance to both junior faculty members and faculty developers.

Conclusion: Five papers on education scholarship, deemed essential by the authors' consensus process, are presented in this paper. These papers may help provide the foundational background to help junior faculty members gain a grasp of the academic scholarly environment. This list may also inform senior faculty and faculty developers on the needs of junior educators in the nascent stages of their careers. [West J Emerg Med. 2016;17(5)519-526.]

INTRODUCTION

Academic scholarship is often intimidating for junior clinician educators. While scholarship is a time-honored tradition within residency programs, success during residency training may not appropriately prepare graduating residents for the challenges and expected benchmarks for a profession in academic medicine. Junior (and even mid-level) faculty members may encounter challenges in finding successful

academic direction at their respective institutions.[1-5] Junior faculty members newly immersed in an academic institution may face competing demands for clinical productivity; teaching and mentoring students and residents; securing funding for and engaging in research; and finding harmony with work-life balance.[5] The aforementioned challenges have the potential to undermine junior faculty members' confidence. If these faculty members are not nurtured in the nascent stages of their careers and do not receive the necessary mentorship and institutional resources that are essential for their development, their respective trajectories as mid-level faculty may be stunted.[4]

Discovering an academic niche and building a portfolio provides professional stability and supports academic appointments and promotions. Despite a track record of scholarly, evidence-based teaching, most tenure and promotion committees reward academically-sound, scholarly productivity more substantively. When considering candidates for promotion to assistant, associate, and full professor, a track record of peer-reviewed scholarship justifies the committee's decision.

Clinician educators may feel isolated, and left to fend for themselves among more senior core faculty. Those who are interested in educational or academic scholarship are often viewed differently from their research colleagues. This can make success as an academic clinician educator challenging.

The Academic Life in Emergency Medicine (ALiEM) Faculty Incubator was created in 2016 to address several of these issues. During our one-year experience, we created modules in which we described and discussed key literature relevant to junior clinician educators embarking on their respective careers within academic medicine. Our paper is a synthetic, narrative review that highlights some of the most important literature on the topic of academic scholarship, the first topic covered in our discovery-based Faculty Incubator curriculum.

METHODS

In the first month of the ALiEM Faculty Incubator, we discussed the topic of educational scholarship. We allowed the discussion to unfold, as we gathered the titles of papers that were cited, shared, suggested, and discussed within the online discussion forum. This forum consists of 30 junior faculty members and eight facilitators (faculty mentors and administrators) that exists via a closed, mixed-media, social media platform (Slack.com, San Francisco, CA). This platform allows for text-based communication, augmented by file-sharing and embedded website links. The discussion that occurred involved an international group of clinician educators spanning three countries (e.g. United States, Canada, and Chile) and multiple time zones.

We monitored the proceedings of the ALiEM Faculty Incubator from March 1-31, 2016, during which time all members participated asynchronously in various discussions around the topic of academic scholarship.

The list generated by the Faculty Incubator proceedings was then supplemented with a general call for suggestions from several social media outlets to optimize the literature list. On Twitter, we "tweeted" requests to have participants of the #FOAMed and #MedEd online communities provide suggestions for important papers on the topic of educational scholarship within emergency medicine (EM). The figure shows an exemplar request tweet.

Once our list of the most high-yield papers on educational scholarship was compiled, the authors subsequently conducted a three-round voting process, inspired by the Delphi methodology. We have not described our method as a pure Delphi methodology since our authorship panel comprises both novices (i.e. junior faculty members, participants in the Faculty Incubator) and experts in the field (i.e. experienced clinician educators, all of whom have published >10 peer-reviewed publications, who serve as mentors and facilitators of the Faculty Incubator). The selection of articles by both novices and experts was intentional: the authors sought to find articles that would both meet the approval of experienced clinician educators and resonate with junior faculty members entering the field of academic medicine. The rationale for reducing the number of papers to five was in an effort to restrict the list to the most crucial papers for junior clinicians to read, and subsequently to provide a short synopsis to explain to both junior educators and faculty developers why these papers were thought to be highly relevant. Of note, we have provided the complete list of all relevant papers discussed in these proceedings in the Table (first column) for those interested in an expanded reading list.

RESULTS

Our initial review of the ALiEM Faculty Incubator discussion thread yielded a total of 17 articles, which were mentioned by mentors and the junior faculty incubator participants (heretofore dubbed *incubatees*). The social

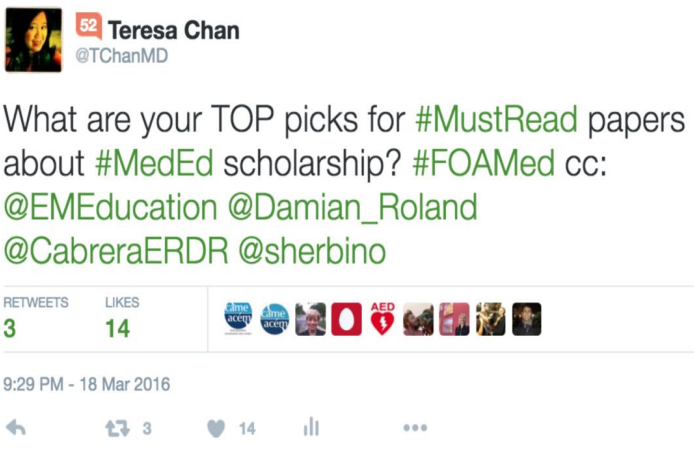

Figure. Exemplar "tweet" calling for online contributions for papers on medical education collaboration.

Table. The complete list of educational scholarship literature collected by the authorship team.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Beckman TJ, Cook DA. Developing scholarly projects in education: a primer for medical teachers. *Med Teach*. 2007 Mar;29(2-3):210-8.[6]	6.87 (0.35)	100%	100%	1
Yarris LM, Deiorio NM. Education research: a primer for educators in emergency medicine. *Acad Emerg Med*. 2011 Oct;18 Suppl 2:S27-35.[7]	6.63 (0.74)	100%	100%	2
Bandiera G, Lee S, Tiberius R. Creating effective learning in today's emergency departments: how accomplished teachers get it done. *Ann Emerg Med*. 2005 Mar;45(3):253-61.[8]	6.00 (1.07)	75%	62.5%	4
Schrager S, Sadowski E. Getting More Done: Strategies to Increase Scholarly Productivity. *J Grad Med Educ*. 2016 Feb;8(1):10-3.[9]	5.89 (1.26)	87.5%	87.5%	3
Cristancho S, Varpio L. Twelve tips for early career medical educators. *Med Teach*. 2015 Oct 22:1-6. [Epub ahead of print][10]	5.89 (0.99)	75%	62.5%	5
Sherbino J, Arora VM, Van Melle E, Rogers R, Frank JR, Holmboe ES. Criteria for social media-based scholarship in health professions education. *Postgrad Med J*. 2015 Oct;91(1080):551-5.[11]	5.63 (0.52)	75%	50%	Honorable Mention
Thurgur L, Bandiera G, Lee S, Tiberius R. What do emergency medicine learners want from their teachers? A multicenter focus group analysis .*Acad Emerg Med*. 2005 Sep;12(9):856-61.[12]	5.63 (0.74)	37.5%	25%	
Cook DA, West CP. Perspective: Reconsidering the focus on "outcomes research" in medical education: a cautionary note. *Acad Med.* 2013 Feb;88(2):162-7.[13]	5.25 (1.16)	37.5%	0%	
Sutkin G, Wagner E, Harris I, Schiffer R. What makes a good clinical teacher in medicine? A review of the literature. *Acad Med*. 2008 May;83(5):452-66.[14]	5.00 (1.07)	25%	0%	
Glassick CE. Boyer's expanded definitions of scholarship, the standards for assessing scholarship, and the elusiveness of the scholarship of teaching. *Acad Med*. 2000 Sep;75(9):877-80.[15]	5.00 (1.51)	25%	0%	
Côté L, Turgeon J. Appraising qualitative research articles in medicine and medical education. *Med Teach*. 2005 Jan;27(1):71-5.[16]	4.88 (1.13)	25%	0%	
Sherbino J, Van Melle E, Bandiera G, McEwen J, Leblanc C, Bhanji F, Frank JR, Regehr G, Snell L. Education scholarship in emergency medicine part 1: innovating and improving teaching and learning. *CJEM*. 2014 May;16 Suppl 1:S1-5.[17]	4.63 (0.92)	12.5%	0%	
Sullivan GM, Sargeant J. Qualities of Qualitative Research: Part I. *J Grad Med Educ.* 2011 Dec;3(4):449-52.[18]	4.50 (0.93)	25%	0%	
Sargeant J. Qualitative Research Part II: Participants, Analysis, and Quality Assurance. *J Grad Med Educ*. 2012 Mar;4(1):1-3.[19]	4.50 (0.93)	0%	0%	
O'Brien BC, Harris IB, Beckman TJ, et al. Standards for Reporting Qualitative Research: A Synthesis of Recommendations. *Acad Med.* 2014 Sep;89(9):1245-51.[20]	4.50 (1.07)	25%	0%	
Wright S, O'Brien BC, Nimmon L, et al. Research Design Considerations. *J Grad Med Educ*. 2016 Feb;8(1):97-8.[21]	4.50 (1.51)	12.5%	0%	
Ericsson KA, Krampe RT, and Tesch-Romer C. The Role of Deliberate Practice in the Acquisition of Expert Performance. *Psychological Revie*w. 1993; 100(3): 363-406.[22]	4.38 (0.92)	12.5%	0%	
Choo EK, Ranney ML, Chan TM, et al. Twitter as a tool for communication and knowledge exchange in academic medicine: A guide for skeptics and novices. *Med Teach*. 2015 May;37(5):411-6.[23]	4.38 (0.52)	0%	0%	
Perry M, Hopson L, House JB, et al. Model for Developing Educational Research Productivity: The Medical Education Research Group. *West J Emerg Med*. 2015 Nov;16(6):947-51.[24]	4.38 (1.68)	12.5%	12.5%	

Table. Continued.

Citation	Round 1 initial mean scores (SD) max score 7	Round 2 % of raters that endorsed this paper	Round 3 % of raters that endorsed paper in last round	Top 5 papers
Mays N, Pope C. Assessing quality in qualitative research. *BMJ*. 2000 Jan 1;320(7226):50-2.[25]	3.75 (1.39)	0%	0%	
Kitto SC, Chesters J, Grbich C. Quality in qualitative research. *Med J Aust*. 2008 Feb 18;188(4):243-6.[26]	3.75 (1.49)	0%	0%	
Kessler C, Burton JH. Moving Beyond Confidence and Competence: Educational Outcomes Research in Emergency Medicine. *Acad Emerg Med.* 2011 Oct;18 Suppl 2:S25-6.[27]	3.75 (1.83)	12.5%	12.5%	
Shapiro ED, Coleman DL. The scholarship of application. *Acad Med.* 2000 Sep;75(9):895-8.[28]	3.75 (1.49)	0%	0%	
Hu WC, Thistlethwaite JE, Weller J, et al. 'It was serendipity': a qualitative study of academic careers in medical education. *Med Educ.* 2015 Nov;49(11):1124-36.[29]	3.38 (1.30)	0%	0%	

media calls over one week (March 18-25, 2016) yielded eight additional suggested articles leading to a total of 25 articles for evaluation by our team. The three-round voting procedure allowed our team to generate a rank-order listing of all these papers in order of relevance, from the most important to the least important. The citations and our ratings of these 25 papers are listed in the Table.

DISCUSSION

The following are summaries of the top five papers accompanied with commentaries on their relevance to both junior faculty members, as well as potential considerations for faculty developers when discussing these works.

1. Beckman TJ, Cook DA. Developing scholarly projects in education: a primer for medical teachers. *Med Teach*. 2007 Mar;29(2-3):210-8.[6]

Summary

In academic medicine, promotion is often based on productivity, which in many universities is synonymous with publication. Publication within medical education, however, is often difficult given the various approaches to study design that are unique to the field and disparate from clinical medicine. This paper outlines a three-step method to rigorously develop scholarly education projects that can potentially lead to peer-reviewed publication.[6] Step 1 is to *Refine the Study Question*.[6] This involves a rigorous review of the current literature by querying traditional and alternative databases, as well as using specific search terms and canvassing the bibliographies of selected articles.[6] This step also involves composing a clear and succinct problem statement that navigates from existing knowledge to the new information the project will contribute to the literature. Initial refinement, per Beckman and Cook, requires the incorporation of a conceptual framework to provide a theoretical context. Finally, the authors suggest that the investigator generate a statement of study intent that includes a hypothesis, where appropriate.[6] Step 2 is to *Identify Study Design and Method*.[6] Here the paper gives a brief overview of different study designs applicable to medical education scholarship. Lastly, Step 3 is to *Select Outcomes,* which involves selecting outcomes that balance feasibility and meaningfulness according to Kirkpatrick's Hierarchy.[6] By following these steps, a medical educator can design an effective and publishable scholarly education project.[6]

Relevance to Junior Faculty Members

This is an essential primer for junior faculty members, especially for those who lack direct mentorship or prior training in education scholarship. The "publish or perish" paradigm is still part of the cultural milieu in many university settings. It is, therefore, important for junior faculty members to obtain academic credit for their educational work via traditional, peer-reviewed publication, commonly via program evaluation as suggested by this paper. While most trainees and junior faculty members are exposed to research design, there are subtleties and differences to education scholarship that are not intuitive for newcomers to the field. In order to perform education scholarship in a meaningful and effective way, junior faculty members need faculty development. This paper provides a foundation for this design, and offers the junior faculty educator a starting point for further learning.

Considerations for Faculty Developers

Faculty developers will find this primer provides helpful information to teach three key groups: 1) educators interested in scholarship, 2) clinical researchers without education expertise, and 3) scholars who are interested in building skills as peer reviewers. Not only does it provide a general overview of the landscape of education scholarship, but it also provides readers with concrete steps for program evaluation.

Written from the perspective of an education scholar, this piece highlights the concepts that are of unique importance in medical education, such as the development of a conceptual framework; education-specific study designs (i.e., validity studies); and selecting relevant outcomes for educational studies. A potential point of confusion in this paper is Step 3, which places a significant focus on the Kirkpatrick Model for outcome measures. When using this paper, it may be prudent to discuss outcome measures with junior colleagues beyond this model. Overall, the references cited include a good starting bibliography for education scholars.

2. Yarris LM, Deiorio NM. Education research: a primer for educators in emergency medicine. *Acad Emerg Med*. 2011 Oct;18 Suppl 2:S27-35.

Summary

Yarris and Deiorio lay out a broad overview of educational research in EM for new educational researchers.[7] They formulate one approach for conducting high quality research in education.[7] The general steps are as follows: 1) Identify a research problem; 2) Perform a literature review with annotated bibliography; 3) Identify a conceptual framework to frame the problem and research question; 4) Craft a research question using the *FINER* (Feasible, Interesting, Novel, Ethical, and Relevant) approach; 5) Select a study design; 6) Conduct the research using your well developed research plan; and 7) Dissemination of said research.[7] The authors pay particular attention to details of how to perform each step, especially focusing on qualitative and quantitative study designs and how they are important, equal, and valid types of data.[7] At the end of the paper the authors present the common barriers and solutions new researchers must overcome to perform such research.[7] Yarris and Deiorio provide further reading on specific topics, as well as advice to the early-career education researcher.[7]

Relevance to Junior Faculty Members

Being a junior academic faculty member can be a stressful experience secondary to the demands on publishing, as has been previously mentioned. Applying perspectives from Yarris and Deiorio's paper, however, can make this period far less stressful. Their paper offers a general framework for how to approach research from the outset to ensure high quality, publishable research.

Novel to this paper is its emphasis on methods and study design, and more specifically the differences between qualitative and quantitative research. Qualitative methodologies are particularly important in educational research, and are poorly taught compared to more traditional quantitative methodologies seen in healthcare research. The paper also impresses upon junior faculty members to ensure that they move beyond measuring Kirkpatrick Level 1 type outcomes (i.e. "I liked this" or "I didn't like this").[7]

Considerations for Faculty Developers

In 1990, Boyer expanded the definition of scholarship to include the scholarship of teaching and learning (SoTL).[30] Clinician-educators are in an ideal position to engage in SoTL, though many lack experience in conducting educational research. This article reviews the process of engaging in educational scholarship and research, providing a structure that faculty developers will find helpful in mentoring junior faculty. While some educational research methodologies may overlap with traditional biomedical research, other methodologies, such as qualitative research techniques, are more likely to be used in educational or social science research. Furthermore, traditional EM specialty journals may not be as receptive to educational research. Educational scholars will find the section on dissemination of educational research helpful in pursuing publication for their manuscripts.

3. Bandiera G, Lee S, Tiberius R. Creating effective learning in today's emergency departments: how accomplished teachers get it done. *Ann Emerg Med*. 2005 Mar;45(3):253-61.[8]

Summary

While there is a fair amount of research on clinical teaching and on the qualities of a successful clinical teacher, very little research focuses on clinical teaching in the emergency department (ED). Clinical teaching in the ED has its unique challenges and opportunities that require specific strategies for success. Bandiera et al. interviewed successful clinical teachers in the ED to ascertain behaviors that make these teachers successful.[8] Using a qualitative methodology, interviews were analyzed using a rigorous method with multiple coders.[8] From this analysis, 12 specific strategies were identified that any clinical teacher can use. These 12 strategies are explored in this paper with specific examples of their implementation provided.[8] Perceived barriers to excellent clinical teaching are also discussed.[8] Upon reading this paper, readers can expect to have a concrete idea of how they can improve their clinical teaching abilities on their next clinical shift and beyond.

Relevance to Junior Faculty Members

What makes a successful clinical teacher in the ED? This article answers that question succinctly with realistic strategies any clinical educator can implement. Most junior faculty members have a strong desire to be excellent clinical teachers, but few will know how to accomplish this. Bandiera et al. went directly to the source – excellent clinical teachers – and asked them what behaviors and attributes make them great teachers.[8] Twelve themes emerged from these interviews. Junior faculty will find this article invaluable in shaping their teaching strategies in the ED despite the threats of time constraints and lack of interest. Junior faculty will learn how to effectively teach learners of all levels of training, including non-EM learners rotating in the ED.

Considerations for Faculty Developers

While interested junior faculty members can attend general faculty development programming within the affiliated medical school that provides their faculty appointment, it is essential that academic EM departments offer specialty-specific faculty development programming. Junior faculty members will require the skill set to teach trainees in the clinical learning environment. This environment, however, can vary from a controlled setting conducive to bedside teaching, to one replete with chaos and multiple resuscitations. To be successful in either milieu, junior faculty will need a checklist of basic educational practices that can guide and facilitate their instruction of trainees.

This article provides the ideal framework for the faculty developer. Each item on the checklist featured in this paper can be developed into its own mini-workshop or lecture, thereby providing the faculty developer with a curriculum for the content with which the junior faculty should become acquainted. The practices discussed here will refresh and reinvigorate faculty who may have adopted a routine practice of teaching, and allow for the reflection of best practices to incorporate in their repertoire of teaching in the ED. Most interestingly, this paper's list of barriers to good ED teaching is a good reminder that all of us face the same problems, whether we are junior educators or senior, award-winning faculty members.

On another level, this paper also serves as an example of a paper using a qualitative methodology to answer a research question. This paper can be used by faculty developers to teach the critical appraisal of qualitative studies, as it offers a variety of excellent points for discussion (e.g. multiple coders).

4. Schrager S, Sadowski E. Getting More Done: Strategies to Increase Scholarly Productivity. *J Grad Med Educ*. 2016 Feb;8(1):10-3.[9]

Summary

This is a narrative review paper that aggregates commonly provided advice and strategies for junior scholars who are interested in being more productive. Advice given covers topics such as the following: 1) The "To do" list; 2) Finding a Balance: Learning to Say "No"; 3) Increasing Productivity by Making Everything Count Twice; and 4) Being Efficient.[9]

Relevance to Junior Faculty Members

Junior faculty are often pulled in many directions, expected to balance teaching, research, mentoring, and clinical work. It can be challenging to balance all of these demands while also maintaining wellness. This paper provides a variety of strategies for selecting projects that align more with personal goals, as well as learning how to say "no."[9] It can be challenging to decline projects when beginning an academic career, but one must also consider the opportunity costs associated with every new project. Additionally, the authors describe strategies for maximizing the value in projects. Examples include converting a new curricular change into a research project and publication, or using the knowledge obtained from a literature review to develop a grand rounds or national lecture.[9] Finally, the authors emphasize the importance of avoiding distractions and various techniques for how to minimize them.[9] Strategies include targeted email checking, scheduling meetings in blocks, techniques for reducing procrastination, and avoiding time wasted on excessive perfectionism (which can be a form of procrastination).[9]

Considerations for Faculty Developers

Academic productivity is not exclusive to junior attendings in EM. Interestingly, the paper cites very diverse sources of these insights ranging from *Forbes* magazine to *Psychology Today* to academic blogs, suggesting that perhaps sometimes the answers we seek may not be simply accessible through PubMed. That said, in EM we are fortunate to have tacit wisdom available via our own academic blogs. For faculty developers looking for more insight on this topic, we suggest you might augment your teaching and reading with the ALiEM *How I Work Smarter* series (http://www.aliem.com/category/non-clinical/how-i-work-smarter/).

5. Cristancho S, Varpio L. Twelve tips for early career medical educators. *Med Teach*. 2015 Oct 22:1-6. [Epub ahead of print][10]

Summary

This is a paper from the *12 Tips* series published in *Medical Teacher*. It contains excellent suggestions and tips gathered and then written by early-career medical educators in Canada.[10] Tips range from advice on how to think and talk about oneself (Tip 1: Articulate your area(s) of interest; Tip 8: Create Multiple Elevator Pitches; Tip 11: Embrace your identity within the field) to "nuts and bolts" ideas (Tip 4: Develop strong communication skills; Tip 5: Cultivate relationships with mentors; Tip 6: Be a good mentee; Tip 10: Build resilience as your armor).[10]

Relevance to Junior Faculty Members

This article provides advice and concrete tips for developing both short- and long-term career plans, and how to align one's goals with that of the institution.[10] Junior faculty members will benefit from understanding how to better align their projects to avoid being spread too thin, with a focus on longer-term goals to support both career and life satisfaction.[10]

This article also highlights the interconnectedness of the medical education community, emphasizing the importance of one's peers in an early-career educator's career path. Often times, networking is underemphasized in medicine when compared to other industries, much to the disadvantage

of junior faculty members. Effective networking can lead to new projects, more mentors, exciting job opportunities, and letters from other academics in the field, which are required for promotions.[10] The authors stress the importance of mentorship along with strategies for effectively selecting a mentor and being a good mentee.[10] Regrettably, the only thing the authors did not provide insight on was how to be a good mentor in turn.

Considerations for Faculty Developers

This paper reminds us that medical education is a field (Tip 11), wherein many people of various backgrounds come together to work in the same arena – a concept that is important to explain when orienting junior faculty members.[10] Understanding this concept early allows junior faculty members to better understand why there are pluralistic views and perspectives within medical education as manifest via presentations, papers, and even reviews of their scholarship. For those developers who wish to have an EM specialty-specific bend on the topic of networking, another article has recently been published on this topic.[31]

Honorable Mention

Sherbino J, Arora VM, Van Melle E, Rogers R, Frank JR, Holmboe ES. Criteria for social media-based scholarship in health professions education. *Postgrad Med J*. 2015 Oct;91(1080):551-5.[11]

Although it was not in the top five papers, this paper was quite highly valued by our panel. The age of social media is upon us, and in EM it is especially important for junior faculty members to be aware of how social media-based work might be turned into scholarship. However, since within many academic environments this is not yet a standard form of scholarship, we were reluctant to endorse it as one of the top five papers. Some departments and universities are beginning to consider the impact of such scholarly works within their academic promotions and tenure process.[32] If a junior faculty member is hired into environments that are supportive of digital and social media scholarship, this paper will be essential for guiding them towards a scholarly approach for their work. For more senior faculty members, this may be a paper that is worth keeping in your reading file to use when you want to support a junior faculty member doing great work, or maybe if you are looking to pave the way towards a more broadened definition of scholarship at your institution.

LIMITATIONS

The main limitation of our proceedings is that our search strategy was not comprehensive. Although we attempted to gather recommendations from multiple sources (e.g., our Faculty Incubator discussions, Twitter), we did not perform an exhaustive, structured literature review. The purpose of this paper, however, was to aggregate an approachable set of high-yield papers that will serve as a starting point for junior faculty members embarking on their academic EM careers. The authors hope that this is the starting point for their exploration and initial development.

CONCLUSION

We have provided a reading list that may be beneficial as an introduction for junior faculty members to the world of educational scholarship. We hope this paper provides junior clinician educators a broad overview of this important topic and makes it more approachable and less intimidating.

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Mobile COWs (Computer on Wheels): Hamburger or VEAL?

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INTRODUCTION

The HITECH (Health Information Technology for Economic and Clinical Health) Act of 2009 galvanized the universal adoption of electronic health record (EHR) systems to improve the quality, delivery, and coordination of patient care.[1] Initial results demonstrated improvement in population health outcomes and increased transparency.[2-3] Through the HITECH Act's Meaningful Use (MU) incentives, EHR adoption also promised shorter hospital stays, reduced costs and improved access to healthcare data.[4] These promises, however, never materialized; studies have demonstrated that EHR adoption causes decreased rates of patients seen per hour, highly variable documentation times, and increased order entry times.[5]

The unintended consequences of the HITECH Act are exacerbated in the emergency department (ED). While the few studies examining practical limitations of ED EHR use are limited to single-site studies with variable, non-validated outcomes, they suggest that MU obstructs ED best customs and practices and is potentially dangerous.[6-7] For instance, real-time computerized charting is difficult because it requires a bedside computer and Internet access, but installing the required hardware is limited by cost and regulations governing the use and renovation of hospital facilities.[8] MU requirements also stipulate a transition to computerized physician order entry (CPOE); however, prior studies have demonstrated that CPOE increases order entry times, exacerbating the well-documented issue of ED crowding and boarding.[1,5,9] In emergent situations, CPOE forces physicians to leave the deteriorating patient's bedside to access a computer before treatment can be rendered.

REVIEW OF CURRENT TECHNOLOGY

Mobile technology could solve these issues: physicians remain at the bedside, no hardware installation other than a Wi-Fi router would be needed, and healthcare facilities would be in compliance with MU. Unfortunately, a market survey of commercially-available EHR systems demonstrates that none have effective mobile platforms; one study comparing the usability of several mobile EHR products found that all ranked below a system usability scale (SUS) of 68 (a score considered average).[10-11]

Some facilities have adopted Computers-On-Wheels (COW) as mobile workstations.[12] A market survey demonstrates that most commercially-available mobile workstations are expensive, frequently costing over $3,000 per unit. This does not include the cost of the computer or accessories. Additionally, the COW's hefty weight and footprint precludes effective mobility especially when multiple units are in use. Imagine the all-too-familiar situation in which nurses, technicians, and physicians are each trying to perform their patient care tasks in the treatment room, but now with COWs in tow. Furthermore, once spent, the COW's battery must be recharged at a power outlet or charging station rendering the COW immobile for several hours. Lastly, it may be challenging for many EDs to find the approved physical space necessary to store and charge a row of multiple COWs.

The purpose of this paper is to describe the development and initial implementation of a potentially superior mobile computing solution in a single prototypical ED.

METHODS

Development of our mobile computing solution dubbed the *Very-Efficient Agile Laptop* (VEAL) began in January 2015 and lasted three months (Figure 1). It is, in summary, a laptop computer mounted to a mobile workstation. While a variety of parameters were considered in the VEAL's design, three features were considered functionally critical:

Compact footprint: Since the COW's size limited efficient

mobility and storage, careful consideration was given for the VEAL's footprint. The design team chose to mount a *Dell Latitude E6450* laptop atop an *UltraLite 200 Series, 200 Model* mobile podium produced by *JACO Inc.* The laptop measures 14.92 x 1.31 x 9.86 inches and weighs 5.64 pounds, while the podium maintains a footprint of 20 x 16 inches with an adjustable height of 30 to 46 inches and weighs 44 pounds.

Wi-Fi Video Conferencing Capability: While Wi-Fi access is required for basic access and use of the EMR, using the laptop's built-in video camera also affords the use of translation services, including American Sign Language (ASL), as well as telehealth, e.g. tele-neurology and tele-psychiatry services.

Exchangeable Batteries: We opted for a system of exchangeable external batteries (Figure 2) rather than relying on the laptop's internal battery to power the device. The internal battery lasts no more than 10 hours, while some ED shifts are as long as 12 hours. Because changing the internal battery would power down the machine, we chose a system of external batteries; during an external battery swap, the internal battery powers the VEAL, preventing shutdown. We purchased the *MP-50000 Powerbank, XTPower®* battery pack, which can power an active VEAL for over 12 hours per charge.

The implementation phase lasted six months, from September 2015 to February 2015. The ED staffed 27 attending and 14 resident physicians per month during this period, serving an average of 130 patients per day. Four to seven physicians are staffed at any given time. Five VEALs were initially introduced and six were available for use by the conclusion of the pilot period. Physicians were given the choice to use either the VEAL or the traditional workstations at their discretion. Traditional wall-mounted workstations were available in 60% of patient care rooms, and physicians had access to 10 dedicated workstations in the doctors' charting room. VEAL usage was tracked via each laptop's distinct IP address.

Figure 1. The Very-Efficient Agile Laptop (VEAL).

Figure 2. Multiple battery packs charging.

Committee Review

The study required no protected health information. All device usage data were collected in aggregate from the Allscripts™ EHR system. All budgetary data were released freely without financial consideration.

RESULTS

Adoption

The standard monthly staffing level for this project's ED requires 27 attending physicians and 14 resident physicians. In the first month of deployment, eight attending and three resident physicians adopted the five available VEAL units for clinical use; in the final month, adoption had increased to 12 attending and 10 resident physicians. Over the six-month implementation period, providers used the VEAL on 55 of the 130 patients (42.5%) treated per day on average in the ED, accessing each chart 12 times per patient visit. In the first month, the VEAL was used in the care of 35/138 (25.3%) patient visits per day with average chart access rate of 7.9 per visit. In the final month, those figures increased to 89/126 (70.6%) patients per day with average chart access rate of 14.0 times per patient visit.

VEAL adopters tended to be younger: 52% (14/27) of

Figure 3. Very-Efficient Agile Laptop (VEAL) storage under physician work computers.

ED attending physicians had chosen to adopt the VEAL for clinical use, while resident physicians adopted the VEAL 78% (18/23) of the time.

Cost

Cost data were obtained from supplier invoices. The podium and laptop were purchased for unit prices of $772 and $1,407 respectively. Two battery packs were purchased per VEAL for a combined cost of $459 per VEAL. Lastly, an *Imprivata*® ID badge reader for convenient EHR login access was added to each unit for $82 each. In total, each VEAL cost $2,721.

In comparison, our hospital's COWs mobile carts were each purchased from Rubbermaid® at a price of ~$4,000.00 while the COW's *Dell Optiplex 9020* PC and monitor cost ~$720. As with the VEAL, an Imprivata badge reader is affixed to each COW for $82. In summary, each COW costs a total of ~$4,857 or 78.5% more than each VEAL.

DISCUSSION

We developed and implemented a smaller, more cost-effective and more functional mobile computing solution for the needs of a busy, academic ED with multiple providers and caregivers. Though initial adoption was faster by younger resident physicians, within six months of implementation, over 70% of all ED patients were cared for with this device. Adoption rates might have been slightly higher were adoption not restricted by the limited number of VEALs available during the pilot period. One indication of the demand for these units was the requests from other departments (e.g. trauma surgery, general surgery, otolaryngology) for identical units for their own use. We believe that several critical design features have contributed to the VEAL's relatively rapid adoption and popularity despite its simple design.

While Wi-Fi is required for EHR use, it also augments patient care on several levels. First, it affords mobile conferencing services. This is particularly important for ASL, as The Joint Commission frequently cites hospitals for limitations in this area.[13] Furthermore, telehealth can be particularly beneficial for healthcare centers without access to subspecialists. Because the VEAL can serve these multiple functions, dedicated telehealth, translation, and ASL units are unnecessary, saving both money and space. Second, the VEAL creates opportunities for patient engagement. Imaging and laboratory results can be accessed at the patient's bedside for patient review. Similarly, accessing online videos, diagrams, and resources can augment real-time patient education.

Next, the exchangeable external battery system enables the VEAL's continuous use. Since all mobile devices—from laptops to cellphones to bedside ultrasounds—are limited by battery life, dependability relies on a continuous power source. Unlike typical consumer electronic devices, which can be recharged while the user sleeps, rechargeable devices like COWs are limited for the 24/7 operations of the ED. In contrast, the VEAL's power source is endlessly renewable.

Most critical is the VEAL's footprint. In addition to mobility, the VEAL's small size allows it to be stored in our facility's smallest corners (Figure 3) and allows patient care to extend to smaller treatment areas. Creating new patient care areas may be necessary as EDs struggle to cope with the well-documented and dramatic increases in ED patient volumes since the implementation of the Affordable Care Act of 2009.

For example, in many centers, physician-in-triage (PIT) systems have been implemented to expedite care and to quickly assign limited ED resources, such as gurneys, to patients who require true emergency care. In the study ED, VEAL's mobility has been critical for the PIT system, which has two main treatment chairs, a single auxiliary bed, an isolation closet, and a hallway. The physician is able to treat and reevaluate multiple patients across a wide,yet cramped treatment area with a single mobile workstation.

One final advantage inherent to the VEAL is continuous sign-on. Because the VEAL stays with the provider throughout the work shift, the physician never needs to sign in or out of the EHR except at the beginning and end of the shift. Contrast this with the more common scenario of signing into or out of the nearest workstations. In the study ED, a provider spends 8-10 seconds per sign-in. In the study ED, providers average 20-25 patient encounters per 8-12 hour shift. With 13+ accesses per patient on average, the sign-on process with traditional workstations (not dedicated to a single physician) consumes some 40 minutes, and causes user frustration. Add to that the time spent walking the few feet each time to a stationary terminal, which also costs additional time and decreases productivity.

LIMITATIONS

There are several limitations to this design and implementation study. The pilot population was small, limited to a single ED within an academic hospital. Results may not be directly applicable to a community hospital. Another limitation is that it was not possible to determine exactly what or how much patient care was performed on the VEAL (i.e. CPOE vs. documentation vs. bedside teaching). Lastly, secondary effects such as ED length of stay, patient satisfaction or quality of care were not examined during this pilot period. Long-term durability of the design and hardware is under scrutiny. We did not quantify VEAL use as a telemedicine or interpreter device.

CONCLUSION

The VEAL is literally and metaphorically an example of leaner, more efficient healthcare. The VEAL delivers enhanced mobility and functionality at lower cost than its predecessor. Early performance data demonstrating rapid physician adoption and deployment in clinical care settings suggest a superior end-user experience. Additional study is needed to definitively demonstrate these benefits and their impacts on patient care. We are currently designing a study to quantify these effects. The VEAL may be an example of innovation improving care for both provider and patient.

As the needs of our patients and society evolve, we believe that the VEAL offers a leaner, higher-value healthcare experience than the COW of years past.

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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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Optic Nerve Sheath Diameter Measurement During Diabetic Ketoacidosis: A Pilot Study

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INTRODUCTION

Diabetic ketoacidosis-related cerebral edema (DKA-CE) occurs in up to 1% of children with type 1 diabetes (T1D),[1] with approximately 20% displaying neurologic symptoms at presentation.[2,3] Similarly, up to 54% have a mild form of subclinical DKA-CE identified by extracellular fluid measurements on magnetic resonance imaging (MRI), which is associated with alterations in neuronal function and cerebral injury on MR spectroscopy.[2-6] This suggests that DKA-CE occurs along a continuum, ranging from asymptomatic imaging changes, mild neurologic injury, to cerebral herniation and death.

DKA-CE is currently assessed by clinical symptoms and advanced imaging techniques, which have significant cost and limitation. Computed tomography (CT) uses ionizing radiation and can miss nearly 40% of children who ultimately develop DKA-CE.[7] MRI is time-consuming, often requires sedation, and may not be available at some centers. Moreover, both CT and MRI require moving critically ill patients out of the intensive care setting. In contrast, point-of-care ocular ultrasound is a relatively low cost, accessible imaging technique that may have the potential to promptly identify DKA-CE through measurement of the optic nerve sheath diameter (ONSD).

The sonographic appearance of the ONSD correlates with elevations in intracranial pressure (ICP), which is thought to be due to cerebrospinal fluid accumulation between the dura and optic nerve with the subsequent appearance of swelling.[8] ONSD measurement has been used to accurately detect increased ICP in a number of clinical situations,[8-10] including pediatric head trauma[11] and hydrocephalus.[12,13] This method has also been validated in adults using direct measurements of ICP via intrathecal infusion tests,[14] lumbar puncture,[15] and intracranial monitoring.[16]

The point at which patients actually progress to subclinical DKA-CE and the minimum duration of preceding symptoms has not been delineated.[7] Furthermore, it is currently unclear how the ONSD changes during T1D-related illness or whether ONSD measurement can discriminate stages along the continuum of DKA-CE development, particularly among those with subclinical DKA-CE or those without obvious neurologic symptoms. Therefore, we sought to perform a pilot study among patients with T1D and DKA to determine how ONSD measurements vary during T1D-related illness, and the potential of this tool for discrimination of subclinical DKA-CE. We hypothesized that mean binocular ONSD would increase with illness severity, and would differ among children with DKA, T1D with hyperglycemia, and well-controlled T1D. The association of mean binocular ONSD with DKA-CE risk factors was also examined.

METHODS

Study Design

This was a cross-sectional study of pediatric patients aged 7–18 years with T1D conducted from March 2014 to May 2015. This study was registered with clinicaltrials.gov (NCT02130180) and approved by the hospital's institutional review board. Informed consent and assent were obtained from all parents and patients, respectively.

A convenience sample of patients was enrolled at a tertiary children's hospital with an annual emergency department (ED) census of 90,000. The hospital's endocrinology clinic is a regionally recognized center for pediatric diabetes education and management, with a T1D census of approximately 1,860 patients. Patients were enrolled in each of three study groups: 1) well-controlled T1D, 2) T1D with hyperglycemia, and 3) DKA. We defined well-controlled T1D as having a no documented hemoglobin A1C >8% and

no previous episodes of DKA other than at the time of T1D diagnosis. DKA was defined as hyperglycemia ≥200 mg/dL, venous pH <7.30 and/or bicarbonate level <15 mmol/L, and either positive urine or serum ketones.[17,18] Patients with hyperglycemia ≥200 mg/dL but not meeting other criteria for DKA were included in the T1D with hyperglycemia group. We excluded patients if they had underlying neurologic conditions predisposing to changes in ICP (hydrocephalus, ventriculoperitoneal shunt, Chiari malformation, pseudotumor cerebri, brain tumor), previously documented increases in intraocular pressure, history of type 2 diabetes mellitus, hyperosmolar hyperglycemic nonketotic state or insulin prior to transfer. Given concerns about the potential confounding relationship between larger intravenous (IV) fluid amounts and cerebral edema development, we excluded patients who received >10 mL/kg of IV fluid prior to transfer.

Well-controlled T1D patients were screened for inclusion criteria using the electronic medical record and enrolled during routine follow up in the endocrinology clinic. Patients with T1D with hyperglycemia or DKA were screened at ED triage, and enrolled after eligibility criteria were confirmed and within four hours of arrival to the ED. All children with T1D with hyperglycemia and DKA were treated according to our institution's hyperglycemia and DKA guideline. This included routine laboratory testing, IV fluid administration, and insulin as determined by the treating physician. Patients were not included if previously enrolled.

The enrolling sonographer collected demographic and medical history via a structured case report form that included information on presenting signs and symptoms, length of symptoms (polyuria, polydipsia, weight loss, vomiting), history of T1D and number of previous DKA episodes, IV fluid and insulin received, treatments administered for DKA-CE, and time from ED registration to ultrasound measurement. The electronic medical record was abstracted to obtain laboratory values (pH, pCO_2, bicarbonate level, blood glucose, sodium, potassium, blood urea nitrogen, creatinine, serum and urine ketones, hemoglobin A1C), confirm historical information, and review hospital admission and follow-up clinic data (hospital course, results of imaging studies, follow up clinic weights). Percent dehydration was calculated from the weight change from the ED to clinic follow up within one

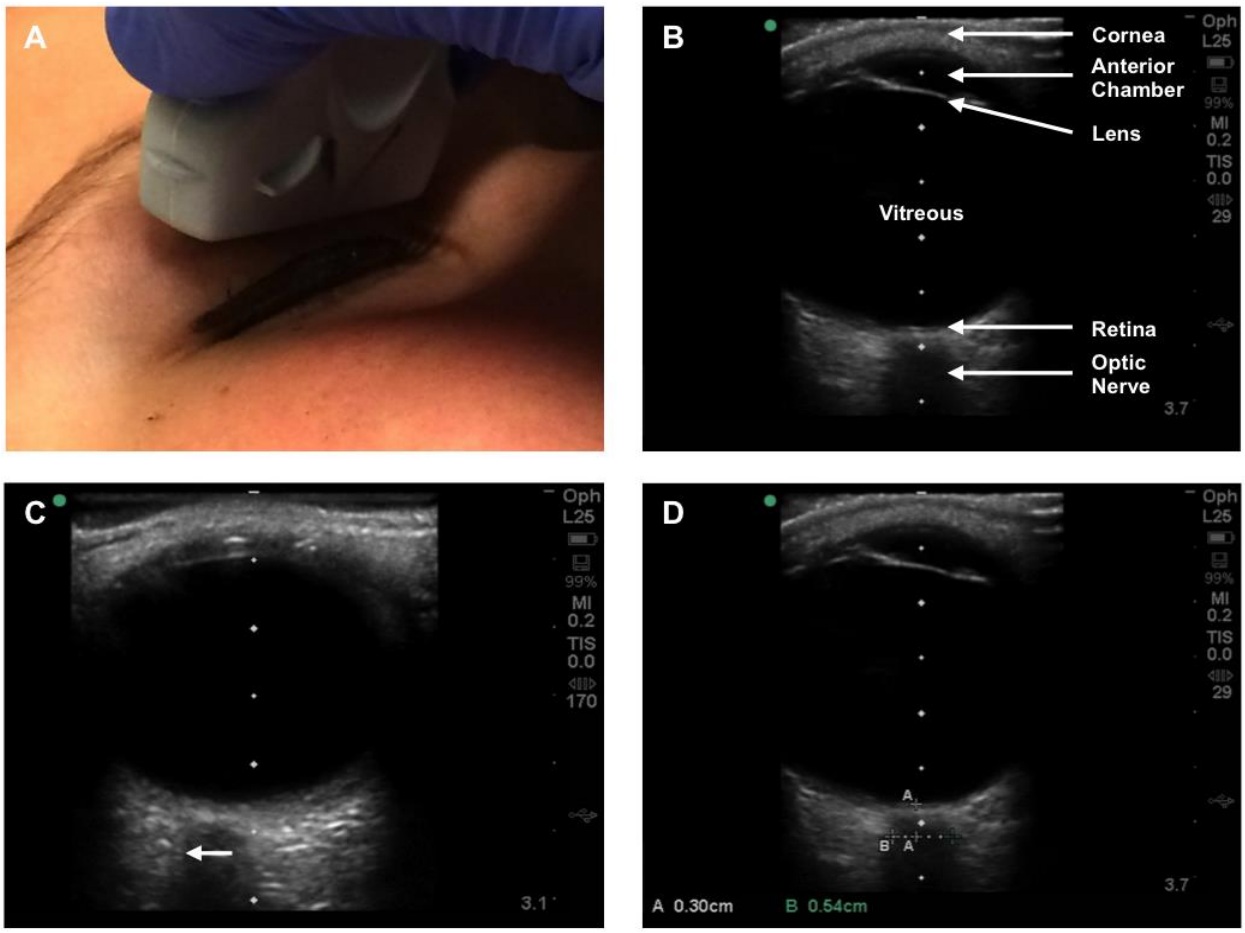

Figure 1. Ocular ultrasound was performed in the transverse plane using a linear transducer to identify the optic nerve (A and B). The nerve sheath was included in optic nerve sheath diameter (ONSD) measurements when visualized (C, arrow) and measurements were taken at a depth of 3 mm posterior to the globe (D).

month of hospital discharge. We then entered data into Excel (Microsoft, Redmond, WA).

Missed eligible patients were identified and the electronic medical record was abstracted to obtain available demographic and clinical parameters in order to ascertain selection bias.

Ultrasound Technique

Sonographers performing ocular ultrasound included a pediatric emergency medicine fellow and pediatric endocrinologist. Ocular ultrasound was performed using a SonoSite M-Turbo ultrasound machine (SonoSite Inc., Bothell, WA) with a 13-6 MHz linear array transducer. Sonographers attended an intensive one-day ultrasound course that included specific training on ONSD measurement. The ultrasound technique was further refined in two separate training sessions using healthy volunteers. Study sonographers were not responsible for the ED care of enrolled patients but were aware of laboratory inclusion criteria in order to assign study group status, and were therefore un-blinded to ultrasound results.

Images were obtained according to standard technique using the anterior transbulbar approach to image the ONSD in an axial plane along the visual axis (Figure 1).[19,20] Ultrasound gel was placed over the transducer, which was then positioned over a closed eyelid with the patient in a supine position. Patients were instructed to direct their gaze to the midline, and the probe was manipulated as needed to best visualize the optic nerve. Images were then captured and ONSD measurements (mm) were taken directly on the ultrasound machine at a depth of 3 mm posterior to the globe. Previous studies and postmortem investigation have shown that this is the optimal position to detect ONSD swelling,[9,21,22] and subsequent studies have established abnormal values associated with elevated ICP as >4.5 mm in children >1 year and >5 mm in adults >18 years.[9,13,23] In keeping with standard technique, the nerve sheath was included in measurements when present.[19,20] Images were saved and exported to a secure USB, and the process repeated for the patient's other eye.

Statistical Analysis

We analyzed data using SPSS Statistics (version 22; IBM, Armonk, NY). Mean binocular ONSD was the primary outcome measure. Numeric ONSD measurements were obtained and classified as normal or increased in size according to established reference values, where >4.5 mm was considered the upper limit of normal in patients aged 1–18 years.[8,13,23] Our secondary outcome was interrater reliability. An additional ocular ultrasound was performed on a subset of patients by the second study sonographer who was blinded to the clinical status and initial ultrasound results. We also examined the association of mean binocular ONSD with DKA-CE risk factors.

We used descriptive statistics to compare patient characteristics with numerical data presented as medians with interquartile range (IQR). We assessed data for normality. The Mann-Whitney U test was used to compare median values between two groups, and one-way ANOVA or the Kruskal-Wallis test was used to compare values between three groups for parametric or non-parametric variables, respectively. We compared categorical variables using χ^2 and Fisher's exact test. Missed eligible patients were analyzed for selection bias.

We used multiple linear regression to determine if risk factors were independently associated with mean binocular ONSD. Explanatory variables in the model included factors that may influence the ONSD or development of DKA-CE, including estimated percent dehydration, length of symptoms (days), total amount of IV fluid received, time to ultrasound, time from IV fluid administration to ultrasound, and laboratory values at presentation (pH, pCO_2, bicarbonate, blood urea nitrogen). Total IV fluid received was separated into three categorizes (≤10 mL/kg, 10–20 mL/kg, and ≥20 mL/kg) and included prehospital and ED fluids received. Missing values were imputed in the regression model using the minimum and maximum for each variable. We excluded well-controlled T1D patients from regression analysis, as this group did not have laboratory investigations aside from hemoglobin A1C. Sensitivity analysis was performed using only images acquired by the pediatric endocrinologist, patients with symptoms ≤24 hours, and those with severe DKA (pH <7.1).[18] We assessed interrater reliability testing of ONSD measurements between sonographers using the raw percent agreement and the intraclass correlation coefficient.

Previous literature,[12,13,23] has shown a mean difference in ONSD ranging from 1–2.8 mm when comparing asymptomatic to symptomatic children, and a standard deviation of approximately 0.36 mm. Given that we were interested in children without obvious neurologic symptoms, we designed our study to detect a lower between group difference in mean ONSD and set this at >0.1 mm, yielding an effect size of approximately 0.3. We therefore aimed to enroll 36 patients in each of three study groups in order to maintain an α=0.05 and power of 0.80.

RESULTS

Study enrollment flow is shown in Figure 2. Demographics were similar among groups (Table 1). African-American children tended to present with DKA more often than white patients, although this difference was not statistically significant. No patients had clinically overt DKA-CE. All but one patient had a Glasgow Coma Scale of 15 at presentation (1 patient with 14).

ED characteristics are shown in Table 2. No patients with T1D with hyperglycemia received IV fluid prior to transfer compared to five patients with DKA (<10 mL/kg). There was no statistical difference in length of symptoms, amount of IV fluid received, or number of patients who received insulin. Among those that received insulin in the ED, all were treated with IV fluid prior to insulin administration according to

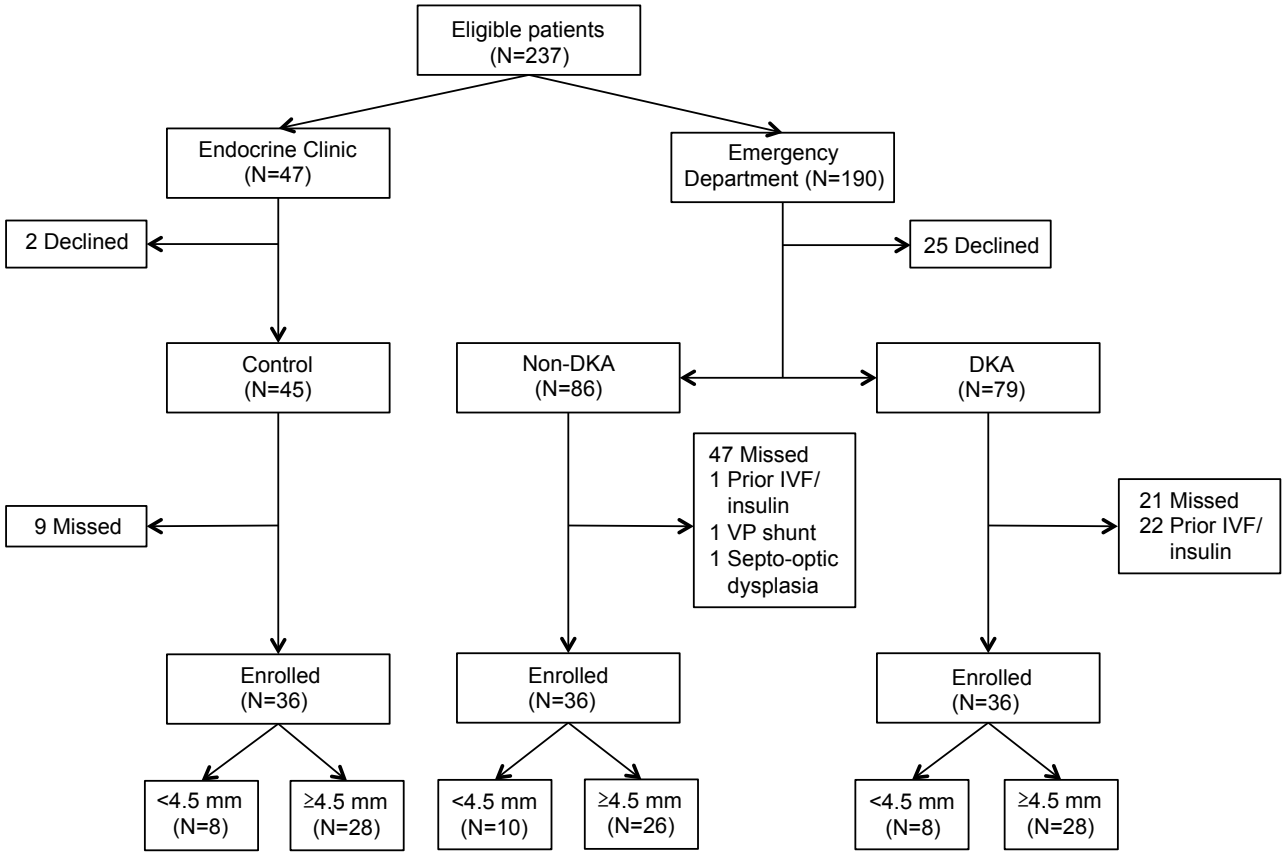

Figure 2. Study flow chart. ONSD measurements were obtained in a total of 108 patients, enrolled in the Endocrine Clinic (controls) or Emergency Department (DKA and non-DKA). Missed eligible patients and those meeting exclusion criteria were tracked throughout the study. A sonographic ONSD measurement ≥4.5 mm was considered enlarged.
DKA, diabetic ketoacidosis; *IVF*, intravenous fluid; *VP*, ventriculoperitoneal

Table 1. Demographic and clinical characteristics of study patients. Control patients were enrolled in the Endocrine Clinic, and DKA and non-DKA patients were enrolled in the emergency department.

Demographics	Control (n=36)	Non-DKA (n=36)	DKA (n=36)	p-value
Age, y	12.0 (9.5–15.0)	12.0 (10.0–14.5)	13.0 (11.5–14)	0.86
Gender, male	20 (56)	19 (53)	22 (61)	0.77
Race*				0.22
White	34 (94)	31 (86)	27 (75)	
African-American	2 (6)	3 (8)	6 (17)	
Ethnicity				0.36
Hispanic/Latino	1 (3)	0 (0)	2 (6)	
Non-Hispanic/Latino	35 (97)	36 (100)	34 (94)	
History of T1D§				0.81
New-onset	–	21 (58)	22 (61)	
≥1 year	23 (64)	13 (36)	13 (36)	
Past DKA events				0.38
0	30 (83)	27 (75)	25 (69)	
≥1	6 (17)	9 (25)	11 (31)	

Data reported as *n* (%) or median (IQR).
DKA, diabetic ketoacidosis; *T1D*, type 1 diabetes
*Two patients in the non-DKA group identified as Hawaiian or other Pacific Islander race, one with DKA identified as American Indian or Alaskan Native, and two with DKA identified as Asian.
§Well-controlled excluded; all patients in this group had known history of T1D.

Table 2. Emergency department evaluation.

Characteristics	Non-DKA (n=36)	DKA (n=36)	p-value
ED evaluation			
Length of symptoms, days	7 (1–10)	5 (1–14)	0.89
Transferred to ED	15 (42)	19 (53)	0.35
Prior IVF (<10 mL/kg)	0 (0)	5 (14)	–
IVF amount*			0.06
≤10 mL/kg	26 (72)	24 (67)	
10–20 mL/kg	4 (11)	1 (3)	
≥20 mL/kg	6 (17)	11 (31)	
Insulin in ED	11 (37)	17 (47)	0.15
% Dehydration§	6.0 (2.2–8.8)	8.7 (5.3–14.1)	0.01
Laboratory values			
Sodium	134 (133–136)	135 (132–139)	0.53
Potassium	4.0 (3.7–4.3)	4.4 (3.8–5.0)	0.18
pH	7.36 (7.34–7.39)	7.21 (7.07–7.28)	<0.001
HCO_3	24 (21–25)	11 (7–14)	<0.001
pCO_2	39 (34–45)	28 (23–31)	<0.001
BUN	15 (12–17)	16 (12–20)	0.20
Glucose	375 (286–529)	428 (358–620)	0.06
A1C†	12.5 (10.6–14.0)	13.9 (11.9–14.0)	0.11

Data reported as *n* (%) or median (IQR).
BUN, blood urea nitrogen; *DKA*, diabetic ketoacidosis; *ED*, emergency department; *HCO_3*, bicarbonate level; *IVF*, intravenous fluid.
*Includes amount of IVF received prior to transfer from another institution. All 5 patients who received IVF prior to transfer ultimately received ≥20 mL/kg of IVF.
§One patient in the non-DKA group and 3 in the DKA group did not have follow-up clinic weights to calculate estimated percent dehydration.
†Ten patients in the non-DKA group and 4 in the DKA group did not have hemoglobin A1C drawn in the ED. Our laboratory does not report hemoglobin A1C values >14. Patients with values listed as ">14.0" were considered to be 14 for analysis (T1D with hyperglycemia n=9; DKA n=17).

Table 3. Ocular point-of-care ultrasound evaluation.

Characteristic	Control (n=36)	Non-DKA (n=36)	DKA (n=36)	p-value
Time from IVF to US, min*§	–	49.0 (20.0–99.5)	74.5 (56.5–136)	0.02
Time to US, min*	–	108 (68–162)	122 (73–191)	0.45
ONSD, mm†	5.2 (0.8)	5.0 (0.9)	5.2 (0.9)	0.79
ONSD, mm*	5.1 (4.5–5.6)	5.0 (4.4–5.5)	5.1 (4.6–5.9)	

Data reported as median (IQR)* or mean (SD).†
§Five patients received IVF prior to ED arrival in the DKA group, and were excluded from analysis.
DKA, diabetic ketoacidosis; *IQR*, interquartile range; *IVF*, intravenous fluid; *ONSD*, optic nerve sheath diameter; *SD*, standard deviation; *US*, ultrasound.

institutional protocol. Patients with T1D with hyperglycemia had significantly lower median percent dehydration compared to those with DKA (p=0.01). Median sodium, potassium, glucose, blood urea nitrogen, and hemoglobin A1C were similar across groups. Patients with DKA had significantly lower pH, bicarbonate, and pCO_2. No patients were treated with sodium bicarbonate, mannitol, 3% saline, or steroids, and no patients had neuroimaging.

Available demographics and ED characteristics were largely similar among missed eligible compared to enrolled patients (Table 4). A higher proportion of missed eligible patients with DKA received insulin in the ED compared to enrolled DKA patients (p=0.03). The majority of eligible patients with well-controlled T1D were enrolled and

therefore not analyzed.

Seventy-nine (73%) ultrasound examinations were performed by the pediatric emergency medicine fellow and 29 (27%) by the pediatric endocrinologist. Time to ultrasound measurement was similar between groups, although time from IV fluid administration to ultrasound was significantly different between groups (p=0.02; Table 3). The between group difference in mean ONSD (mm) was not significant (p=0.79). Sensitivity analysis using only images acquired by the pediatric endocrinologist showed similar ONSD results among well-controlled T1D (median 5.5, IQR [5.0–6.0]), T1D with hyperglycemia (median 5.4, IQR [4.8–6.2]), and DKA (median 4.8, IQR [4.5–5.9]). There was no difference in the between group mean ONSD when including only patients with severe DKA (n=10, median 6.1, IQR [4.6–6.4]) (p=0.39). There was no difference in mean ONSD when including only T1D with hyperglycemia (n=9, median 4.95, IQR [4.3–5.4]) and DKA (n=9, median 5.20, IQR [4.75–5.83]) patients with symptoms ≤24 hours (p=0.45).

No variables in our regression model were significantly associated with mean ONSD. Four patients (5.5%) did not have a blood urea nitrogen level drawn, and four (5.5%) patients did not have follow-up clinic weights within one month of discharge to calculate estimated percent dehydration. No variables were significantly associated with mean ONSD after imputation using the minimum and maximum values in place of missing variables.

Nine (8.3%) patients had two independent ultrasound examinations performed by the separate study sonographer for internal reliability. The raw agreement between sonographers was 88.9% and the intraclass correlation coefficient was 0.71.

DISCUSSION

In our study population, ONSD measurements did not vary significantly based on T1D-related illness severity and were not independently associated with presenting laboratory parameters, known DKA-CE risk factors, or time to ultrasound.

Early identification of those at risk for DKA-CE continues to be a challenge despite multiple known risk factors[1,24,25] Recent investigation suggests that impaired cerebral autoregulation may lead to vasogenic edema formation.[4,5,26-28] This has also been supported by measurement of middle cerebral artery flow velocity via transcranial doppler ultrasonography.[29,30] However, ultrasound measurement of middle cerebral artery flow is difficult to reliably reproduce.[31] Hansen et al. recently investigated ONSD measurements among children with DKA, but their evaluation was limited to only seven patients.[32]

ONSD measurement is a rapid and non-invasive imaging technique that has been used to detect increased ICP in a number of clinical conditions.[8,10-16,23,33-39] Sensitivity and specificity have ranged from 83–100% and 84–100% using direct measurement of cerebrospinal fluid pressure or CT as a gold standard reference,[15,16,33,34,36,37,39] but have been reported to be as low as 75% and 44%, respectively.[35] In a recent meta-analysis of 12 studies including 478 adults and children, sensitivity and specificity for detecting CT findings associated with increased ICP were 95.6% and 92.3%, respectively.[40] The pooled OR was 319.3 (95% CI [79–1290]). These findings suggest that measurement of the ONSD accurately identifies elevated ICP.

Investigation using pediatric ophthalmologist or radiologist-performed sonography has shown a significant difference in mean ONSD among children with elevated ICP compared to controls or an asymptomatic baseline measurement.[9,10,12,13] However, pediatric emergency physician-performed ultrasound studies have shown sensitivities and specificities ranging from 61–83% and 22–38%, respectively, when compared to CT or direct cerebrospinal fluid pressure measurement.[8,38] These studies included children with various etiologies of symptoms, many of whom had ventriculoperitoneal shunt malfunction and obstructive hydrocephalus, which may lead to impaired cerebrospinal fluid circulation and therefore an underestimate of ICP by ONSD measurement and decreased test sensitivity.[41] Moreover, previous research in children with shunt malfunction has indicated that increased ICP may be present without papilledema,[42,43] which appears sonographically as an increased ONSD with optic disc cupping.

We were able to demonstrate good interrater reliability between sonographers after completion of a structured emergency ultrasound course with further refinement of skills in two separate scanning sessions. This is similar to previous data reported by Le et al, who demonstrated good interrater agreement of ONSD measurements obtained by pediatric emergency medicine fellow/attending compared to a pediatric ophthalmologist (κ=0.64) and ophthalmic sonographer (κ=0.52).[8] Good to excellent agreement has also been demonstrated among adult emergency medicine resident/attending compared to CT (intraclass correlation coefficient 0.9; 95% CI [0.88–0.93]),[44] and in studies using MRI[45] and postmortem specimens.[21]

In our study, the ONSD was measured in an axial plane along the visual axis, which is considered standard technique.[19,20] However, alternative imaging techniques exist. The most common is the coronal approach, which can be performed over the superior lid or infraorbitally, and involves placing the probe along the lateral orbit directed medially.[46,47] The visual axis technique has shown similar ONSD measurements when compared to the infraorbital coronal approach.[46] Conversely, Blehar et al found that ONSD measurements were significantly larger when measured by the visual axis compared to coronal technique, although these findings were limited to a sample of only 27 patients.[47] It has been speculated that the visual axis technique may lead to larger ONSD measurements due to potential shadowing along the optic nerve sheath and therefore producing a larger diameter,[47,48] although this has not been studied in children.

Additionally, some suggest performing measurements in at least two planes, such as axial and sagittal, to fully characterize pathologic findings.[19,20] The use of single vs. bi-plane imaging for ONSD measurement has not been studied and was therefore not employed in our investigation.

While we found no difference in ONSD measurements between groups, all groups displayed mean measurements above the upper limit of normal for age. It may be that children with T1D have a fundamentally different baseline ONSD, although this has not been systematically evaluated. Our findings may also be explained by our measurement of the ONSD via the axial plane along the visual axis, or by assessment at one point in time rather than obtaining serial measurements during the course of treatment. Previous investigation among adults undergoing intrathecal infusion testing showed that the average cerebrospinal fluid pressure threshold to produce ONSD dilation was 22 mmHg (range 15–30 mmHg), and that ONSD measurements were directly correlated with cerebrospinal fluid pressure above an individual patient's threshold until a "saturation" point was reached when no further dilation occurred.[14] These findings suggest that changes in ICP may go undetected by ONSD measurement when ICP is low or normal, and that serial ultrasound measurements may be more useful than single scans once ICP has become elevated above an individual patient's threshold. This is also supported by previous investigation showing that 20–40% of patients with clinically overt DKA-CE have no signs of edema on initial cranial CT, with subsequent CTs often showing edema and/or hemorrhage.[7,49] Hansen et al recently studied seven children with DKA at various time points and noted that, although no significant difference in effect size, three out of seven patients developed ONSD measurements changes ≥0.3 mm during treatment.[32] Although we did not compare ONSD values to direct measures of ICP in our study, cerebrospinal fluid pressure may not have been high enough at our data collection point to produce significant ONSD changes reflective of subclinical DKA-CE.

Several aspects of our study are worth further mention. While previous research suggested that IV fluid replacement may precipitate DKA-CE,[50,51] recent investigation has shown that the rate and volume of IV fluid may not substantially contribute.[24,26,52] In our study, both treatment groups received ≤10 mL/kg of IV fluid prior to transfer, with no difference in total IV fluid amount received. Although time from IV fluid administration to ultrasound was significantly different between groups, we believe this likely reflects the difficulties in obtaining IV access in severely ill children, which is supported by our finding that percent dehydration was higher among those with DKA. Moreover, ONSD values were not affected by IV fluid amount, time from IV fluid administration to ultrasound, length of symptoms, or other known DKA-CE risk factors in our regression model. It should be noted, however, that our study was powered for our primary outcome to detect a difference in mean ONSD rather than multiple regression. A post-hoc power analysis of our regression model, with nine predictor variables and an observed R^2 of 0.39, demonstrated an observed power of 0.63.

There was a higher proportion of African-American patients with DKA in our sample compared to White or Hispanic patients. Although this difference was not statistically significant, this may represent a clinically significant difference and is in keeping with recent literature showing that African-American children with T1D experience poorer glycemic control and more episodes of DKA compared to White or Hispanic children.[53] Finally, although DKA-CE is more common in younger children,[1,54] we excluded patients <7 years for assent purposes.[55]

LIMITATIONS

Point-of-care ultrasound requires training and is operator dependent, which may limit generalizability. We did not assess for the presence of secondary signs that may indicate elevated ICP, such as optic disc elevation, or the "crescent" or "doughnut" sign,[19,56] and we did not perform analysis of accumulated ultrasonography experience given the number of patients. However, measurement of the ONSD, as was performed in this study, is considered standard for evaluation of elevated ICP. We enrolled a convenience sample of patients due to the limitations of sonographer availability, which resulted in a number of missed eligible subjects. Nonetheless, missed eligible patients were largely similar to those enrolled, making this unlikely to have affected our results (Table 4). Study sonographers enrolled patients prior to examinations and were therefore not blinded to clinical status. Our study would have benefited from comparison of ONSD measurements to measures of ICP, such as opening pressure or the apparent diffusion coefficient via MRI. However, such evaluation was beyond the scope of our pilot investigation.

We were unable to enroll any patients with clinically overt DKA in our convenience sample, although one patient had a GCS of 14. In addition, excluding patients who received >10 mL/kg of IV fluid or insulin prior to transfer may have resulted in exclusion of patients likely to develop DKA-CE. However, the point at which progression to subclinical or clinically overt disease occurs, and the minimum duration of preceding symptoms has not been delineated.[7] Therefore, the aim of this pilot investigation was to assess how the ONSD changed during episodes of DKA, particularly among patients without obvious neurologic symptoms, and therefore inform larger studies that may evaluate patients with known subclinical or clinically overt disease. For these reasons, we designed our study with more rigorous inclusion/exclusion criteria. Although accounting for more acute symptoms prior to presentation may have allowed us to distinguish patients at higher risk of DKA-CE, as neurologic symptoms often develop precipitously,[2,24] sensitivity analysis among patients with symptoms ≤24 hours showed no difference in ONSD.

Table 4. Missed eligible compared to enrolled patients.

	Missed eligible		p-value	
Characteristics	Non-DKA (n=47)	DKA (n=21)	Enrolled vs missed non-DKA	Enrolled vs missed DKA
Demographics				
Age, y	13 (9–16)	11 (9–15)	0.65	0.42
Gender, male	18 (38)	8 (38)	0.19	0.09
History of T1D			0.22	0.32
New-onset	21 (45)	10 (48)		
≥1 year	26 (55)	11 (52)		
Past DKA events			0.49	0.56
0	32 (68)	13 (62)		
≥1	15 (32)	8 (38)		
ED evaluation				
IVF amount			0.34	0.23
≤10 mL/kg	27 (58)	12 (57)		
10–20 mL/kg	10 (21)	3 (14)		
≥20 mL/kg	10 (21)	6 (29)		
Insulin in ED	14 (30)	16 (76)	0.94	0.03
% Dehydration*	3.2 (0.3–7.3)	9.1 (4.3–12.6)	0.12	0.77
Laboratory values				
Sodium	134 (131–136)	134 (132–138)	0.37	0.85
Potassium	4.1 (3.8–4.4)	4.5 (4.1–5.0)	0.25	0.34
pH	7.38 (7.36–7.41)	7.20 (7.10–7.29)	0.13	0.47
HCO_3	23 (21–24)	9 (7–15)	0.26	0.77
pCO_2	38 (36–42)	27 (23–36)	0.77	0.80
BUN	14 (11–17)	17 (12–20)	0.56	0.83
Glucose	363 (255–494)	492 (384–669)	0.72	0.23
A1C§	11.2 (9.5–14.0)	13.9 (11.3–14.0)	0.39	0.63

Data reported as *n* (%) or median (IQR).
BUN, blood urea nitrogen; *DKA*, diabetic ketoacidosis; *ED*, emergency department; *HCO_3*, bicarbonate level; *IVF*, intravenous fluid; *T1D*, type 1 diabetes.
*Five patients in the missed non-DKA group and 3 in the missed DKA group did not have follow-up clinic weights to calculate estimated percent dehydration.
§Eleven patients in the missed non-DKA group and 3 patients in the missed DKA group did not have hemoglobin A1C levels drawn in the ED.

Although no previous studies have evaluated the influence of insulin or IV fluid on ONSD measurement, it is unclear if these therapies significantly alter cerebrospinal fluid volume or pressure, and therefore the ONSD, during treatment of DKA. This is unlikely to have substantially affected our results given that the proportion of patients receiving insulin, total amount of IV fluid received, and time to ultrasound were similar between groups. A significantly higher proportion of missed eligible DKA patients received insulin in the ED, which suggests that we may have enrolled less ill patients in our study. Yet, this is unlikely given that missed eligible DKA patients had similar pH, bicarbonate, glucose, blood urea nitrogen, and percent dehydration compared to enrolled patients.

Our study highlights several key issues for future research efforts. First, multi-center investigation will be required to capture patients with DKA-CE, as this is a rare event. Second, investigators should aim to compare ONSD measurements to gold standard techniques when feasible. Obtaining elective lumbar puncture for opening pressure measurement in acutely ill children, as well as the time delay from ultrasound measurement to MRI, will pose unique challenges. Third, investigators should examine how the ONSD changes with time during DKA. This is particularly important to explore the relationship between the ONSD and rehydration. Serial measurements of the ONSD during treatment of DKA will be needed, and determining the effect size of specific treatments

will likely require a larger sample. Finally, our finding that mean ONSD measurements are above the upper limit of normal in children with T1D should be validated in larger studies and involve a comparison of the coronal and axial imaging techniques.

CONCLUSION

In our study population, mean ONSD measurement did not vary significantly based on T1D-related illness severity and was not associated with DKA-CE risk factors in our regression model. Our findings suggest that the progression to subclinical disease and continuum of DKA-CE development may not be sufficiently discriminated by this technique. Our results may inform further studies designed to capture patients with mild neurologic injury who are more likely to develop subclinical DKA-CE, and those with clinically overt disease. Other areas for future investigation include assessment of serial measurements of the ONSD during rehydration and correction of acidosis using a paired analysis, and serial evaluation of the ONSD during the peak onset of DKA-CE (4–12 hours into therapy). Multi-center efforts will likely be needed to capture patients with subclinical or clinically overt DKA-CE.

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Resuscitation Prior to Emergency Endotracheal Intubation: Results of a National Survey

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Introduction: Respiratory failure is a common problem in emergency medicine (EM) and critical care medicine (CCM). However, little is known about the resuscitation of critically ill patients prior to emergency endotracheal intubation (EETI). Our aim was to describe the resuscitation practices of EM and CCM physicians prior to EETI.

Methods: A cross-sectional survey was developed and tested for content validity and retest reliability by members of the Canadian Critical Care Trials Group. The questionnaire was distributed to all EM and CCM physician members of three national organizations. Using three clinical scenarios (trauma, pneumonia, congestive heart failure), we assessed physician preferences for use and types of fluid and vasopressor medication in pre-EETI resuscitation of critically ill patients.

Results: In total, 1,758 physicians were surveyed (response rate 50.2%, 882/1,758). Overall, physicians would perform pre-EETI resuscitation using either fluids or vasopressors in 54% (1,193/2,203) of cases. Most physicians would "always/often" administer intravenous fluid pre-EETI in the three clinical scenarios (81%, 1,484/1,830). Crystalloids were the most common fluid physicians would "always/often" administer in congestive heart failure (EM 43%; CCM 44%), pneumonia (EM 97%; CCM 95%) and trauma (EM 96%; CCM 96%). Pre-EETI resuscitation using vasopressors was uncommon (4.9%). Training in CCM was associated with performing pre-EETI resuscitation (odds ratio, 2.20; 95% CI, [1.44-3.36], p<0.001).

Conclusion: Pre-EETI resuscitation is common among Canadian EM and CCM physicians. Most physicians use crystalloids pre-EETI as a resuscitation fluid, while few would give vasopressors. Physicians with CCM training were more likely to perform pre-EETI resuscitation. [West J Emerg Med. 2016;17(5)542-548.]

INTRODUCTION

Resuscitation of critically ill patients often commences with emergency endotracheal intubation (EETI) and the institution of mechanical ventilation, which is commonly performed by emergency medicine (EM) and critical care medicine (CCM) physicians.[1] Unfortunately, adverse events related to EETI, such as failed intubation, hypoxemia, and post-intubation hypotension, occur at an increased rate compared to elective endotracheal intubations.[2,3] Hemodynamic instability in the peri-intubation phase can result from a variety of factors such as loss of sympathetic drive with medications, positive pressure ventilation, diverse adverse effects of medications, skill level of the intubator, availability of resources, and the patient's physiology, illness and comorbidities.[4,5] Patient optimization prior to EETI may be important to ensure hemodynamic stability and adequate oxygen delivery in an attempt to minimize further deterioration during the physiologic challenge of EETI, including post-intubation hypotension and hypoxemia, which are associated with increased morbidity and mortality.[3,4,6]

Pre-EETI patient resuscitation to optimize hemodynamics commonly involves the use of intravenous (IV) fluids and vasopressor medications; however, there are no standards of care guiding these practices. Most EETI studies have focused on the intubation and post-intubation phases of care.[7,8] Although there is a substantial body of literature regarding pre-oxygenation prior to EETI,[9-11] few publications have addressed the use of fluid and vasopressors for pre-EETI resuscitation. There is some evidence to suggest that pre-EETI fluid administration and vasopressor use reduces the incidence of life-threatening complications associated with intubation in intensive care unit (ICU) patients.[12] More information is needed on strategies used by physicians to optimize hemodynamics during EETI; this information will be useful in planning future research studies to investigate the effects of pre-EETI strategies on patient outcomes.

The objective of this study was to better understand the practices used by Canadian EM and CCM physicians to optimize hemodynamics in critically ill patients undergoing EETI. Specifically, we sought to evaluate whether physicians use resuscitation fluids and vasopressor medications pre-EETI, and to identify physician characteristics associated with performing pre-EETI resuscitation.

METHODS

To determine the resuscitation practices of physicians prior to EETI, we developed a clinical scenario-based cross-sectional survey using SelectSurvey (www.selectsurvey.net) and distributed it to Canadian EM and CCM physicians. Face and content validity for the survey was ensured through an iterative process among the authors and the Canadian Critical Care Trials Group (CCCTG). Agreement by all members was required for the final survey version. Information on physician characteristics was collected through the survey including their primary specialty, number of years in practice (post-residency time only), academic affiliation (academic or community hospital), and whether they had completed a fellowship in CCM. The survey was comprised of three clinical scenarios (congestive heart failure [CHF], pneumonia, and trauma). The scenarios and complete survey are available in the Supplementary Materials. Clinicians were asked to answer questions using a five-point Likert scale (always, often, sometimes, rarely, never) based on "what they would do if they were managing the scenario in their usual place of work" to allow for potential variation in respondent practice, support, and resources. The Institutional Research Ethics Board approved this study.

We used a combined web-based and postal survey strategy. The questionnaire was distributed via email (with an electronic link to SelectSurvey) and mailed (along with a pre-stamped envelope) to all EM and CCM physician members of the Canadian Association of Emergency Physicians (CAEP), the Canadian Critical Care Society (CCCS) and the CCCTG. Membership lists were combined and any duplicate names, physical addresses, or email addresses were identified and removed. The survey was administered in both English and French. After the initial email distribution, physicians who did not return their survey were sent an additional email survey four weeks after the first mailing. This process was repeated, and non-responders from this third email were then mailed a paper copy of the survey to return by post. Controls were put in place that allowed each physician to only complete the survey one time, and respondent anonymity was assured by coordination of survey distribution by a blinded administrative support person. Study participation was voluntary and completion of any part of the survey implied consent to participate.

The study definition of pre-EETI was determined through consensus among members of the research team and experts in EM and CCM. A respondent was defined as practicing pre-EETI resuscitation if they met either of the following two criteria: a) they answered "always" or "often" to whether they would give the patient IV fluid during the pre-EETI phase and, depending on the type, also gave a specific amount "always" or "often" (crystalloids, > 1000mL; 5% albumin, > 500mL; 25% albumin, any volume; packed red blood cells, any volume; synthetic colloids, > 500mL); or b) they "always" or "often" would give a vasopressor in the pre-EETI phase, and if they did, would administer it via a peripheral venous catheter (i.e., would not delay resuscitation while a central venous catheter was inserted). Internet-based survey responses (via the electronic survey tool) were used to populate the database directly as per design. Paper mail survey responses were manually entered into the electronic database. The accuracy of survey data quality control was assured by performing a double check of 10% of the paper survey responses. We used data from completed survey questions; questions without a response were not included in the analysis.

We collected data on physician characteristics (primary specialty, number of years in practice, clinical workload, and academic affiliation) as well as their stated pre-EETI practices (intravascular solutions, vasopressor medications, and methods for obtaining vascular access).

Respondents were grouped by specialty as either an EM or a CCM physician. The EM group included the specialties EM (FRCPC [Fellow of the Royal College of Physicians of Canada]), EM (CCFP-EM [Canadian College of Family Physicians – EM certificate]), EM (CCFP or other), and family medicine; the CCM group was limited to intensivists and included physicians from the specialties of internal medicine, anesthesia, surgery, as well as any physician who had completed a CCM fellowship. We described physician characteristics and self-reported pre-EETI practices using proportions. Reported monitoring parameters and resuscitation end-points were graphically represented as diverging stacked bar charts using a compressed five-point Likert scale (always/often, sometimes, and rarely/never). We used multivariable logistic regression to model the association between predictor variables of physician characteristics (primary specialty [reference: internal medicine], years of practice [reference: < 1 year], CCM fellowship [reference: no CCM fellowship]) and dichotomous outcome variables (practicing pre-EETI resuscitation). Associations that were identified through the multivariable analyses were expressed as odds ratios (ORs) and 95% confidence intervals (CIs). For all statistical tests, a p-value of < 0.05 was considered to be significant. We performed all analyses using IBM SPSS Statistics Version 21 and R (version 3.1.0, Spring Dance) in the RStudio GUI (version 0.98.932).[13]

RESULTS

Characteristics of Respondents

The response rate to the survey was 50.2% (882/1758). A quality check of responses from 10% of paper surveys found data in the database to be 99.8% accurate. Table 1 shows characteristics of respondents and includes brief descriptions of physician specialties. When asked about their primary specialty, 72% (634/882) of respondents provided information; 73% (463/634) were grouped as EM physicians and 27% (171/634) were grouped as CCM physicians. Among physicians who indicated their level of experience and affiliation, the majority (61%, 403/662) had at least 10 years in practice, with 27% (180/662) reporting over 20 years of experience, and most (79%, 521/661) worked in an academic institution. Twenty-six percent (26%, 171/657) of physicians reported they had completed a CCM fellowship.

Pre-EETI Resuscitation

Applying the definition of pre-EETI resuscitation developed by the research team, we assessed how many physicians would perform resuscitation prior to EETI in each of the clinical scenarios. Based on their responses, physicians would commonly perform pre-EETI resuscitation in the pneumonia (61%, 508/834) and trauma (83%, 561/675) scenarios, but not in the CHF scenario (18%, 124/694). Of respondents who would perform pre-EETI resuscitation, physicians preferred to administer fluids in the pneumonia (fluids 93%, 472/508; vasopressors 7%, 36/508) and trauma (fluids 98%, 550/561; vasopressors 2%, 11/561) scenarios. In contrast, pre-EETI resuscitation using vasopressors was more common in the CHF scenario (fluids 15%, 19/124; vasopressors 85%, 105/124). Overall, physicians would perform pre-EETI resuscitation using either fluids or vasopressors in 54% (1193/2203) of cases. Physicians chose to administer both fluids and vasopressors as part of their pre-EETI resuscitation strategy in 12% (138/1193) of cases.

Fluid Resuscitation Prior to EETI

The vast majority of EM and CCM physicians indicated they would "always/often" administer fluid pre-EETI in the

Table 1. Physician characteristics in study to determine resuscitation practices of physicians prior to emergency endotracheal intubation.

Characteristic	No. (%)
Specialty (n=634)	
EM (CCFP-EM)	275 (43)
EM (FRCPC)	126 (20)
Internal medicine	96 (15)
Anesthesia	57 (9)
EM (CCFP or other)	42 (7)
Family medicine	20 (3)
Surgery	18 (3)
CCM fellowship (n=657)	
No	486 (74)
Yes	171 (26)
Number of years in practice, y (n=662)	
11-20	223 (34)
> 20	180 (27)
6-10	149 (23)
1-5	101 (15)
< 1	9 (1)
Type of practice (n=661)	
Academic	519 (78)
Community	140 (21)
Both	2 (<1)
Currently performing EETI (n=657)	
Yes	651 (99)
No	6 (1)

EM, emergency medicine; *CCFP,* Canadian College of Family Physicians; *FRCPC,* Fellow of the Royal College of Physicians Canada; *CCM,* critical care medicine; *EETI*, emergency endotracheal intubation.
Values are in n (%).

pneumonia (EM 98%, 442/451; CCM 96%, 161/168) and trauma (EM 98%, 451/460; CCM 99%, 168/169) scenarios. In the CHF scenario, 45% (191/428) of EM physicians and 46% (71/154) of CCM physicians would "always/often" give fluid pre-EETI. Overall, physicians reported they would "always/often" administer an IV fluid prior to EETI in 81% (1484/1830) of cases.

Preferences of physicians for administering IV fluid prior to EETI are shown in Figure 1. Among IV fluids, a crystalloid fluid (0.9% saline/Lactated Ringer's) was most frequently selected by physicians as their preference for use ("always/often") prior to EETI in the CHF (EM 43%, 191/448; CCM 44%, 71/161) pneumonia (EM 97%, 440/452; CCM 95%, 160/168) and trauma (EM 96%, 444/461; CCM 96%, 161/167) scenarios. When asked the approximate volume of IV fluid they normally would administer prior to EETI (based on their preferred type of IV fluid), the amount selected most frequently ("always/often") was 500-999ml in the pneumonia scenario (53%, 404/760), 1500-1999ml in the trauma scenario (51%, 317/620), and zero fluid (i.e., they would not use any IV fluid) in the CHF scenario (42%, 272/649).

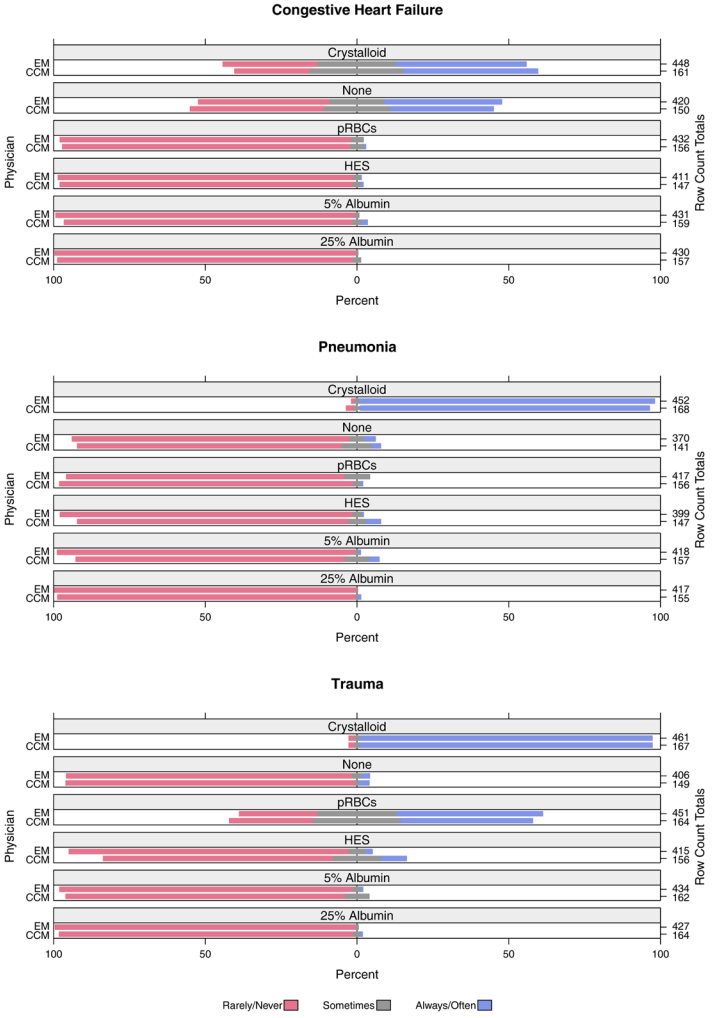

Figure 1. Class of intravenous fluid that emergency medicine (EM) and critical care medicine (CCM) physicians would administer prior to emergency endotracheal intubation in each clinical scenario.
pRBCs, packed red blood cells; *HES*, hydroxyethyl starch.

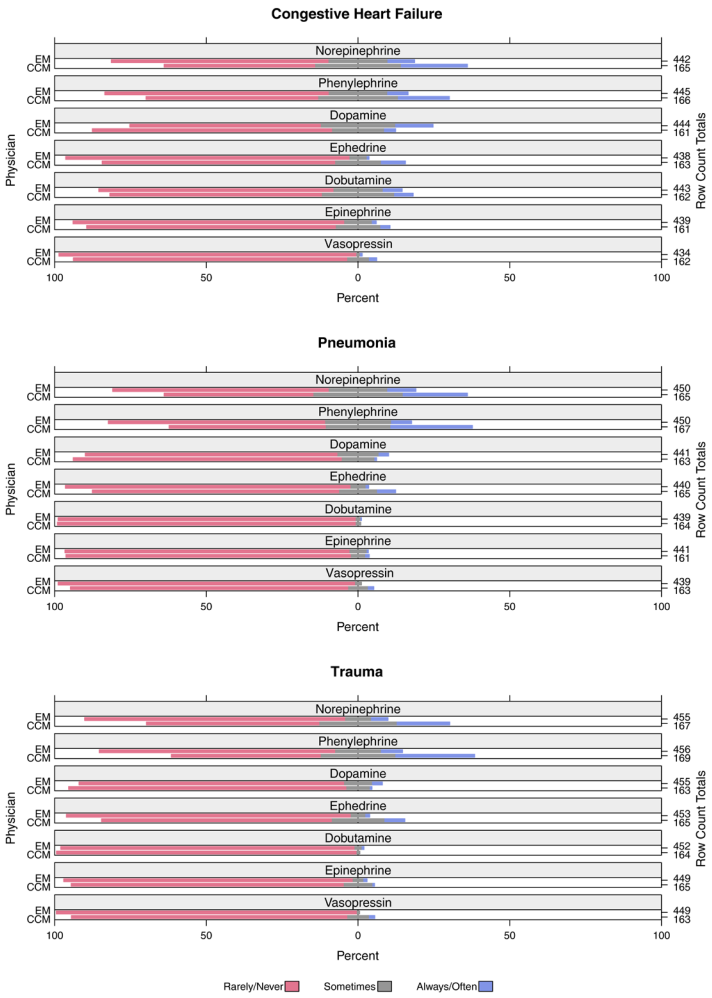

Figure 2. Type of vasopressor that emergency medicine (EM) and critical care medicine (CCM) physicians would normally administer prior to emergency endotracheal intubation (either as a bolus or infusion) in each clinical scenario.

Pre-EETI Use of Vasopressors

Figure 2 shows physician preferences for how often they would administer various vasopressor medications prior to EETI, assuming the patient in each scenario had no central venous access. Overall, a minority of physicians indicated they would "always/often" use any vasopressors pre-EETI (4.9%, 630/12798). The vasopressors selected most frequently by EM physicians as the ones they would "always/often" administer were dopamine in the CHF scenario (12%, 55/444), norepinephrine in the pneumonia scenario (9%, 42/450), and phenylephrine in the trauma scenario (7%, 32/456). In comparison, the vasopressors CCM physicians indicated they would use "always/often" prior to EETI were phenylephrine

in the pneumonia (27%, 45/167) and trauma (26%, 44/169) scenarios, and norepinephrine in the CHF scenario (22%, 36/165). When assessed by physician specialty, CCM physicians were more likely to "always/often" administer a vasopressor prior to EETI (OR, 2.23; 95% CI, [1.91-2.61], p<0.001) compared to EM physicians.

Vascular Access

In order to establish vascular access for pre-EETI resuscitation, most physicians indicated they would "always/often" use a single peripheral IV in the CHF (EM 75%, 330/440; CCM 73%, 121/166) and pneumonia (EM 77%, 336/435; CCM 75%, 125/167) scenarios. In the trauma scenario, multiple peripheral IVs were chosen most frequently as the method physicians would "always/often" use for obtaining vascular access (EM 95%, 439/463; CCM 90%, 151/168). Overall, most physicians responded they would "rarely/never" insert an arterial catheter (mean 81%, range 79% to 83%) and "rarely/never" insert a central venous catheter (mean 63%, range 54% to 67%).

Factors Associated with Pre-EETI Resuscitation

A multivariate logistic regression model was fitted to evaluate for association between physician characteristics and whether they would perform resuscitation prior to EETI (Table 2). Physicians who had completed a CCM fellowship were more likely to perform pre-EETI resuscitation (OR, 2.20; 95% CI, [1.44-3.36], p<0.001) compared to physicians without a CCM fellowship. Using physicians with internal medicine specialization as a reference standard, we found that only EM (CCFP-EM or other) training was associated with increased likelihood of providing pre-EETI resuscitation (OR, 1.64; 95% CI, [1.02-2.66], p=0.043) among the specialties of physicians included in the study. There was no association between performing pre-EETI resuscitation and number of years in practice. In comparison with the pneumonia scenario, physicians were significantly more likely to perform pre-EETI resuscitation in the trauma scenario (OR, 1.35; 95% CI, [1.09-1.67], p=0.006) and less likely to practice pre-EETI resuscitation in the CHF scenario (OR, 0.09; 95% CI, [0.07-0.11], p<0.001).

Table 2. Factors associated with pre-emergency endotracheal intubation resuscitation.

Variable	Adjusted OR (95% CI)	p-value
Specialty (ref: Internal medicine)		
EM (FRCPC)	1.43 (0.87, 2.33)	0.15
Anesthesia	1.22 (0.77, 1.94)	0.39
EM (CCFP-EM or other)	1.64 (1.02, 2.66)	0.043
Family medicine	1.57 (0.89, 2.76)	0.12
Surgery	0.67 (0.34, 1.34)	0.26
Unknown	0.65 (0.36, 1.15)	0.14
CCM fellowship	2.20 (1.44, 3.36)	<0.001
Years in Practice (ref: < 1 year)		
1-5 years	2.02 (0.80, 5.11)	0.13
6-10 years	1.40 (0.57, 3.49)	0.46
11-20 years	1.24 (0.50, 3.06)	0.64
>20 years	1.11 (0.45, 2.74)	0.83
Unknown	0.43 (0.15, 1.27)	0.13
Scenario (ref: Pneumonia)		
CHF	0.09 (0.07, 0.11)	<0.001
Trauma	1.35 (1.09, 1.67)	0.006

OR, odds ratio; *FRCPC,* Fellow of the Royal College of Physicians Canada; *CCFP,* Canadian College of Family Physicians; *EM,* emergency medicine; *CCM,* critical care medicine; *CHF,* congestive heart failure.
Multivariate analysis was adjusted for physician specialty, fellowship in critical care medicine, and number of years in practice.

DISCUSSION

In this pan-Canadian survey of EM and CCM physician practices for optimization of hemodynamics in critically ill patients undergoing EETI, we observed both common practices and practice variability. Using our definition of pre-EETI resuscitation, we found most physicians would perform pre-EETI resuscitation in the scenarios of pneumonia and trauma, but not in CHF. Physicians who would perform pre-EETI resuscitation preferred to use fluids in the pneumonia and trauma scenarios, and vasopressor medications in the CHF scenario. Overall, 81% of physicians indicated they would resuscitate with some amount of IV fluid pre-EETI to optimize patient hemodynamics. Most physicians would administer crystalloid solutions in preparation for EETI, while relatively few would administer a vasopressor medication. The findings of this investigation suggest pre-EETI resuscitation practices vary with patient condition and physician specialty.

Few studies have examined the use of fluids and vasopressors for resuscitation prior to EETI. In a prospective multicenter study of critical care patients, Jaber and colleagues evaluated the implementation of an intubation management protocol that included pre-intubation fluid loading and vasopressor use; they reported significant decreases in both life-threatening (21% vs. 34%, p=0.03) and other complications (9% vs. 21%, p=0.01) in comparison with standard care.[12] Perbet and colleagues examined the effect of pre-intubation fluid loading as part of a multicenter observational study of risk factors for severe cardiovascular collapse (CVC) after EETI in ICU patients and found it was not significantly associated with the occurrence of CVC.[9] There is also evidence that implementation of an airway management training program for pulmonary and critical care medicine fellows with emphasis on pre-intubation optimization of hemodynamics, oxygenation, and team/

equipment preparation improves the first-attempt success rate for ICU intubations and reduces the rate of complications.[14] While these studies suggest pre-intubation resuscitation is associated with improved outcomes following EETI, more research is required to elucidate the effects of pre-EETI practices on patient outcomes.

Our findings suggest that the majority of Canadian EM and CCM physicians would resuscitate critically ill patients using crystalloid fluids prior to EETI, yet few physicians would administer vasopressor medications pre-EETI. These results are comparable to an Australian survey of preferences for fluid resuscitation in major trauma patients which found that 85% (56/66) of critical care registrars chose to use crystalloids as a primary resuscitation fluid; however, this study did not specifically investigate resuscitation practices prior to intubation.[15] Although some studies have surveyed the airway management practices of physicians,[16-25] these have primarily focused on intubation devices, techniques, and medications. Four of these studies examined the practice of rapid sequence intubation in the United Kingdom, the United States, and Canada,[17, 23-25] and evaluated whether residents and attending physicians would pre-oxygenate patients before anesthesia induction; these surveys found nearly all respondents (98%-100%) would administer oxygen before induction. None of these studies examined whether physicians or trainees would perform pre-intubation resuscitation using fluids or vasopressors. Our study provides needed information on the pre-EETI resuscitation practices used by physicians to optimize patient hemodynamics.

LIMITATIONS

The 49.8% survey non-response rate is an important limitation of this study, since non-response bias may affect the validity of our findings. Most of the survey respondents practiced in academic settings; this may bias the results and limit their generalizability to physicians practicing in non-academic settings. Study participants were identified using the mailing lists of CAEP, the CCCS, and the CCCTG. Although these organizations do not represent all EM and CCM physicians in Canada, they were the most comprehensive national listings of EM and CCM physicians that were available to the study team. As with other surveys of physician practices, our results are based on self-reporting rather than documentation or observation, which could introduce information bias and a recall bias. We attempted to minimize bias by instructing physicians to respond based on what they would do if they were managing a patient in their usual place of work.

Another important limitation is that the definition of pre-EETI resuscitation used in this study has not been published previously. To the best of our knowledge, an established definition of pre-EETI resuscitation does not exist. The definition used in this study was developed by the study authors and experts in EM and CCM in an attempt to summarize the available data in a meaningful way. Although we believe our definition reflects common clinical practice, it may not be reflective of all resuscitation practices performed by physicians to optimize patients for EETI. Furthermore, the clinical scenarios developed for this study did not include any description of the volume status of the patients. As conditions such as pulmonary edema and jugular venous distention are likely to impact the strategies used by physicians to treat critically ill patients, the inclusion of information regarding volume status in the scenarios would have strengthened this study. Finally, while we assessed for the association between physician-related factors and performing pre-intubation resuscitation, it is possible we did not consider all potential factors that may contribute to variation in pre-EETI resuscitation practices.

CONCLUSION

In summary, this study addresses an important phase in the resuscitation of critically ill patients that has not received due attention. The results of this scenario-based survey show that pre-EETI resuscitation using either fluids or vasopressors was provided by physicians in over half (54%) of cases, while both fluids and vasopressors were provided in only 12% of cases. Pre-EETI resuscitation strategies varied with patient condition and physician specialty. Respondents indicated that a crystalloid solution would be administered in many cases prior to EETI, as opposed to vasopressor medications, which were selected in a minority of cases.

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Leadership and Teamwork in Trauma and Resuscitation

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Introduction: Leadership skills are described by the American College of Surgeons' Advanced Trauma Life Support (ATLS) course as necessary to provide care for patients during resuscitations. However, leadership is a complex concept, and the tools used to assess the quality of leadership are poorly described, inadequately validated, and infrequently used. Despite its importance, dedicated leadership education is rarely part of physician training programs. The goals of this investigation were the following: 1. Describe how leadership and leadership style affect patient care; 2. Describe how effective leadership is measured; and 3. Describe how to train future physician leaders.

Methods: We searched the PubMed database using the keywords "leadership" and then either "trauma" or "resuscitation" as title search terms, and an expert in emergency medicine and trauma then identified prospective observational and randomized controlled studies measuring leadership and teamwork quality. Study results were categorized as follows: 1) how leadership affects patient care; 2) which tools are available to measure leadership; and 3) methods to train physicians to become better leaders.

Results: We included 16 relevant studies in this review. Overall, these studies showed that strong leadership improves processes of care in trauma resuscitation including speed and completion of the primary and secondary surveys. The optimal style and structure of leadership are influenced by patient characteristics and team composition. Directive leadership is most effective when Injury Severity Score (ISS) is high or teams are inexperienced, while empowering leadership is most effective when ISS is low or teams more experienced. Many scales were employed to measure leadership. The Leader Behavior Description Questionnaire (LBDQ) was the only scale used in more than one study. Seven studies described methods for training leaders. Leadership training programs included didactic teaching followed by simulations. Although programs differed in length, intensity, and training level of participants, all programs demonstrated improved team performance.

Conclusion: Despite the relative paucity of literature on leadership in resuscitations, this review found leadership improves processes of care in trauma and can be enhanced through dedicated training. Future research is needed to validate leadership assessment scales, develop optimal training mechanisms, and demonstrate leadership's effect on patient-level outcome. [West J Emerg Med. 2016;17(5)549-556.]

INTRODUCTION

Coordinating doctors, nurses, and ancillary staff to care for patients requires teamwork and leadership. This is particularly true in emergency settings where providers from numerous specialties converge to care for critically ill patients with limited data and under strict time constraints. The most

recent Advanced Trauma Life Support (ATLS) guidelines have codified leadership's importance by emphasizing that for a team to "perform effectively one team member should assume the role of the team leader."[1] However, unlike the majority of other key elements of trauma care (e.g. airway assessment), the ATLS manual does not provide specific teamwork training recommendations or guidelines for leadership. As a result, the leadership and teamwork structure for trauma care is generally dictated by provider preference, institutional history, and local culture rather than uniform standards.

Leadership styles are divided into two main categories: directive or empowering. Directive leadership is typical of a military chain of command. The commanding officer explicitly instructs subordinates on which tasks to perform and when to perform them, effectively managing and supervising the decision-making process through role distribution and flow of information.[2,3] This type of leadership is effective when tasks are simple, straightforward, and/or the leader is the only team member with expertise.[4] In empowering leadership, leaders delegate responsibility, allowing colleagues to make decisions while the leader focuses on team communication and coordination. The primacy of directive leadership has been increasingly challenged. Newer theories postulate that empowering (shared) leadership is more effective when tasks are complex.[4] These theories suggest the more complex a task, the more necessary it is for team members to share the responsibility of management of information, communication, and adaptability to achieve success.[4]

However, the optimal leadership style and team structure for trauma is largely unstudied. Trauma resuscitation has elements that are simple/task-oriented and components that are highly complex requiring team member coordination. As such, directive and empowering leadership styles might both play a role. Furthermore, the development of emergency medicine as a specialty has changed the structure of leadership in trauma. Cross-disciplinary and shared leadership structures now exist in which trauma surgeons and emergency physicians mutually make decisions for the benefit of the patient. Research to elucidate the optimal style and structure of leadership in trauma is limited by a lack of validated tools to measure the quality of leadership and teamwork. Once standards are developed, training programs can be created on the basis of strong scientific evidence.

The goal of this paper was to review the scientific literature on leadership and teamwork in trauma and resuscitation patients. Specifically, we evaluated 1) how leadership and teamwork affect patient care, 2) which tools are available to measure effective leadership or teamwork, and 3) what methods can be used to train physicians to become better team leaders/team members.

METHODS

We searched the PubMed database using the keywords "leadership" and then either "trauma" or "resuscitation" as title search terms from 1973 through 2014. This resulted in the identification of a total of 345 and 158 abstracts respectively. An expert in emergency medicine and trauma reviewed these abstracts and identified prospective observational and randomized controlled studies measuring leadership and teamwork quality. We included studies on medical resuscitation due to the paucity of studies that specifically addressed leadership in trauma. Due to medical resuscitation's similar dependence on teamwork under strict time constraints, we believe that these situations parallel sufficiently to extrapolate meaningful data for trauma teams. We excluded studies in which the resuscitation occurred in or was simulated in other patient care settings including the operating room or intensive care unit. Additional exclusion criteria included manuscripts not available in English and manuscripts in which leadership/teamwork were mentioned but not the focus of the paper. After applying our exclusions we had 10 relevant articles focusing on trauma and six additional articles on medical resuscitation. The database search was followed by an ancestral search of the references of included articles using the same inclusion and exclusion criteria. Since very little information exists on this topic, experts were consulted to identify additional relevant manuscripts.

We organized results according to which of the three study questions they addressed: 1. How does leadership/leadership style affect patient care and team performance? 2. How can effective leadership/teamwork be measured? 3. How can leaders be trained?

RESULTS

After applying our inclusion and exclusion criteria, we included 16 articles in this review. A summary of the selected articles is displayed in two tables: Table 1 includes 10 articles on trauma, and Table 2 includes six articles on medical resuscitation.

1. Does leadership affect patient care and team performance?

Strong leadership and teamwork improve processes of care in trauma including completion of primary and secondary surveys while the optimal style and structure of leadership are influenced by patient characteristics and team composition.

Of the 16 studies included in this review, nine examined how leadership and teamwork affect patient care. The literature suggests that effective leadership is associated with better processes of care in both trauma cases and medical resuscitation (Tables 1 and 2). With respect to trauma cases,[4] studies evaluated how leadership and teamwork affect time to complete ATLS standards. Specifically, Hoff et al. demonstrated that teams with designated trauma team leaders (command physicians) were more likely to adhere to ATLS standards of care. Teams with a leader had higher rates of completion of their secondary survey and formulation of a plan than teams without an identified leader.[5] In Lubbert et al., a lack of leadership led to more errors and delays in

Table 1. Summary of trauma resuscitation studies on teamwork and leadership.

No	Setting	Design	Intervention	Sample size	Endpoints	Main results	Reference
1	Trauma Center	Retrospective observational study (video recordings)	none	425 trauma cases	· Leadership quality · Respect of ATLS standards	· Evidence of leadership increases the level of adherence to ATLS standards of care	Hoff 1997 [6]
2	Trauma Center	Retrospective observational study (video recordings)	none	50 trauma cases	· Video recordings to assess team work	· Video recording is a good tool to assess how trauma resuscitations work, but is frequently not used adequately	Ritchie 1999 [27]
3	Training Center	Prospective observational study (pre-post observation)	28-day military trauma team training	30 team members 2 trauma cases	· Trauma Team Evaluation Tool (TTET, team organization & expected tasks)	· Team training was associated with significant improvement in team organization and TTET scores.	Holcomb 2002 [17]
4	Trauma Center	Prospective observational study	none	unknown	· Leadership effectiveness measured by adapted Pearce & Sims scale · Trauma team level of experience · Trauma severity	· Effectiveness of leadership depends on the severity of the patient's injury and on the level of experience of the team · Direct leadership is more effective when the patient's condition is more severe, or when the team is less experienced · Empowered leadership is more effective in less severe cases or when used with experienced teams	Yun 2005 [15]
5	Trauma Center	Retrospective observational study (video recordings)	none	387 trauma cases	· Locally developed score of team performance	· Errors in team organization lead to more errors in expected tasks	Lubbert 2009 [7]
6	Trauma Center	Prospective observational study (pre-post observation)	Team training using the Team STEPPS program and simulation	33 pre-training trauma cases 40 post-training trauma cases	· Trauma Team Performance Observation Tool (TPOT) · Delays to accomplish tasks related to ATLS standards of care	· Training was associated with a better TPOT score · Training was associated with a significant reduction of delays to accomplish ATLS-related tasks	Capella 2010 [8]

ATLS, advanced trauma life support; TeamSTEPPS, Team Strategies and Tools to Enhance Performance and Patient Safety

performing expected tasks during the primary and secondary surveys.[6] In Capella, strong teamwork led to decreased time to computed tomography (CT), endotracheal intubation, and transfer to the operating room.[7] Similarly, Steinemann showed that leadership and teamwork led to decreased resuscitation time and increased "near-perfect" task completion during the primary survey.[8]

Five of the studies focusing on medical resuscitation showed leadership/teamwork increased successful task completion.[9-13] For example, in Cooper et al., strong leadership led to improvements in task-performance scores that included items like basic ventilation and chest compressions.[9] In Yeung et al, strong leadership was associated with higher quality and more successful cardiopulmonary resuscitations.[13] Hunziker authored two studies that noted students trained in leadership had fewer delays in initiating basic life support than students who were trained on technical skills alone.[11,12] Similarly, in Marsch et al. poor leadership and task distribution were associated with poor team performance as measured by longer time to deliver basic life support and perform cardioversion, as well as fewer successful resuscitations.[10]

The optimal style and structure of leadership varied based

Table 2. Summary of live or experimental (simulation) studies on team work and leadership in medical resuscitation.

No	Setting	Design	Intervention	Sample size	Endpoints	Main results	Reference
7	Trauma Center (n=2)	Retrospective observational study (video recordings)	None	268 trauma cases	· Structure of leadership · Decision-making agreement · ATLS expected tasks	· Intra-disciplinary and cross-disciplinary shared leadership were better than solo or parallel decision making	Sarcevic 2011 [16]
8	Trauma Center	Prospective observational study (pre-post observation)	Team training using a 4-hour simulation session	137 trauma team members 141 pre-training trauma cases 103 post-training trauma cases	· T-NOTECHS scale · Delays to accomplish expected tasks	· Team training was associated with an improved score of team work (T-NOTECHS) and reduced delays for expected tasks	Steinemann 2012 [9]
9	Trauma Center	Prospective observational study	none	81 trauma team members 22 trauma cases	· Modified Campbell Leadership Descriptor Survey tool (CLDS) · Delays to accomplish ATLS-related standards of care	· A high leadership quality (CLDS score) was associated with a significant reduction in delays to accomplish ATLS-related expected tasks	Sakran 2012 [19]
10	General Hospital (Canada)	Qualitative study (Pre-post interviews)	Training of trauma team providers using the STARTT program	41 trauma team members	· Providers' attitudes toward Crew Resource Management's (CRM) importance and simulation training	· STARTT training was highly valued (high level of providers' satisfaction) · STARTT training was associated with an improved appreciation of simulation and CRM team work	Ziesmann 2013 [21]

ATLS, advanced trauma life support; *T-NOTECHS,* nontechnical skills scale for trauma

on patient characteristics and team composition. Directive leadership was shown to be most effective when patients' Injury Severity Scores (ISS) were high or teams were less experienced, while empowering leadership was more effective when ISS was low or teams were more experienced.[14] Leaders who actively participated in patient care, for example by performing procedures, had lower team-performance scores because the leader was unable to oversee, monitor and supervise the resuscitation.[9] The structure of leadership also impacts patient care. When emergency physicians and surgeons share leadership roles by collaborating, there was better decision agreement and faster delivery of care than if each physician made decisions unilaterally or independently (solo or parallel decision-making).[15] See Supplemental Digital Content (SCD) 1 for diagram of leadership structures.

2. How can effective leadership/teamwork be measured?

While there is no consensus on the most effective tool to measure leadership or teamwork, at this time the Leader Behavior Description Questionnaire (LBDQ) has been the most widely used and validated.

Of the 16 studies, eight assessed quality of leadership using standardized scales that focused on various components of leadership/teamwork behavior including communication. Four studies used tools to evaluate team performance that included an evaluation of the team's leadership as a sub-scale,[6-8, 16] while four studies evaluated leadership in isolation.[9, 13, 15, 17] Lubbert et al used an attending surgeon to evaluate video-recorded traumas over a two-year period using an internally developed leadership/team work scoring scale. The scale focused on errors in team functioning in 10 domains including the following: timing of complete team arrival, organization/communication, protective measures, and patient transfer. The leader was rated on five items: clearly evident, efficient, perform the resuscitation in the correct order, work according to protocol, and maintain the patient under constant supervision.[6] Each of these five items was evaluated as present (yes/no). The Trauma Team Performance Observation Tool (TPOT) was used by Capella.[7] Trained evaluators assessed team performance by the following categories: leadership, situation monitoring, mutual support, and communication skills. Each of these categories was evaluated using a set of questions. For example, under the leadership category was the question: "Does the leader continually render the plan of care to the team and ensure task prioritization?" and this was measured on a five-point Likert scale.[7] The Trauma NOTECHS is a five-point Likert scale with four domains:

cooperation and resource management, communication and interaction, assessment and decision-making, and situation awareness/coping with stress. The scale was modified in Steinemann et al. by a panel with extensive trauma experience to make it more relevant to trauma. Teamwork was rated by critical care nurses and trained medical students.[8] In Holcomb's study, senior physicians and nurses used the Trauma Team Evaluation Tool to evaluate team organization on a 0-2 scale. Teams were more effective if there was a clearly defined team leader with other team members assuming functional roles.[16]

Four scales evaluated leadership in isolation rather than in the context of teamwork.[9, 13, 15, 17] The modified Campbell Leadership Descriptor Survey tool was used in Sakran's study and was filled out by team members (e.g. residents, trauma fellows, and nurses) after a resuscitation. The evaluation tool is rated on a four-point Likert-type scale in nine leadership domains: vision, management, empowerment, diplomacy, feedback, innovative/creative, style, energy, and leadership.[18] The LBDQ was the only scale used in more than one study.[9, 13] The LBDQ, which was developed at Ohio State University in the 1950s for team members to describe leadership behavior, evaluates leaders in two behavioral domains: initiating structure and consideration. Initiating structure includes task-oriented behaviors and consideration includes people-oriented behaviors. Trained observers evaluate how much the leader displays these behaviors by marking always, often, occasionally, seldom, or never. There are 40 total behaviors including the following: lets group members know what is expected of them, maintains definite standards of performance, and treats all group members as his/her equals.[19] Cooper et al. first used this scale in medical resuscitation. The authors eliminated consideration items because these behaviors were unlikely to be important under time constraints, and the 10 initiating structure items were adapted to fit resuscitation scenarios. In the end the authors claimed the modified LBDQ had excellent unidimensional validity.[9] In Yeung et al. they used Cooper's modified LBDQ to evaluate leadership behavior and also showed high inter-rater reliability.[13]

3. How should we train leaders?

All resuscitation leadership training programs used a combination of didactic teaching with simulations and showed improvements in team performance. However, the length, intensity, and experience level of participants varied widely.

Seven studies included in our review evaluated and described methods for training physicians to become better leaders. Training programs included didactic teaching to emphasize key leadership behaviors followed by live, mannequin, or computer-based simulations to practice and solidify new skills/behaviors, and all programs demonstrated improved team performance. Programs differed in the length of instruction and the training level of participants. Few programs focused on other methods of training such as textbook, small group, apprenticeship, or panel discussions.[7, 8, 12, 16, 20, 21] In Fernandez et al., 231 medical students and residents used a computer-based simulation training module targeting appropriate resuscitation teamwork behaviors including goal development, strategy formulation, communication, and leadership. During follow-up high-fidelity simulation, trainees demonstrated improved leadership behavior scores as well as patient care scores determined by items such as appropriate chest compressions.[21] In Steinemann et al., residents and attending physicians participated in a team-based training program consisting of videotaping and debriefing mannequin simulations. After training, 100 trauma resuscitations were recorded and analyzed, and participants in the training program had improved task performance and achieved decreased emergency department resuscitation time.[8] In Hunziker's leadership training, participants were taught to perform four practical items: 1) decide what to do; 2) tell your colleagues what to do; 3) make short and clear statements; 4) adhere to a treatment algorithm. Students subsequently had better outcome measures including time to beginning cardiopulmonary resuscitation (CPR) and maintaining the correct chest compression rate.[11]

Two studies used standardized training programs rather than developing their own. One used TeamSTEPPS developed by the U.S. Agency for Health Care and Quality and the other used Standardized Trauma and Resuscitation Team Training (STARTT) program developed by the UK National Health Service.[7,20] TeamSTEPPS is widely used by both the defense and airline industries and has been used in healthcare settings to train leaders.[7] The program consists of a didactic course with text and supporting DVD supplemented by video vignettes to illustrate key concepts. After training, teams using this program had improved scores in leadership, situation monitoring, mutual support, and communication as measured by the Trauma Team Performance Observation Tool. Additionally, teams had faster patient arrival rates to the CT scanner, endotracheal intubation, and operating room in live trauma resuscitations after receiving leadership training.[7] The STARTT program trains trauma team members by incorporating a seven-chapter textbook, lectures, and discussion of key performance goals including leadership, communication, and situational awareness followed by high-fidelity trauma simulation as well as live-actor simulation.[20] After training, participants in Zeismann's study had high satisfaction and significant improvement in attitudes towards teamwork.[20]

While programs did not differ widely in method of delivering content, they varied dramatically in length and intensity as well as the level of experience of trainees. Despite these differences, they all demonstrated improved leadership and team functioning after training. The shortest training programs had didactic sessions that were under a half hour. Hunziker et al. showed technical improvements in delivering

CPR after just 10 minutes of leadership training, and students demonstrated sustained improvement after a four-month follow up.[11] Fernandez's 25-minute computer-based training module showed improved team performance and could be easy to implement.[21] The longest program was a 28-day military training course using human patient simulation (HPS) and included hands-on clinical experience, case reviews, lectures, skill station sessions, and a before-and-after test of didactic trauma knowledge.[16] Team training was emphasized throughout the 28-day course but was not the only topic addressed. Human patient simulation was an effective teaching and evaluation tool, and the 10 teams undergoing training had team performance scores nearing expert teams after 28 days.[16] The other programs ranged in length from two hours to eight hours.[7, 8, 12, 13, 20] In addition, trainees varied by program including medical students, residents, and attendings in various combinations. Therefore, training programs could not be compared based on the level of experience of participants even though each group is likely to require tailored training by role. No studies commented on whether training program content was changed, altered, or designed specifically for level of expertise, and program content was not available to analyze any meaningful difference in course complexity.

DISCUSSION

According to the Centers for Disease Control and Prevention, unintentional injury remains the leading cause of death in people under 44 years of age and the fifth overall cause of death in the United States.[22] In addition, traumatic injury has grave economic consequences with $80.2 billion in medical costs and $326 billion in lost productivity annually.[23] While the development of regional trauma centers had a rapid and profound impact on trauma care and outcomes, progress has slowed in recent years, and new strategies are needed to improved trauma outcomes. In this review, we find that leadership and teamwork have a significant impact on trauma processes of care. Encouragingly, we found that leadership can be improved with dedicated training in as little as 10 minutes.

Leadership is a multi-dimensional, complex behavior that includes effective communication, efficiency, decision-making, and resource management skills. As a consequence, measuring leadership is challenging. Compared with other industries, the importance of leadership in trauma care has only recently been recognized.[1] Most leadership measurement tools have been borrowed from other industries and adapted to trauma rather than being developed specifically for trauma care. Our review found that only one tool, the modified LBDQ, was used in more than one study of leadership during resuscitations. In general, most leadership measurement tools have not been subject to rigorous psychometric validation. Moreover, raters included individuals with varying levels of medical sophistication (ranging from medical students to experienced trauma surgeons). It is impractical for senior physicians or nurses to serve as raters for most trauma resuscitations. Future efforts should focus on developing a tool that can be used by raters with limited medical training while maintaining high reliability and validity.

The optimal style of leadership is affected by patient characteristics and team composition. ISS and team experience determine which leadership style is optimal in trauma. Directive leadership was more effective with high ISS and inexperienced teams, and empowering leadership was more effective with lower ISS and more experienced teams. When a patient is more severely injured, decisions must be made quickly with limited time for thorough discussion, thereby favoring a directive approach. Similarly, when team members are relatively inexperienced decision-making should default to an experienced leader who can direct subordinates. Empowering leadership is more effective with experienced team members who already possess the knowledge to make their own decisions, as the leader is free to oversee and guide the resuscitation. In addition, empowering leadership facilitates learning for team members by allowing them to make their own decisions and debate these with senior clinicians. [17] In many cases there is only time for this type of deliberate discussion when patients are less severely injured. Therefore, for critical patients who require physicians to deliver swift and decisive care, conflict exists between which leadership style is best for the patient and which is best for training physicians. More research is necessary to determine which style of leadership should be used in training facilities to provide the best education to residents while simultaneously providing quality care for patients.

With the development of emergency medicine as a recognized medical specialty, the composition of many trauma teams changed. Emergency and trauma physicians began jointly running trauma cases, and cross-disciplinary decision-making became increasingly common. In this structure, emergency and trauma physicians collaborate in order to decide on a unified action plan. In contrast, parallel decision-making occurs when emergency physicians and trauma surgeons make their own decisions without consulting one another. Our results showed that if emergency physicians and surgeons share leadership roles by collaborating (cross-disciplinary) care is delivered faster if each physician makes decisions independently (parallel decision-making). See SCD 1. Overall, the leadership style, structure, and approach will not be the same in all circumstances, and optimal leaders will need to be adaptable in order to apply the correct style and structure of leadership to situation.

This review finds compelling evidence that leadership is a skill that can be taught and improved upon. There are many possible educational modalities including lectures, textbooks, small groups, and workshops that could be used to train leaders. However, the optimal training method and duration is elusive. In our review, the most commonly used training

method was a combination of didactics and simulation. While this strategy was effective, simulation training, especially with the use of high-fidelity mannequins, is resource intense and may be cost prohibitive. Training programs also varied in length and trainee level of experience. Training programs included medical students, residents, and attending physicians in many combinations. Therefore, while medical students and physicians likely require different training, we could not look for changes in design, length, or content based on trainee level of experience. Future research is needed focusing on each group individually to develop the most cost effective and efficient training methods.

Optimizing outcomes for trauma victims requires a multi-dimensional approach. Common strategies in the past have included new surgical techniques, new drugs, and new trauma center systems. Improving leadership/teamwork may be a novel mechanism to accelerate progress in the future. Our review finds that leadership is associated with improvements in processes of care during resuscitations and is highly trainable. However, the literature to date is limited by the lack of 1) patient level outcomes 2) easy-to-use, validated measurement tools, and 3) understanding of the optimal training methods. To move forward, easy-to-use, validated tools and cost-effective training programs must be developed. Future efforts should focus on confirming that leadership not only affects processes of care but also that this translates directly to improved patient outcomes.

LIMITATIONS AND CONCLUSION

There were several limitations in this study. We only searched PubMed, which is typical for medical research, but since this topic spans sociology and organizational theory we may have missed relevant articles. We think this is unlikely given experts in trauma and emergency medicine performed an ancestral review by tracking down references cited by relevant sources to capture any remaining articles that fit our criteria. There is a limited pool of studies that focused solely on trauma. To expand the number of studies we decided to include medical resuscitation because it also requires a team to act in a time-sensitive manner to provide the best possible patient care. Importantly, the key findings of the review are unchanged if we restrict the analysis to only studies of trauma resuscitation. Since no gold standard currently exists, each study used its own tool to evaluate leadership and teamwork. Most scales were only partially validated, and only the LBDQ was used in more than one study. The variety of measurement tools made it impossible to pool together results. Additionally, most studies used process-of-care improvements as endpoints rather than patient outcome. Past studies have shown that this assumption is solid, but studies that look at patient outcome directly are necessary to confirm these results.[24, 25]

Despite these limitations, addressing team organization and leadership skills results in improved speed and quality of care for patients in resuscitation settings. Therefore, leadership and teamwork training could be a key issue for improving patient care, but our level of knowledge about what defines and how to measure effective teamwork/leadership is lacking. Future efforts should focus on better defining, teaching, and assessing leadership and trauma team organization and definitively equating improvements in processes of care with improved patient outcomes.

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Does Pneumatic Tube System Transport Contribute to Hemolysis in ED Blood Samples?

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Introduction: Our goal was to determine if the hemolysis among blood samples obtained in an emergency department and then sent to the laboratory in a pneumatic tube system was different from those in samples that were hand-carried.

Methods: The hemolysis index is measured on all samples submitted for potassium analysis. We queried our hospital laboratory database system (SunQuest®) for potassium results for specimens obtained between January 2014 and July 2014. From facility maintenance records, we identified periods of system downtime, during which specimens were hand-carried to the laboratory.

Results: During the study period, 15,851 blood specimens were transported via our pneumatic tube system and 92 samples were hand delivered. The proportions of hemolyzed specimens in the two groups were not significantly different (13.6% vs. 13.1% [p=0.90]). Results were consistent when the criterion was limited to gross (3.3% vs 3.3% [p=0.99]) or mild (10.3% vs 9.8% [p=0.88]) hemolysis. The hemolysis rate showed minimal variation during the study period (12.6%–14.6%).

Conclusion: We found no statistical difference in the percentages of hemolyzed specimens transported by a pneumatic tube system or hand delivered to the laboratory. Certain features of pneumatic tube systems might contribute to hemolysis (e.g., speed, distance, packing material). Since each system is unique in design, we encourage medical facilities to consider whether their method of transport might contribute to hemolysis in samples obtained in the emergency department. [West J Emerg Med. 2016;17(5)557-560.]

INTRODUCTION

Emergency department (ED) blood samples have a high rate of hemolysis (6%–30%) when sent to the clinical laboratory for analysis.[1–3] ED hemolysis is much higher than the 2% benchmark established by the American Society for Clinical Pathology. This is especially problematic given the high-volume, crowded nature of an ED.[4] Hemolysis of a sample often requires repeat specimens to be drawn and tested. These repeat tests delay treatment and clinical decision making, prolong patients' ED length of stay, and cause patient dissatisfaction due to multiple sticks for repeated blood draws. While the reasons for high hemolysis rates are likely multifactorial, they are typically caused by the pre-analytic phase of the testing process.[2] One possible source is the use of pneumatic tube transport systems to transfer the test tubes from the ED to the clinical laboratory.[5,6]

Pneumatic tube transport systems are common in modern hospitals because they increase the speed of sample delivery to the laboratory. They have been shown to decrease laboratory turnaround time,[7–9] which is a benchmark quality indicator in "stat" laboratory testing.[10] However, the decrease in turnaround time might come at the cost of sample quality. Ellis and Hasan both led ED-based studies that revealed significantly increased specimen hemolysis rates after pneumatic tube systems were installed.[5,6] In contrast, other studies of pneumatic tube use demonstrated no significant changes in hemolysis rates.[8,9,11–15] Because of this discrepancy in the literature, and in search of techniques to lower our own institution's hemolysis rates, we sought to determine whether hemolysis rates of blood samples obtained in the ED were increased when transported in a pneumatic tube system versus being hand carried to the lab.

METHODS

Study Design

This work was part of a larger performance improvement program aimed at reducing rates of hemolysis in blood specimens obtained in an urban, tertiary referral ED with an annual census of 64,000. The hospital laboratory database system (SunQuest®) was queried for potassium results for specimens obtained during a seven-month study period (January–July 2014). Although other analytes can be affected by hemolysis, we chose to analyze hemolysis in potassium due to the frequency and patient impact of a hemolyzed potassium sample. From facility maintenance records, we found discrete time periods lasting 60 minutes or more (eventually when added totaling a cumulative of 24 hours) when specimens were hand carried due to pneumatic tube system downtime, as logged by the laboratory's central specimen receiving desk. These discrete downtime periods were used because they were considered to be the most valid comparison. We determined the proportions of samples with hemolysis that were hand-carried and transported by the pneumatic tube system. Pneumatic tube transport involved sending samples through the system to a building across the street with an estimated distance of no more than 500 feet point to point. There are numerous bends to accommodate launch and receiving locations within this process. Because this was part of a quality improvement project this study was granted exemption from institutional board review approval.

Sample Analysis

The hemolysis index is measured on all plasma and serum samples submitted for potassium analysis. A dimensionless hemolysis index is available from our automated instrumentation (Roche cobas8000, c702 analyzer), which provides the index as a quality indicator. If hemolysis is detected, the result is reported in the electronic medical record as either grossly hemolyzed and rejected (GHEMO) or mildly hemolyzed (HK), with a cautionary comment added to the numerical result.

Statistical Analysis

We performed two-sided chi-squared tests with a type I error of 0.05 with SAS® (v.9.2., Cary, NC).

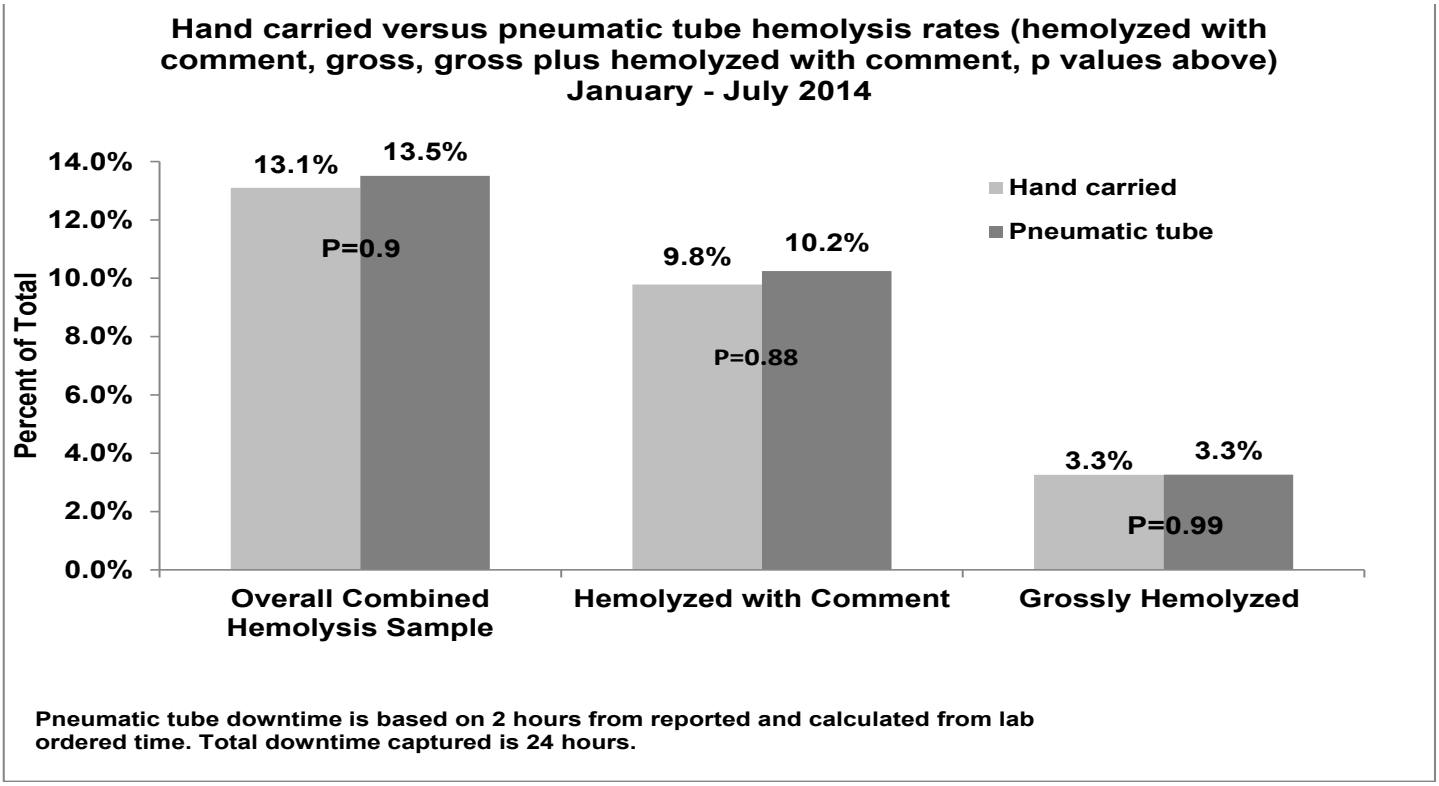

Figure. Comparison of hand carried vs pneumatic tube transported emergency department sample hemolysis January – July 2014.

RESULTS

During the seven-month study period, 15,851 blood specimens were collected in the ED and transported to the laboratory using standard methodology with the pneumatic tube system. Ninety-two samples were hand delivered during the system's downtime. The proportions of combined hemolyzed specimens in the pneumatic tube (13.6%) and hand-carried (13.1%) groups (GHEMO or HK) were not significantly different (p=0.90, Figure). Results were consistent when the hemolysis criterion was limited to GHEMO (3.3% vs 3.3% [p=0.99]) alone or HK (10.3% vs 9.8% [p=0.88]) alone. Overall hemolysis rates showed minimal variation during the study period (12.6%–14.6%).

DISCUSSION

This study showed no statistical difference in the percentages of hemolyzed specimens among those transported by a pneumatic tube system or hand delivered from our ED. Our findings are similar to those of Fernandes et al and Stair et al, who also found no statistical difference in hemolysis rates between the two methods of transport of samples from their EDs.[8,15] In contrast, Ellis, Hasan, and Steige each found a large increase in hemolysis with the implementation of pneumatic tube systems in their institutions.[5,6,16]

Each pneumatic tube system is unique. Their characteristics (e.g., delivery route, velocity) appear to affect sample pressures during transport, which might influence hemolysis rates. Variables that have been shown to cause cell deterioration and increase hemolysis include rapid accelerations and decelerations,[17,18] increased length of travel, and high speeds.[13,18] Other variables that reduce hemolysis during transport include the use of gel tubes,[19] properly filled tubes,[16] and padded inserts within the canisters.[12]

In our facility, hemolysis in non-ED samples occurs at about an incidence of 3%, in contrast to the higher incidence observed in our ED samples (13.5%). ED samples are routinely obtained during intravenous (IV) placement while the standard process for obtaining inpatient and ambulatory samples is via straight-stick method, which is known to have a lower hemolysis rate. [1,2]

LIMITATIONS

The study is a retrospective chart review and therefore may carry some limitations typically associated with such reviews. It is possible that some hand-carried specimens were included in the pneumatic tube sample, as hand-carried specimens were only identified for downtime periods of 60 minutes or greater when the pneumatic tube system was not functioning. If significant numbers of hand-carried samples were inadvertently included in the pneumatic tube group, this may have in part contributed to the finding of no difference between the two groups. However, the large sample size of the pneumatic tube group should have mitigated any such effect. In addition, we chose the discrete downtime periods for hand-transported samples in order to minimize the possibility of inadvertent inclusion of pneumatic tube samples in this group. Relying on engineering logs to identify downtimes could have resulted in missing some time periods when the pneumatic tube system was down but not recorded.

While it was standard practice in the ED during the study period to obtain samples during IV placement, there may be heterogeneity in phlebotomy technique, equipment and the experience of the phlebotomist, which can be a confounding factor affecting the data. This analysis was performed at an early phase of our larger performance improvement project. However, the study period occurred prior to implementation of any process improvement activities aimed at reducing hemolysis. This study was performed in a single ED with unique characteristics (pneumatic tube system, blood drawing techniques) and may not be generalizable to other settings.

CONCLUSION

Our pneumatic tube system does not increase the rate of hemolysis in blood samples collected in our ED. We encourage each institution to examine the features of its pneumatic tube system and consider whether its characteristics and configuration might be contributing to the hemolysis of blood samples.

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Wide Variability in Emergency Physician Admission Rates: A Target to Reduce Costs Without Compromising Quality

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Introduction: Attending physician judgment is the traditional standard of care for emergency department (ED) admission decisions. The extent to which variability in admission decisions affect cost and quality is not well understood. We sought to determine the impact of variability in admission decisions on cost and quality.

Methods: We performed a retrospective observational study of patients presenting to a university-affiliated, urban ED from October 1, 2007, through September 30, 2008. The main outcome measures were admission rate, fiscal indicators (Medicaid-denied payment days), and quality indicators (15- and 30-day ED returns; delayed hospital admissions). We asked each Attending to estimate their inpatient admission rate and correlated their personal assessment with actual admission rates.

Results: Admission rates, even after adjusting for known confounders, were highly variable (15.2%-32.0%) and correlated with Medicaid denied-payment day rates (p=0.038). There was no correlation with quality outcome measures (30-day ED return or delayed hospital admission). There was no significant correlation between actual and self-described admission rate; the range of mis-estimation was 0% to 117%.

Conclusion: Emergency medicine attending admission rates at this institution are highly variable, unexplained by known confounding variables, and unrelated to quality of care, as measured by 30-day ED return or delayed hospital admission. Admission optimization represents an important untapped potential for cost reduction through avoidable hospitalizations, with no apparent adverse effects on quality. [West J Emerg Med. 2016;17(5)561-566.]

INTRODUCTION

Healthcare costs are at the forefront of discussions of the United States healthcare system.[1] The U.S. spends more than any other country on medical care[2] without demonstrable differential in positive outcomes for many conditions.[3] Inpatient hospitalizations drive one-third of total healthcare expenditure in the U.S.[4,5] Forty percent of all admissions,[3] and as many as 70% of admissions for major service lines such as general medicine, pulmonary, gastrointestinal, general surgery, and orthopedics[6] originate in the emergency department (ED). Publicly supported EDs and uninsured patients have higher ED admission rates than private sector hospitals.[7]

Emergency physicians' decisions to admit rely on assorted cues and information from patients. This framework[4,5] is the

basis for most clinical decision-making today. Objective criteria and scoring systems have been proposed to supplant this subjective model.[8,9] However, attending physician judgment remains the standard of care for ED admission decisions. Inter-physician variability in admission decisions and its impact on cost and quality have not been studied in detail. In addition to reducing costs, avoiding unnecessary admissions reduces patient exposure to high-risk patient safety events such as venous thromboembolism (VTE),[10] central line-associated blood stream infections (CLABSI),[11] catheter-associated urinary tract infections (CAUTI),[12] falls,[13] and medication errors.[14]

Observations by the authors led us to suspect there would be significant differences between emergency physicians in their admission rates at our institution. We sought to understand these admission patterns and their effects on financial and quality indicators. We hypothesized a positive correlation between admission rates and inappropriate admissions, and a negative correlation between admission rates and repeat ED visits or delayed hospital admission (as such patients were admitted at the index visit).

As a proxy for inappropriate admissions, we used rates of Medicaid (Medi-Cal) denied-payment days. To ensure appropriate admissions, Medicaid ("Medi-Cal" in California) reviews admission documentation and may deny payment for admission on the basis of inadequate documentation, delays in care, and lack of medical necessity for admission.[15] We analyzed the relationship between rates of inpatient admission, quality indicators (15- and 30-day return visits, delayed hospital admissions), and insurance denial of reimbursement for inpatient days. Variability not explained by known risk factors for admission might suggest other means of decreasing admission rates, thereby controlling costs.

METHODS

This retrospective, observational study was conducted at a 377-licensed bed, publicly supported, academic teaching hospital. It is staffed to 200 beds and serves a medically-indigent population, without cardiothoracic, neurosurgical, or inpatient orthopedic services. During the study period, the ED had 23 beds and provided over 41,000 visits annually. While not a trauma center, it is one of two principal training sites for an emergency medicine (EM) residency training program. Patients are evaluated and cared for by EM, internal medicine, or family practice residents, with EM attending supervision. Patient visits are associated with each treating (resident) and supervising (attending) provider. Non-emergent patients triaged during daytime hours are seen in separate urgent care clinics staffed by general internists and pediatricians. Patients seen in non-emergent areas were excluded from this study.

Around-the-clock EM attending coverage is provided by full- and part-time faculty board certified in EM. Many are also board certified in internal medicine. Insurance coverage of the inpatient population included 51% Medicaid, 38%

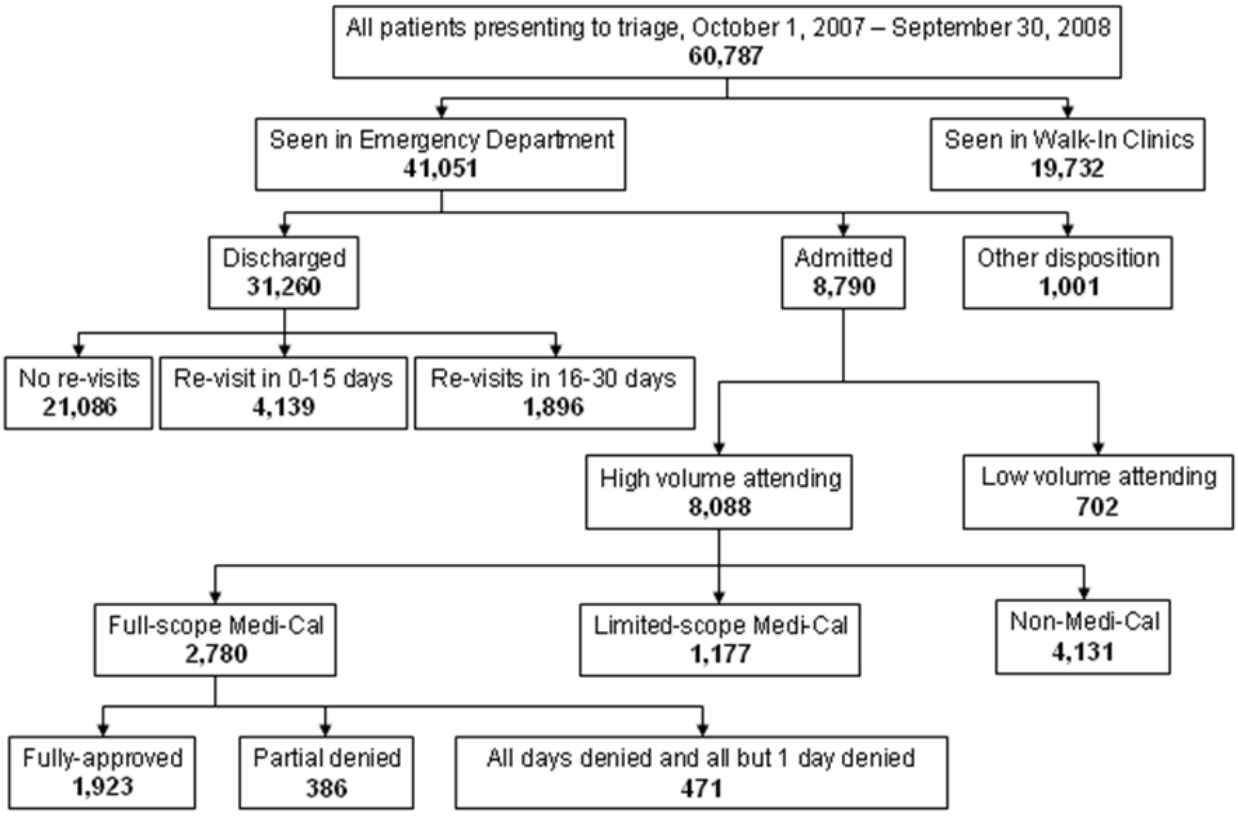

Figure. Study inclusion cohort.

uninsured, 8% Medicare, and 3% private insurance. Sixty-three percent of inpatient admissions originate in the ED. This above-average rate of ED admissions is consistent with public hospitals serving medically-indigent populations.[7]

All ED encounters from October 1, 2007, through September 30, 2008, were included in the study. Those admitted to the hospital were associated with the ED attending physician at the time the decision to admit was made. Attending physicians with fewer than 100 admissions during the study period were excluded from analysis to reduce spurious results from small-number analysis. Study physicians covered the ED more than 85% of the time. The study population is depicted graphically in the figure.

This study used data contained in the Advanced Triage and Emergency Medicine Management (ATEMM) system. ATEMM is a fully-computerized operational workflow program providing and collecting real-time point-of-care ED information. No separate data collection was required for data elements related to patient-specific activity in the ED.

We obtained utilization review (UR) data for Medicaid patients from an electronic system used by the medical director for utilization review. Data on board certification status and practice duration were gleaned from medical staff records. The attending schedule was abstracted from the AmIOn scheduling system (Spiral Software: Norwich, VT).

For each hospital admission, the UR database was cross-referenced to identify Medicaid beneficiaries**.** The UR database has a framework for categorization of Medicaid denied-payment days. One categorization is "physician-attributable denied days," which refers to days whose payment denial was related to inappropriate admission or inadequate documentation, rather than to administrative reasons such as difficulty transferring to a higher level of service. We classified admissions with one or fewer approved days as a proxy for a denied admission. Patients admitted, only to be sent home by the inpatient admission team the same day, were counted as one denied day. We analyzed physician-attributable and non-attributable (e.g., awaiting transfer, placement, or administrative actions) denied days separately. Each attending physician's admission rate was correlated with the percentage of admissions with at least one denied day and with quality indicators (ED repeat visits and delayed hospitalizations within 15 and 30 days of the index ED discharge).

We defined ED repeat visits as a return to our ED or urgent care clinic for any reason within 15 and 30 days following an index presentation. Delayed hospitalizations were defined as hospitalization at our institution for any reason (via the ED or not) within 30 days of an index presentation for which the patient was discharged from the ED.

We analyzed data for known confounders of admission rate: distribution of attending shifts in the day, evening, or night; percentage of pediatric patients; distribution of patient arrivals in the day, evening, or night; percentage of patients who arrived by ambulance,[16] and suspected confounders of admission rate: number of years as an EM attending; and full- or part-time faculty status. Finally, we asked each attending to estimate their inpatient admission rate and correlated their personal assessment with actual admission rates.

Statistics were performed using SPSS 11.5 (Chicago, IL) and Microsoft Excel 2003 Data Analysis Tool Pack (Redmond, WA). For all analyses, $p < 0.05$ was considered significant.

The study was approved by the institutional review board.

RESULTS

A total of 41,248 ED visits occurred during the study timeframe; 31,373 (76.1%) were discharged, 8,813 (21.4%) were admitted, and 1,062 (2.6%) had another disposition (e.g., left against medical advice, transferred, etc.). Eight thousand eighty-eight patients (19.6%) were admitted by 20 attending physicians. Nine attending physicians were full time; 12 had additional board certification, all in internal medicine. Attendings had practiced between one and 27 years. Individual physician shift distribution ranged from 2.8% to 68.1% day shifts, 31.4% to 87% evening shifts, and 0% to 58.6% night shifts. Comparing demographic characteristics of patients seen by various attendings, the range of mean ages, percent who were male, and percent who arrived by ambulance of all patients seen by individual attending physicians was 37 to 43 years, 46.8% to 52.2%, and 5.9% to 7.8%, respectively.

Results are summarized in the table. Admission rates by attending ranged from 15.2% to 32.0%. Physician-attributable Medicaid denied days by attending ranged from 0% to 14.5%. There remained a significant, positive correlation ($p = 0.038$) between admission rate and percent of patients with at least one denied day after multivariate adjustment for distribution of attending shifts and patient arrival times, percentage of pediatric and ambulance-arrival patients, number of years as an EM attending, and full- or part-time faculty status. There was no correlation between admission rate and total number of denied days.

Returns to the ED after initial ED discharge ranged from 8.0% to 13.5% within 15 days and 12.5% to 19.1% within 30 days. Delayed inpatient admissions ranged from 1.2% to 3.6% within 15 days and 2.0% to 5.6% within 30 days of an index presentation for which the patient was discharged from the ED. The correlations between admission rate and 15-day and 30-day ED returns, and between admission rate and 15-day and 30-day delayed admission, were not significant.

Attending physician estimates of their admission rate ranged from 7% to 33%. Seventy-one percent overestimated and 24% underestimated their actual admission rate. The range of mis-estimation was 0% to 117%. Forty-eight percent estimated their admission rate within 20% of their actual admission rate; 24% were between 20 and 50% of their actual rate; 29% of the estimates were beyond 50%. There was no significant correlation between actual and self-described admission rate.

Table. Attending physician patient profiles.

Attending alias	Admission rate (%)†	% Medicaid admissions‡	% of Medicaid admissions with 1 or more physician-attributable denied days‡	15-Day returns to ED (%)†	30-Day returns to ED (%)†	15-Day delayed admission (%)†	30-Day delayed admission (%)†	% Arrive by ambulance †	% Male gender†	Mean patient age†
MD 1	32.0	34.6	10.7	10.8	17.5	1.6	3.2	5.9	49.2	42
MD 2	30.0	32.8	9.5	12.8	18.5	2.2	4.2	6.3	48.0	42
MD 3	29.9	35.6	9.0	11.0	16.3	2.8	3.7	6.1	49.9	41
MD 4	29.1	33.9	14.5	9.2	14.1	1.8	2.2	7.8	49.4	42
MD 5	26.7	32.4	8.2	13.5	18.1	2.6	3.4	5.2	50.7	40
MD 6	26.5	41.3	6.5	10.5	14.5	1.9	2.7	5.0	46.8	43
MD 7	25.0	34.9	11.8	9.7	14.1	2.0	3.0	6.6	47.2	41
MD 8	24.0	34.4	8.6	12.1	16.9	1.2	2.0	6.5	49.7	40
MD 9	22.2	30.9	5.6	9.2	14.9	2.7	4.2	6.8	52.0	41
MD 10	21.7	30.2	12.1	11.0	15.6	1.7	2.5	5.9	48.8	41
MD 11	21.4	33.0	7.5	11.4	16.3	2.6	3.9	5.5	48.7	40
MD 12	20.6	36.6	7.7	11.5	17.7	2.2	3.4	6.0	47.6	41
MD 13	20.0	30.6	7.5	11.5	19.1	2.7	4.5	5.8	49.7	40
MD 14	19.3	36.2	9.6	8.3	13.4	1.5	2.4	6.2	48.8	40
MD 15	19.2	23.4	0.0	10.2	14.7	1.9	2.4	5.5	52.2	40
MD 16	18.7	39.0	5.5	8.0	12.5	1.6	2.8	5.5	48.1	41
MD 17	18.4	35.8	6.9	13.2	18.9	3.6	5.6	6.0	48.8	40
MD 18	18.4	35.0	11.1	11.3	15.9	3.3	4.2	5.4	50.3	40
MD 19	18.2	35.8	4.4	12.3	16.7	3.0	4.1	6.4	48.5	41
MD 20	16.3	36.1	7.2	10.3	14.7	2.7	3.6	5.1	50.3	41

Data Sources: †Advanced Triage and Emergency Medicine Management (ATEMM), ‡Utilization Review database.

DISCUSSION

There was more than 100% variability among ED attending physicians in their decision to admit, with admission rates of some providers greater than twice the rates of others, unexplained by known confounders. This enormous variability has important implications for healthcare cost and quality. Inpatient admissions account for $600-800 billion expenditure annually.[17,18] Emergency physicians are in a key position to moderate escalating healthcare costs associated with inpatient care, as their decisions impact at least 40% of admissions.[3] Reducing admissions by 10-25% (well below the variation observed in this study) could save approximately 1.0-2.5% of total health expenditures.[19] Additional benefit could be achieved through avoiding high-risk events such as VTE, CLABSI, CAUTI, falls, and medication errors. The potential economic and patient care impact of optimizing physician admission decisions from the ED remains an underappreciated component of healthcare redesign. Admitting practice patterns should promote appropriate and efficient use of the healthcare delivery system without sacrificing quality of care. Greater collaboration between hospitalist physicians and greater care coordination/case management may reduce unnecessary admissions. Variable admission patterns based on differences in patient,[20] hospital,[21] and geographic characteristics[22] have been shown, with consequent variation in resource expenditure.[23] Physician-level differences have been shown to influence cost of care, for example, in the intensive care unit, where such differences were not associated with lower mortality rates.[24] To our knowledge, this is the first demonstration of physician-level variability in adult ED admission rates and has significant implications for national healthcare cost control.

Variability in admission rate appears to be due, in part, to variation in emergency physician risk preference.[25] If all physicians in our cohort had the same admission behaviors as the theoretical "optimal" physician (lowest admission, denied day, revisit, and delayed hospital admission rate), then, at this hospital alone, there would have been 2,518 fewer inpatient admissions, 430 fewer delayed hospitalizations, and 2,466 fewer repeat ED visits during the study period. The inpatient cost savings are clear; the corresponding increase in outpatient cost associated with non-inpatient care delivery is less well-defined.

This study found a significant positive correlation between admission rate and Medicaid denied days at this ED. The "optimal" admission rate depends on point of view. A hospital with a predominantly fee-for-service private insurance population will benefit fiscally from emergency physicians with high admission rates if those providers do not have correspondingly-high denied day rates. In a capitated integrated delivery network, ED physicians with high admission rates will adversely affect net income because additional admissions accrue costs without corresponding reimbursement.

Evidence-based ED admission decision-support systems, such as InterQual®, which have been implemented in real time in some institutions, often conflict with attending physician admission decisions; Glassman, et al. found an appropriateness rate of only 49% comparing medical admissions based on clinician discretion against InterQual® Criteria (1995).[9] Determining admission appropriateness based on severity of illness and intensity of service criteria may not capture certain elements relevant to disposition decision-making (e.g., patient self-efficacy with home care).

There is need to improve methods of real-time or near-real-time feedback on the appropriateness of admission decisions to EM trainees and practitioners. This must not be limited to "edge cases" of dramatically-bad decisions but, rather, the differences in routine decisions we found among our high-volume, board certified attending physicians. It remains unclear what combination of subjective judgment and objective criteria are most advantageous. There remains much work to be done to determine the appropriate methodology for teaching, assessing, and providing feedback to optimize admission decision-making. Contributing to the dilemma is that many of those who teach others had little insight into their own admission rates.

LIMITATIONS

This study has several limitations. It was conducted at a single academic site treating a medically-indigent population. Re-presentations and re-admissions were captured only from this institution. Inpatient denied days is an imperfect proxy for appropriateness of admission, as designation of days as "denied" or "covered" depends on activities beyond control of the ED physician (e.g., daily documentation of need for continued hospitalization). Emergency physician decision to admit is influenced by many factors, including the availability of consultants and timely outpatient follow up, arrival time, means of arrival and, occasionally, patient preference. It was not possible to control for all potential confounders to isolate provider variation as the singular determinant behind widely-disparate admission rates.

CONCLUSION

Variability in emergency physician admitting patterns impacts the global cost and quality of healthcare. A mechanism to routinely track and provide feedback of admission decisions and subsequent outcomes to EM physicians in training and practice could decrease variability and produce more predictable patterns. The dramatic variability in admission rates should be confirmed in other teaching and non-teaching environments and with other payers to determine if the results can be generalized.

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Workplace Violence and Harassment Against Emergency Medicine Residents

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Introduction: Several studies have shown that workplace violence in the emergency department (ED) is common. Residents may be among the most vulnerable staff, as they have the least experience with these volatile encounters. The goal for this study was to quantify and describe acts of violence against emergency medicine (EM) residents by patients and visitors and to identify perceived barriers to safety.

Methods: This cross-sectional survey study queried EM residents at multiple New York City hospitals. The primary outcome was the incidence of violence experienced by residents while working in the ED. The secondary outcomes were the subtypes of violence experienced by residents, as well as the perceived barriers to safety while at work.

Results: A majority of residents (66%, 78/119) reported experiencing at least one act of physical violence during an ED shift. Nearly all residents (97%, 115/119) experienced verbal harassment, 78% (93/119) had experienced verbal threats, and 52% (62/119) reported sexual harassment. Almost a quarter of residents felt safe "Occasionally," "Seldom" or "Never" while at work. Patient-based factors most commonly cited as contributory to violence included substance use and psychiatric disease.

Conclusion: Self-reported violence against EM residents appears to be a significant problem. Incidence of violence and patient risk factors are similar to what has been found previously for other ED staff. Understanding the prevalence of workplace violence as well as the related systems, environmental, and patient-based factors is essential for future prevention efforts. [West J Emerg Med. 2016;17(5)567-573.]

INTRODUCTION

Nearly two million assaults occur annually as a result of workplace violence in the United States, with 12% occurring in the healthcare industry.[1] Workplace violence is defined as any act or threat of physical violence, harassment, intimidation, or other threatening and disruptive behavior at one's place of employment.[2] One of the highest risk areas in the hospital for workplace violence is the emergency department (ED).[3] Staff members care for acutely ill and injured patients with a broad spectrum of undifferentiated medical conditions, social issues, and psychiatric disease that may cause these individuals to become unpredictably aggressive or violent during their stay.

In a recent survey of ED staff, 51% of physicians reported being physically assaulted by a patient or visitor.[4] In 20% of EDs, guns or knives are present daily or weekly,[5] and the ED is the most frequent site for hospital shootings.[6] Even verbal threats can be a serious problem, as they have been shown to increase the risk of future serious incidents of violence.[7] Despite these risks, 50% of residents feel that their hospital

security is inadequate.[8] To our knowledge, there has been only one previous study that focused exclusively on the resident experience with physician harassment, where McNamara et al demonstrated nearly universal harassment (98%) with an associated increased risk of physician burnout.[9] For over 20 years, there has been no new research that focuses exclusively on violence against residents in the ED.

Physicians with fewer years of training have been shown to be more often subjected to workplace violence,[10] and are likely to have less experience and training in managing such difficult situations. Residents may also be less inclined to document violent events for fear of consequences, and are known to experience significant barriers to reporting these sentinel events.[11] The purpose of this study was to quantify and describe the current incidence of violence and harassment against emergency medicine (EM) residents by patients and visitors, as well as identify current perceived barriers to safety in the ED.

METHODS

Study Design, Setting, and Population

This was a cross-sectional survey study conducted at three EM residency training programs based within the Mount Sinai Health System in New York City, including four large tertiary care facilities as well as two public hospitals and two trauma centers with a combined census of over 500,000 annual ED visits. All 142 EM residents within the Mount Sinai system were eligible to participate (60 at one postgraduate year [PGY]1-4 program and 82 at two PGY1-3 programs).

This study was approved as exempt research by the institutional review boards at each of the participating institutions.

Study Protocol

Two independent investigators searched PubMed using the search terms "violence," "assault," "emergency department," "staff," "residents," "housestaff," and "health care workers" to identify a potential survey instrument. Among the studies identified through this search, the investigators determined by mutual agreement which set of survey questions had the greatest applicability to the resident population to be evaluated. The survey instrument selected as most relevant was published by Gates et al (2006) and included a variety of multiple-choice questions regarding the amount and types of violence (e.g. physical, sexual) that staff experienced or witnessed as well as perceived barriers to safety in their EDs (see Appendix A).

The residency leadership team at Mt. Sinai, comprised of the program director, assistant program directors and chief residents, reviewed the survey instrument and adapted it. Questions unrelated to the experience of resident physicians were removed from the original Gates instrument. Additionally, exhaustive definitions of each type of violence that were included in the original study were omitted and condensed descriptors were substituted for brevity; language limiting the reportable incidents to the previous six months was also removed as off-service rotations creating uneven amounts of time in the ED was thought to be a potential confounder. The revised instrument was piloted on two recent Mount Sinai Health System residency graduates who were not a part of the study; slight revisions were made to the wording of questions for clarification.

Paper copies of the survey instrument were distributed to residents at the time of their 2015 annual American Board of Emergency Medicine In-Training Examination (ABEM ITE). Participation in the study was optional, and responses were kept anonymous. Residents were informed that exclusion or non-participation in the study would not affect their performance on the ABEM ITE or their resident standing, and instructed to report their personal experiences only. Completion of the survey implied assent. We excluded from participation residents who were absent from the ABEM ITE or did not complete the survey at that time. Surveys were collected at the end of the ABEM ITE, and results were entered into a secure database.

To compare respondent demographics to those of the entire population in order to assess for nonresponse bias, we reviewed demographic data provided by each residency. Sex demographics of the entire population were compared to those that anonymously participated in the survey.

Outcome Measures

The primary outcome was the incidence of violence experienced by residents while working in the ED during their EM residency thus far. The secondary outcomes were the subtypes of violence experienced by residents as well as the perceived barriers to safety while at work.

Data Analysis

Completed survey data were entered into a secure Microsoft Excel (2011, Redmond WA) spreadsheet by a trained research assistant blinded to the objectives of the study. We calculated descriptive statistics as well as one-way ANOVA and odds ratios using IBM SPSS version 20.0 (2011, Armonk NY).

RESULTS

Demographics

The response rate to our survey was 84% (119/142). Female residents comprised 37.8% (44/119) of the participants. This was highly representative of the overall population based on review of the residency websites, which demonstrated a female population of 37.3% (52/142). There were 36 PGY1, 35 PGY2, 36 PGY3, and 12 PGY4 residents across all residencies of the 119 residents who completed the survey. Mount Sinai represented 52 of the 119 respondents, Mount Sinai Beth Israel represented 39 of the 119 respondents, and Mount Sinai Saint Luke's Roosevelt represented 28 of the 119 respondents.

Table 1. Number of violent incidents reported by residents, with the second column representing events committed by patients, and the third representing those committed by visitors.

	Patients		Visitors	
Incidents	Frequency	Percent	Frequency	Percent
0	41	34.5	105	88.2
1	26	21.8	9	7.6
2	25	21.0	4	3.4
3	11	9.2	1	0
4	7	5.9	0	0
5	3	2.5	0	0
6	1	0.8	0	0
7+	5	4.2	0	0
Total	119	100	119	100

Physical Abuse

A majority of subjects (65.5%, 78/119) reported an experience of physical violence in the ED committed by a patient, while 11.8% (14/119) reported experiencing violence committed by visitors. The median number of times a resident experienced violence by a patient during their EM residency was 1.0 (IQR [2.0–0.0]) while the median number of times a resident experienced violence from a visitor was 0.0 (IQR [0.0-0.0]). The frequency of number of reported violent incidents committed by patients and visitors is displayed in Table 1.

There was a statistically significant difference between PGY level and frequency of violent incidents from patients as determined by one-way ANOVA F(3,115)=5.3, p=0.002. A Tukey post-hoc analysis revealed a statistically significant difference in violent incidents between PGY1s (0.7 ± 1.2) when compared to PGY2s (1.9±2.1, p=0.02 CI [0.13-

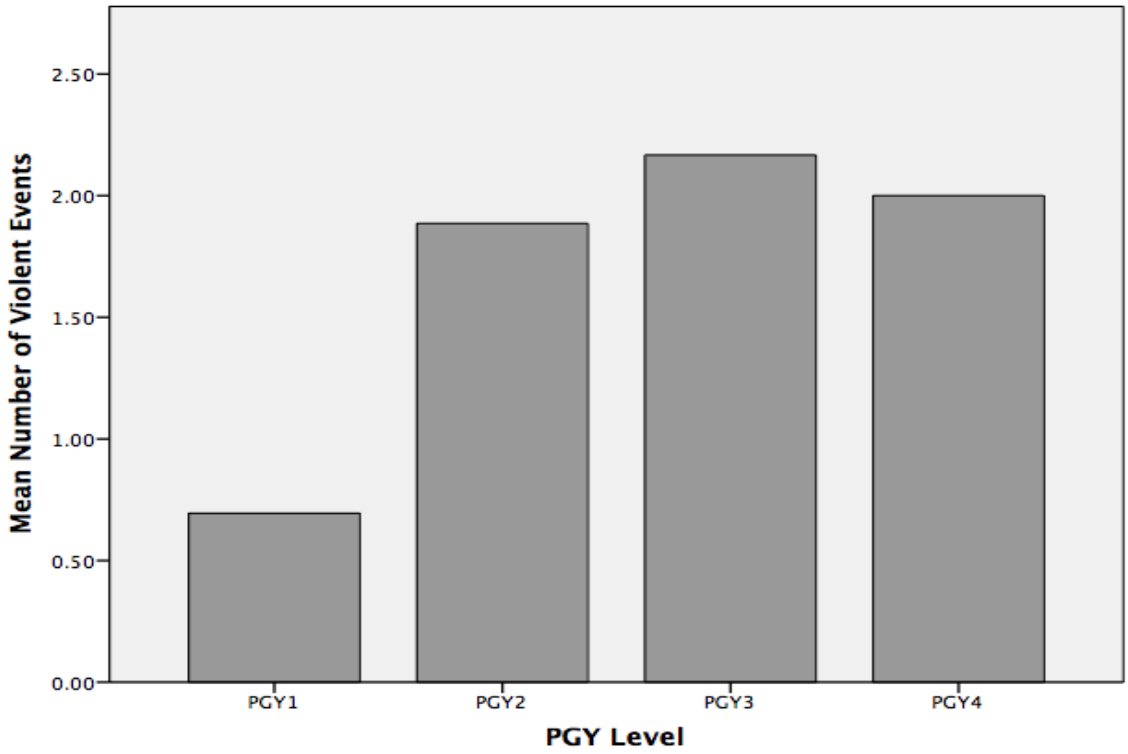

Figure. Mean number of violent events from patients by postgraduate year (PGY) level.

Table 2. Descriptive statistics for those residents who experienced verbal harassment, verbal threats and sexual harassment in the emergency department from patients and visitors.

Report		Frequency	Percent
Verbal harassment	From patient (n=119)	115	96.6
	From visitor (n=119)	103	86.6
Verbal threats	From patient (n=119)	93	78.2
	From visitor (n=118)	66	55.9
Sexual harassment	From patient (n=119)	62	52.1
	From visitor (n=119)	26	21.8

2.3]) and PGY3s (2.2±1.6, p=0.002 CI [0.42-2.5]), however no significant difference when compared to PGY4s (2.0±2.1, p=0.105 CI [-0.2-2.8]). There was no significant difference for PGY2s when compared to PGY3s (p=0.899 CI [-1.3-0.77]) or PGY4s (p=0.997 CI [-1.4-1.6]), and PGY's had no statistically significant difference in attacks when compared to PGY3's (p=0.991 CI [-1.6-1.3]), suggesting both a consistent pattern of exposure time and violence and no protective or harmful effect of years of experience. Mean number of violent incidents for each PGY level is depicted in the Figure.

Verbal Harassment

Nearly all of the respondents (115/119, 96.6%) reported prior verbal harassment from a patient in the ED. Slightly fewer (103/119, 86.6%) reported prior verbal harassment from a visitor. More than three quarters (93/119, 78.2%) reported having experienced verbal threats from a patient while a majority (66/119, 55.5%) reported prior verbal threats by a visitor. Further descriptive statistics can be found in Table 2.

Sexual Harassment

Sexual harassment by a patient was reported by a majority (62/119, 52.1%) of the residents. Of these, 31/74 (41.9%) of the male responders reported sexual harassment, while 31/45 (68.9%) of the female responders reported the same. Descriptive statistics for sexual harassment are provided in Table 2. There was an increased odds ratio between gender and likelihood of sexual harassment (OR=3.071 95% CI [1.4-6.7]). Sexual harassment by a visitor was reported by 26/119 (21.8%) of the respondents, with 15/74 (20.3%) of the male and 11/45 (24.4%) of the females reporting this experience. There was minimal difference in odds between these groups with OR=1.273 (95% CI [0.5-3.1]). Resident reported sexual harassment is further characterized in Table 2.

Contributing Factors

Almost all of the respondents (118/119, 99.2%) reported that certain patient factors contribute to physical abuse. Among these, the most frequently reported were alcohol (113/119, 95.0%) and drug use (112/119, 94.1%). Psychiatric disease was also reported frequently as a contributing factor with (109/119, 91.6%) respondents reporting that this may have contributed to their experiences, while 70/119 (58.8%) reported organic causes such as dementia leading to physical abuse. The patient's inability to deal with a crisis situation was cited by 76/119 (63.9%) of the respondents cited as a factor for physical abuse.

Nearly all participants (118/119, 99.2%) reported environmental factors such as a lack of security or police presence (82.4%; 95% CI [75.5-89.2%]), and security or police not responding in a timely manner (68.1%; 95% CI [59.7-76.4%]) as the most common contributors to physical abuse. Patient areas being open to the public, and ease of bringing weapons into the ED were both cited by 69 (58.0%) as leading to increased risk of violence.

Slightly fewer residents (115/119, 96.6%) reported staffing factors as a cause of physical abuse, with a lack of adequate staff (79.8%; 95% CI [72.6-87.0]) being the most common. Slightly less than half (59/119, 49.6%; 95% CI [40.6-58.6%]) of respondents felt that working evening and nights made them more likely to encounter violence.

Workplace Safety

Nearly a quarter of resident responders (27/119, 22.7%) reported feeling "Occasionally," "Seldom" or "Never" safe while at work in the ED. Almost half (58/119, 48.7%) felt "Very Dissatisfied" or "Somewhat Dissatisfied" with the current security in their ED. Tables 3 and 4 demonstrate the descriptive statistics for questions regarding workplace safety in our survey.

Table 3. Frequency at which residents reported feeling safe at work.

	Frequency	Percent
Never	8	6.7
Seldom	1	0.8
Occasionally	18	15.1
Often	79	66.4
Always	13	10.9
Total	119	100.0

Table 4. Resident satisfaction with emergency department security.

	Frequency	Percent
Very dissatisfied	16	13.4
Somewhat dissatisfied	42	35.3
Neutral	22	18.5
Somewhat satisfied	29	24.4
Very satisfied	10	8.4
Total	119	100.0

Violence Prevention

A small minority of residents (20/119, 16.8%) confirmed prior training in violence prevention or de-escalation techniques, 17 of these within the preceding 12 months. Nine of these (45%) were PGY 1s, with four (20%), three (15%) and four (20%) representing PGY 2, 3 and 4s respectively. Fourteen (74%) of those who took violence prevention training courses were male.

DISCUSSION

In the past two decades, only one other study has focused exclusively on the resident physician experience with violence in an American urban ED, with our results demonstrating similar measurements of violence against emergency physicians in training. Our response rate was overall high, with 84% of potential respondents participating in the study. Respondent demographics were comparable to the overall population of the participating residencies (62.6% male, 37.3% female) and also appear to be representative of the demographics of emergency medicine across the country, with the latest documentation from the Association of American Medical Colleges demonstrating EM residents as being 63% male and 37% female.[12]

Our results demonstrate that 78% of respondents experienced at least one act of workplace violence, which is consistent with a previous study reporting a rate of 76%,[13] but higher than another report that 37% of resident physicians had experienced physical violence committed by patients and visitors.[9] Touzet et al reported an even higher rate of violence committed against ED staff, with 96% experiencing a violent incident (although this study population also included nurses and medical technicians).[3] Only 16% of residents in our study reported prior training in violence prevention or de-escalation techniques. This percentage is similar to prior studies in which 14% of ED physicians overall had previously participated in violence training/workshops.[14]

The patient-based factors reported in this study to correlate most highly with propensity to violence (alcohol, drug use, and history of psychiatric disease, 95%, 94.1%, and 91.6%, respectively), are similar to what has been reported in prior literature.[3,8] Previous studies of ED-based workplace violence have found that 84% of all physician respondents believed that patients making verbal threats were intoxicated "frequently or most of the time." Similarly, 68% of physicians believed that those patients who had physically assaulted them in the ED were intoxicated "frequently or most of the time."[8]

The majority of residents in this study reported at least one incidence of verbal harassment (96.6%) or verbal threats (78.2%). This is higher than previously reported levels of verbal harassment of residents by patients and visitors of 86.1% and verbal threats of 60.9%.[9] Over half (52.2%) of residents in the current study reported being sexually harassed by a patient, and the majority also reported sexual harassment (68.9% of female participants, 41.9% of male participants). These findings suggest a higher prevalence of sexual harassment, especially of male residents, than previously reported.[3]

While it is important to note that 77.3% of the residents in our study reported feeling safe at work "Often" or "Always," nearly a quarter of residents felt safe "Occasionally," "Seldom" or "Never" while working in the ED. These results are nearly identical to prior studies in which 25% of all eemergency physician respondents reported feeling safe at work "Sometimes," "Rarely," or "Never."[4,8] A study of all ED staff found that only 7.2% "always" felt safe in the ED, similar to the 10.9% of residents who "always" felt safe in our study. An unsafe work environment has been shown to correlate with negative mental health effects,[15] increased costs to the hospital,[16] decreased productivity at work,[17] and decreased job satisfaction for ED staff, along with having harmful effects on patient care.[18] A work environment that is perceived as unsafe also detracts from resident wellness: residents questioned their decision to become emergency physicians, and experienced emotional and family disruption as a result of workplace violence.[9] Although our study found similar rates of violence against residents as previous studies that included a broader range of workers in the ED, it is interesting to note that residents, attending physicians, nurses and other ED staff each have very different levels and rates of contact with potentially violent patients.

Self-reported violence against EM resident staff committed by patients and visitors is a significant concern within the ED environment, and the majority of residents in this study reported being the victim of at least one incident of physical violence or sexual harassment in the ED. If these results are validated with prospective, observational data, ED security policies and staffing should be examined to ensure that they are maximizing the safety of ED staff. On an institutional level, hospital leadership can commit to a comprehensive violence reduction plan.[7] On a state or national level, policy changes that clearly define a no-tolerance policy for ED violence would likely help reduce the incidence of violence against all ED staff. As our study found a higher rate of sexual harassment for physicians than has been previously reported, future research could aim to confirm these findings and examine specific interventions to target this behavior.

Additionally, nonviolence and de-escalation techniques should be further investigated as a possible method to reduce violent incidents in the ED.[19] If successful, these training programs could be explored as a possible addition to the ABEM Model of Clinical Practice for Emergency Medicine.

LIMITATIONS

The study was based on self-reported survey responses, so the results may be vulnerable to recall bias; as with all surveys, there is no way to objectively verify the accuracy of the reported incidents. This was a cross-sectional study and therefore represents only one moment in time. The time of year of the survey, as well as several well-publicized incidents of violence in the depertment in the months before the survey may have influenced the residents' recall. This study asked residents at all stages of their training to report their exposure to violence without controlling for the number of months spent in the ED (due to PGY year or off-service rotations), which may have affected reported levels of violence. This survey was provided to residents at urban, academic hospital centers and may not be representative of other hospital or clinical settings with a different patient populations and less alcohol/substance abuse or psychiatric disease. However, given the number and variety of New York hospitals surveyed, the results are likely representative of the experience in the city at large. The response rate for this study was 84%. We were unable to account for demographic information for those residents who did not participate in the survey, as we did not collect data from this group. However, we did attempt to compare the demographics of those who completed the survey with the residency populations as a whole based on each residency's respective website. While participation holds the potential for selection bias, we presume a lack of participation was most likely due to missing the ABEM ITE. Missing the ABEM ITE was most likely due to clinical responsibilities or vacation; therefore, those who did not respond to our survey were unlikely to be systematically different from our respondents, and our analysis of the demographics of the residency websites seems to confirm this. It is possible that residents who responded to the survey may have had experienced a greater or fewer number of episodes of violence than the population at large, but we consider systematic bias unlikely. While we attempted to include all of the most commonly cited reasons for ED violence in our survey, it is possible there were other reasons missed by our instrument. Additionally, our modified survey instrument has not been validated for use in the ED population, though modifications for our study were minimal.

CONCLUSION

In summary, workplace violence is experienced by New York City residents at an alarming rate, similar to previously reported rates of violence for attending physicians and other ED staff. Psychiatric disease and substance use among patients are reported risk factors for increased threats and violence. As a workplace that is perceived to be unsafe has been shown in other studies to affect job satisfaction and patient care, further research is warranted to determine the parameters that affect violence in the ED.

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Derivation of Two Critical Appraisal Scores for Trainees to Evaluate Online Educational Resources: A METRIQ Study

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Introduction: Online education resources (OERs), like blogs and podcasts, increasingly augment or replace traditional medical education resources such as textbooks and lectures. Trainees' ability to evaluate these resources is poor, and few quality assessment aids have been developed to assist them. This study aimed to derive a quality evaluation instrument for this purpose.

Methods: We used a three-phase methodology. In Phase 1, a previously derived list of 151 OER quality indicators was reduced to 13 items using data from published consensus-building studies (of medical educators, expert podcasters, and expert bloggers) and subsequent evaluation by our team. In Phase 2, these 13 items were converted to seven-point Likert scales used by trainee raters (n=40) to evaluate 39 OERs. The reliability and usability of these 13 rating items was determined using responses from trainee raters, and top items were used to create two OER quality evaluation instruments. In Phase 3, these instruments were compared to an external certification process (the ALiEM AIR certification) and the gestalt evaluation of the same 39 blog posts by 20 faculty educators.

Results: Two quality-evaluation instruments were derived with fair inter-rater reliability: the METRIQ-8 Score (Inter class correlation coefficient [ICC]=0.30, p<0.001) and the METRIQ-5 Score (ICC=0.22, p<0.001). Both scores, when calculated using the derivation data, correlated with educator gestalt (Pearson's r=0.35, p=0.03 and r=0.41, p<0.01, respectively) and were related to increased odds of receiving an ALiEM AIR certification (odds ratio=1.28, p=0.03; OR=1.5, p=0.004, respectively).

Conclusion: Two novel scoring instruments with adequate psychometric properties were derived to assist trainees in evaluating OER quality and correlated favourably with gestalt ratings of online educational resources by faculty educators. Further testing is needed to ensure these instruments are accurate when applied by trainees. [West J Emerg Med. 2016;17(5)574-584.]

INTRODUCTION

With widespread access to and use of the Internet, there have increasingly been calls by the academic community for scientists to share their knowledge with the public and data with fellow researchers.[1-2] Consistent with this open access movement, there has been a push to expand the repository of online educational resources (OERs). In medical education, this movement has been dubbed Free Open Access Medical education (FOAM). Social media platforms, such as blogs and podcasts, have catalyzed the proliferation of OERs partly because of their ease of publishing.[3-4] Because these resources are readily accessible and literally at the fingertips of most clinicians and trainees, they are increasingly supplanting both medical journals and textbooks as a leading source of individualized, asynchronous learning.[5-7] Furthermore, healthcare professionals are forming virtual communities of practice to share knowledge and network with their peers and trainees, revolving around these social media platforms.

With these new resources comes the burden of teaching learners and educators how to critically appraise them. Just as critical appraisal of primary literature is a key component of a robust medical education, so too is the ability to critically read secondary reference materials such as review papers and textbooks. However, whereas most medical school and residency curricula are required to incorporate the critical appraisal of the medical literature,[8-9] little attention is given to appraising secondary resources such as textbooks, lectures, and OERs. This is concerning because inter-rater reliability of gestalt ratings of these products by trainees is quite poor.[10] Whereas multiple critical appraisal instruments have been published to assist clinicians in the evaluation of the literature (e.g. the *Journal of the American Medical Association* User's Guide to the Medical Literature series[11]), none have been developed for OERs.

Several recent studies have explored how to evaluate blogs and podcasts. Using a modified systematic review, Paterson et al. found 151 quality indicators for secondary resources in the existing educational literature that may be relevant for these resources.[12] Subsequently, medical educators in various specialties as well as expert bloggers and podcasters in emergency medicine and critical care endorsed many of these quality indicators in two modified Delphi studies.[13-14] Another rating tool, dubbed the *Academic Life in Emergency Medicine* Approved Instructional Resources (ALiEM AIR) Score, was developed for use by groups of medical educators.[15] This score was based on a best approximation of what educators thought were key features of a robust blog post or podcast summary. None of these studies, however, provided a practical, simplified scoring tool to help health professionals and trainees assess the quality of OERs.

In this study, we attempted to translate the information from the previous review of the literature[12] and modified Delphi studies[13-14] to create a functional quality evaluation instrument to guide trainees in critical appraisal of blog or podcast-related written materials.

METHODS

This study was conducted in three phases. Phase 1 reduced a previously derived and evaluated list of quality indicators to a manageable number for further assessment using data reduction techniques. Phase 2 further evaluated the remaining quality indicators in a group of trainees. We used these data to derive quality evaluation instruments and assess their reliability. Phase 3 assessed the concordance of the derived instruments with two currently accepted methods of quality evaluation (ALiEM AIR certification and educator gestalt).

An institutional review board granted an exemption for all three phases of the study. Phase 1 of the study involved the further analysis of data obtained in three previous studies[13, 16-17] that were granted exemptions by the Hamilton Research Ethics Board (http://fhs.mcmaster.ca/healthresearch/hireb.html). Phase 2 and 3 also received an exemption. Phases 2 and 3 involved a multi-centre, web-based, cohort rating study that was conducted during April-August 2015.

Phase 1: Quality Indicator Selection.

This study built upon the work of three previously published studies. Paterson et al. defined 151 potential quality indicators that could be applied to OERs such as blogs and podcasts.[12] This extensive list, however, is too unwieldy for learners to use practically in guiding their decision-making for appraising OERs. Subsequently, two consensus-building Delphi studies were conducted to identify what expert groups (medical educators, expert podcasters, and expert bloggers) felt were the most important quality indicators.[13-14, 18] For the purposes of Phase 1 of this study, iterative steps were made to shorten the list of quality indicators.

The overall process is depicted in Figure 1. First, we examined the priorities of expert groups (medical educators, expert OER producers) from two previous modified Delphi studies.[13-14] These expert groups were selected by peer nomination via snowball sampling technique[14] or by self-determination through attendance at an international consensus conference.[13] In both of these studies all 151 items were ranked on seven-point Likert scales (1=strongly disagree, 7=strongly agree with item). As such, we were able to use these data to calculate item total correlations (ITC) for the 151 possible quality indicators. ITCs are an indication of the relationship between individual items and the measurement of the scale. We eliminated items with an ITC of less than 0.3, because low ITCs can be used to eliminate items that poorly fit with the scale's measurement construct.[19]

Items with a low mean score across all the experts in the two Delphi groups (i.e. rated <5.5 on the 7-point scale) were also eliminated as possible items for our score derivation. To ensure that we valued the ratings of all groups, we also conducted a principle component analysis to look at the groupings of priorities across the groups of educators, podcasters, and bloggers.

Finally, we conducted a two-round consensus building exercise within our study team's clinician educators (TC,

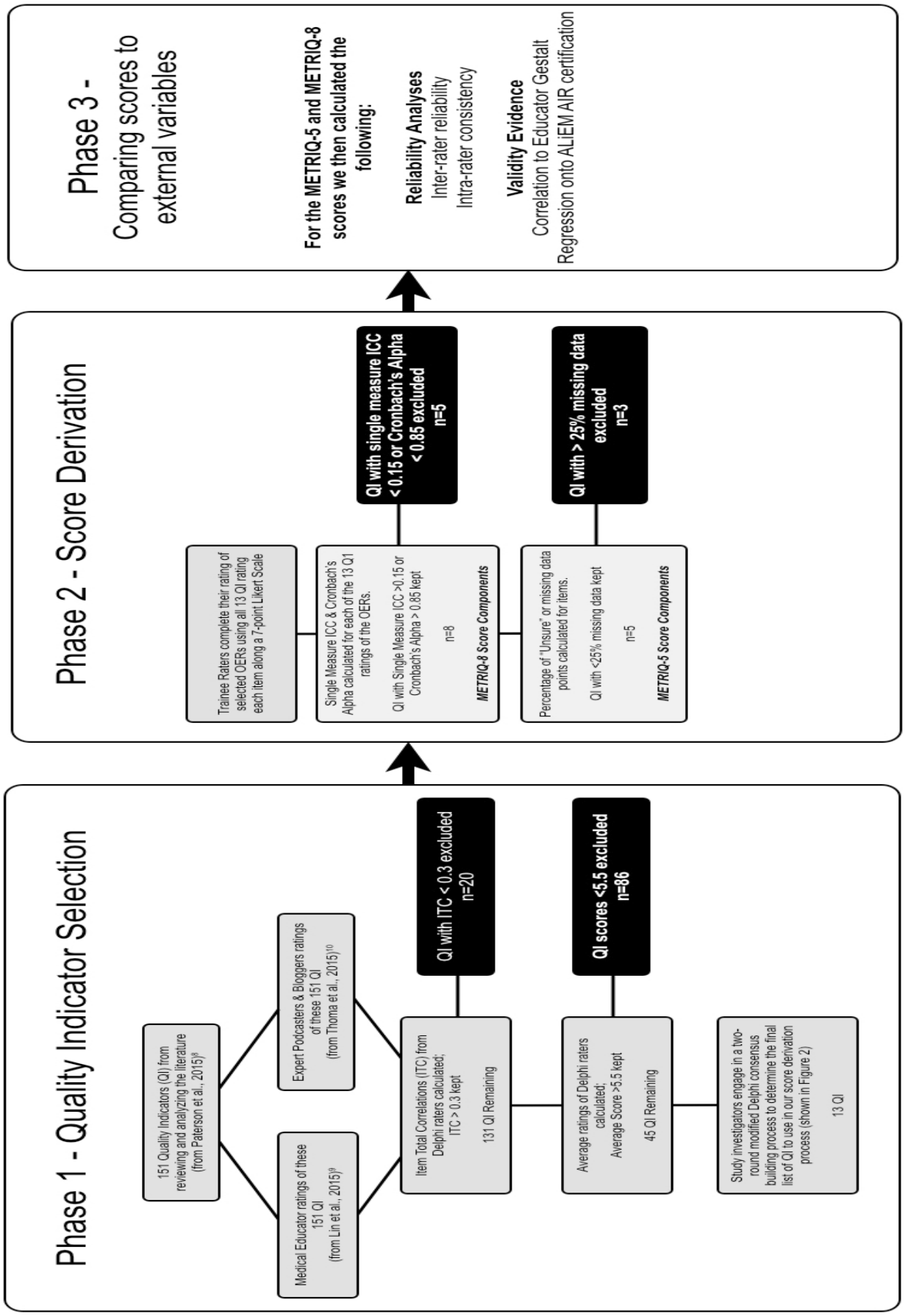

Figure 1. Flow diagram of study design. Phase 1 depicts the quality-indicator (QI) selection process, Phase 2 depicts the score derivation process based on the reduced list of QIs, and Phase 3 describes the reliability and validity testing data for the two derived instruments for scoring the quality of medical blogs and podcasts.
QI, quality indicator; *ITC*, item total correlation; *ICC*, intraclass correlation coefficient; *ALiEM*, Academic Life in Emergency Medicine; *AIR*, approved instructional resources.

Table 1. Parent websites and distribution of the 39 selected blog or podcast online educational resources (OER), from which the gestalt score was derived (Phase 2).

Website name	Number of rated posts
Academic Life in Emergency Medicine	12
BoringEM	1
Clinical Monster	1
Dr. Smith's ECG blog	2
Don't Forget The Bubbles	2
Emergency Medicine Ireland	1
EM Lyceum	3
EM Basic	1
EMCrit	1
EM Literature of Note	1
ERCast	3
Life in the Fast Lane	2
Pediatric EM Morsels	4
R.E.B.E.L EM	1
The NNT	1
The Poison Review	2
The Skeptics Guide to Emergency Medicine	1

NB: For a complete listing of all the rated blog posts, please refer to Appendix.

BT, ML, CC, MA) to determine items we felt would be most easily rated by junior learners without training. Our team focused on eliminating items that demonstrated any of the following: required extensive knowledge or expertise, were difficult to judge without training, or were difficult to understand or define.

Phase 2: Critical Appraisal Score Derivation

Rater Population and Materials. Participating collaborators were trainees (medical students, n=36; residents, n=9) from Canada and the United States, who were recruited from centers affiliated with our investigatory team and by a snowball referral process. The participants are all listed as collaborators in this study in the acknowledgments section and participated voluntarily.

The rated materials were drawn from a list of openly accessible online blog posts, previously rated for educational merit by the ALiEM AIR program (http://www.aliem.com/new-air-series-aliem-approved-instructional-resources/).[15] From a list of the initial 80 ALiEM AIR-rated OERs, we randomly selected 39 (20 were ALiEM AIR certified as good quality, and 19 that were not) for inclusion in Phase 2. Table 1 lists the parent websites for these 39 blog post or podcast-related OERs, and Appendix lists each OER's website addresses and expert gestalt ratings.

Data Collection and OER Scoring. Participating trainee raters were given three months to rate 39 OERs using a web-based Google Forms survey. Each OER was rated on 13 potential scoring system items from our reduced list (Figure 2). Each item was rated upon a seven-point Likert scale, which was anchored at 1 by the statement "Attribute not displayed," and at 7 by the statement "Attribute displayed well."

One OER was rated twice by each rater to allow for a calculation of intra-rater consistency. We used a modified Dillman technique to provide raters with three reminders over the study duration.[20]

Derivation of Our Scoring System Models. To derive our proposed scoring systems, we calculated the single measure intraclass correlation coefficient (ICC) and Cronbach's alpha for each of the 13 potential scoring system items for all the trainee-rated OERs.[19] We also calculated a repeated-measures ANOVA to determine intra-rater consistency for the 13 potential subscores (quality indicators) for the same rater rating the same OER at two different times.

As there were many 'missing data' due to rater uncertainty, we used the imputation model of substituting the grand mean for each quality indicator item to compensate for these. This imputation technique is deemed a highly conservative approach for calculating an ICC and Cronbach's alpha. A subset of the investigatory team (TC, KK) then set a Cronbach's alpha threshold (or average measures ICC) of ≥0.85 and a Single Measure ICC of ≥0.15 in order to derive our first scoring system model, as we felt that items that scored <0.15 in the ICC would be considered quite poor. Of note, single measure ICC measures of 0.1-0.2 are considered poor, 0.3-0.4 are considered fair, 0.5-0.6 considered moderate, 0.7-0.8 indicates strong agreement, and >0.8 indicates almost perfect.[19] The items that met these thresholds were used to generate the first model.

Table 2. Educator gestalt rating scale of blogs and podcasts for trainee learning.

Would you recommend this to a learner?							
0 Unsure	1 No, this is an inappropriate resource for this audience	2	3	4 This may be useful to this audience	5	6	7 Yes, this is a great resource for this audience

Q1. Universal technology - Does the resource employ technologies that are universally available to allow learners with standard equipment and software access?
Q2. Maintenance - Is the resource maintained such that its text and multimedia elements remain functional?
Q3. Concise content - Does the resource contain an appropriate amount of information for its length?
Q4. Scholarly use of language - Does the resource use efficient, accurate language that is appropriate for its target audience?
Q5. Is the editorial process independent from sponsors, conflict of interest, and other sources of bias?
Q6. Are the processes (e.g. editorial, peer review, evaluation, etc) that were used to create the resource outlined?
Q7. References - Does the resource cite its references?
Q8. Editorial process - Is there an editorial process?
Q9. Consistency with citations - Are the resource's statements consistent with its references?
Q10. Background - Does the resource provide enough background information to situate the learner in the context of prior knowledge?
Q11. Moderation - Are interactions between learners moderated effectively to ensure professional conduct?
Q12. Publisher - Is it clear who published the resource?
Q13. Reading/Listening - Is the resource composed in a way that makes it easy to understand? (not overly convoluted)

Figure 2. Final list of 13 quality indicators rated by trainee raters on a 7-point Likert scale.

Our second model incorporated the previous model, but eliminated items that generated a substantial amount of missing data (i.e. rated as "unsure"). For practicality, we felt it was important for individual raters to be able to use the quality indicator subscore items. Therefore, any items yielding a substantive amount of missing data (i.e. >25% of items were unable to be scored by the trainee raters) were eliminated as well.

Phase 3: Comparing the scoring models with educator gestalt and ALiEM AIR ratings

Rater Population, Materials, and Data Collection. Participating collaborators for educator gestalt ratings were practicing academic emergency physician volunteers with a primary interest in medical education (n=20) from Canada and the United States. The participants were recruited by members of the investigatory team (TC, BT, ML, CC, MA) and are all listed as collaborators in this study in the acknowledgments section. ALiEM AIR certification status information was taken from the first six modules listed on the ALiEM.com webpage (https://www.aliem.com/aliem-approved-instructional-resources-air-series/).[14]

Outcome Variables:

Other Critical Appraisal Methods. Informed by the components of external validity described by Messick,[22] we

Table 3. Demographics of raters who evaluated online educational resources.

	Instrument development trainee raters (n=40)		Expert gestalt educator raters (n=20)	
% by country of origin	2.5% United States of America 97.5% Canada		75% United States of America 25% Canada	
Year of training or years in practice at the time of their enrollment	0 years in practice (All are trainees)		10.3 years in practice (SD 10.2)	
Academic affiliation	Year 1 medical student	40%	Full professor	10%
	Year 2 medical student	30%	Associate professor	15%
	Year 3 medical student	18%	Assistant professor	65%
	Year 4 medical student	3%	Clinical appointment	10%
	Year 1 resident	5%	None	5%
	Year 2 resident	3%		
	Year 3 resident	3%		
% current or past official medical education position within institution	N/A		90% total Breakdown	
			Dean / chair	15%
			Residency PD	40%
			Residency APD	45%
			Other GME role	30%
			Clerkship director / UGME role	30%
			Research/quality Improvement role	20%

PD, program director; *APD*, associate or assistant program director; *GME,* graduate medical education; *UGME,* undergraduate medical education.

Table 4. Correlations between the scores by subjects in the first and second rating incidence.

Question item number	Pearson's *r* between the first rating and second rating of each possible quality indicator subscore item	p-value
Q1	0.92	<0.001
Q2	0.84	<0.001
Q3	0.37	0.05
Q4	0.63	<0.001
Q5	0.33	0.08
Q6	0.45	0.02
Q7	0.93	<0.001
Q8	0.57	0.001
Q9	0.74	<0.001
Q10	0.71	<0.001
Q11	0.79	<0.001
Q12	0.81	<0.001
Q13	0.85	<0.001

compared the scoring models to other existing measures of quality for OERs.

The 39 trainee-scored OERs were rated by educators using the same data collection method outlined in Phase 2. However, rather than rating each OER using the 13 quality indicators, the faculty were asked to use their gestalt, expert judgment to decide whether the OER would be acceptable for trainee learning. See Table 3 for the qualifications of the faculty raters. Educator's gestalt was rated using a seven-point Likert scale (Table 2).

In addition to the educator gestalt score, the ALiEM AIR certification process served as another comparative scoring system. This was a separate rating process external to our study and raters with a separate panel of nine expert faculty panellists selecting OERs for a resident audience. The certification of these posts is openly accessible via the

Table 5. Inter-rater agreement on the quality indicator subscore components, calculated using a 2-way random effects model for consistency to calculate the ICCs (interclass correlation coefficient).

Question item number	Single measure ICC*** (95% CI)	Average measure ICC*** (95% CI)	Number of missing data points	% Missing
Q1*	0.04 (0.02-0.08)	0.64 (0.47-0.79)	202	13%
Q2*	0.03 (0.01-0.07)	0.56 (0.35-0.74)	193	12%
Q3	0.17 (0.12-0.26)	0.89 (0.84-0.94)	206	13%
Q4*	0.12 (0.07-0.19)	0.84 (0.76-0.90)	208	13%
Q5*	0.10 (0.06-0.16)	0.81 (0.71-0.89)	713	45%
Q6**	0.28 (0.20-0.39)	0.94 (0.91-0.96)	476	30%
Q7	0.38 (0.28-0.50)	0.96 (0.94-0.98)	216	14%
Q8**	0.22 (0.15-0.32)	0.92 (0.89-0.95)	773	48%
Q9**	0.16 (0.11-0.25)	0.88 (0.82-0.93)	465	29%
Q10	0.22 (0.14-0.32)	0.92 (0.87-0.95)	287	18%
Q11	0.17 (0.11-0.26)	0.89 (0.83-0.93)	290	18%
Q12	0.29 (0.21-0.41)	0.95 (0.92-0.97)	319	20%
Q13*	0.14 (0.09-0.22)	0.87 (0.80-0.92)	285	18%

* Eliminated in Score Models 1 and 2 due to alpha <0.85 or single measure ICC <0.15

** Eliminated in Score Model 2 since trainees were unsure too often (>25% missing data)

*** p-value was <0.001 for all ICC calculated

Score Model 1: METRIQ-8 Score (Maximum 56 points)	Score Model 2: METRIQ-5 Score (Maximum 35 points)
Q3 Concise content - Does the resource contain an appropriate amount of information for its length?	Q3 Concise content - Does the resource contain an appropriate amount of information for its length?
Q6 Content Construction - Are the processes (e.g. editorial, peer review, evaluation, etc) that were used to create the resource outlined?	Q7 References - Does the resource cite its references?
Q7 References - Does the resource cite its references?	Q10 Background - Does the resource provide enough background information to situate the learner in the context of prior knowledge?
Q8 Editorial Process - Is there an editorial process?	Q11 Moderation - Are interactions between learners moderated effectively to ensure professional conduct?
Q9 Consistency with citations - Are the resource's statements consistent with its references?	Q12 Publisher - Is it clear who published the resource?
Q10 Background - Does the resource provide enough background information to situate the learner in the context of prior knowledge?	
Q11 Moderation - Are interactions between learners moderated effectively to ensure professional conduct?	
Q12 Publisher - Is it clear who published the resource?	

Figure 3. Two proposed online educational resources evaluation instruments.

Internet.[21] Of note, those who had acted as an ALiEM AIR rater were excluded from rating for this present study.

Validity Evidence

Akin to many clinical decision rule (CDR) study designs, we opted to perform regression analyses using our two newly derived score models to determine whether they would regress to two comparative scoring instruments: the educator gestalt score and the ALiEM AIR certification using a binary logistic regression model. For the purposes of the correlation analyses, we chose to use the pragmatic score models (with substitution of a zero score when there were missing data) since individual users would not have access to grand means for the subscore components.

RESULTS

Phase 1: Quality Indicator Selection

The overall results and process are depicted in Figure 1. ITCs for the 151 possible quality indicators were calculated using data from the previous Delphi studies.[13-14] Twenty items had an ITC<0.3, and 81 of the remaining items were rated <5.5 on the seven-point Likert scale across the two Delphi groups, and thus they were eliminated. The two-round, consensus-building exercise within our study team identified 13 of the final 45 items as being most easily rated by trainees. This list is outlined in Figure 2.

Phase 2: Score Derivation

Table 3 depicts the demographics for the 60 total volunteers, who were recruited for the OER rating exercises.

Of this group, 28 of the 40 trainee raters (27 medical students, one resident) completely reviewed all OERs in our study. The remaining 12 trainee raters yielded incomplete datasets requiring the use of an imputation model to calculate the ICC in our score derivation procedures as described in the methods section. All 20 educators generating the gestalt ratings reviewed the complete set of OERs.

Intra-Rater Consistency for the 13 Quality Indicators

Since one item was rated at two different points in our

Table 6. A comparison of the reliability calculations of the two proposed online educational resources evaluation instruments using different missing data procedures.

	METRIQ-8 score		METRIQ-5 score	
	Pragmatic analysis	Imputation analysis	Pragmatic analysis	Imputation analysis
Single measure ICC (95% CI)	0.30 (0.22-0.42)	0.38 (0.29-0.51)	0.22 (0.15-0.32)	0.35 (0.26-0.47)
Average measure ICC (95% CI)	0.94 (0.92-0.97)	0.96 (0.94-0.98)	0.92 (0.88-0.95)	0.96 (0.93-0.97)

ICC, intraclass correlation coefficient.

*NB: The pragmatic analysis awards a zero value to any missing data points. The imputation analysis substitutes the grand mean for the missing data points (any items which were not rated by the trainee raters).

Table 7. Relationships between average METRIQ-8 and METRIQ-5 Scores with other comparative instruments (average educator gestalt score, ALiEM AIR certification).

	METRIQ-8 score pragmatic score	METRIQ-5 score pragmatic score
Pearson correlation (r) to educator gestalt score for recommending resource to a trainee	r=0.35 p=0.03	r=0.41 p<0.01
Logistic regression for ALiEM AIR certification status	Odds ratio 1.28 (1.09-1.50) Wald test (1,38)=8.8 p=0.003	OR = 1.5 (1.14-2.20) Wald test (1,38)=8.4 p=0.004

rating exercise by our trainee raters, we were able to calculate a measure of internal consistency for the various items. For this analysis, we eliminated raters with incomplete data sets, using only the remaining raters to calculate a repeated-measures ANOVA to determine if there was a significant change in the quality indicator subscores when the rater encountered the OER on the second occasion. We did not detect a significant main effect of the repeated measurement occasion in our analysis ($F=0.54$, df (1), $p=0.47$). Across the 13 conditions, the first and second ratings of this item mostly correlated. We calculated the Pearson correlations for these scores, which ranged from 0.33 to 0.93 for the various items (Table 4).

Inter-Rater Reliability for the 13 Quality Indicators

After applying our selected imputation model (substitution of grand mean) to compensate for missing data, we calculated the intraclass correlation coefficients for each of the 13 quality indicator subscores. We used two-way random effects model for consistency measures to determine the single and average measure ICCs (Table 5). A single measure ICC allows us to understand the consistency of a randomly drawn single rater's scores. The average measure ICC gives the reliability of the score generated by averaging or totalling the scores of *all the raters* who evaluated the OER. It can help estimate how reliability is improved by increasing the number of raters or ratings and give an indication of the actual reliability of the score generated by using several raters.[19] This eliminated five of our possible quality indicator subscores items to generate the eight-item Score Model 1.

Missing Data Across the 13 Quality Indicator Subscores

Certain items yielded a high number of missing data points because participants were unsure whether to rank these items. For the purposes of deriving the score, we felt it would be prudent to generate a score model that only included items with a low number of missing data points. We therefore used a cut off of >25% missing data points within a subscore dataset to eliminate another three items from the list in Score Model 1 (eight items) to generate Score Model 2 (five items).

Properties of the Scores

Score Model 1 and 2 propose an eight-component and five-component score, respectively, which we will hereafter refer to as the METRIQ 8 Score and METRIQ 5 Score, respectively. Figure 3 lists the subscores for both OER evaluation instruments, proposed by this derivation study.

Reliability of the Aggregate Scores for METRIQ-8 and METRIQ-5

For the reliability calculation of the aggregate scores, we used both a pragmatic analysis which included 0-scores for any facet where a trainee rater was unsure and also an imputation analysis which included the grand mean of the subscore item. Both models were found to be moderately reliable regardless of the analytic approach with $p<0.001$, with the METRIQ-8 performing slightly more reliably than METRIQ-5. (Table 6).

Phase 3: Comparing the scoring models with educator gestalt and ALiEM AIR ratings

We evaluated our scoring model instruments against both educator gestalt and ALiEM AIR certification status. We first determined the correlation between our METRIQ-8 and METRIQ-5 models and average educator gestalt score for 20 educators. We also used a logistic regression model to determine if our models would regress upon the ALiEM AIR certification status (certified or not).

Correlation Between Mean Educator Gestalt Score and the Average METRIQ-8 and METRIQ-5 Scores

To strengthen the validity evidence for our nascent scoring systems, we calculated the Pearson correlation statistic for the average educator gestalt scores and the pragmatic versions of both METRIQ-8 and METRIQ-5. We detected moderate correlations ($p<0.05$ for both) between our proposed scores and the average educator gestalt scores as shown in Table 7.

Logistic Regression onto ALiEM AIR Certification Status

To determine if our score had a relationship with ALiEM AIR certification, we conducted a binary logistic regression on the ALiEM AIR certification status. As demonstrated by the Wald test, this yielded a significant odds ratio for both scores. The odds ratios for METRIQ-5 and METRIQ-8 scores were 1.28, ($p=0.03$) and 1.5 ($p=0.004$) respectively.

DISCUSSION

Teaching clinical providers the skill of critically appraisal OERs will be increasingly important as blogs and podcasts proliferate.[4] With traditional secondary resources such as textbooks and lectures, the credibility of the source of these teachings (i.e. the editorial board of a textbook or the professorial status of a teacher) are often cited as the rationale behind why trainees and educators accept these resources as unequivocally valid without formal critical appraisal. While neither trainees nor educators have traditionally given much thought to the critical appraisal of these traditional secondary resources, the ubiquity and accessibility of OERs makes it imperative that we begin to teach trainees to be both judicious and educated in their use of these resources. Similar to what the DISCERN score did for online patient-oriented materials,[23-24] our proposed METRIQ-8 and METRIQ-5 scores may allow us to ensure that trainees and educators are better able to appraise the quality of the resources they use to learn and teach, respectively.

Our investigatory team derived two scoring systems by drawing on the tradition of creating clinical decision rules (CDRs) to guide novice decision-making in patient care. We have attempted to follow a rigorous derivation process in this study, akin to those used to derive CDRs.[25-26] In fact, the culmination of this study is equivalent to a Level 4 derivation study.[26] Both of the proposed evaluation scoring instruments will require external validation. The METRIQ-8 score performs slightly better in terms of reliability. Its higher reliability may be a result of purely having more items, and thus yielding greater precision. In contrast, the METRIQ-5 score may be more easily used by trainees given its brevity (only five questions) and decreased complexity. The METRIQ-5 score may correlate better with other external measures of quality for these reasons.

Moving forward, further testing of the METRIQ scores in various populations will be required as reliability and validity are context specific, and depend on how the scores are used. METRIQ-8 and METRIQ-5 will need to be evaluated by separate and internationally diverse rater populations to provide further validity evidence, support their use, and extend their generalizability. Additionally, head-to-head comparisons with other scoring systems (such as the ALiEM AIR score, which is meant to be used by faculty members when selecting educational resources) will be necessary.[15] We were only able to look at the relationship of our new scores with ALiEM AIR certification status (i.e. awarded or not). The use of this dichotomous data (certified or not) rather than the detailed score results (a continuous score ranging from 0 to 35) may have limited our calculations. Finally, a prospective study design looking at whether these instruments correlate with usage (i.e. webpage views or social media sharing) may be useful.

In a previous study by our research group, we found that trainees were able to select resources with single-measure ICCs of 0.22 for each other.[10] The use of the pragmatic METRIQ-8 score improves upon this while the METRIQ-5 score approximates this consistency but further defines what may guide that gestalt. The much higher average measures ICCs suggest that a group-based rating system may be best for selection of resources for trainees. Much akin to other crowd-based rating systems (e.g. BEEM rating score[27-28] and Yelp), group-based decision-making ultimately may be the best guide for rating individual resources.

LIMITATIONS

There are several major limitations to this study. First, the use of the medical educator gestalt score as a reference standard may be questionable, since this measure has been shown to be insufficiently reliable and lacking sufficient validity evidence to provide consistent guidance to trainees.[10] However, it is the most commonly used method for determining the quality of OERs. Second, we have used uncalibrated raters. Previous research has shown that rater cognition improves significantly if we use calibration processes such as rater-training.[29] Third, we used a convenience sampling of raters in both the trainee and medical educator groups, which may have been biased by their contact with our investigatory group, although we attempted to sample broadly from multiple centres. We are actually quite hopeful that with rater training and calibration the use of the METRIQ scores could be improved. Fourth, our methods may be critiqued for being overly complicated. We have attempted to use robust and reproducible methods for reducing the 151 possible quality indicators that were previously found in the literature.[12] In an effort to aggressively reduce this list, we used fairly novel methods to create two sensibly compact evaluation instruments that may be reliably applied by trainees. As such, it is prudent to compare our new scores directly with other known scores such as the ALiEM AIR before extensive use. Moreover, this study also attempts to gather some validity evidence to support the two proposed scores, but is limited because we used the non-blinded ALiEM AIR certification status of OERs to compare with our two proposed scoring instruments. Finally, many of the authors for this paper are website editors, authors, or affiliated in some way with the various blogs listed used for this study. To minimize the effects of our bias, we sought collaborators with fewer stakes and affiliations (i.e. the peer-nominated experts) to review the materials. We also included members of the team (CC, KK, KK) who are not significantly invested in these OER outlets to provide some level of objectivity and reflexivity to our investigator team.

CONCLUSION

We have derived two possible evaluation instruments (METRIQ-8 and METRIQ-5), which may help trainees identify higher quality OERs, establish a precedent for reviewing and critically appraising secondary resources, and guide OER producers (bloggers and podcasters) to improve the quality of their educational content. These instruments correlated favourably with experienced faculty educator gestalt ratings of online educational resources.

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Treatment of Nausea and Vomiting in Pregnancy: Factors Associated with ED Revisits

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Introduction: Nausea and vomiting in pregnancy (NVP) is a condition that commonly affects women in the first trimester of pregnancy. Despite frequently leading to emergency department (ED) visits, little evidence exists to characterize the nature of ED visits or to guide its treatment in the ED. Our objectives were to evaluate the treatment of NVP in the ED and to identify factors that predict return visits to the ED for NVP.

Methods: We conducted a retrospective database analysis using the electronic medical record from a single, large academic hospital. Demographic and treatment variables were collected using a chart review of 113 ED patient visits with a billing diagnosis of "nausea and vomiting in pregnancy" or "hyperemesis gravidarum." Logistic regression analysis was used with a primary outcome of return visit to the ED for the same diagnoses.

Results: There was wide treatment variability of nausea and vomiting in pregnancy patients in the ED. Of the 113 patient visits, 38 (33.6%) had a return ED visit for NVP. High gravidity (OR 1.31, 95% CI [1.06-1.61]), high parity (OR 1.50 95% CI [1.12-2.00]), and early gestational age (OR 0.74 95% CI [0.60-0.90]) were associated with an increase in return ED visits in univariate logistic regression models, while only early gestational age (OR 0.74 95% CI [0.59-0.91]) was associated with increased return ED visits in a multiple regression model. Admission to the hospital was found to decrease the likelihood of return ED visits (p=0.002).

Conclusion: NVP can be difficult to manage and has a high ED return visit rate. Optimizing care with aggressive, standardized treatment in the ED and upon discharge, particularly if factors predictive of return ED visits are present, may improve quality of care and reduce ED utilization for this condition. [West J Emerg Med. 2016;17(5)585-590.]

INTRODUCTION

Background

Nausea and vomiting in pregnancy (NVP) refers to a spectrum of symptoms that affect 50-90% of all pregnant women, typically in the first trimester and can adversely affect both maternal and fetal health.[1-3] Hyperemesis gravidarum (HEG) represents the most severe form of NVP and is present in approximately 0.5 to 2 percent of pregnancies.[1,4,5] HEG is often characterized by maternal weight loss and fluid, electrolyte, and nutritional abnormalities[3] and is the most common indication for hospitalization during early pregnancy with an average of 1.3 hospital admissions per HEG patient. It is second only to preterm labor as the most common reason for hospitalization during pregnancy[6,7] and carries up to a 25% hospital readmission rate.[8] HEG is also the most common cause of pregnant patients missing time at work (average

hospital stay of 2.6-4 days) and reduced quality of life.[1,8] The obstetric literature suggests factors predisposing patients to the severe variants of NVP include nulliparity, younger patient age, non-white race, and the presence of comorbidities including pre-existing diabetes, depression or other psychiatric illness, asthma, and hyperthyroid disease.[1,9] Although diagnostic tests indicative of starvation and dehydration such as ketonuria, abnormal electrolytes, liver function tests, and hematocrit have traditionally been used as markers for severe NVP, there have been multiple studies showing that these may not successfully predict hospital readmission.[4,9]

Patients with NVP and HEG are frequently assessed and treated in the emergency department (ED), yet little is known regarding the quality of care that they receive or their rates of ED utilization. We are aware of no peer-reviewed publications to date in either the ED or obstetric literature that specifically assesses the care of this condition in the ED or provides guidelines for its treatment in this setting. The American College of Obstetrics and Gynecology (ACOG) has published practice guidelines on the treatment of NVP that are often referenced for this condition but are not specifically focused on care in the ED.[10]

We hypothesize that NVP treated in the ED does indeed have a high re-visit rate and that the variables of decreased patient age, decreased gestational age, decreased maternal gravidity, the presence of multiple gestation pregnancies, and the presence of lab abnormalities are associated with a higher likelihood for return ED visits for treatment of NVP. We also aimed to assess treatment patterns of NVP in the ED.

METHODS

Study Design and Setting

We conducted a retrospective database analysis the electronic medical record from a single, large academic hospital. Institutional review board (IRB) approval was granted in advance of this study.

Study Population

Patients who met inclusion criteria were adult women treated in the ED between 1/1/10 and 12/31/10 who received ICD-9 diagnosis codes for variants of "nausea and vomiting in pregnancy" or "hyperemesis gravidarum."

Measures

A manual chart review by a single reviewer was conducted on identified patients with demographic and treatment variables collected via standardized collection form (Appendix 1 and 2).

Demographic and historic variables included age, gravity, parity, gestational age, comorbidities, and multiple gestations. Treatment variables abstracted included type, amount, and timing of antiemetics administered, type and amount of IV fluids given, length of ED stay, disposition, and discharge prescriptions. Our primary outcome was return visit to the ED at any point during gestation for NVP.

The methods of this study did follow published methodological criteria for a medical record study for abstractor training, case selection criteria, variable definition, abstractor forms, performance monitoring, medical record identification, sampling method, and IRB approval. The abstractor was not blinded to the hypothesis, there was no inter-observer reliability measured (due to a single reviewer), and there were no missing data.[11]

Data Analysis

Descriptive statistics were used to evaluate treatment trends. We used logistic regression analysis to examine the relationships between all variables and the primary study outcome of return visits to the ED for NVP. For the purpose of regression modelling, we defined binary indicators for the followng: presence of ketonuria, presence of multiple gestations, obstetrics consultation on initial ED visit, admission, and the administration of Phenergan or odansetron (in any quantity) in the ED. Age, gravity, partiy, gestational age (in weeks), ED length of stay (minutes), and number of liters of total IV fluids given were analyzed as continuous variables. We examined variables individually, and we included those that were significantly associated with readmission in a multiple logistic model. These variables were chosen a priori by author consensus, consistency with cited previous literature, and availability for analysis. We conducted all statistical analyses using STATA (Version 14, College Station, TX).

RESULTS

In the study year, 62,473 adult patients presented to the study site ED. Of these, 113 patient visits were identified that met inclusion criteria for this study and were found to have a mean age of 27.1 years (SD±5.25), mean gravidity of 2.90 pregnancies (SD±1.94), and mean gestational age of 8.78 weeks (SD±3.21).

The mean overall length of ED evaluation was 730 min (SD±513), which included 49 of the 113 patients (43%) whose treatment included placement in ED observation status. When ED-based observation status patients were removed, mean length of ED stay was 389.18 minutes (SD±228.63). Of the 113 patient visits, 17 (15%) ultimately resulted in hospital admission and 95 (85%) were discharged home either from the ED or ED-based observation status (Figure).

We observed wide variation in treatment approaches to NVP in the ED (Table 1). Seven different antiemetics were used in the ED. Ondansetron was most commonly used—99 patients (87.6%) received ondansetron, 39 patients (34%) promethazine, and 39 patients (34%) prochlorperazine. In total, ondansetron constituted 191/282 (68%) of all total doses of antiemetic administered in the ED. Only 37% of patients received more than one different antiemetic agent while in the ED with a mean maximum time between doses of antiemetics of 359.22 minutes (SD±221.7). Antiemetics were

predominantly administered intravenously with 4 of 95 discharged patients (4.2%) receiving oral or rectal antiemetics prior to discharge home. Only 6 of 95 discharged patients (6.4%) received prescriptions for, or were previously on, vitamin B6. Ondansetron was the most common discharge prescription provided (44/99 prescriptions written), while 36 of 95 discharged patients (37.9%) received prescriptions for anything other than, or in addition to, ondansetron.

There were five different types of IV fluids administered with a mean number of liters received of 2.96 (SD±1.64). Of the total 333 liters of IV fluids given, the most commonly administered was normal saline (188 liters; 56%), followed by D5LR (78 liters; 23.4%) and D5.45 (54 liters; 16%). In total, 77% of patients (87) received normal saline; 23% D5.45 (26) and 21.3% D5LR (24).

High gravidity, high parity and early gestational age were associated with an increase in return ED visits in a univariate logistic regression model, while only early gestational age (OR 0.74 95% CI [0.59-0.91]) were associated with an increase of return ED visits in a multivariate model.

Of the 113 ED patient visits, 38 (33.6%) had a return ED visit for NVP with a total of 25/77 (32.5%) of individual patients representing more than one of the ED visits. None of the 17 patients admitted on their initial ED visit returned (p=0.002) in a two-tailed test of proportion; as a perfect predictor this variable was not to be included in the univariate or multiple regression models. In univariate regression analysis, only three of our putative predictor variable demonstrated significant association with readmission: Increasing gestational age was associated with reduced risk of readmission (OR 0.74 95% CI [0.60-0.90]), while increasing parity (OR 1.50 95% CI [1.12-2.00]) and gravidity (OR 1.31 95% CI [1.06-1.61]) were associated with increased risk of revisits. In multiple regression analysis including only these three variables, only the association with increasing gestational age remained significant (OR 0.74 95% CI [0.60-0.90]). No other variables were found to be predictive of return visits to the ED including those classically associated with severe forms of nausea and vomiting in pregnancy including the presence of ketonuria, a multiple gestation pregnancy, or electrolyte abnormalities. No treatments (type of antiemetic or IV fluid) had a statistically significant impact on either admission rate or rate of return visits to the ED (Table 2).

DISCUSSION

As a paucity of literature exists to provide best practices for treatment of NVP specifically in the ED setting, practitioners often rely on established practice patterns for treating nausea and vomiting of other etiologies. Comparing our results to current ACOG guidelines for general treatment of NVP, several trends emerge that may represent potential opportunities for treatment optimization in the ED and upon discharge home.

In this study, antiemetics administered in the ED largely consisted of monotherapy with parental ondansetron. Ondansetron is often used as the antiemetic of choice for patients presenting to the ED with various conditions causing nausea and vomiting due to its efficacy and favorable side effect profile. Although the ACOG guidelines do recommend metoclopramide (Category B) and promethazine (Category C) in their treatment algorithm[10] before ondansetron (Category B), considering ED provider familiarity, it is not an unreasonable starting point for treatment of NVP in the ED. However, a more aggressive and earlier initiation of multi-agent antiemetic therapy should be considered either in place of, or in addition to ondansetron (despite the increased risk of extrapyramidal effects from these other medications) when considering the long average ED length of stay in this study with patients primarily receiving monotherapy with

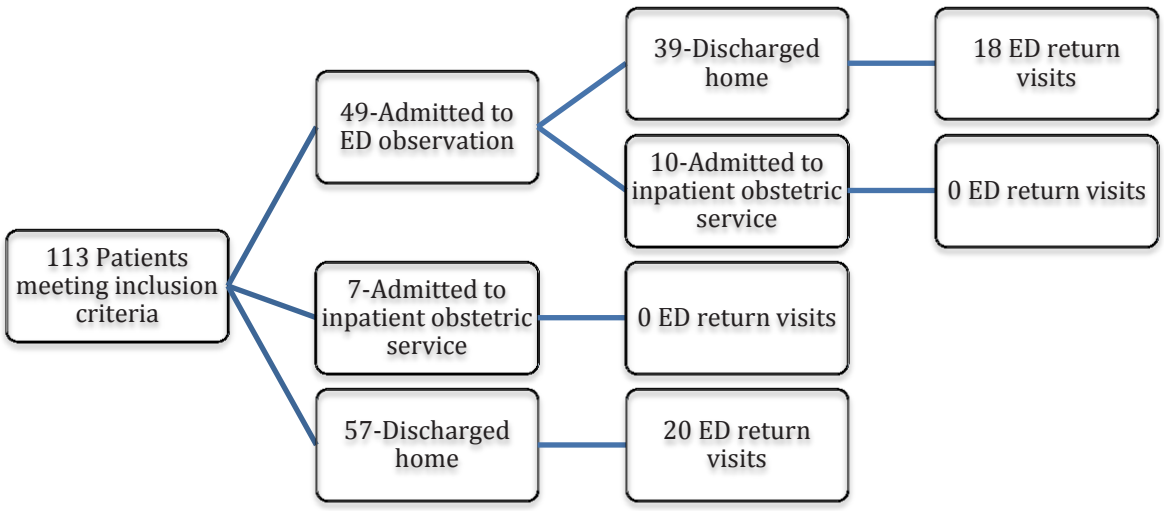

Figure. Study flow diagram.
ED, emergency department

Table 1. Means and standard deviations of demographic and treatment variables.

Variable	Mean	SD
Patient age	27.1	5.25
Gestational age (weeks)	8.78	3.21
Gravity	2.9	1.94
Parity	1.38	1.38
ED LOS (minutes)	730	513
Total doses of antiemetics	2.5	2.01
Number of types of antiemetics	1.35	0.693
IV fluid volume (L)	2.96	1.64

ED, emergency department; *LOS,* length of stay; *IV,* intravenous

ondansetron. This may have more relevance with the increasingly controversial safety profile of ondansetron use in pregnancy with recent evidence suggestive of possible increases in fetal complications including cardiac malformations, development of cleft palate, and other major congenital malformations.[12-15]

Although patients presenting to the ED with various conditions causing nausea and vomiting are frequently treated primarily with parental therapy, given the frequent refractory nature of NVP, it may be reasonable to also consider not only a trial of oral intake but also attempting symptom control with either oral or rectal antiemetic agents to ensure successful outpatient symptom control. This becomes more compelling when taking into account the already long mean ED length of stay observed in this study, one that often includes observation status care—potentially indicating the ability to accommodate a trial of alternate route of antiemetic therapy without significantly impacting ED length of stay or utilization while possibly reducing recurrent ED visits.

The majority of patients in this study were discharged home without any prescriptions for new or additional antiemetics. Many patients were already on ondansetron at home and this was the most commonly prescribed in our study. Very few patients were discharged with prescriptions for other antiemetic therapy recommended by ACOG including metoclopramide or promethazine, and very few received prescriptions for the other ACOG first line recommended agents, pyridoxine and doxylamine. Given the recurrent nature of NVP, inadequate treatment of recurrent symptoms after discharge may have contributed to the frequent return ED visits seen in these patients. Although impossible to attribute causality to the optimization of discharge medications as preventing repeat ED visits, it is interesting to further consider that none of the 17 patients ultimately admitted to the inpatient obstetric service had a repeat presentation to the ED. Improved discharge planning and care could potentially contribute to reducing recurrent ED visits for this condition.

A significant portion of our patients' ED visits (43%) included extended observation care status. Although observation level care did not significantly reduce rate of ED re-presentation, NVP does seem to be an ideal condition for ED observation care with the opportunity for extended treatment and optimization of treatment. This could include a trial of oral challenge and symptom control with non-parental antiemetics. This also provides a potential opportunity to ensure necessary outpatient resources such as adequate prompt follow up or even OB involvement while in the ED—particularly if symptoms prove refractory or if the patient is presenting recurrently to the ED.

This study demonstrated a high overall rate of return

Table 2. Summary of logistic regression analysis for the primary outcome.

Variable	Univariate odds ratio (95% CI)	Multiple odds ratio (95% CI)
Age (years)	1.07(0.99-1.16)	N/A
Gravity	1.31(1.06-1.61)	0.81(0.45-1.46)
Parity	1.50 (1.12- 2.00)	1.86(0.82-4.24)
Gestational age (weeks)	0.74 (0.60-0.90)	0.74 (0.59- 0 .91)
Multiple gestation	2.06 (0.39- 10.77)	N/A
Electrolyte abnormality	0.36 (0.07- 1.74)	N/A
Admission	No admitted patients returned to the hospital	
Ketonuria	0.89 (0.36-2.22)	N/A
Anti-emetics prescribed on discharge	1.90(0.83- 4.31)	N/A
Obstetrics-gynecology consulted	0.82 (0.29-2.33)	N/A
Number of liters of IVF	1.14(0.90-1.45)	N/A
ED evaluation in minutes	1.00 (0.99-1.00)	N/A
Ondansetron given in ED	1.46(0.43-4.94)	N/A
Promethazine given in ED	0.87(0.39-1.98)	N/A

ED, emergency department, *IVF,* intravenous fluids

ED visits. Identifying factors associated with recurrent ED visits such as lower gestational age, or high gravidity and parity, may potentially allow care providers to more effectively target increasing attention towards care optimization for high-risk patients using the methods discussed above.

In order to optimize treatment of NVP in the ED, it appears that we may need to shift our treatment approach. This should include consideration of replacement of or supplementation of ondansetron monotherapy with a more diverse and aggressive treatment strategy involving multiple antiemetics, more extensive outpatient prescriptions in accordance with ACOG's recommendations, and ensuring close obstetric follow up with a potential role for extended observation status or an observation unit stay. We are in the process of developing a more standardized protocol for treatment of NVP with plans to study similar outcomes after treatment is more clearly protocolized with regards to antiemetic agent selection, route and frequency of anti-emetics, and prescriptions for home anti-emetics.

LIMITATIONS

Some limitations are inherent to this study and its design that impact its generalizability. The sample size in this study is small but is consistent with the other studies of NVP and HEG published in the obstetric literature. The fact that this study was conducted at a single site could have implications if certain treatment patterns are more prevalent on an institutional or regional level and may not necessarily be representative of wider ED practice patterns.

Patients were identified for inclusion in this study if they received an ICD-9 diagnosis code of variants of "nausea and vomiting in pregnancy" or "hyperemesis gravidarum." It is possible that patients presented with this disease process but received alternative or less specific diagnostic coding (i.e gastritis, nausea, or vomiting) and were missed from study inclusion. Because we only identified patients who came through the ED, this creates the possibility of missing patients who were admitted via alternative mechanisms such as direct admission. However, we were able to see if any of the patients initially meeting criteria by coming through the ED were subsequently directly admitted to the hospital.

Lastly, the retrospective study design limited our ability to gather any additional information from the patient that may have been helpful if conducted prospectively including quantitative beta-hCG levels (which are not routinely obtained in treatment of these patients but could have potential to predict severe variants of NVP), compliance with medications, dietary patterns, or other demographic variables not already contained in the EMR such as living situation, or presence of other stressors. This also limited our ability to assess follow-up information on patients with out-of-network providers such as visits to other hospitals or EDs, and subsequent obstetric follow-up care and outcomes.

CONCLUSION

Despite being a condition commonly seen in the emergency department, there is limited literature focused on specifically assessing or guiding treatment of NVP in the ED. NVP can be refractory to therapies commonly employed for other cause of nausea and vomiting, and in this study demonstrated a high ED return visit rate. To our knowledge, this study represents the first systematic attempt to identify patient and treatment factors that predict which patients are at highest risk of return visits. The wide variance in practice patterns combined with high return rate point to an opportunity for improving quality and consistency of care. Further work is needed to develop treatment guidelines for ED-specific care of NVP as well as improve discharge and follow-up planning to help reduce ED utilization. With the increasing pressure on healthcare systems to reduce hospital admission and, in particular, readmissions, this type of information will become increasingly important in the ED setting.

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Association of Age, Systolic Blood Pressure, and Heart Rate with Adult Morbidity and Mortality after Urgent Care Visits

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Introduction: Little data exists to help urgent care (UC) clinicians predict morbidity and mortality risk. Age, systolic blood pressure (SBP), and heart rate (HR) are easily obtainable and have been used in other settings to predict short-term risk of deterioration. We hypothesized that there is a relationship between advancing age, SBP, HR, and short-term health outcomes in the UC setting.

Methods: We collected retrospective data from 28 UC clinics and 22 hospitals in the Intermountain Healthcare system between years 2008-2013. Adult patients (≥18 years) were included if they had a unique UC visit and HR or SBP data. Three endpoints following UC visit were assessed: emergency department (ED) visit within three days, hospitalization within three days, and death within seven days. We analyzed associations between age, SBP, HR and endpoints using local regression with a binomial likelihood. Five age groups were chosen from previously published national surveys. Vital sign (VS) distributions were determined for each age group, and the central tendency was compared against previously published norms (90-120mmHg for SBP and 60-100bpm for HR.)

Results: A total of 1,720,207 encounters (714,339 unique patients) met the inclusion criteria; 51,446 encounters (2.99%) had ED visit within three days; 12,397 (0.72%) experienced hospitalization within three days; 302 (0.02%) died within seven days of UC visit. Heart rate and SBP combined with advanced age predicted the probability of ED visit ($p<0.0001$) and hospitalization ($p<0.0001$) following UC visit. Significant associations between advancing age and death ($p<0.0001$), and VS and death ($p<0.0001$) were observed. Odds ratios of risk were highest for elderly patients with lower SBP or higher HR. Observed distributions of SBP were higher than published normal ranges for all age groups.

Conclusion: Among adults seeking care in the UC, associations between HR and SBP and likelihood of ED visits and hospitalization were more pronounced with advancing age. Death following UC visit had a more limited association with advancing age or the VS evaluated. Rapidly increasing risk below SBP of 100-110 mmHg in older patients suggests that accepted normal ranges for SBP may need to be redefined for patients treated in the UC clinic. [West J Emerg Med. 2016;17(5)591-599.]

INTRODUCTION

Over the past several decades, urgent care (UC) clinics have become an increasingly popular venue among patients seeking unscheduled ambulatory care in the United States.[1-3] The 2014 Urgent Care Association of America survey found that UC clinics manage nearly 78 million patient encounters per year within approximately 6,100 UC clinics (excluding retail clinics).[1-3] Intermountain Healthcare, a vertically integrated healthcare delivery system has likewise observed a disproportionately larger increase in UC patient encounters between 2004 and 2013 of 91%, compared to a 14% increase in emergency department (ED) visits, and a 12% increase in primary care visits during that same time period. Given the increasing burden of chronic disease management in primary care,[4-6] and consumer preference for convenience,[7] this trend is likely to continue. However, despite the increase in UC visits, studies describing short-term clinical outcomes following evaluation and management in the UC remain limited.

A number of patients with severe illness have been observed to inappropriately present to UC, rather than the ED. As this phenomenon is likely to continue, timely and accurate identification of patients at risk for serious illness or adverse outcomes is critically important to ensure patient safety in the UC setting. With every visit, UC clinicians must make decisions to either discharge patients home, or to transfer them to a higher level of care such as the ED or hospital. Though many variables exist in patient triage, providers in the UC setting have traditionally relied upon abnormal vital signs (VS), particularly heart rate (HR) and systolic blood pressure (SBP), to assist in identifying patients with potentially acute, life-threatening illnesses. Normal ranges of vital signs including SBP and HR have been defined for both children and adults.[8-11] While there is some variation among definitions, particularly the upper limit of normal vital signs, 90-120mmHg for SBP and 60-100bpm for HR are commonly cited.[12-15] However, these ranges are based on a state of wellness and lack contextual relevance regarding age and other important variables (i.e. setting of care, chief complaint, disease burden, etc.), and thus limit their utility in clinical decision making.

While some studies take into account specific disease states and venues of care to help providers estimate risk of clinical decline based on vital signs, there may be limited applicability to the UC setting. First, prominent ambulatory guidelines regarding vital signs (e.g. SBP and hypertension) are designed to focus on longer-term outcomes such as myocardial infarction or stroke.[16-17] Furthermore, short-term outcomes such as proximal death or intensive care unit (ICU) admission may be too limiting for measuring an appropriate margin of safety in the UC setting.[18-20] Additionally, critical care models using vital signs (HR and SBP) and other relevant data to forecast short-term health outcomes may be challenging to apply to a heterogeneous patient population of the UC (as similarly described in the ED literature).[21-22]

Despite these limitations, advancing age has been defined as an independent risk factor for poor short-term health outcomes among those with sepsis, influenza, and pneumonia.[23-28] Likewise, the relationship between SBP, age, and mortality has been examined in a recent trauma study.[29] As such, we sought to further investigate the relationship between advancing age, vital signs (HR and SBP), and short-term health outcomes in the unscheduled ambulatory domain.

The objectives of our study were to (1) describe the age-specific distributions of HR and SBP observed in adults at the UC clinic, (2) define the short-term morbidity and mortality after a visit to an UC clinic, and (3) examine the association between age-specific vital signs and subsequent hospital utilization and/or mortality.

METHODS

Study Design

We performed a cross-sectional retrospective study by including adult patients (> 18 years old) cared for in 28 Intermountain Healthcare UC clinics and 22 hospitals between January 2008 and December 2013. The study was approved by the institutional review board.

Data Source, Quality and Outcomes

Patient electronic health information is stored in Intermountain Healthcare's enterprise data warehouse (EDW), a repository with over six million patient records.[39] Each patient received a unique enterprise-wide identification that is used for every inpatient and outpatient encounter. This identifier was used to confirm an UC visit as defined by a billed encounter through our financial accounting system and was subsequently linked to the EDW to obtain subsequent resource utilization and clinical outcomes data. We included only UC encounters with a HR or SBP recorded in the electronic health record (EHR)..Duplicate records of UC encounters were collapsed into a single visit.

Patients initially seen at an Intermountain Healthcare UC setting were followed for subsequent visits in any of the 22 EDs or hospitals during the study period. We defined outcomes of interest as an ED visit within three days, [30-33]hospitalization within three days,[30-33] and death within seven days.[30-34] Mortality was recorded in the EHR and further validated using data from the State Office of Vital Records.

The EDW was queried for demographic, vital sign, and clinical outcomes data. Systolic blood pressure was obtained by automated monitors (Dinamap or Phillips) or taken manually. Likewise, HR values were obtained by pulse oximetry, automated blood pressure/heart rate devices, or taken manually. All VS data were entered into discrete data fields in the EHR; non-discrete data were excluded in the data analysis. Furthermore, when more than one set of VS was recorded in a codified field within the EHR on the same day,

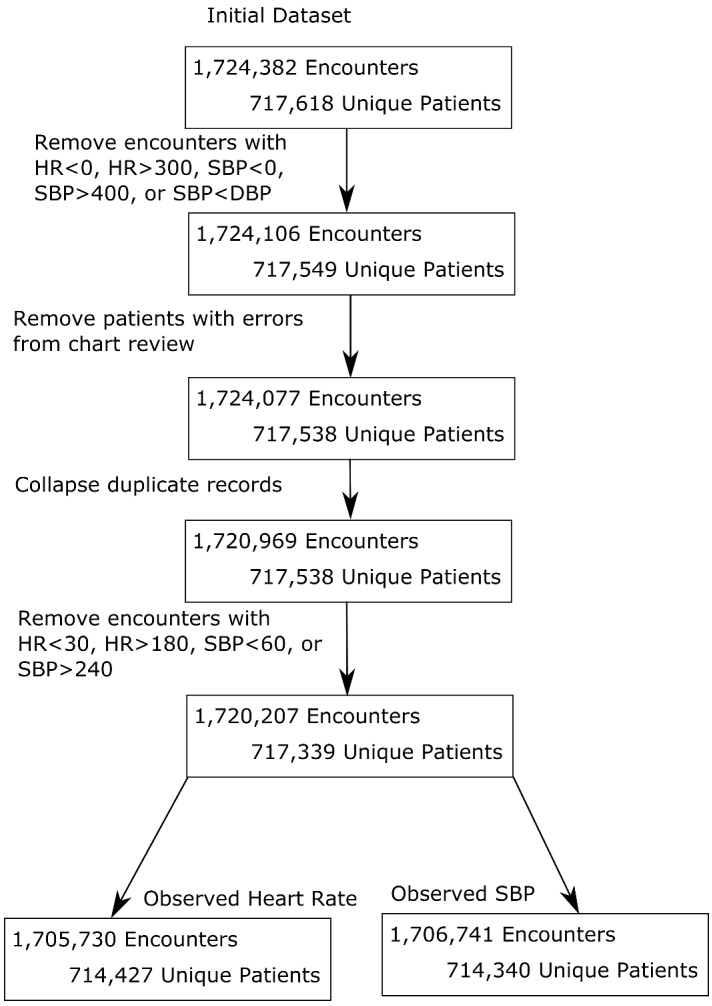


Figure 1. Workflow of patient inclusion/exclusion.
HR, heart rate; *SBP*, systolic blood pressure; *DBP*, diastolic blood pressure.

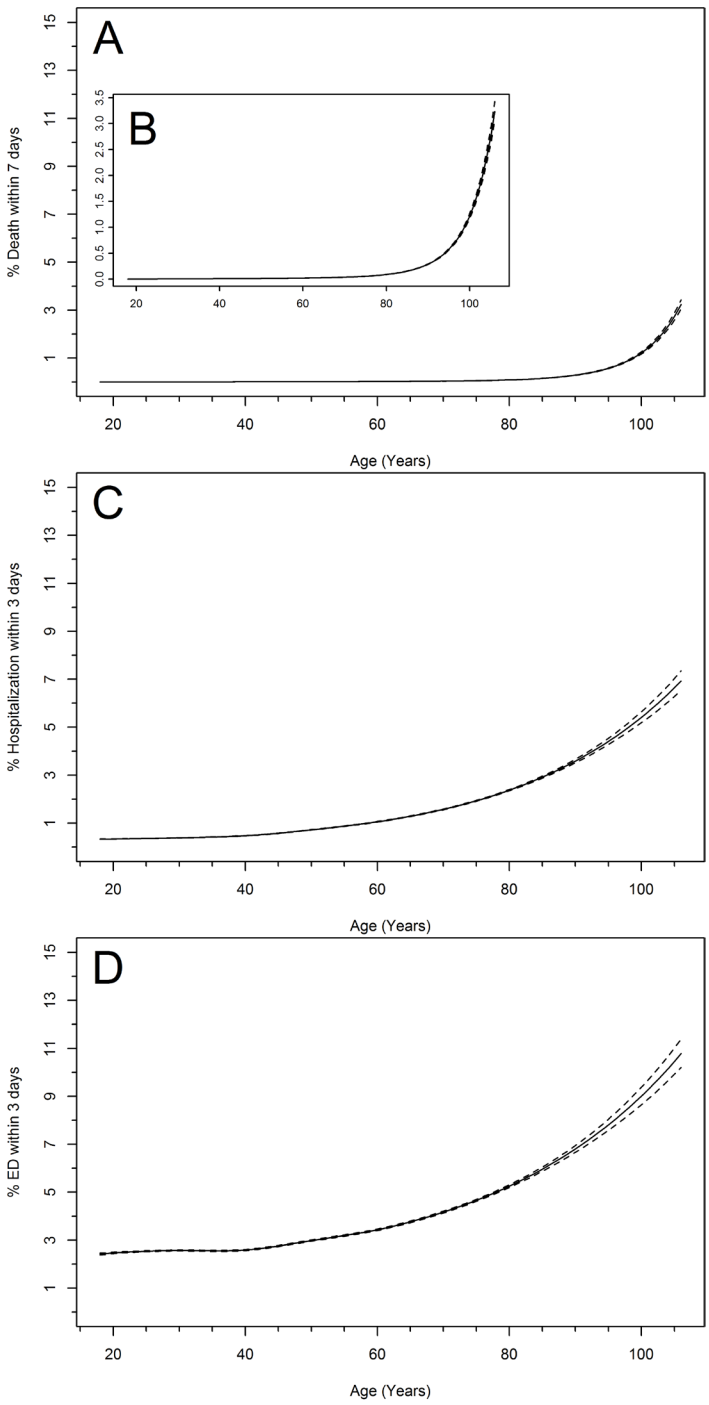
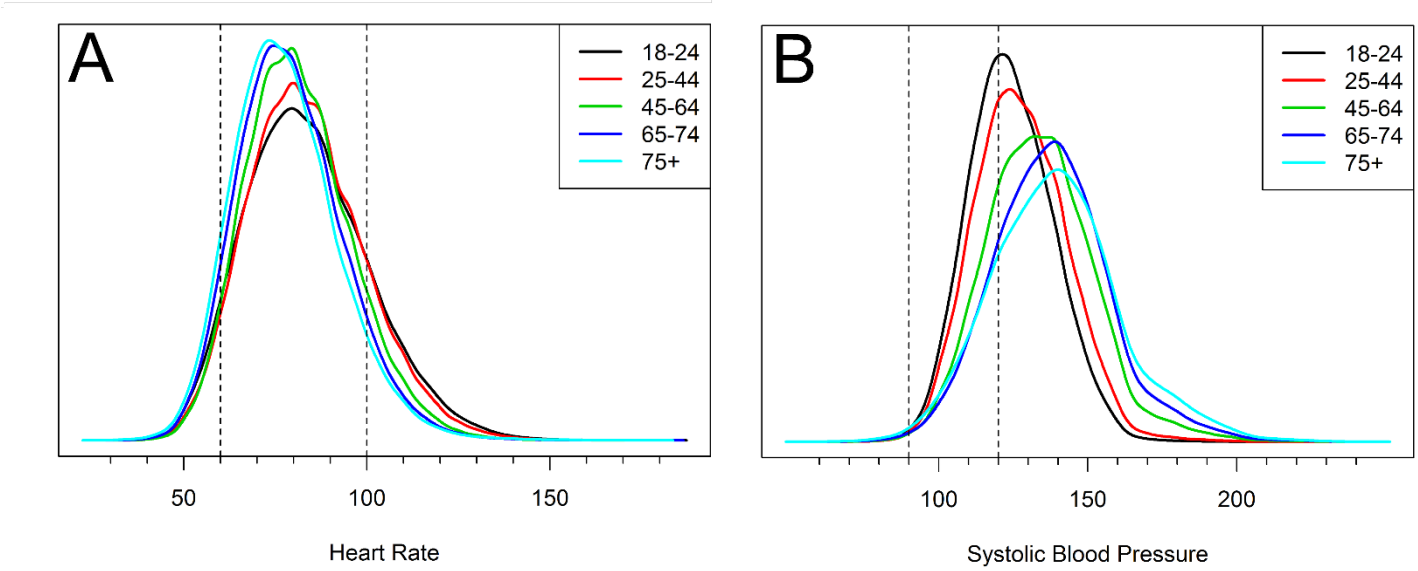


Figure 2. Age-specific risk curves for morbidity and mortality subsequent to an urgent care (UC) visit. Part A shows mortality within 7 days of an UC visit, magnified in part B. Part C shows percent hospitalization within 3 days and part D shows percent emergency department visits within 3 days of an UC visit. The solid line represents point estimates and the dotted lines are 95% confidence intervals.

we excluded the encounter due to uncertainty of the clinical setting where the vital sign was obtained.

We excluded cases if HR and SBP values were outside physiologic ranges (e.g. HR <0 or >300, SBP <0 or >400), or where there were obvious data quality issues such as diastolic blood pressure exceeding SBP. Review of extreme VS values suggested poor data quality and small sample sizes; therefore, the dataset was further limited to HR of ≥30bpm and ≤180 bpm and SBP of ≥60mmHg and ≤240mmHg. Two authors manually reviewed data in two phases. In the first phase > 200 charts were randomly identified and the designated author reviewers performed iterative cycles of data validation to ensure that the VS were correctly attributed to the UC visit, and the outcomes (ED visits, hospitalizations, and deaths) were accurate. Secondly, a final data validation was manually performed on all deaths (302 encounters).

To assess the impact on advancing age on health outcomes following an UC visit, we chose five age groups based on the Centers for Disease Control and Prevention's National Hospital Ambulatory Medical Care Survey[35] (Group 1: 18-24, Group 2: 25-44, Group 3: 45-64, Group 4: 65-74, Group 5: 75+).



HR Central Tendency				SBP Central Tendency			
Age	**90%**	**95%**	**99%**	**Age**	**90%**	**95%**	**99%**
18-24 years old	59-114 bpm	55-120 bpm	50-134 bpm	**18-24 years old**	102-148 mmHg	99-153 mmHg	92-262 mmHg
25-44 years old	60-112 bpm	56-118 bpm	50-132 bpm	**25-44 years old**	104-153 mmHg	100-158 mmHg	92-175 mmHg
45-64 years old	60-107 bpm	57-113 bpm	50-126 bpm	**45-64 years old**	106-164 mmHg	102-174 mmHg	93-194 mmHg
65-74 years old	58-104 bpm	55-110 bpm	50-124 bpm	**65-74 years old**	108-172 mmHg	102-181 mmHg	92-199 mmHg
75+ years old	57-103 bpm	54-110 bpm	47-125 bpm	**75+ years old**	106-178 mmHg	100-187 mmHg	89-203 mmHg

Figure 3. Distributions of observed values of heart rate (HR) (A) and systolic blood pressure (SBP) (B) for different age groups. Generally accepted "normal" ranges are indicated by vertical dashed lines.[12-15] The tables below the graphs show the 90th, 95th and 99th percentiles by age group. Aggregate HR data fit within the "normal" range approximately 82% of the time for HR, but only about 31% for SBP.
bpm, beats per minute; *mmHg*, millimeters of mercury

Statistical Analysis

We fit a local regression with binomial likelihood to explore the relationship between advancing age, vital signs (HR and SBP), and short-term health outcomes in the unscheduled ambulatory domain.[36] Graphics were generated to display the age-adjusted risk for each outcome measure based on HR and SBP. Additionally, data were presented as an odds ratio table for hospitalization. To further understand and categorize age-specific distributions on HR and SBP prevalence in the UC setting, we computed the central tendency for the five age groups. All data were analyzed using R (version 3.1.1, Vienna, Austria).

RESULTS

We initially included a total of 1,724,382 patient encounters (717,618 patients) in the data analysis; after applying the exclusion criteria noted above, this resulted in 1,720,207 encounters (717,339 patients) for final analysis. Because some patient encounters had either only HR measures or SBP measures (the vast majority had both), we finally segmented the data into 1,705,730 encounters (714,427 patients) for HR and 1,706,741 encounters (714,340 patients) for SBP in order to allow for VS analysis (Figure 1).

A total of 51,446 UC encounters (2.99%) were followed by an ED visit within three days, 12,397 encounters (0.72%) resulted in hospitalization within three days, and 302 (0.02%) were associated with death within seven days. The average age was 42±18 years old. Females represented 59.72% of subjects (1,027,387 encounters, 394,822 patients), 40.28% were male (692,809 encounters, 322,510 patients), and 11 encounters (7 patients) did not have gender recorded. Females averaged 2.60 UC encounters per patient, and males averaged 2.15 UC encounters per patient during the study period.

Risk for ED visit, hospitalization and death increased with age in a curvilinear pattern (Figure 2). When the 90th percentile was computed for observed HR values, Group 1 (18-24 years old) ranged between 59-114 bpm, Group 2 (25-44 years old) was 60-112 bpm, Group 3 (45-64 years old) was 60-107 bpm, Group 4 (65-74 years old) was 58-104 bpm, and Group 5 (75 + years old) was 57-103 bpm (Figure 3A). HR values that fit within published normal ranges occurred 82% of the time within our dataset, and increased to 86% when considering advanced age (Groups 4 and 5).

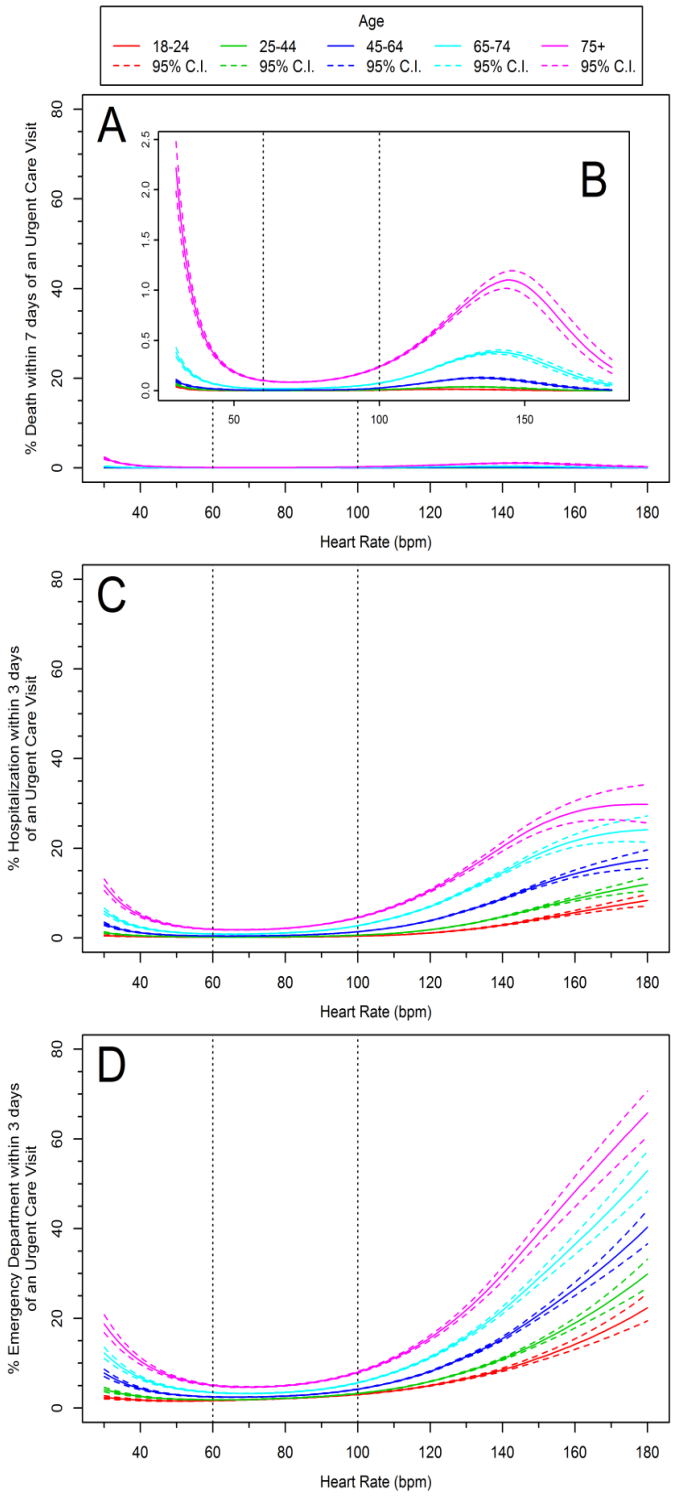


Figure 4. Age-specific heart rate (HR) risk curves for morbidity and mortality subsequent to an urgent care (UC) visit. Part A shows death within 7 days of an UC visit, magnified in part B. Part C shows percent hospitalization within 3 days of an UC visit, and Part D shows percent emergency department visits within 3 days of an UC visit. Published "normal" ranges are noted by vertical dashed lines.[12-15] The solid lines represent point estimates and the dotted lines are 95% confidence intervals.
bpm, beats per minute.

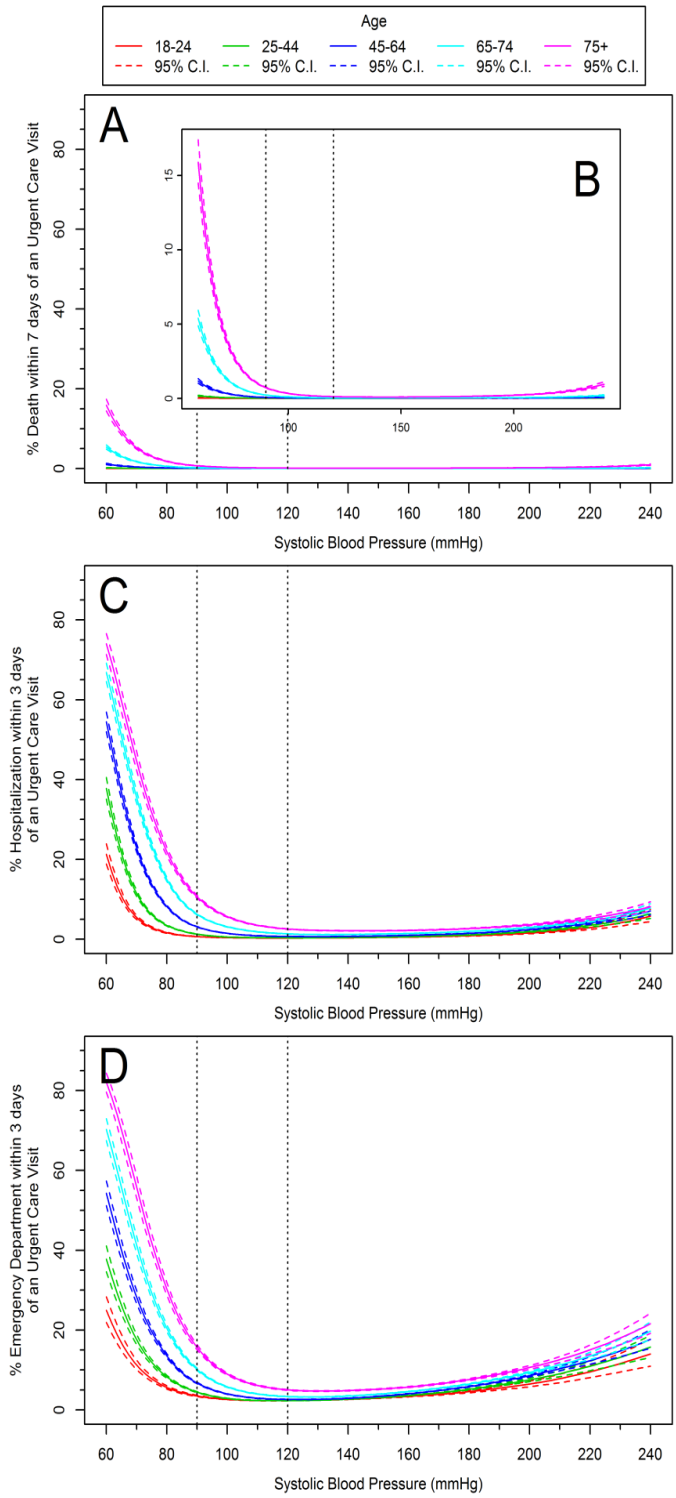


Figure 5. Age-specific systolic blood pressure (SBP) risk curves for mortality and morbidity subsequent to an urgent care (UC) visit. Part A shows percent death within 7 days of an UC visit, magnified in part B. Part C shows percent hospitalization within 3 days of an UC visit, and part D shows percent hospitalization within 3 days of an UC visit. Published "normal" ranges are noted by vertical dashed lines.[12-15] The solid lines represent point estimates and the dotted lines are 95% confidence intervals.
mmHg, millimeters of mercury.

Table 1. Odds ratio table of heart rate ranges and hospitalization within 3 days subsequent to an urgent care visit, subsegmented by age. Note, the top number in each row denotes the odds ratio, the second is the 95% confidence internal, and the last is the sample size within each grouping.

Heart Rate (bpm)						
			<60 bpm	60-100	101-129	130+
Age (years)	18-24	OR	0.77	1.00	3.31	17.55
		CI (95%)	0.5-1.1	N/A	2.9-3.8	14.1-21.8
		n	16,247	35,331	45,273	2,745
	25-44	OR	1.19	1.35	4.67	16.52
		CI (95%)	0.9-1.5	1.2-1.5	4.2-5.2	13.9-19.7
		n	34,512	619,284	105,487	5,008
	45-64	OR	2.22	2.89	11.54	51.40
		CI (95%)	1.8-2.8	2.6-3.2	10.4-12.9	42.1-62.7
		n	19,134	362,062	41,619	1,344
	65-74	OR	4.24	5.48	20.90	121.51
		CI (95%)	3.3-5.5	4.9- 6.1	18.2-23.9	92.3-159.9
		n	7,220	100,256	8,637	350
	75+	OR	9.82	10.57	33.41	104.01
		CI (95%)	8.2-11.8	9.6-11.7	29.3-38.1	78.2-138.3
		n	7,648	86,740	6,479	354

bpm, beats per minute; *OR*, odds ratio; *CI*, confidence interval; *n*, sample size; *N/A,* not applicable.

Table 2. Odds ratio table of systolic blood pressure ranges and hospitalization within 3 days subsequent to an urgent care visit, subsegmented by age. Note, the top number in each row denotes the odds ratio, the second is the 95% confidence internal, and the last is the sample size within each grouping.

Systolic Blood Pressure (mmHg)								
			<80 mmHg	81-89	90-99	100-120	121-180	180+
Age (years)	18-24	OR	9.76	6.39	1.59	1.00	1.15	1.89
		CI (95%)	3.5- 27.1	3.4-11.9	1.1-2.3	N/A	1.0- 1.3	0.3-14.1
		N	142	591	7,432	116,227	174,311	179
	25-44	OR	31.50	6.15	2.20	1.32	1.41	5.60
		CI (95%)	20.1- 49.4	4.0-9.5	1.7-2.8	1.2-1.5	1.3-1.6	4.0-7.9
		N	269	1,282	15,268	246,078	500,120	2,383
	45-64	OR	82.30	27.96	8.55	2.82	2.62	7.35
		CI (95%)	57.6-117.6	20.9-37.3	7.0-10.4	2.5-3.2	2.3-2.9	6.0-9.0
		N	219	783	5,780	91,912	319,683	6,511
	65-74	OR	116.78	55.90	19.18	6.21	4.30	10.02
		CI (95%)	73.1-186.4	38.7- 80.7	14.8-24.8	5.3-7.2	3.8-4.9	7.9-12.8
		N	101	267	1,448	19,389	92,220	3,048
	75+	OR	105.63	50.69	24.95	11.83	7.91	11.33
		CI (95%)	71.4-156.3	36.5-70.4	20.1-31.0	10.3-13.6	7.0-8.9	9.2-13.9
		N	155	367	1,755	17,065	77,638	4,118

mmHg, millimeters of mercury; *OR*, odds ratio; *CI*, confidence interval; *n*, sample size; *N/A,* not applicable.

The 90th percentile for SBP ranged from 102-148 mmHg for Group 1, 104-153 mmHg for Group 2, 106-164 mmHg for Group 3, 108-172 mmHg for Group 4, and 106-178 mmHg for Group 5 (Figure 3B). Only 31% of SBP values in this dataset fit within published normal ranges for the age groups; this decreased to 18% when considering advanced age (Groups 4 and 5). Furthermore, a SBP less than 99 mmHg was a rare observation in all age groups ($<95^{th}$ percentile), even more so, a SBP of 90mmHg ($\leq 99^{th}$ percentile) suggesting that in the UC setting any SBP value < 100mmHg should be viewed cautiously.

Vital signs (HR and SBP) and advancing age demonstrated curvilinear associations with the likelihood of an ED visit and hospitalization ($p<0.0001$) (Figures 4 and 5). We observed significant associations with advancing age and death, or vital signs (HR or SBP) and death ($p<0.0001$). However, outcomes between age and HR with death, and age and SBP with death were not statistically significant ($p=0.66$ and $p=0.07$ respectively).

The influence of age on the relationship between vital signs (HR and SBP) and hospitalization is further illustrated in Tables 1 and 2. For example, in patients with a HR between 60-100 bpm, a nearly 10-fold greater likelihood of hospitalization was observed in patients 75 years of age or older compared to patients 18-24 years of age (OR 10.57, 95% CI [9.6-11.7]). We observed a similar relationship for SBP of 100-120 mmHg in patients 75 years of (OR = 11.83, 95% CI [10.3-13.6], Tables 1 and 2).

DISCUSSION

To our knowledge, this is the largest published study of UC encounters and subsequent short-term outcomes. Predictor variables and the outcomes of interest were selected based on the potential for increased downstream healthcare utilization and/or clinical deterioration. This study found that approximately 3% of UC visits had a subsequent escalation of care or death, with the vast majority comprised of ED encounters. While this is consistent with a national survey of UC visits (78% response rate) describing 4% or less rate of transfer to the ED,[2] the comparison is limited due to the fact that a significant number of our three-day ED visits were likely not intended transfers. Comparisons for our rate of hospitalization (0.72%) and death (0.02%) are unavailable due to lack of published data. Therefore, future research will be needed to establish more accurate baselines for outcomes following an UC visit.

Data demonstrated that the distribution of observed HR values varied little between different age groups, and was generally centered within the accepted normal range for adults. Older patients tended toward a narrower distribution with lower heart rates than younger patients. This is not surprising since HR tends to decrease with age.[38] The relationship between age-stratified HR and short-term outcomes was also curvilinear, with a more pronounced effect above 90-100 bpm. This suggests that in the unscheduled ambulatory setting, heart rates of 90-100 may be indicators of risk, especially in older patients.

The distribution of observed SBP values in our population varied between age groups, with older patients tending toward a higher SBP. Interestingly, the distribution of SBP observed in all age groups were higher than published normal ranges (Figure 3B). However, the risk of short-term deterioration was not as profound for hypertensive patients as it was for patients with lower SBP. The relationship between lower SBP and short-term deterioration was most pronounced among older patients, in which the risk began to increase more rapidly below a SBP of approximately 100-110mmHg—well above "low normal".[37] These findings suggest that for older patients seeking unscheduled care in the UC clinic, the safe lower limit of SBP may need to be redefined.

Taken together, these findings suggest that rather than relying upon textbook "normal" ranges for adult vital signs to estimate clinical risk, UC providers may find venue-specific data relating VS ranges to short-term outcomes more useful in medical decision-making. For example, when evaluating an elderly patient with an acute complaint, the provider may not view a SBP of 105 as "nice and low" but instead may understand that the patient may be at an inflection point on the risk curve, and could evaluate more closely other indicators of impending deterioration.

The idea that VS measurement and interpretation require context is one that has gained some attention, but this is the first time that the "context" of an UC visit has been related to vital signs and short-term health and utilization outcomes. Additional work is needed to validate these findings and to seek to provide a better understanding of the nature and distribution of vital signs in other healthcare venues.

LIMITATIONS

There are several limiting factors worth noting in this study. While this is a very large dataset, and Intermountain Healthcare treats approximately 50% of the state's population, our findings are based on only one healthcare system and may not be generalizable to other systems. Some of our outcome data may be considered incomplete because our visit outcomes of interest could not be collected for patients who received care at other facilities and death records were not obtained from outside of our state. Additionally, at the time of this study, our EHR/EDW did not capture whether a visit to the ED or hospital after an UC visit was intended (i.e. the result of a transfer) or unintended. A proportion of these patients may have been referred to the ED or directly admitted to the hospital, but this cannot be determined from this dataset. This categorization could be useful in describing unanticipated short-term health outcomes and will be important in future reviews. Additionally, we excluded a small number of encounters with extreme vital signs from our analysis. While patients do

rarely present to the UC clinic with HR <30 bpm or >180 bpm, and/or with SBP of <60mmHg or >240mmHg, the risk associated with these vital signs should be immediately apparent to the provider and guide appropriate treatment.

The scope of this paper was limited to vital signs and age. Because of this, we did not examine other possible predictor variables, such as disease burden, medications, chief complaint, treatment provided, prior healthcare utilization, payer type, leaving against medical advice/elopement, time of day, seasonality, or provider type. Further research will be needed to understand the interaction between risk factors, specific disease processes and clinical deterioration in the UC setting.

CONCLUSION

In this large cohort of UC encounters, there were associations between advancing age, vital signs (HR and SBP), and likelihood of ED visits and hospitalization following an UC visit. An association was also observed between advancing age or vital signs (HR or SBP) and death. While SBP values between 90-100 mmHg are commonly referenced as the lower limit of normal in healthy adults, SBP values <100 mmHg were uncommon in this cohort, and were significantly related to adverse short-term health outcomes. Published normal ranges for SBP (90-120 mmHg) may need to be redefined for adult patients seen in the UC setting.

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Drs. Hart and Woodruff contributed equally to the work of this manuscript.

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The Peregrinating Psychiatric Patient in the Emergency Department

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Many emergency department (ED) psychiatric patients present after traveling. Although such travel, or peregrination, has long been associated with factitious disorder, other diagnoses are more common among travelers, including psychotic disorders, personality disorders, and substance abuse. Travelers' intense psychopathology, disrupted social networks, lack of collateral informants, and unawareness of local resources complicate treatment. These patients can consume disproportionate time and resources from emergency providers. We review the literature on the emergency psychiatric treatment of peregrinating patients and use case examples to illustrate common presentations and treatment strategies. Difficulties in studying this population and suggestions for future research are discussed. [West J Emerg Med. 2016;17(5)600-606.]

INTRODUCTION

Patients who travel long distances and present for psychiatric care are familiar to emergency providers. Yet the epidemiology, diagnoses, and treatment needs of these "travelers" remain largely unknown. The ready accessibility of emergency department (ED) care compared to outpatient or inpatient mental health services is attractive to traveling patients who are unfamiliar with local healthcare providers or have few local social supports and no healthcare providers.[1] This paucity of local resources complicates ED providers' treatment and disposition planning. The act of traveling itself may occur as the result of mental illness or introduce stressors that exacerbate psychopathology.

Travel by psychiatric patients was first recognized as a complication of Munchausen's syndrome.[2,3] In Munchausen's, or factitious disorder, patients present with the unconscious production of somatic symptoms and are prone to traveling long distances to seek care from new providers. In this context, peregrination – derived from the Latin *peregrinating*, "to travel abroad" – was used to describe a patient's traveling. However, Munchausen's is quite rare (<1% of consultation-liaison consults) relative to the observed frequency of long-distance patients presenting for emergency mental healthcare (6.6% in one study).[4,5] Thus, factitious disorder is not likely the most common diagnosis among most peregrinating psychiatric patients.

This paper reviews the literature on patients who present for emergency psychiatric care after traveling long distances. The diagnostic and treatment considerations raised through a systematic literature review are framed with case examples. The authors then share strategies for managing peregrinating psychiatric patients based on the literature and their experience as medical directors of psychiatric emergency services at large public safety-net hospitals.

METHODS

We reviewed the scientific literature for articles describing the prevalence, pathology, or treatment of patients who present to the ED after traveling. A search using the unrestricted terms "travel" and "psychiatry" was conducted in the PubMed and PsycINFO databases. No date limiters were used. Papers' titles and abstracts were screened for a full-text review. PubMed's "Related Articles" feature and a review of included papers' bibliographies provided additional records. Figure demonstrates a flow chart of the article selection process.[6]

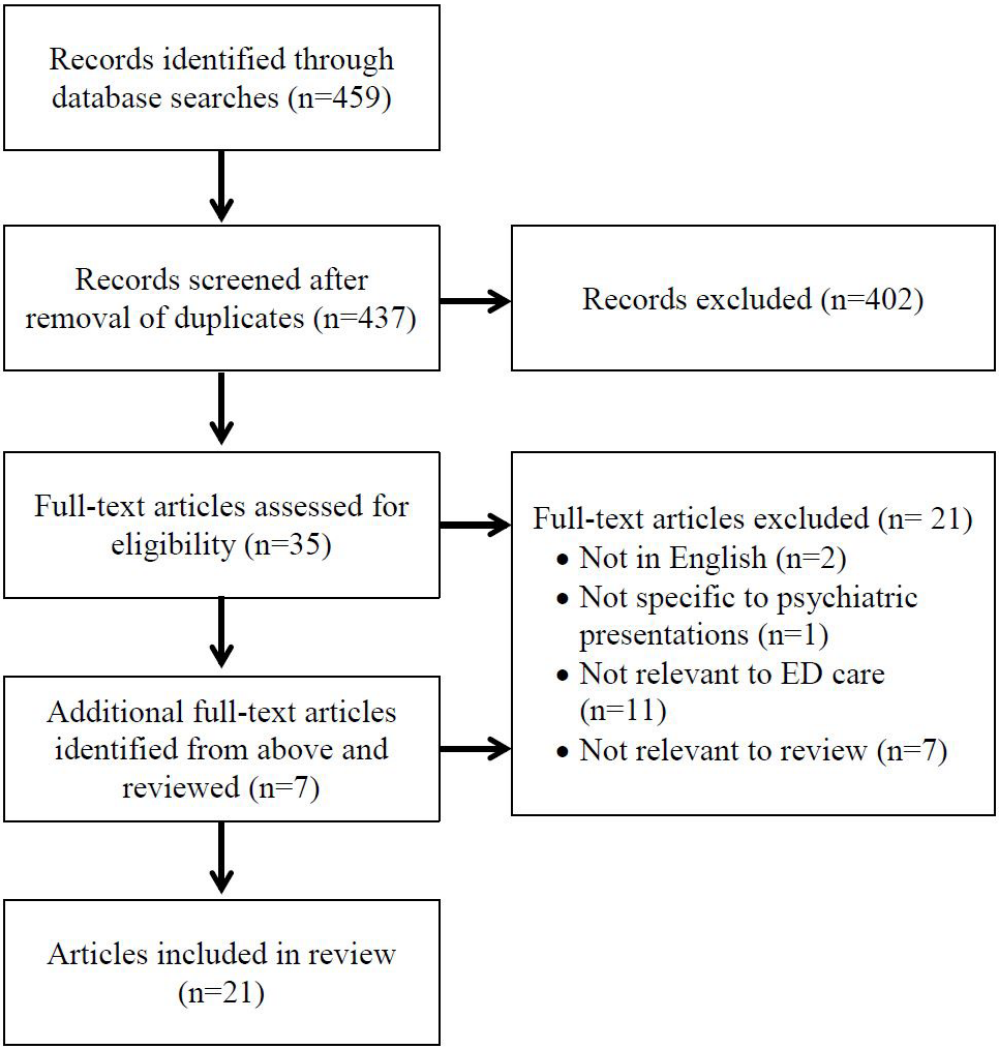

Figure. Article selection flow chart.
ED, emergency department

Overview of the Literature

We identified 21 articles as potentially relevant to the treatment of traveling psychiatric patients in the ED. The most relevant articles included case series (two articles),[7,8] case reports (three articles),[9-11] and a review of pertinent pathology (one article).[3] Four papers compared traveling ED patients to non-traveling controls.[5,12-14] Another 12 papers addressed psychiatric sequelae of acute travel, including seven articles on jet lag. Because these patients may present to EDs for care, these articles were included in this review. Articles were almost entirely limited to descriptions of traveling patients or relevant pathology: Only one article focused on treatment recommendations – to help patients with psychotic disorders prevent decompensation due to jet lag – but was focused on outpatient, preventative treatment.[15]

Identifying Travelers

Terminology and case definitions of patients who travel vary greatly. One study of ED patients used the term "long-distance patients," defined as those arriving to the ED from greater than 100 miles away.[5] Investigators in Hawaii studied travelers who had arrived to the state in the preceding four months[7] or changed at least two time zones in the preceding 10 days.[12] An Israeli study compared tourists traveling three or fewer time zones to those traveling seven or more.[16]

Other available definitions are not specifically used for emergency care. For example, an examination of psychiatric re-admission rates among inpatients with schizophrenia in Taiwan compared patients from "remote" and "non-remote" towns using a government definition accounting for "location, geography, and medical availability."[17] Government definitions of mobility not specific to clinical care include persons moving greater than 500 miles or across county or state lines.[18,19]

Travel and residential moves are common in American life, but it is unclear how these migration patterns apply to healthcare settings.[18] In census data, very few Americans cite health reasons as the purpose of their move. Seriously mentally ill patients who lack residences are not readily captured or easily represented by census data.[20] Similarly, persons not

staying in paid accommodations are unlikely to be tallied by travel associations. Such homeless persons are exactly those frequently seen in psychiatric emergency services. And while health reasons are rarely a reason for moving or traveling, patients who do travel for healthcare might be expected to be sicker and use greater healthcare resources.

Prevalence of Travelers in the ED

Only one study describes the prevalence of patients who travel long distances for emergency psychiatric care. In that cohort study of traveling patients, 6.6% of patients in a psychiatric emergency service lived more than 100 miles from the hospital's city.[5] Because the hospital was located in a rural area, the authors suspected a higher prevalence may exist among urban hospitals.

Presentations of the Traveling Psychiatric Patient

The following brief cases illustrate ED presentations commonly described in the literature or treated by the authors. In studies that have compared travelers to non-travelers, patients appear more likely to have depressive, manic, or psychotic episodes.[12,16] Patients coming to the ED from farther away within a metropolitan area may be relatively more likely to have severe mental illness and involuntary presentations.[13,14]

Case 1

A 30-year-old man presents with suicidal ideation after relapsing on alcohol. He recently moved to the area after a long period of unemployment, anticipating work with an oil drilling company. However, the job fell through, he has no local friends or family, and he lacks money to return home. This anxiety and new homelessness triggered his relapse.

Persons who move to a new area to seek employment, new residential amenities, or for family/relationship reasons may present to EDs in crisis. These patients are unable to access their usual coping skills and social supports owing geographic isolation. Loneliness, frustration, or regret may be prominent; patients may present with depression and perhaps after a suicide attempt.[7] In general, residential mobility is associated with greater neuroticism and lower conscientiousness.[19] Because neuroticism is associated with adverse health outcomes at a population level, it may be that persons who move are more likely to require psychiatry and medical care.[21]

Tourists and short-term residents often present with acute anxiety reactions, often precipitated by a minor event in the context of separation from social supports, fatigue from prolonged travel, and jet lag:

Case 2

A 40-year-old man presents with chest pain and shortness of breath. The emergency physician diagnoses a panic attack. The patient has been in town caring for his terminally ill mother, which has proven a financial burden and emotionally exhausting. Today, the patient became overwhelmed with anxiety that his wife and children may be ill as well. The patient has history of an anxiety disorder but recently ran out of medications after missing a follow-up appointment in his hometown.

These patients may present to the ED with panic attacks, somatic reactions, seemingly paranoid thoughts (e.g., "something terrible is happening to my family"), or disorganization and psychotic reactions.[8,22] Anxiety reactions may be more common among patients traveling for funerals or illnesses in the family.[12]

Patients with mental illness are prone to decompensation while traveling. For example, patients with a history of depression or mania are at elevated risk for depression or mania when travelling across time zones.[15,16,23] Travel disrupts medication adherence and limits access to a patient's mental health professionals.[12] More serious medical complications are possible: One report describes two patients with schizophrenia who developed possible neuroleptic malignant syndrome upon traveling to a warm tropical country.[24]

Case 3

A 45-year-old woman comes to the ED from a rural part of the state. She has borderline personality disorder and a history of over a dozen overdoses. She recently lost her girlfriend, which prompted an overdose and inpatient admission near her home. However, she had a conflict with her inpatient team, left, and now arrives to your academic medical center "for a second opinion" to help her "stabilize on medications."

This case exemplifies the presentation of an "intentional" traveler who travels consciously and purposefully to obtain care at a specific facility.[5] In most ways, intentional travelers are not demographically or diagnostically different than local patients. In the study defining intentional patients, these patients appeared to travel to access the resources of a larger hospital or avoid the stigma of psychiatric treatment in their home communities.[21] Some patients indulge in a "rescue fantasy" that they have traveled to a hospital that will help them; this fantasy can complicate discharge or disposition planning. Personality disorders are common among intentional patients.

As opposed to these intentional patients, "incidental" travelers do not specifically seek psychiatric care but nonetheless come to the ED's attention. This group often includes patients who are hitchhiking or homeless and brought in by police or ambulance. These patients are significantly more likely than locals to have had prior psychiatric treatment, suffer psychotic and substance use disorders, and require inpatient hospitalization.[5] Case four describes such a patient:

Case 4

A 25-year-old man with a history of schizophrenia calls 911 fr*om a homeless shelter because of intense command auditory hallucinations to hurt himself. He has been in town for six days from out of state. He tells you he moved "because*

I needed to" and that he often remains in a city for about a month. He will leave town "when the voices tell me to."

Patients with schizophrenia and delusional disorder often present after traveling from another state with vague intentions or paranoia; for example, they may "want a change" or to "see the mountains." Their knowledge of local resources is often similarly unclear, and they may be uncertain where to obtain shelter, food, or medication. Some patients present after calling 911 with suicidal ideation. An assessment quickly reveals that the patient uses this strategy repeatedly in new cities to obtain treatment and orient to local resources. These patients may become high utilizers over a short period before moving on to another city.

Patients with bipolar disorder are also prone to peregrination during manic episodes. These patients are unlikely to seek out care once in a new city. More likely, they present via police or ambulance after causing a disruption in the community. Co-occurring substance use is not uncommon.

Patients with personality, dissociative, and factitious disorders often arrive to emergency care in dramatic fashion:

Case 5

A 53-year-old man presents to the ED with memory loss. He had flagged down a bus driver seeking help. He describes having recently arrived to the city but cannot remember where he came from or even who he is. He cannot recall who his family members are and lacks any identifying papers (but has $600 in his sock).[25]

Case 6

A 30-year-old woman presents to the ED with chest pain and shortness of breath. She states she has protein C deficiency and a history of pulmonary emboli. New to town, she describes prior surgeries – she has a prominent midline abdominal incision – for "life-threatening" medical issues without manifest anxiety. She is talkative and cooperative with care but vague as to prior interventions and treating physicians.

Despite their intact thought process, these patients describe profound hallucinations, delusions, or cognitive symptoms that belie their ability to travel long distances. Case 6 characterizes classic Munchausen's, in which patients peregrinate; change providers; seek recurrent medical interventions; and disclose dramatic but vague histories of present illness.[3] (This patient may have true protein C deficiency as well.) Patients with dissociative fugue present complaining of amnesia or confusion.[9,10] Elucidating the patient's history through a collateral informant, clinicians typically identify a profound social stressor precipitating migration. Gander syndrome, another dissociative disorder, may be present among travelers and is characterized by *vorbeireden*, in which approximate answers are given to questions, but those answers suggest the patient has a sense of the correct answer.[11] (E.g., How many legs does a dog have? *Five.*)

Malingering should be considered in patients who are uncooperative, demand controlled substances, display atypical or inconsistent symptoms, and have evident secondary gain.[26] Malingering is seen among patients with antisocial personality disorder who travel to avoid legal prosecution or violent reprisals.

Case 7

A 30-year-old woman is brought in by ambulance after being found unconscious at a bus station. She awakes with the administration of intravenous naloxone. She reports that she is traveling cross-country and used heroin during an overnight layover. Disinterested in treatment, she desires discharge to catch her bus.

Substance use is present in most psychiatric emergencies and prevalent among travelers.[27] Vacationers, particularly students on spring break, are prone to excessive alcohol use.[28] Some patients miss bus or airplane connections because they have been using substances; patients may then be approached by security services or self-present seeking detoxification in the ED. If stranded and unable to continue home, their distress only increases. The psychotic symptoms of schizophrenia or bipolar disorder may be exacerbated by stimulant, hallucinogen, or marijuana use. The availability of drugs may itself promote travel: the legalization of marijuana in Colorado and Washington states has prompted migration of homeless persons to those states.[29,30]

The act of travel itself may induce biological stress that induces psychiatric illness. Air travel has been associated with cognitive impairment, delirium, and psychosis among elderly patients.[31,32] These acute complications likely arise from fatigue as well as disruptions in circadian rhythms and diurnal cortisol regulation.[16,33]

Approach to Treating Travelers

Ill, isolated, and in need of treatment, the traveling patient in the ED presents unique challenges for treatment. Our review revealed no treatment recommendations for the treatment of traveling patients in the ED. We provide some guidance based on our experience in emergency psychiatry.

Solicit a history

An evaluation of patients who travel must begin with a history of present illness that includes for how long the patient has been in town and why the patient moved. The timing of peregrination provides clues to changes in functioning, symptom severity, and reasons for presentation. This line of questioning naturally leads to an assessment of the patient's self-care: Where is the patient staying? What are sources of food, clothing, and income? Do they have a cell phone to facilitate follow up? Table 1 lists several key questions for evaluation.

Understanding the patient's travel pattern is important for treatment planning in the ED. How long does the patient

Table 1. Key questions for evaluating the peregrinating emergency department patient.

Question	Clinical information
How long have you been in this city?	Collect history of present illness and consider time course of symptoms.
What brought you to this city?	Understand motivation.
Where are you staying? Where do you eat? What is your income source?	Assess for grave disability and identify basic needs.
How often do you move?	Learn pattern of behavior and usual coping styles.
Who do you know here? Any friends? Family?	Identify sources of support.
How long do you plan to stay here?	Begin planning for follow-up care.

typically stay in a city? How did the patient pay for travel previously? Patients who move every few weeks are unlikely to engage in case management. The need for inpatient hospitalization must be determined based on acute safety concerns, but we find that many traveling patients do not participate in subsequent follow-up care. Thus, for chronic travelers, inpatient hospitalization is typically unhelpful for improving prognosis or engagement in treatment.

Assess familiarity with local resources

Clinicians then identify the patient's local resources: What family or friends live in the area? What employment opportunities exist for the patient? Patients new to town often require orientation to local healthcare and shelter resources. Oftentimes, patient express suicidal ideation that may be ameliorated by a brief introduction to the city, meal sites, day shelters, and crisis services. A map that locates these services and provides phone numbers is invaluable.

For patients without a local social network, the clinician should learn where the patient's supportive persons reside and how to connect the patient with them.

Obtain collateral information

Obtaining prior medical records or identifying collateral informants for travelers can be difficult. Patients may be resistant to disclosure or unaware of where they received treatment. In these cases, several strategies are helpful. Insurance companies often have on-call clinicians who will review claims, share diagnoses, and even provide treatment notes regardless of geographic location; a patient disclosure authorization is not required to talk to the insurer. Chronically mentally ill patients are often treated by community mental health providers that closely collaborate with local crisis lines. We have found that calling the regional crisis line in the patient's prior residence can elucidate contact information for a recent case manager or treatment records; at least, the crisis counselor can provide clues as to local hospitals and agencies that are likely to have treated the patient. Major city hospitals and mental health agencies in the traveler's city of origin may be found through an Internet search or an informal survey of colleagues in the ED. Many peregrinating patients present to EDs with discharge paperwork from another hospital; these records are vital. Multi-state record systems such as ED information exchanges or prescription drug monitoring databases can report where patients have previously received care.

Contact information for family or friends may be identified through outside hospital records, among the patient's belongings, or in the patient's cell phone. These persons may offer information helpful for an evaluation as well as provide the patient a social network to assist in disposition or other problem-solving.

Focus on safety and the acute presentation

Like any patient presenting to the ED, travelers merit treatment of acute pathology and a comprehensive assessment of suicide and violence risk. As with local patients, long-distance patients may benefit from pharmacotherapy for agitation, psychosis, or anxiety; detoxification and substance treatment services should be considered.

Specific interventions and disposition planning should reflect the patient's local resources, individual strengths, and personal goals. Brief psychotherapy for traveling patients starts with a supportive stance that explores patients' strengths and sources of resilience – after all, the same cognitive, financial, and social capacities required to travel may also facilitate treatment. In our experience, travelers with paranoia or involuntary ED presentations are resistant to accessing care: emergency providers should strive to help these patients feel comfortable returning to the ED should new problems arise.

Tourists and travelers with reliable plans to return to usual care in another city may be assisted with bridging prescriptions or guidance to urgent care providers for help until returning to a usual provider (as with Case 2). Absent concerning side effects, changes in psychiatric medications and dosing are best handled by the patient's regular provider rather than in an acute ED visit.

"Bus therapy"

Some hospitals provide a one-way bus ticket to another state for patients with challenging psychiatric presentation and

recurrent service utilization.[34,35] This practice is pejoratively called "Greyhound Therapy."[34] There are no data as to the outcomes of bus therapy. In some instances, travelers specifically request help with a bus ticket, and clinicians are able to speak with family members or outpatient providers in the city to which patients wish to return. Under these circumstances it is reasonable to facilitate travel in hopes of helping the patient re-establish contact with an established social and healthcare network.

However, providing a bus ticket to a patient with no plan for shelter or resources in the destination city is "patient dumping."[35] Bus therapy in this fashion is unethical and discouraged. Dumping constitutes a failure of the duty to care for patients and distorts the just distribution of mental health resources.

FUTURE DIRECTIONS

Much about patient peregrination remains to be discovered. The frequency and costs associated with peregrination are unknown, as are firm data regarding psychiatric and medical morbidity among these patients. Studying these patients is difficult: Travelers move across regions and healthcare systems, change insurance providers frequently, and are unlikely to participate in longitudinal studies. Widespread adoption of electronic medical records may facilitate an investigation of these patients. At a local level, hospitals can develop case definitions and collect information on the care needs of travelers. It is unclear what outcomes would be of value in evaluating the care of traveling patients.

CONCLUSION

Peregrinating psychiatric patients are commonly seen in the ED. These patients consume significant attention and resources in the emergency department. The historical association of traveling with factitious disorder has obscured the broad range of diagnoses associated with traveling patients (Table 2). Indeed, clinical practice and limited data suggest that travelers represent a patient population with significant psychopathology. Emergency clinicians' assessment and treatment must reflect the unique needs of the peregrinating patient.

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Table 2. Common diagnoses among peregrinating psychiatric patients.

Anxiety, depression, or crisis after re-location for work or personal reasons
Schizophrenia
Bipolar mania
Delusional disorder
Substance abuse
Personality disorders, including borderline and antisocial
Factitious disorder
Dissociative disorders
Malingering
Delirium, cognitive impairment, or psychosis secondary to jet travel

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Increased 30-Day Emergency Department Revisits Among Homeless Patients with Mental Health Conditions

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Introduction: Patients with mental health conditions frequently use emergency medical services. Many suffer from substance use and homelessness. If they use the emergency department (ED) as their primary source of care, potentially preventable frequent ED revisits and hospital readmissions can worsen an already crowded healthcare system. However, the magnitude to which homelessness affects health service utilization among patients with mental health conditions remains unclear in the medical community. This study assessed the impact of homelessness on 30-day ED revisits and hospital readmissions among patients presenting with mental health conditions in an urban, safety-net hospital.

Methods: We conducted a secondary analysis of administrative data on all adult ED visits in 2012 in an urban safety-net hospital. Patient demographics, mental health status, homelessness, insurance coverage, level of acuity, and ED disposition per ED visit were analyzed using multilevel modeling to control for multiple visits nested within patients. We performed multivariate logistic regressions to evaluate if homelessness moderated the likelihood of mental health patients' 30-day ED revisits and hospital readmissions.

Results: Study included 139,414 adult ED visits from 92,307 unique patients (43.5±15.1 years, 51.3% male, 68.2% Hispanic/Latino). Nearly 8% of patients presented with mental health conditions, while 4.6% were homeless at any time during the study period. Among patients with mental health conditions, being homeless contributed to an additional 28.0% increase in likelihood (4.28 to 5.48 odds) of 30-day ED revisits and 38.2% increase in likelihood (2.04 to 2.82 odds) of hospital readmission, compared to non-homeless, non-mental health (NHNM) patients as the base category. Adjusted predicted probabilities showed that homeless patients presenting with mental health conditions have a 31.1% chance of returning to the ED within 30-day post discharge and a 3.7% chance of hospital readmission, compared to non-homeless patients presenting with mental health conditions (25.2%, 2.6%) and NHNM (7.7%, 1.5%).

Conclusion: Homeless patients presenting with mental health conditions were more likely to return to the ED within 30 days and to be readmitted to the hospital. Interventions providing housing might improve their overall care management and have the potential to reduce ED revisits and hospital readmissions. [West J Emerg Med. 2016;17(5)607-612.]

INTRODUCTION

One in four American adults suffers from a mental health condition at some point.[1,2] Despite a reported lower use of medical services overall,[1,3] these patients have been observed to be frequent users in the emergency department (ED).[4-7] Frequent ED visits could be a result of their uncontrolled health conditions.[8-12] Alternatively, when they consistently use the ED as their primary source of care, the avoidable ED revisits and hospital readmissions stress an already crowded healthcare system.[10, 13-16]

Folsom et al. found that 15% of individuals with serious mental health conditions suffer from homelessness.[17] The homeless population is vulnerable due to limited self-care ability, substance abuse and co-morbidities such as infections, skin diseases or HIV.[18-20] Similar to patients with mental health conditions, many use the ED as a regular source of care.[5, 17, 21-23] Studies in the U.S. and Canada have shown that providing housing to homeless individuals may result in fewer hospital days and ED visits.[18, 19, 24-27]

To address the medical needs of patients with mental health conditions, studies have focused on identifying factors that predict their ED revisits and hospital readmissions.[11, 14] Young to middle age, male sex, Medicaid or uninsured and history of illicit drug use were among the major risk factors.[4, 5, 8, 20, 21] However, the magnitude to which homelessness affects mental health patients' health service utilization remains unclear in the medical community.[11, 28] The objective of this study was to examine the impact of homelessness on ED revisits within 30 days post discharge and hospital readmissions among patients presenting with mental health conditions.

METHODS

We conducted secondary analysis of administrative data in the ED at an urban safety-net hospital covering all adult ED visits in 2012. Patient age, sex, race/ethnicity, type of insurance, level of acuity, and ED disposition were obtained. We defined homelessness as having the keyword "homeless" in the address line, or if the homeless item was checked in the patient registration form. Level of acuity (Emergency Severity Index - ESI) was a five-level triage algorithm assigned at patient's arrival, from 1 (most urgent) to 5 (least urgent). All data were de-identified. The study was approved by the institutional review board.

The study divided the ED patient population into two groups, based on whether or not the patient had presented with a mental health condition during the study period. The investigators defined patients' mental health status by converting the primary ICD-9 at visit-level into nine categories using the validated NYU ED Algorithm using SAS 9.4 (SAS Institute, Cary NC).[16] The NYU ED Algorithm helps classify ED utilization as being emergent, ED care needed, preventable, and whether the visits are mental health, alcohol, substance or injury related.[16] Any patient having ≥1 visits reclassified under the "mental health principal diagnoses" category was considered as a patient ever presented with mental health conditions, regardless of the diagnoses of his/her other visits. We used this approach to minimize bias toward patient visits that were non-mental health-related that would potentially underestimate the mental health population in the patient sample.

Visit-level data and the number of visits per individual patient were recorded. The study had two outcome variables: 1) 30-day ED revisit, and 2) 30-day hospital readmission. We calculated both 30-day ED revisit and hospital readmission time based on the time difference between patients' discharge date and the arrival date of their next visit. Any subsequent visit with a diagnosis of "aftercare" was considered a planned visit and was not captured as a revisit or readmission. The investigators extended tracking into the following year to ensure all 30-day ED revisits and hospital readmissions were captured for any ED visit taking place in December during the study period.

We used a multilevel modeling approach to account for patients with multiple visits in the dataset. Multivariate logistic regression was performed to test for moderation of homelessness on patients' mental health status on the study outcomes. We computed adjusted predicted probabilities using regression coefficients to estimate the probability of a patient having 30-day ED revisits or hospital readmissions given his/her patient and visit characteristics. All statistical analyses used a two-sided test with α set to 0.05 and were analyzed with Stata 13.[29]

RESULTS

The study included 139,414 adult ED visits in 2012, represented by 92,307 unique patients. Of the unique patients (43.5±15.1 years, 51.3% male, 68.2% Hispanic/Latino), 7.5% met the criteria of ever presented with mental health conditions during the study period (accounted for 11.7% of total visits), while 4.6% of patients were homeless at any time during the study period (accounted for 10.9% of total visits). Patients who presented with mental health conditions were more likely to be younger (38.3±13.6 vs. 43.9±15.1), male sex (61.1% vs. 50.5%), White (22.2% vs. 9.8%) or African-American (24.4% vs. 10.5%), and homeless (21.5% vs. 3.2%) compared to patients without mental health conditions ($p<0.001$). Patients who presented with mental health conditions had a higher number of total visits (2-5 visits: 35.9% vs. 21.0%, >5 visits: 6.6% vs. 1.4%), averaging 2.4±3.8 visits (range 1-184) versus 1.4±1.8 visits (range 1-98) among patients without mental health conditions ($p<0.001$) (Table 1 top).

In terms of visit-level data, patients who presented with mental health conditions were more likely to be covered by Medicare (9.6% vs. 4.8%, delta: 4.8%, 95% CI: [4.4, 5.2]) and other government programs (31.1% vs. 9.5%, delta: 21.6%, 95% CI: [21.1, 21.6]); to present to the ED with a lower level of acuity (ESI: 3.14 vs. 2.99, delta: 0.15, 95% CI: [0.14, 0.16]); to more frequently be transferred to outside facilities including psychiatric hospitals (33.7% vs. 4.6%, delta: 29.1%, 95% CI: [28.7, 29.6]); but less likely to be admitted to the hospital for non-psychiatric medical conditions (11.7% vs. 13.9%, delta: 2.2%, 95% CI: [1.7, 2.8]) compared to patients without mental health conditions ($p<0.001$). However, 42.5% of their subsequent ED visits were 30-day ED revisits, versus 17.2% by patients without mental health conditions (delta: 25.3%, 95% CI: [24.7, 26.0], $p<0.001$). In addition, 4.7% of their ED revisits resulted in hospital readmission, compared to 2.6% by patients without mental health conditions (delta:

Table 1. Characteristics of patient-level and visit-level data, by mental health status.

Characteristics	Total		Mental health		Non-mental health		p-value
	n	%	n	%	n	%	
Patient-level data	n=92,307		n=6,933 (7.5%)		n= 85,375 (92.5%)		
Age (mean, SD)	43.5	15.1	38.3	13.6	43.9	15.1	<0.001
Male	47311	51.3%	4237	61.1%	43074	50.5%	<0.001
Race/ethnicity							
White	9919	10.8%	1541	22.2%	8378	9.8%	<0.001
Asian	6021	6.5%	388	5.6%	5633	6.6%	
African-American	10637	11.5%	1694	24.4%	8943	10.5%	
Latino	62914	68.2%	3147	45.4%	59767	70.1%	
Other	2815	3.1%	163	2.4%	2652	3.1%	
Homeless*	4210	4.6%	1493	21.5%	2717	3.2%	<0.001
Number of total visits							
1	70,233	76.1%	3,991	57.6%	66,232	77.6%	<0.001
2-5	20,438	22.1%	2,486	35.9%	17,952	21.0%	
>5	1,646	1.8%	456	6.6%	1,190	1.4%	
mean, SD	1.5	2.0	2.4	3.8	1.4	1.8	<0.001
median, range	1	1-184	1	1-184	1	1-98	
Visit-level data	n=139,414		n=16,303 (11.7%)		n=123,111 (88.3%)		
Insurance							
Private	3,473	2.5%	274	1.7%	3,199	2.6%	<0.001
Medicare	7,424	5.3%	1,558	9.6%	5,866	4.8%	
Medicaid	50,153	36.0%	5,895	36.2%	44,258	36.0%	
Other government programs	16,797	12.1%	5,075	31.1%	11,722	9.5%	
No insurance	61,567	44.2%	3,501	21.5%	58,066	47.2%	
Homeless (per visit)	7,231	5.2%	2,784	17.1%	4,447	3.6%	<0.001
Homeless (by patients with * definition)	15,159	10.9%	5,950	36.5%	9,209	7.5%	<0.001
Level of acuity (mean, 95% CI)**	3.01	3.01-3.01	3.14	3.13-3.15	2.99	2.99-3.00	<0.001
ED disposition							
Admitted to hospital	19,068	13.7%	1,911	11.7%	17,157	13.9%	<0.001
Transferred	11,158	8.0%	5,501	33.7%	5,657	4.6%	
Against medical advice	17,818	12.8%	1,955	12.0%	15,863	12.9%	
Home	91,370	65.5%	6,936	42.5%	84,434	68.6%	
ED revisit, ≤30 days	28,080	20.1%	6,935	42.5%	21,145	17.2%	<0.001
Hospital readmission	4,010	2.9%	761	4.7%	3,249	2.6%	<0.001

*Homelessness - at any time during study period
**Level of Acuity: score 1-5, 1 referring to highest acuity
SD, standard deviation; *CI,* confidence interval; *ED,* emergency department.

2.1%, 95% CI: [1.8, 2.3], p<0.001).(Table 1 bottom).

Results from multilevel multivariate logistic regression (Table 2 top) showed a significant interaction between homelessness and mental health status. Overall, homeless patients presented with mental health conditions were more likely to have 30-day ED revisits (OR: 5.48, 95% CI: [4.85-6.18], p<0.001) and hospital readmissions (OR: 2.82, 95% CI: [2.31-3.46], p<0.001) compared to non-homeless, non-mental health (NHNM) patients. Among patients presenting with mental health conditions, being homeless contributed to an additional 28.0% increase in likelihood (4.28 to 5.48 odds) of 30-day ED revisits and 38.2% increase (2.04 to 2.82 odds) of

Table 2. Multilevel multivariate logistic regression analysis (n=92,307) showing interaction between homelessness and mental health status.

Independent variables	ED revisit, ≤30 days		Hospital readmission	
	Odds ratio	95% CI	Odds ratio	95% CI
MH x homeless	5.48***	4.85-6.18	2.82***	2.31-3.46
MH x non-homeless	4.28***	3.99-4.59	2.04***	1.80-2.31
Non-MH x homeless	1.95***	1.77-2.15	1.72***	1.46-2.04
Non-MH x non-homeless	ref		ref	
Age	1.01***	1.01-1.0.1	1.01***	1.01-1.02
Male	1.33***	1.27-1.38	1.27***	1.17-1.37
Race/ethnicity				
White	ref		ref	
African-American	1.39***	1.29-1.50	0.96	0.83-1.11
Latino/Hispanic	0.93*	0.87-0.99	1.07	0.95-1.21
Asian	0.77***	0.70-0.86	1.04	0.87-1.25
Other	0.27***	0.22-0.33	0.38	0.24-0.60
Insurance				
No insurance	ref		ref	
Medicare	0.76***	0.69-0.84	1.18	0.99-1.39
Medicaid	1.35***	1.29-1.41	2.60***	2.38-2.85
Other government programs	0.65***	0.61-0.70	1.13	0.99-1.30
Private	0.38***	0.32-0.44	0.55**	0.39-0.78
Level of acuity**	0.94***	0.92-0.96	0.64	0.61-0.68
ED disposition				
Home	ref		ref	
Admitted to hospital	1.03	0.97-1.09	2.12***	1.93-2.31
Transferred	0.97	0.90-1.04	1.24**	1.09-1.42
Against medical advice	1.82***	1.72-1.93	1.29***	1.13-1.45
Adjusted predicted probabilities				
MH x homeless	31.1%		3.7%	
MH x non-homeless	25.2%		2.6%	
Non-MH x homeless	15.0%		2.8%	
Non-MH x non-homeless	7.7%		1.5%	

*p<0.05, **p<0.01, ***p<0.001
**Level of Acuity: score 1-5, 1 referring to highest acuity
MH, mental health; *Ref,* reference category; *ED,* emergency department.

hospital readmissions, while adjusting for other covariates. As for homeless patients, those presenting with mental health conditions contributed to an additional 181.0% increase in likelihood (1.95 to 5.48 odds) of 30-day ED revisits and a 64.0% increase (1.72 to 2.82 odds) of hospital readmissions.

Results from adjusted predicted probabilities showed that being homeless increased mental health patients' probability of returning to the ED within 30 days from 25.2% to 31.1%. For hospital readmissions, the probability increased from 2.6% to 3.7%. Comparing to non-homeless non-mental health (NHNM), homeless patients presenting with mental health conditions demonstrated a four-fold increase (31.1% vs. 7.7%) in 30-day ED revisits, and 2.5-fold increase (3.7% vs. 1.5%) in hospital readmissions compared to NHNM patients (Table 2 bottom).

DISCUSSION

The findings that homeless patients and those presenting with mental health conditions have a significant increase in 30-day ED revisits and hospital readmissions compared to patients with neither of these problems is mostly consistent with prior literature on these patient groups. [14-7, 17, 21-23] What is

novel in our study is finding that being homeless and having a mental health condition interact to produce even higher use, which likely contributes to an already crowded healthcare system.[10, 13-16] These findings highlight the need for ED resources to treat patients in either of these categories.

Current literature on ED revisits and hospital readmissions is limited by the lack of advanced statistical modeling to account for within-patient level data.[11, 14, 20] Using multilevel modeling helped control for the within-patient clustering effects so that patient characteristics of the repeated visitors would not be overrepresented in the estimations. In addition, testing for the interaction between homelessness and mental health conditions provided a quantitative measure and magnitude on either category to predict the study outcomes. As suggested in the literature,[19] the two conditions interact in limiting an individual's ability to care for self. This results in an increased likelihood of seeking more advanced-stage medical treatments.

The study has several limitations. Homelessness was a self-report measure; institutionalized individuals who provided an address of their shelter were eligible for inclusion without additional verification. This approach is a conservative definition of homelessness and if anything would tend to underestimate the odds of recidivism. The study also focused on a single-site, urban safety-net hospital, which might limit the generalizability. To define patients' mental health status, the investigators only used patients' primary diagnosis and might underestimate the prevalence of ED patients with mental health conditions. If this is the case, our estimates of the odds of recidivism for the mental health and homeless population will be biased downward (e.g. the actual odds ratios would be greater than we observed). However, the study results provided an estimate of the underserved, low-income patient population that was more likely to suffer from homelessness and mental health conditions. The data are practical given they reflect on a sample living in Los Angeles, a city where the rates of both conditions rank among the top in the nation, with high demand for medical needs but limited resources to address the problems.[30, 31]

CONCLUSION

In summary, homelessness increased the likelihood of 30-day ED revisit and hospital readmission among patients who presented with mental health conditions. Interventions such as providing housing may improve their overall care management and have the potential to reduce their ED revisits and hospital readmissions over time.

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ED Patients with Prolonged Complaints and Repeat ED Visits Have an Increased Risk of Depression

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Introduction: The objective of this study was to explore associations between presenting chief complaints of prolonged symptomatology, patient usage of the emergency department (ED), and underlying depression so that emergency physicians may better target patients for depression screening.

Methods: A convenience sample of ED patients were administered the Beck Depression Inventory-II (BDI-II) to assess for depression. We correlated completed BDI-II surveys to patient information including demographics, pertinent history of present illness information, and past medical history.

Results: Out of 425 participants screened, we identified complaints of two weeks or longer in 92 patients (22%). Of these patients, mild to severe depression was recognized in over half of the population (47), yet only nine patients reported a prior depression diagnosis. These 92 patients also visited the ED three times as frequently as those patients with more acute complaints ($p<0.001$). Finally, our study showed that patients with mild to severe depression had three times as many ED visits compared to patients with minimal or no depression ($p<0.001$).

Conclusion: Patients with complaints of symptomatology two weeks or longer are more likely to have underlying depression when presenting to the ED. Patients with three or more ED visits within the past year also have a greater incidence of underlying depression. We found a strong correlation between complaints with symptomatology of two weeks or longer and multiple ED visits, in which underlying depression may have contributed to these patients' ED visits. [West J Emerg Med. 2016;17(5)613-616.]

INTRODUCTION

This study was designed to explore the association between chief complaints of prolonged symptomatology, patient usage of the emergency department (ED), and underlying depression. We hypothesized that patients with complaints of symptomatology two weeks or longer present to the ED more frequently than those with more acute complaints, and that depression may be an underlying factor contributing to their medical symptoms. The ability to identify underlying depression in this population could provide an opportunity to better manage a patient's overall care.

METHODS

This prospective study was performed at The University of Toledo Medical Center Emergency Department (UTMC-ED), a Level I trauma center located in Toledo, Ohio. We collected data under the approval of the University of Toledo institutional review board (IRB): IRB#107866.

We used a convenience sample of patients presenting to the ED over a six-month period to select study participants. Subject enrollment occurred Monday through Sunday on a rotating shift to best ensure an even sampling of patients. Volunteering participants were provided an information sheet

and waiver of consent. Subject exclusion criteria included those patients who were less than 18 years of age, non-English speaking, intoxicated, had critical illnesses, or who were otherwise medically unable to consent.

Participants were administered a Beck Depression Inventory-II (BDI-II), a self-reporting survey of 21 multiple-choice questions, to determine the presence and severity of depression symptoms as listed in the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders 4th Edition (DSM-IV). After completion of the BDI-II, subjects finished their participation in the study and no further communication relating to the study was conducted.[1] Each question contained four to six weighted responses increasing in severity with answer ratings between 0-3. Completed surveys were hand scored by adding the corresponding response values chosen by the patient. We grouped patients by their level of depression via the BDI-II scores as follows: 0-13 having no or minimal depression, 14-19 with mild, 20-28 with moderate, and 29-63 with severe depression.

We reviewed electronic medical records of participating patients for the visit where the BDI-II was administered and any prior visits to the UTMC-ED within the preceding 12 months. Patient demographics, chief complaints, and past medical histories were recorded. Patient demographics were obtained from the patient's medical record via a self-reported face sheet in triage given to all ED patients. For purposes of this study, we classified chief complaints as "chronic" symptomatology if the patient described the condition manifesting for two weeks or longer. The number of visits to the UTMC-ED one year prior to the visit when the BDI-II was administered was recorded.

We identified associations between categorical factors (e.g., medical history) and depression using chi-square or Fisher's exact tests (for less common diagnoses). Mann-Whitney-Wilcoxon test was used for continuous factors (e.g., age, length of stay, ED visits). Because the continuous factors were not distributed normally, the median and interquartile ranges (IQR 25th to 75th percentile) are presented.

RESULTS

We successfully enrolled 425 subjects who completed all study materials. Patients were grouped by their BDI-II scores, corresponding with their severity of depression symptoms. Of the 425 patients, 245 (58%) were classified with no or minimal depression; 62 patients (15%) mild depression; 85 patients (20%) moderate depression; and 33 (8%) severe depression (Figure). These findings are similar to previous studies calculating the prevalence of depression in the ED.[2] For the remainder of this study, patients were grouped into two cohorts: patients with no or minimal depression (BDI-II score; 0-13) and patients with mild, moderate or severe depression (BDI-II score; 14-63) (Table 1).

Sample population demographics including sex, age and race are shown in Table 1. One hundred forty-nine patients (35%) were male and 276 (65%) were female. Females had a significantly higher percentage of depression than males ($p=0.004$). Two hundred twenty (52%) subjects indentified as Caucasian; 196 (46%) African American; and nine (2%) other. The median age was 32 years (IQR of 23 to 44). There was a significant association between self-reported depression in the ED and older age ($p<0.001$). Patients classified as having mild to severe depression had a median age of 35 years (IQR 26 to 48), while patients with no or minimal depression had a median age of 30 (IQR 22 to 41). These data are comparable to national statistics, which show the female gender and older age groups have an increased prevalence of depression.[3]

We divided the sample population by the classification of an acute versus chronic chief complaint during the visit when the BDI-II was completed. As shown in Table 2, of the 425 patients, 333 (78%) were classified as having a chief complaint with acute symptomatology and 92 (22%) had a chief complaint of chronic symptomatology. Patients presenting with a chronic chief complaint visited the UTMC-ED at three times the frequency of the acute patients (Table 2) ($p<0.001$).

Patients presenting with acute versus chronic chief complaints and number of ED visits were compared with

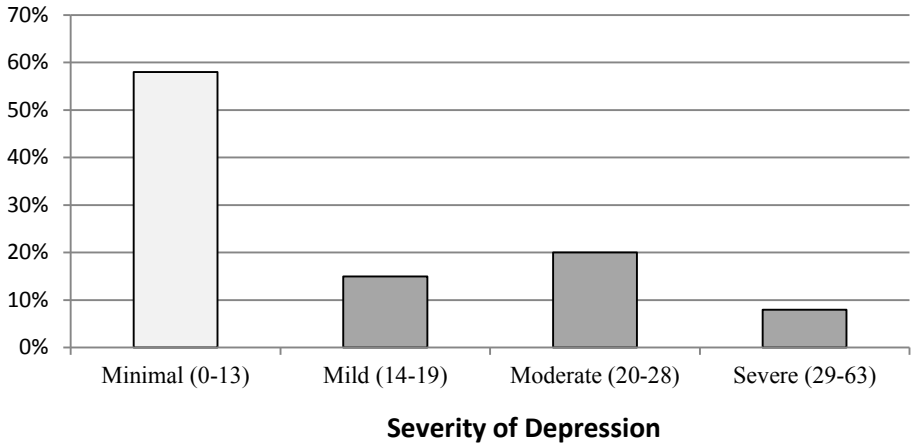

Figure. Patients classified by severity of depression (BDI-II score).

Table 1. Comparison of sample population demographics by severity of depression.

	Overall	Mild, moderate or severe depression	Minimal depression	P-value
Number of patients	425	180 (42%)	245 (58%)	--
Sex				0.004*
Female	276 (65%)	131 (73%)	145 (59%)	
Male	149 (35%)	48 (27%)	101 (41%)	
Age (years)	median 32	median 35	median 30	<0.001**
	IQR 23 to 44	IQR 26 to 48	IQR 22 to 41	
Race				0.38*
Caucasian	220 (52%)	98 (55%)	122 (51%)	
African American	196 (46%)	79 (45%)	117 (49%)	
Other	9 (2%)			

IQR, interquartile range; *Chi-square p-value reported; **Mann-Whitney-Wilcoxon test

Table 2. Number of emergency department (ED) visits by patients presenting with acute vs. chronic chief complaints.

	Acute complaint (<2wks)	Chronic complaint (>2wks)	P-value
Number of patients	333 (78%)	92 (22%)	--
ED visits	median 1	median 3	<0.001*
	IQR 1 to 3	IQR 1 to 5	

ED, emergency department; *IQR*, interquartile range; *Chi-square p-value reported

Table 3. Chief complaints and number of emergency department (ED) visits by severity of depression.

	Overall	Mild, moderate or severe depression	Minimal depression	P-value
Number of patients	425	180 (42%)	245 (58%)	--
Chief complaint				0.05*
Acute (<2 weeks)	333 (78%)	133 (74%)	200 (82%)	
Chronic (>2 weeks)	92 (22%)	47 (26%)	45 (18%)	
ED visits	median 2	median 3	median 1	<0.001*
	IQR 1 to 4	IQR 1 to 6	IQR 1 to 3	

ED, emergency department; *IQR*, interquartile range; *Chi-square p-value reported

their severity of depression determined via the subject's BDI-II score (Table 3). We identified a significant association between more severe depression, a chronic chief complaint ($p<0.05$) and increased visits ($p<0.001$).

DISCUSSION

Within EDs, physical symptoms are often misinterpreted as having an organic origin while mental illnesses, such as depression, may be the underlying cause or exacerbating the patient's complaint. Studies estimate that 23-30% of ED patients have an underlying factor of depression and greater than 60% of patients with depression are unidentified.[4,5,6] In a 2012 report, 79.7% of adults reported visiting the ED due to lack of access to other providers. [7] With a significant percentage of the U.S. population visiting the ED each year due to a lack of access to a primary source of healthcare, detecting depression in the ED is of utmost importance.[7]

Depression screening questionnaires are frequently used in the primary care setting. However, administering questionnaires to every patient who presents to the ED would be an impractical and costly process. The physician's clinical judgment for the diagnosis of underlying depression is key, and then if needed, a questionnaire such as the Beck Depression Inventory-II (BDI-II) or Patient Health Questionnaire-9 (PHQ-9), can be used for confirmation. The BDI-II in our study classified 42% of the patients presenting to the UTMC-ED as having mild, moderate or severe depression. This figure is within range of other studies estimating the prevalence of depression using the BDI-II and the Hospital Anxiety and Depression Scales (HADS) questionnaires.[4,5]

EDs have become the safety net for many who seek treatment for chronic medical issues. These data signify that patients who present to the ED with chief complaints of symptomatology of two weeks or longer were more likely to

have underlying depression compared to those with more acute complaints. In our study, the use of "two weeks or longer duration of symptoms" must be differentiated from a "chronic" complaint. Chronicity is defined by specific criteria for a medical illness, including the total duration of symptoms, the number of days symptoms are experienced and the number of days symptom free. To simply our criteria for clinical practice implementation, we used a patient self-reported duration of symptoms lasting two weeks or longer as a cutoff to be targeted for depression screening. Our data also exemplify that those patients who visited the ED three or more times in the preceding year have a significantly greater chance of having underlying depression compared to those with less frequent ED visits. Therefore, screening patients with frequent ED visits and prolonged symptomatology for depression may be beneficial in identifying and providing care for this mental health disorder.

Future studies are needed to access the appropriate channeling and coordination of care for patients identified with depression in the ED. Connecting these patients to appropriate mental health resources could be beneficial, but it is not known if these patients would be compliant with mental health follow up. Providing these patients with the resources to obtain follow-up care for their depression may be a suitable approach.

LIMITATIONS

Limitations of this study are primarily based upon use of a convenience sampling of patients and an inventory to screen for depression. A convenience sampling of patients may limit the ability to generalize study findings to the population as a whole. Enrolling patients on a rotating shift and all days of the week was done to minimize this limitation. Like other self-reporting inventories, the BDI-II can have scores or emotions that are easily exaggerated or minimized by the person completing the survey.[8] While this can be the case, overall, the BDI-II has strong correlations with the Hamilton Depression Rating Scale with a Pearson r of 0.71, suggesting good agreement and clinical correlation. Further, the BDI-II has high one-week retest reliability (Pearson r of 0.93), thus indicating it is not overly sensitive to daily variations in mood.[1]

CONCLUSION

Based on this study, ED patients presenting with a chief complaint of symptomatology lasting two weeks or longer and those who have frequently presented to the ED in the past year have a significantly greater incidence of underlying depression. By targeting these high-risk ED patients for depression screening or follow up, emergency physicians may be able to better manage their care.

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Adolescent with Foot Pain

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A previously healthy 14-year-old female presented to the emergency department because of a left foot injury. She reported "twisting" her foot while walking. She complained of left foot pain, but was able to ambulate with a limp. Physical exam was significant for soft tissue edema and isolated tenderness to the dorsum of the left foot in the region of the cuboid. She had full range of motion at the ankle joint without pain or tenderness and was neurovascularly intact. Radiographs were obtained and revealed cuboid subluxation (Figure).

DIAGNOSIS

Cuboid subluxation. Cuboid subluxation is generally diagnosed clinically, based on history and physical exam, and definitive radiographic evidence is rare. Injury presentation is varied, but case reports often describe pain isolated over the cuboid following a forceful inversion of the foot while bearing weight. Physical exam typically reveals tenderness over the cuboid. Because of normal variations between the cuboid and its surrounding structures, traditional radiographs, computerized tomography, and magnetic resonance imaging are generally non-diagnostic for this injury.[1-8] Additionally, midtarsal joint abnormalities that cause pain while weight bearing may be missed on non-weight bearing films.[2] Imaging, however, is often ordered even when suspicion for cuboid subluxation is high to rule out other causes of foot pain.

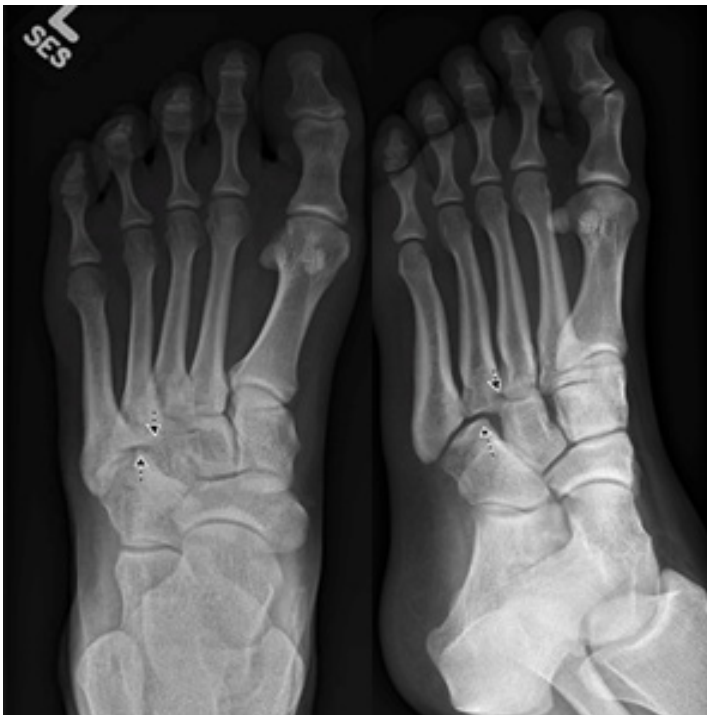

Figure. Anterior-posterior (left) and oblique (right) radiograph of the left foot with lateral displacement of the cuboid relative to the base of the fourth metatarsal (arrows).

In the case image above (Figure), there is lateral displacement of the cuboid relative to the base of the fourth metatarsal (arrows). A good rule-of-thumb and highly suggestive radiographic finding of cuboid subluxation is a disturbed relationship between the medial-cuboid and its articulation with the fourth metatarsal.

Treatment may require manual reduction and responds well to conservative physiotherapy management. Our patient was fitted with a controlled ankle motion (CAM) walking boot and was given crutches. She was referred to the orthopedic surgery clinic for further management.

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Hemorrhagic Encephalopathy From Acute Baking Soda Ingestion

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Baking soda is a readily available household product composed of sodium bicarbonate. It can be used as a home remedy to treat dyspepsia. If used in excessive amounts, baking soda has the potential to cause a variety of serious metabolic abnormalities. We believe this is the first reported case of hemorrhagic encephalopathy induced by baking soda ingestion. Healthcare providers should be aware of the dangers of baking soda misuse and the associated adverse effects. [West J Emerg Med. 2016;17(5)619-622.]

INTRODUCTION

Baking soda is marketed to consumers for numerous household and personal purposes. Its active ingredient is sodium bicarbonate. Despite the widespread use of proton pump inhibitors and H2 blockers, baking soda continues to be used as an antacid for relief of indigestion. The recommended dosage for using baking soda as an antacid is ½ teaspoon in 4-8oz of water every two hours. Each teaspoon of baking soda contains 41.8mEq of sodium.[1] Sodium bicarbonate is generally safe when used appropriately. However, if misused, it has the potential for significant toxicity. Metabolic alkalosis, hypernatremia, hypokalemia, hypochloremia, and hypoxia have been reported.[2] Severe hypernatremia can cause neuronal cell shrinkage, retraction of cerebral tissue, and potentially intracranial hemorrhage. We present a case of severe metabolic alkalosis and hypernatremic hemorrhagic encephalopathy after an acute intentional baking soda ingestion.

CASE REPORT

A 33-year-old male with a history of schizophrenia and polysubstance abuse presented to the emergency department (ED) with altered mental status. Emergency medical technicians reported that the patient was discovered in the middle of the street, agitated and confused with an empty box of baking soda in his pants pocket.

On initial evaluation, the patient appeared alert, tremulous and distressed. His vitals were temperature 35.7°C (96.2°F), heart rate 124 beats/min, respirations 18 breaths/min, blood pressure 126/93, oxygen saturation 94% on room air. The physical examination was significant for a thin male, rocking back and forth, mumbling incoherently and forcefully blinking his eyes. The head and neck examination was notable for horizontal nystagmus, intermittent involuntary facial twitching, moist mucus membranes and no facial droop. Pupils were equal, round, and reactive to light bilaterally. The cardiac examination revealed regular tachycardia. Neurologic examination was significant for a coarse tremor to his arms and upper torso. He would intermittently lift his legs and arms off the bed then slam them down on the stretcher. He was stuttering, disoriented, and unable to answer questions. Cerebellar function could not be tested due to the patient's mental status. The rest of his exam was normal.

Initial laboratory values were Na 172mEq/L, K 2.5mEq/L, chloride 98mEq/L, CO_2>45mEq/L, glucose 433mg/dL, BUN 16mg/dL, creatinine 1.85mg/dL, magnesium 3.2mg/dL, phosphate<1mg/dL, and calcium of 11mg/dL. Liver function tests were remarkable for a bilirubin of 1.4mg/dL, total protein of 8.5g/dL, albumin of 5.6g/dL. White blood cell count was 11.6 cells/microL and his hemoglobin was 17g/dL. A room air venous blood gas measurement 7.53, pCO_2 60mmHg, pO2 39mmHg, HCO_3 50mEq/L, with a base excess of 21.6mEq/L. The electrocardiogram (EKG) showed sinus tachycardia with a prolonged QTc of 528msec. Urinalysis: pH of 8.52 and granular casts. Serum osmolality was 364 mOsm/kg and venous lactate 12.3 mmol/L. A urine toxicology screen was negative for amphetamines, barbiturates, benzodiazepines, cocaine, methadone, opiates, phencyclidine, cannabionoids, and tricyclic antidepressants. Blood alcohol, acetaminophen,

and salicylate levels were negative. A head computed tomography (CT) was obtained and revealed multiple areas of intracranial hemorrhage in the left temporal and bilateral cerebellar regions. Additionally there was subarachnoid hemorrhage in the left frontal lobe and right posterior frontal lobe (Figure). CT angiography was normal without aneurysm. CT of the chest, abdomen, and pelvis was significant only for diffuse mild dilation of the small bowel and marked fluid content of the entire GI tract.

While in the ED, the patient received 2L normal saline and intravenous potassium replacement. Neurosurgery was consulted but did not recommend any surgical intervention. He was admitted to the intensive care unit where he continued to receive IV normal saline and electrolyte repletion. The patient's mental status improved to his baseline over the next 24 hours and he was able to endorse that he had consumed an entire box of baking soda (net wt 16oz/454g). His estimated sodium burden was 5,403mEq. A repeat head CT showed stable intracranial hemorrhages. He denied suicidal ideation and after evaluation, psychiatry deemed the patient safe for discharge. He was discharged on hospital day 4 at which time he had a non-focal neurologic exam.

DISCUSSION

Pathophysiology

Baking soda toxicity causes hypernatremic metabolic alkalosis with associated hypochloremia, hypokalemia and urinary alkalization, all of which were present in our patient.[3-7] Healthy adult subjects less than 60 years old with normal renal function can tolerate up to 1700mEq of sodium bicarbonate with minimal symptoms.[8] Our patient ingested an estimated 5,403mEq of sodium. Increased serum bicarbonate following ingestion results in increased renal excretion, known as bicarbonate diuresis.[3,9,10] Such diuresis is accompanied by loss of chloride, sodium, potassium, and water. However, in large ingestions there can be substantial free water loss, resulting in an impaired glomerular filtration rate (GFR) and ultimately reduced bicarbonate filtering.

Central nervous system (CNS) hypernatremia causes an osmotic shift of water out of neurons, cellular dehydration and neuronal cell shrinkage. Cerebral volume loss causes retraction of tissues within the skull. Increased tension on dural bridging veins results in rupture of vascular structures and ultimately intracranial hemorrhage, most often in the subdural space.[11]

Certain populations are at greater risk of complications associated with baking soda misuse, including alcoholics (due to volume depletion associated with poor oral intake chronic vomiting), the elderly, hypovolemic patients, and patients with underlying pulmonary or renal disease.[12]

Reasons for overdose

Published cases of baking soda toxicity frequently involve its excessive use as an antacid.[2,6,12-14] A retrospective review of all symptomatic cases reported to the California Poison Control system between 2000-2012 found that the most common reasons for reports were antacid misuse (60.4%), attempts to alter urine drug testing (11.5%), and urinary tract infection treatment (4.7%).[12] There have been other reports of baking soda toxicity in the setting of pica and topical use in an infant with diaper rash.[3,15] Our patient was unable to articulate his reasons for ingestion.

Clinical Presentation

Baking soda toxicity can present in numerous ways. Most commonly, patients present with nausea, vomiting, and abdominal pain;[16] however,1-5% of patients will present with neurologic symptoms such as lethargy, drowsiness, nystagmus, seizures, weakness and rarely coma.[12] Cardiac arrhythmias and cardiopulmonary arrest have been reported, as well as a case of a pregnant woman at 37 weeks gestation with baking soda pica who presented with rhabdomyolysis and peripartum cardiomyopathy.[5,15,17] Spontaneous rupture of the stomach after sodium bicarbonate ingestion, thought to be due to increased CO_2 production following bicarbonate reaction with acidic gastric contents, has also been reported.[18]

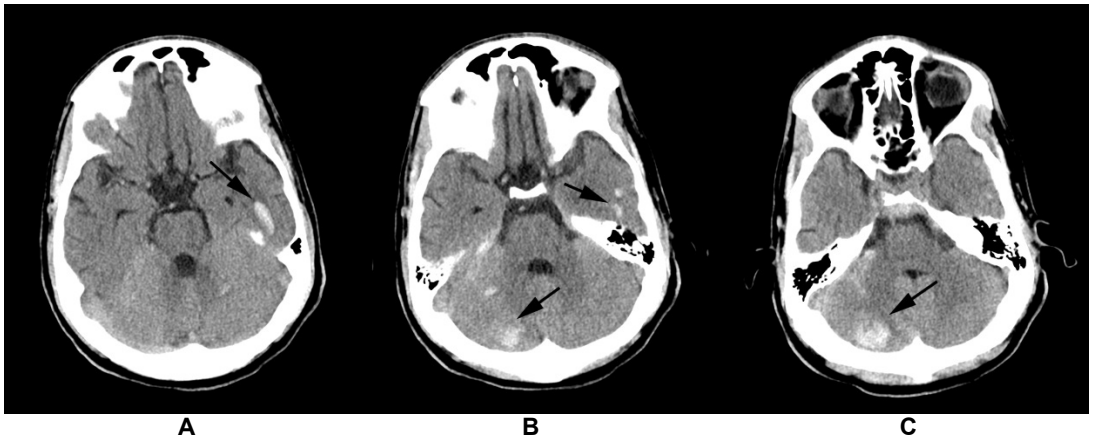

Figure A, B and C. Non contrast CT head demonstrating left temporal and right cerebellar hemorrhages.

Published reports of hypernatremia as a cause of cerebral hemorrhage are rare. We could not find any cases of baking soda ingestion resulting in cerebral hemorrhage and hypernatremia. There are cases of hypernatremic hemorrhagic encephalopathy in neonates and children, typically associated with dehydration and/or medical treatments. Such cases usually have sodium levels over 160mmol/L.[19-22] The first case of hypernatremic hemorrhagic encephalopathy in an adult patient was reported in 2010, the result of hypotonic fluid loss-induced hypernatremia.[11]

Evaluation

Laboratory evaluation for suspected baking soda ingestion should include a complete metabolic panel, arterial blood gas and EKG.

Metabolic alkalosis, if severe, can lead to compensatory hypoventilation and hypercapnia, which was seen with our patient. Severe metabolic alkalosis is associated with a leftward shift of the oxygen-hemoglobin dissociation curve, resulting in impaired oxygen delivery to tissue and hypoxemia. Cardiopulmonary arrest and death from hypercapnic respiratory failure in the setting of metabolic alkalosis has been reported.[5]

Hypokalemia can result in a prolonged QT interval and subsequent ventricular arrhythmias.[5,6]

Treatment

Treatment of toxic baking soda ingestions includes intravenous fluid resuscitation and potassium supplementation. Most cases of metabolic alkalosis will resolve with volume resuscitation. The first step is to calculate the free water deficit. The equation is as follows: FW Deficit = 0.6 x weight (kg) x (current Na mml/L / 140-1). The correction factor is 0.6 for men and children, 0.5 for women and elderly men, and 0.45 for elderly women. In acute settings (development of hypernatremia in minutes to hours) correction can occur with rapid transfusion of 5% dextrose in water with goal 1meq/L/hr. Dialysis can also be considered. In subacute settings (occurring over 1-2 days) correction can occur between 0.5-1meq/L/hr. In chronic settings (>2 days) correction should occur 0.5meq/L/hr for adults and 0.3meq/L/hr for pediatric patients to limit potential risk of cerebral edema that may be associated with rehydration.[23,24] Unlike hyponatremia, rapid correction of hypernatremia in adults is not known to be harmful in the acute and subacute setting and many patients are under corrected.[23,25] For pediatric patients with an unknown duration of hypernatremia, it is recommended that patients avoid correction>0.5meq/L/hr. Large potassium deficits are typically present with baking soda toxicity and should be aggressively monitored and replaced. Hemodialysis can be considered in critically ill patients with renal failure and severe electrolyte derangements that are not responding to fluid and electrolyte repletion.[26]

In the setting of ventricular dysrhythmias, electrolytes should be corrected. Amiodarone and lidocaine are first line for treatment of ventricular tachycardia. Seizures should be treated with benzodiazepines.[8]

In summary, we present a case of a baking soda overdose resulting in hemorrhagic encephalopathy, metabolic alkalosis and hypernatremia. Baking soda can lead to life-threatening complications when misused. Healthcare providers should be aware of the common practice of using baking soda as a home remedy for indigestion and the potential dangers associated with its misuse. The combination of hypernatremia and metabolic alkalosis should raise suspicion for ingestion of baking soda. Although rare, severe acute hypernatremia can result in intracranial hemorrhage due to CNS dehydration and stretching of vascular structures within the skull.

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Two Cases of Anti-NMDA Receptor Encephalitis

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INTRODUCTION

Anti-N-methyl-D-aspartate receptor (anti-NMDAR) encephalitis is a form of autoimmune encephalitis with prominent neuropsychiatric features. Patients present with acute psychosis, memory impairment, dyskinesias, seizures, and/or speech disorders. The clinical course is often complicated by respiratory failure, requiring intubation. Approximately half of patients are found to have an associated ovarian tumor, which expresses NMDAR. Recognition of anti-NMDAR encephalitis by emergency physicians is essential in order to initiate early treatment and avoid psychiatric misdiagnosis. The disease is highly treatable with tumor removal and immunosuppression, and most patients demonstrate a full recovery. In this case series, we report two cases of anti-NMDAR encephalitis in adult women in the United States and provide a review of the literature.

CASE REPORTS

Case #1

Chief complaint: "Acting drunk"

A 27-year-old Japanese-American female presented to the emergency department (ED) in August for altered mental status. She had been seen in the ED one and a half weeks prior for fever, diarrhea and vomiting and was discharged home on promethazine. At the time of her second ED visit, her husband described four days of increasing altered mental status and stated that the patient was "acting drunk." She also had short-term memory deficits, insomnia, hallucinations, falls, and episodes of stiffening and jerking movements. Her past medical, surgical, social, and family histories were negative. She had no recent trauma or zoonotic exposures.

On exam, her vital signs were significant only for a temperature of 38 degrees Celsius rectally and heart rate of 110. She appeared agitated and confused. She had no cervical adenopathy or meningismus. Her pupil exam was normal. Her cardiopulmonary, abdominal, and skin examinations were unremarkable. Despite her confusion, she was alert and moving all extremities. She was uncooperative with the majority of the neurologic exam. Her reflexes, including Babinski's, were normal. Her speech was clear, but she appeared to be having visual and auditory hallucinations.

Her basic metabolic panel, blood alcohol, urine toxicology screen, thyroid stimulating hormone (TSH), human immunodeficiency virus antibody, acetaminophen and salicylate levels were all within normal limits. Her complete blood count was significant for a white blood cell (WBC) count of 17 x 10^9 cells/L. Her cerebrospinal fluid (CSF) was significant for 33 white blood cells/μL with 95% lymphocytes, 0 red blood cells/μL, and normal protein and glucose (37 mg/dL, 87 mg/dL, respectively). Her CSF gram stain was negative. A non-contrast head computed tomography (CT) and magnetic resonance imaging (MRI) scan were both normal. A chest x-ray was normal.

The patient was admitted to the hospital for further workup and treatment. She developed intractable seizures and hypoventilation, requiring intubation and sedation. The patient's CSF was found to be positive for anti-NMDA receptor antibody IgG. Subsequently, a transvaginal ultrasound was performed, which showed a 4 cm ovarian dermoid cyst.

The patient was diagnosed with anti-NMDA receptor encephalitis and improved with immunosuppression and removal of the dermoid cyst.

Case #2

Chief complaint: "Changes in speech"

A 28-year-old African-American female presented to the ED with changes in speech. She stated that her speech had been "slow" for the past two weeks, associated with an intermittent occipital headache. She denied visual disturbances

or focal deficits. Her family members stated that she was having changes in her personality (increased anxiety and tearfulness) and insomnia. Two weeks prior to her current presentation, she had been seen at an outside ED for a "flu-like" illness. Her past medical, surgical, social, and family histories were unremarkable.

On exam, her vital signs were unremarkable. Her head and neck, cardiopulmonary, abdominal, and skin examinations were unremarkable. On neurologic exam, she was alert, oriented, with normal motor and sensation throughout her extremities. Cerebellar exam was within normal limits, including a normal gait. Her speech was slurred with episodes of aphasia. She appeared anxious and was tearful.

Her basic metabolic panel, TSH, and urine toxicology screen were normal. Complete blood count was significant for WBC count of 12.5 x 10^9 cells/L. Head CT was normal. The patient was admitted and over the next 24 hours, she developed worsening anxiety, mania, paranoia, agitation, auditory and visual hallucinations, left facial droop, and ataxia of the right upper extremity. The admitting team performed a lumbar puncture 36 hours after her initial ED presentation. The patient's CSF was significant for 320 WBC/μL with 92% lymphocytes, 10 red blood cells/μL, glucose of 50 mg/dL, and protein of 70 mg/dL.

Serum NMDAR antibody IgG was positive. A pelvic ultrasound and pelvic MRI were both negative. The patient was treated with intravenous immunoglobulin (IVIG) and methylprednisolone for three days and had a complete recovery.

DISCUSSION

Between 1997 and 2007, several authors reported cases of patients with paraneoplastic encephalitis associated with an ovarian teratoma;[1-10] however, the exact etiology of the disease was unknown. In 2007, Dalmau and colleagues discovered anti-N-methyl-D-aspartate receptor (anti-NMDAR) antibodies in the serum and CSF of patients with these distinct neuropsychiatric symptoms.[11] The disease is now called anti-NMDAR encephalitis and has been widely described. In fact, the California Encephalitis Project found that anti-NMDAR encephalitis was more common than any individual viral etiology of encephalitis in patients younger than 30 years old, exceeding enterovirus, herpes simplex virus, varicella zoster virus, and West Nile virus.[12]

Table. Incidence of symptoms associated with anti-NMDA receptor encephalitis as described in previous case-studies.

Study and year	Median age and range (years)	Number of patients (Percent female)	Viral prodrome[a]	Psychiatric symptoms[b]	Memory deficits	Changes in speech[c]	Seizures	Movement disorders[d]	Central hypoventilation and/or intubation
Dalmau (2007)[e]	27 (14-44)	12 (100% F)	10 (83%)	10 (83%)	6 (50%)	6 (50%)	11 (92%)	7 (58%)	10 (83%)
Iizuka (2008)	26.5 (17-33)	4 (100% F)	4 (100%)	4 (100%)	NR	4 (100%)	3 (75%)	4 (100%)	3 (75%)
Dalmau (2008)	23 (5-76)	100 (91% F)	72 (of 84 pts,86%)[f]	77 (77%)	23 (23%)	NR[g]	76 (76%)	86 (86%)	66 (66%)
Florance (2009)	14 (2-48)	81[h] (85% F)	15 (of 31,48%)	19 (of 32,59%)	NR	17 (of 32,53%)	23 (of 30,77%)	26 (of 31,84%)	7 (of 31,23%)
Gable (2012)	12.5 (2-28)	32 (75% F)	NR[j]	≥24[j] (75%)	NR	23 (72%)	22 (69%)	20 (63%)	13 (41%)
Lin (2014)	18 (7-28)	12 (83.3% F)	7 (58.3%)	11 (91.6%)	NR	7 (58.3%)	11 (91.6%)	12 (100%)	8 (66.7%)
Wang (2015)	21.6 (9-39)	51 (63% F)	31 (61%)	46 (90%)	16 (31%)	23 (45%)	43 (84%)	29 (57%)	14 (28%)

F, female; *GI,* gastrointestinal; *URI*, upper respiratory tract infection; *R,* range; *NR,* not reported

a: Viral prodrome includes symptoms such as fever, cough, rhinorrhea, vomiting, diarrhea, headaches.

b: Psychiatric symptoms include hallucinations, insomnia, fear, catatonia, delusions, mania, paranoia, anxiety, and agitation.

c: Changes in speech include mutism, dysarthria, aphasia, and incomprehensible speech.

d: Movement disorders include orofacial dyskinesias, choreoathetoid movements, muscle rigidity, dystonic postures, and oculogyric crisis.

e: Dalmau and colleagues include previously reported cases in their case series.

f: Information was only available for 84 patients

g: Changes in speech described, but exact number was not reported.

h: There were 81 patients in the study, but the characteristics of the pediatric patients are those reported.

j: The exact number of prodromal symptoms and psychiatric symptoms is not reported. However, 56% of patients had a fever, 28% had GI symptoms, 19% had URI symptoms, and 38% had headache. Hallucinations (66%), psychosis (59%), and irritability (75%) were reported separately, but there was no description of the overall number of patients with psychiatric symptoms.

Anti-NMDA receptor encephalitis typically starts with a viral-like prodrome and patients may have headache, fever, nausea, vomiting, diarrhea, anorexia, insomnia, or upper respiratory tract symptoms[11-18] (Table). A few days to weeks later, patients develop psychiatric symptoms (hallucinations, insomnia, fear, catatonia, delusions, mania, paranoia, anxiety, and agitation), short-term memory loss, abnormal movements (orofacial dyskinesias, choreoathetoid movements, muscle rigidity, dystonic postures, oculogyric crisis), seizures, and/or changes in speech (mutism, dysarthria, aphasia, incomprehensible speech).[11,12,14-18] Other neurologic symptoms such as hemiparesis and ataxia occur less frequently.[11] On presentation, patients may have a fever.[11,13] As the disease progresses, patients may develop central hypoventilation, requiring intubation, and autonomic instability (hyperthermia, tachycardia, bradycardia, hypertension, hypotension).[13,19]

Emergency physicians may be unfamiliar with the clinical presentation of anti-NMDAR encephalitis, since it was not fully characterized in the literature until recently. The diagnosis is often delayed as patients undergo extensive testing (MRI, electroencephalogram, lumbar puncture) and evaluation by neurology and/or psychiatry services to rule out infection or other neurologic or psychiatric cause.[15,19] Many patients get admitted to a psychiatric unit prior to definitive diagnosis.[11] Head CT is usually normal, but MRI may be abnormal in 25-55% of cases.[20] Cerebrospinal fluid will be abnormal in 79–100% of cases with elevated WBCs showing a lymphocytic predominance, normal glucose, and normal or elevated protein, with or without oligoclonal bands.[11,14,16,21] The definitive diagnosis is made through the detection of antibodies to NR1, NR2A and/or NR2B subunits of the NMDA receptor in the CSF or serum.[13,14,15,22]

Approximately one half of patients with anti-NMDAR encephalitis have an associated tumor[14,15,16,19], most commonly an ovarian teratoma, which, along with the autoimmune nature of the disease, may explain the female predilection for the disorder.[15,16] The frequency of teratomas varies with age, with female patients in the third decade of life having the highest frequency of teratomas.[15,16] These teratomas have been shown to contain both mature and immature neuronal tissue, which expresses NMDA receptor subunits NR1, NR2A and/or NR2B on the surface,[22] which is thought to be the basis of the antibody response.[11] Several other tumors have rarely been reported (i.e. testicular teratoma[15], small-cell lung cancer[15], neuroblastoma[19], Hodgkin's lymphoma[19]), but the majority of patients without an ovarian teratoma have no tumor at all.[14,15,16,19]

Consideration of anti-NMDAR encephalitis by emergency physicians is essential so that early treatment can be initiated. Clinicians should consider the diagnosis in new-onset psychosis or even recurrent psychosis, especially in female patients. The majority of patients will recover with first-line treatment, including tumor removal and immunotherapy (corticosteroids, IVIG, and/or plasmapheresis).[11,12] Dalmau et. al. reported full recovery of eight out of nine patients following tumor resection and immunotherapy.[11] Refractory cases may respond to rituximab and/or cyclophosphamide.[21]

In conclusion, emergency physicians should suspect anti-NMDAR encephalitis in any young female who presents with new onset seizures, psychiatric symptoms, memory loss, dyskinesias, and/or changes in speech. Patients should be tested for anti-NMDAR subunits in the CSF and serum and should undergo imaging to exclude an ovarian teratoma (ultrasound or MRI). Anti-NMDAR encephalitis is highly treatable with tumor removal and immunosuppression.

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A Rare but Important Clinical Presentation of Induced Methemoglobinemia

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INTRODUCTION

Phenazopyridine is considered one of the classic causes of drug-induced methemoglobinemia. It is often taught as such and seen in board review courses. Nevertheless, the epidemiology is unknown, presentation quite rare, and less than five cases have been reported in PubMed in over 35 years.[1-4] We present a case with a different set of patient characteristics than seen in the few recent case reports, and an approach to treatment that validates further uniqueness, justifying reporting the case in the literature. In particular, the patient was a young otherwise-healthy adult, with the initial diagnosis and decision to treat based on clinical grounds versus laboratory values.

CASE REPORT

A 32-year-old otherwise-healthy female presented to the emergency department (ED) with a chief complaint of lower abdominal pain, dysuria, urinary frequency, and hesitation for four days. On the day of presentation she started to have worsening symptoms and left flank pain.

Her temperature was 36.7 Celsius, heart rate of 87 beats per minute, blood pressure of 144/84, respiratory rate of 24 breaths per minute, and pulse oximetry of 85% on room air. In the resuscitation bay she was placed on monitor, and oxygen was delivered via non-rebreather 10-liter facemask, with an oxygen saturation of 79% (Image 1).

On initial evaluation she denied shortness of breath, cough, congestion, chest pain, or any other respiratory symptoms. She was alert and oriented, but stated that something did not feel right. Upon further questioning she reported taking phenazopyridine three times daily for the preceding three days. At one point during the interview, her oxygen saturation dropped to the mid 60s, but the patient did not report any symptoms. The rest of her history was non-contributory except for the occasional use of nicotine and a childhood episode of hospitalization for a kidney infection. Upon physical examination, she appeared to be pale but in no apparent respiratory distress. She also had a slight bluish/gray discoloration on her lips (Image 2).

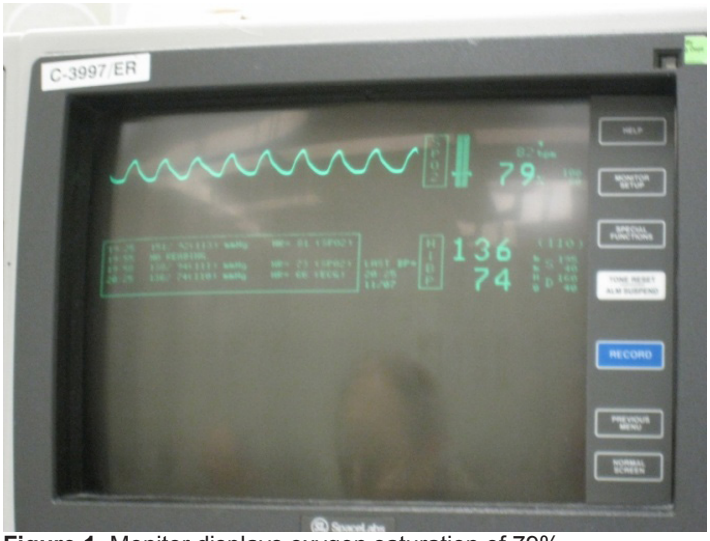

Figure 1. Monitor displays oxygen saturation of 79%.

Breath sounds were clear bilaterally. She had left costo-vertebral angle tenderness, and was tender in the suprapubic area of the abdomen, without rebound or guarding.
At this point, it was determined that she most likely had methemoglobinemia secondary to phenazopyridine ingestion, in addition to pyelonephritis. Methylene blue was ordered

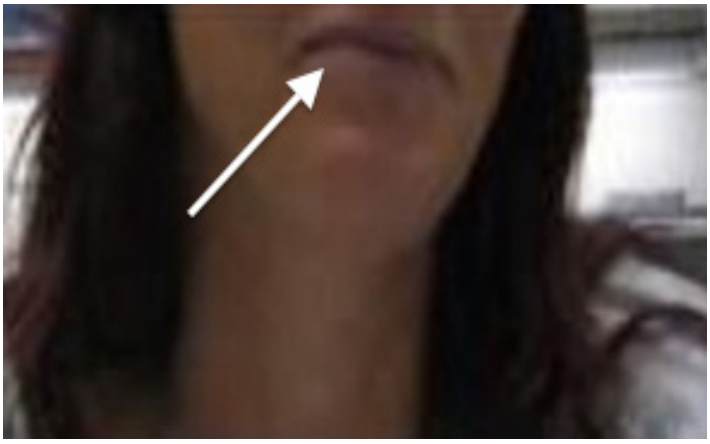

Figure 2. White arrow indicates blue/grey discoloration of lips.

from the pharmacy and we proceeded with the laboratory testing, and other diagnostic evaluations.
Laboratory tests noted hemoglobin of 10.3 g/dL, and hematocrit of 31.4%. Urinalysis was dark brown, hazy, positive for nitrates, large leukocyte esterase, many bacteria, and >180 WBCs/HPF.

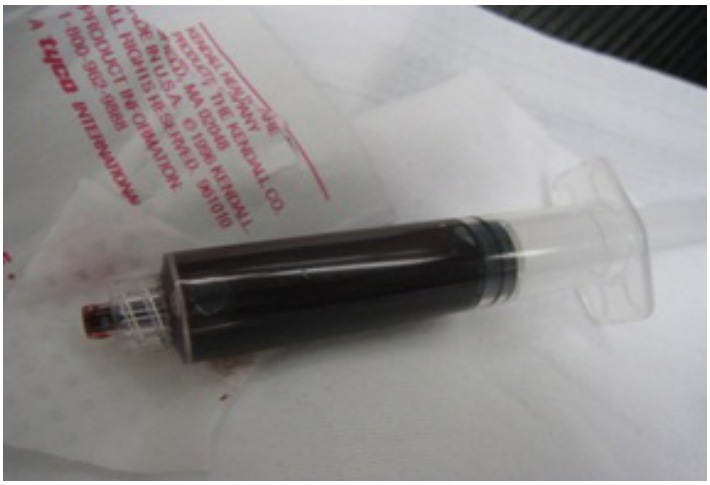

Figure 3. Blood grossly appears chocolate brown color.

The methemoglobin level was 11.9%. The blood from this draw was noted to be chocolate brown (Image 3).

Prior to the return of the ordered laboratory studies, methylene blue was received. We felt that our history and physical exam gave us a very strong clinical suspicion for the diagnosis of methemoglobinemia and pyelonephritis. Given our concern for the prolonged central cyanosis in conjunction with the comorbidity of the pyelonephritis, we decided to proceed and treat the methemoglobinemia. She was given methylene blue 100mg IV. Shortly after receiving the methylene blue, she stated that she felt that her mind had "cleared up," and that she felt less "foggy." Her oxygen saturation level improved to the low 90s on room air.

At this time, the internal medicine (IM) service was consulted for admission and she was started on ceftriaxone 1g intravenous for her pyelonephritis. A second methemoglobin level was obtained by the IM service six hours after the dose of methylene blue and it was 0%. Approximately 24 hours after admission, oxygen saturation was documented at 99% on room air, with an arterial blood gas (ABG) reading of pH=7.5/pCO2=28/pO2=123/HCO3=21/BE=0.

The patient was in the hospital for three days. Her hospital course was unremarkable.

Prior to discharge, she no longer had urinary symptoms, and she felt markedly improved. Her discharge instructions included "do not ever use phenazopyridine!"

DISCUSSION

Phenazopyridine is a commonly used over-the-counter (OTC) medication reported by patients presenting to the ED with complaints of dysuria. Conversely, methemoglobinemia induced from phenazopyridine ingestion is rarely seen in the ED. The epidemiology is unknown and very few cases are cited in the literature, with most in the remote past.[1-4] Cases of methemoglobinemia are most frequently cited in the literature after use of dapsone and local anesthetics (i.e. benzocaine and lidocaine), and rarely reported in the emergency medicine literature.[4-7]

Methemoglobin forms when the ferrous (Fe2+) irons of heme are oxidized to the ferric (Fe3+) state. In the ferric state, methemoglobin is unable to bind oxygen. In addition, the oxygen affinity of any remaining ferrous heme in the hemoglobin tetramer is increased. As a result, the oxygen dissociation curve is shifted to the left, resulting in hypoxia and lactic acid production.[8]

Methemoglobin is reduced to ferrous hemoglobin by two pathways. The main pathway—which is the only physiologically important pathway—is the NADH-dependent reaction catalyzed by cytochrome b5 reductase (b5R). The alternative pathway—which is not physiologically active—uses NADPH generated by glucose-6-phosphate dehydrogenase (G6PD) in the hexose monophosphate shunt to reduce methemoglobin to hemoglobin. Extrinsically administered electron acceptors, such as methylene blue, are required for this pathway to be activated.[9]

Methemoglobinemia can be congenital or acquired.[9] Congenital causes are seen in cytochrome b5 reductase deficiency or hemoglobin M disease. All patients with hereditary methemoglobinemia should avoid exposure to aniline derivatives, nitrates, and other agents that may, even in normal individuals, induce methemoglobinemia.

Induced or acquired causes occur when methemoglobin production is accelerated beyond the capacity of NADH reductase activity. This usually occurs as a drug reaction.

Methemoglobinemia may be clinically suspected by the presence of clinical "cyanosis" in the presence of a normal arterial pO2 (PaO2) obtained by arterial blood gases. The blood in methemoglobinemia has been variously described as dark red, chocolate, or brownish to blue in color, and, unlike

deoxy-hemoglobin, the color does not change with the addition of oxygen (Image 3).

In asymptomatic patients, usually those with methemoglobin levels <20 percent, no therapy other than discontinuation of the offending agent(s) suffices. Patients with acutely acquired methemoglobinemia may be asymptomatic at lower levels of methemoglobin (i.e., <20 percent). Methylene blue therapy is indicated if the patient is symptomatic, or if the methemoglobin level is >20 percent. Symptoms, when present, include headache, fatigue, dyspnea, and lethargy. At methemoglobin levels >40 percent, respiratory depression, altered consciousness, shock, seizures, and death may occur. Blood transfusion or exchange transfusion may be helpful in patients who are in shock. Hyperbaric oxygen has been used with anecdotal success in severe cases.

Methylene blue given intravenously in a dose of 1 to 2 mg/kg over five minutes provides an artificial electron transporter for the ultimate reduction of methemoglobin via the NADPH-dependent pathway. The response is usually rapid; the dose may be repeated in one hour if the level of methemoglobin is still high one hour after the initial infusion, but retreatment is frequently not necessary.[10]

In our patient, the decision to treat was based on the history and physical exam in addition to the urinalysis. Our trigger was the fact that the co-morbidity of the kidney infection and its potential anaerobic stress as well as the consideration of possibly extensive lab-result lag time in a busy county trauma center.

Although rarely seen, it is important to remember that this commonly used and accessible medication can precipitate methemoglobinemia. This case illustrates multiple classic teaching modules in emergency medicine including central cyanosis and dyshemoglobinemia. This case also illustrates the invaluable utility of a good history. This can be done rapidly and with directive, even in a busy modern ED.

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A Curious Case of Right Upper Quadrant Abdominal Pain

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An otherwise healthy 36-year-old man presented with sudden-onset right upper quadrant abdominal pain and vomiting. A bedside ultrasound, performed to evaluate hepatobiliary pathology, revealed a normal gallbladder but free intraperitoneal fluid. After an expedited CT and emergent explorative laparotomy, the patient was diagnosed with a small bowel obstruction with ischemia secondary to midgut volvulus. Though midgut volvulus is rare in adults, delays in definitive diagnosis and management can result in bowel necrosis. Importantly, an emergency physician must be able to recognize bedside ultrasound findings associated with acutely dangerous intrabdominal pathology. [West J Emerg Med. 2016;17(5)630-633.]

INTRODUCTION

Fifty percent of midgut volvulus cases present within the first month of life, and 90% in the first year.[1] After three months, malrotation with midgut volvulus is considered rare.[2] Midgut volvulus begins with incomplete embryologic midgut rotation or fixation. Later the bowel can twist, leading to obstruction of the bowel and its mesenteric blood supply.[3] Typically, midgut volvulus presents with sudden onset abdominal pain with bilious vomiting in the neonate.[4] It can progress to peritonitis, bowel necrosis, shock, and death.[3] In this adult patient, a similar presentation initially led to a work-up for gallbladder pathology, which revealed unexpected red flags for dangerous pathology and led to expedited care. A delay in diagnosis may have ultimately resulted in bowel infarction and death.

CASE REPORT

A 36 year-old male with no past medical history called emergency medical services after he developed acute-onset, constant, right upper quadrant pain and one episode of non-bloody, non-bilious vomiting. Upon arrival to the emergency department (ED), his pain was rated 9/10 and his vital signs were temperature 97 F (36.1 C), pulse 61, respirations 18, blood pressure 155/103, and O_2 saturation 100%. His examination revealed a firm abdomen, significant right upper quadrant tenderness, and voluntary guarding. Soon after the initial exam, the patient had a second episode of non-bloody, non-bilious vomiting for which he was given ondansetron, ranitidine, and one liter of 0.9% normal saline. A prompt point-of-care ultrasound (POCUS) demonstrated a normal gallbladder. However, it also showed free intraperitoneal fluid in Morison's pouch and a loop of

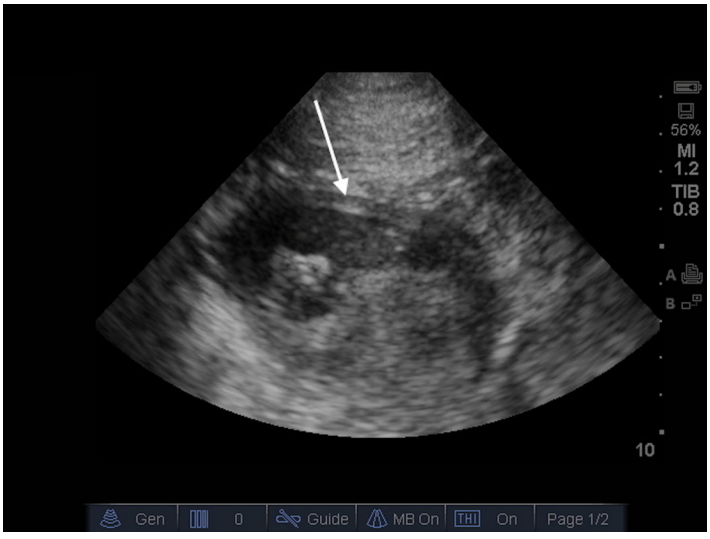

Figure 1. Bowel in transverse view demonstrating distention and wall edema

distended bowel with wall edema (Figure 1). An upright chest radiograph did not demonstrate pneumoperitoneum or any other abnormality. During this period of investigation, the patient's pain increased in intensity, he exhibited multiple episodes of vomiting, and his abdomen became more rigid.

Presuming an acute abdomen, we contacted surgery for emergent consultation and transported the patient for an expedited computed tomography (CT) abdomen and pelvis with intravenous contrast. The venous lactate level returned at 6.1 mmol/L which prompted the administration of a bolus of two additional liters of normal saline using pressure bags.

The attending radiologist interpreted the CT:

> "Malrotation with the third portion the duodenum... Multiple dilated loops of jejunum with suggestion of wall thickening…Distorted mesenteric anatomy with a swirled appearance of the mesenteric vessels. Given this constellation of findings, the appearance is suspicious for a volvulus with early or partial bowel obstruction."

The patient was taken emergently to the operating room where midgut volvulus was confirmed. According to the perioperative documentation, the entire small bowel was black, and upon manual detorsion, portions of the bowel regained its normal, pink color indicating restored perfusion. The assisting pediatric surgeon successfully performed a Ladd Procedure, and the abdomen was left open.

On the second hospital day, another evaluation in the operating room revealed bowel with both venous congestion and edema but without necrosis. The bowel appeared both viable and peristaltic. On the fourth hospital day, a third and final inspection demonstrated pink and healthy bowel with decreased edema. After decompressing the gastrointestinal tract, the abdomen was closed. The patient was discharged on his ninth hospital day without any additional complications and has continued to do well during follow-up visits.

DISCUSSION

Malrotation is defined as an abnormal twisting of the small intestines during embryological development, whereas volvulus refers to the condition when this abnormal twisting results in bowel and vascular obstruction.[3] Midgut volvulus overwhelmingly presents in the first month of life and rarely in adults.[2] Aside from the issue of age, the diagnosis is complicated in adults as clinical features of midgut malrotation with or without volvulus significantly differ from those in neonates. Adults may present with intestinal obstruction, chronic abdominal pain, malabsorption and diarrhea, peritonitis and septic shock, solid food intolerance, common bile duct obstruction, and abdominal distension.[5] A common presenting symptom such as vomiting may be absent in 73% of adults. Whereas, in pediatric cases it is absent in only 7%.[4] As a result, delays in definitive diagnosis of adults with midgut malrotation are common.[6] In 32% of adult patients, many years may pass before the diagnosis of malrotation is confirmed with the appropriate diagnostic test.[4,7] This delay should be concerning given that malrotation has been called a "time bomb" that can lead to "devastating intestinal necrosis" once volvulus occurs.[4] Ischemia and pressure necrosis can rapidly lead to intestinal perforation in as few as eight hours, truly making this a surgical emergency.[8,9]

CT findings for midgut volvulus fall into three categories: Mesenteric ischemia, small bowel obstruction, and anatomic abnormalities. A finding specific to midgut malrotation is the "whirlpool sign," which refers to the swirled appearance of the mesentery and superior mesenteric vein (SMV) when they are wrapped around the superior mesenteric artery (SMA) (Image 2).[10,11] Ultrasonography (US) can identify volvulus as well. The two main US findings associated with midgut malrotation are transposition of the SMA and the SMV (sensitivity 67%-100%, specificity 75%-83%) and the whirlpool sign (sensitivity 81-92%, specificity 92-100%).[12-15] In SMA and SMV transposition, the SMV is located on ventral left of the SMA; however, this finding is not always seen in malrotation, and even when present, the patient may be asymptomatic.[12] The two vessels are identified by using color Doppler to distinguish arterial from venous flow.[13] Traditionally, the diagnostic gold standard for malrotation is an upper gastrointestinal series (sensitivity of 54-79%), but its low yield and invasiveness negate its practicality in the ED.[15,16]

Emergency physicians are focused on differentiating between sick and not sick. In this patient, the POCUS findings of intraperitoneal free fluid and bowel wall edema significantly expedited specialty consultation and confirmatory diagnostic testing. Without POCUS, manual detorsion in the OR would have been delayed, and the marginally viable bowel may not have been saved. The use of early ultrasonography is well supported by the literature. In two recent studies, POCUS

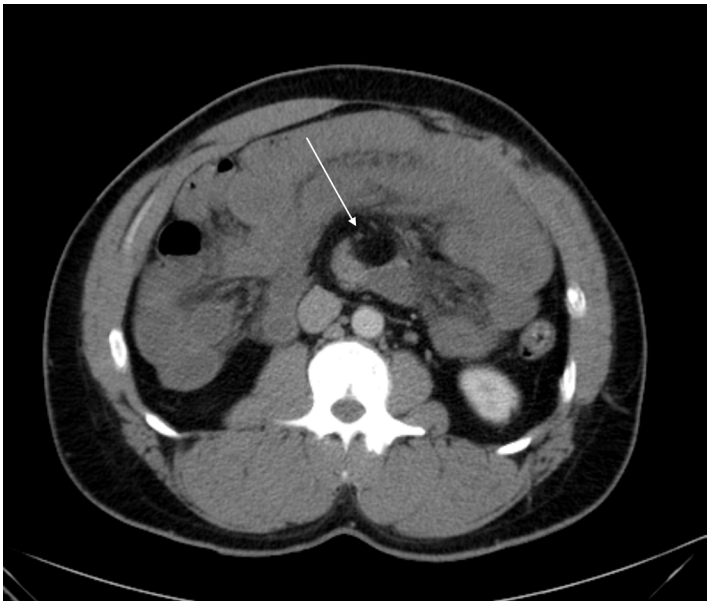

Figure 2. Arrow indicates whirlpool sign

helped the provider in 83-87% of patients with undifferentiated acute abdominal pain.[18,19] Importantly, it changed clinical decision-making in 22-47% of patients; this included preventing intended laparotomies or revealing a diagnosis other than the initial clinical impression.[18,19] In other instances, POCUS can obviate the need for further imaging such as in suspected renal and biliary colic.[19,20] The use of POCUS to allow reduced utilization of computed tomography (CT) may have a significant public health benefit, with an estimated 1.5-2.0% of all cancers in the United States attributable to radiation from CT.[23,24]

In this case, the finding of intraperitoneal free fluid on POCUS raised the provider's level of suspicion for acutely dangerous pathology. In a retrospective review of pediatric patients with acute abdominal pain, free fluid on diagnostic imaging doubled the rate of a surgical condition from 25% to 57.4% ($p<0.001$) as well as increased the rate of surgery from 6.3% to 94.4% ($p<0.001$).[24] While free fluid alone is not specific for a surgical pathology, providers must consider this finding when deciding to obtain or prioritize specialty consults and more specific imaging such as CT in these patients. Additionally, the POCUS in this case identified dilated bowel with wall edema. Ultrasonography has also been shown to be useful in identification of bowel obstructions and may serve as the sole imaging modality.[25] Using the diagnostic criteria of >2.5 cm dilated loops of bowel proximal to collapsed loops of bowel and absent or decreased peristalsis activity, POCUS had a +LR of 9.55 (95% CI = [2.16 to 42.21]) and – LR 0.04 (95% CI = [0.1 to 0.13]) for intestinal obstruction.[25] In the appropriate clinical setting, such findings on POCUS should increase the provider's suspicion for intestinal obstruction and need for prioritization of that patient's care.

A patient with right upper quadrant pain and vomiting may reasonably be suspected to have gallbladder disease. POCUS in this case did not reveal gallbladder pathology but did serve to identify an extremely sick patient with an alternative diagnosis and resulted in an acceleration and prioritization of this patient's care. Delays in care could have been catastrophic for this patient. While midgut volvulus case reports and series have been published in the surgical literature, this diagnosis has had limited representation in the emergency medicine literature. Emergency physicians should be aware of this diagnosis as well as the sonographic findings in the abdomen that are predictive of pathology that may require surgical intervention. Care of these patients must be expedited, as a delay to definitive diagnosis and treatment may lead to increased morbidity and mortality. In patients with midgut volvulus with associated small bowel obstruction and ischemia, "time is bowel." An awareness of this potentially life-threatening diagnosis can reduce time to confirmatory testing and definitive treatment in the operating room.

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A Comparison of Chest Compression Quality Delivered During On-Scene and Ground Transport Cardiopulmonary Resuscitation

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Introduction: American Heart Association (AHA) guidelines recommend cardiopulmonary resuscitation (CPR) chest compressions 1.5 to 2 inches (3.75-5 cm) deep at 100 to 120 per minute. Recent studies demonstrated that manual CPR by emergency medical services (EMS) personnel is substandard. We hypothesized that transport CPR quality is significantly worse than on-scene CPR quality.

Methods: We analyzed adult patients receiving on-scene and transport chest compressions from nine EMS sites across Minnesota and Wisconsin from May 2008 to July 2010. Two periods were analyzed: before and after visual feedback. CPR data were collected and exported with the Zoll M series monitor and a sternally placed accelerometer measuring chest compression rate and depth. We compared compression data with 2010 AHA guidelines and Zoll RescueNet Code Review software. CPR depth and rate were "above (deep)," "in," or "below (shallow)" the target range according to AHA guidelines. We paired on-scene and transport data for each patient; paired proportions were compared with the nonparametric Wilcoxon signed rank test.

Results: In the pre-feedback period, we analyzed 105 of 140 paired cases (75.0%); in the post-feedback period, 35 of 140 paired cases (25.0%) were analyzed. The proportion of correct depths during on-scene compressions (median, 41.9%; interquartile range [IQR], 16.1-73.1) was higher compared to the paired transport proportion (median, 8.7%; IQR, 2.7-48.9). Proportions of on-scene median correct rates and transport median correct depths did not improve in the post-feedback period.

Conclusion: Transport chest compressions are significantly worse than on-scene compressions. Implementation of visual real-time feedback did not affect performance. [West J Emerg Med. 2016;17(5)634-639.]

INTRODUCTION

The 2010 American Heart Association (AHA)/ International Liaison Committee on Resuscitation (ILCOR) Cardiopulmonary Resuscitation (CPR) Guidelines call for a minimum chest compression rate of 100 to 120 compressions per minute and a minimum chest compression depth of 1.5 to 2 inches (3.75-5 cm).[1] Two clinical studies have reported the quality of chest compressions delivered before emergency medical services (EMS) transport and the quality of those delivered during transport.[2,3] Further evidence has suggested that visual, automated CPR feedback improves CPR quality.[4,5]

Research with the use of mannequins has shown that CPR quality is inferior on a moving stretcher[6] and in a moving ambulance.[7] We hypothesized that the quality of CPR during ambulance transport is significantly worse than CPR delivered in a static situation ("on scene"—e.g., on the ground or in

the street). The aim of this study was to compare the quality of CPR delivered by paramedics on scene to the quality of CPR delivered by paramedics during transport in two distinct periods: before the use of visual feedback ("pre-feedback") and after the use of visual feedback ("post-feedback"). Visual feedback was deployed systemwide during the study period, and we thought that this was an important confounding variable that could not be ignored; hence, we used two distinct periods with matched cases.

METHODS

Study Setting and Population

Mayo Clinic Medical Transport (MCMT) is a nine-site EMS system with a public service area in Minnesota and Wisconsin. In October 2009, MCMT incorporated CPR feedback technology using a sternally positioned accelerometer to quantitatively measure the quality (i.e., the rate and depth) of CPR. We conducted this study with the nine EMS sites in Minnesota and Wisconsin where prehospital care is provided by MCMT's Gold Cross Ambulance Service. Resuscitation protocols are identical at each site. This is an a priori secondary analysis of data obtained from a large recently published prospective multicenter clinical trial on adult patients treated with CPR in the prehospital environment.[8] We included adults (age ≥18 years) who had nontraumatic out-of-hospital cardiac arrest, received CPR on scene, and were subsequently transported with ongoing CPR in an ambulance. The null hypothesis was that there is no difference in proportional delivery of correct CPR depth and rate between on-scene CPR and transport CPR.

Data Collection and Processing

We obtained institutional review board approval from the hospitals that received patients.

Demographic data and transport times were collected with the use of Zoll RescueNet Code Review data and documentation software (Zoll Medical Corp). CPR quality indicators (rate and depth) were abstracted with the use of Zoll M series CPR accelerometer technology and entered into an Excel database (Microsoft Corp). We categorized CPR depth and rate as "above (deep)," "in," or "below (shallow)" the target range according to AHA guidelines.

Classification of Time Periods and Quality of CPR

In October 2009, MCMT and Gold Cross Ambulance Service incorporated visual CPR feedback technology (Zoll Medical Corp) in all sites with a sternally positioned accelerometer to quantitatively measure the quality (rate and depth) of CPR. At all times during the study period, prehospital providers were required to use a metronome during CPR, although verification of its use was not possible.

Correct CPR depth was defined as compressions of 1.5 to 2 inches (3.75-5 cm). Correct CPR rate was defined as 100 to 120 compressions per minute. We calculated the proportions of correct CPR depths and rates as percentages of all compressions administered during each CPR episode. Hands-off time was not measured during this study. Only periods when compressions were done were analyzed. We analyzed all data with JMP Version 8.0 statistical software (SAS Institute, Inc).

Outcomes

The primary outcome was the proportional rate and depth of CPR compressions delivered during on-scene resuscitation and during transport resuscitation. Secondary outcomes were survival to admission and discharge.

Statistical Analysis

For comparisons of proportional rate and depth of compressions between on-scene and transport resuscitations, we analyzed the cohort in two groups: pre-feedback period (without visual feedback from the Zoll monitor) and post-feedback period (with visual feedback from the Zoll monitor) because we considered this a substantial confounding variable. We used the Wilcoxon signed rank test for paired patient data in each group and the Kruskal-Wallis test for nonpaired data. We used simple descriptive statistics for measures of central tendency to describe demographic and time data. All probability tests were 2-tailed with an α level of .05.

RESULTS

Participants

A total of 140 adults had CPR performed on scene and were then transported and required CPR at some time during transport.

Descriptive Data

Table 1 summarizes cohort demographic features, including age, sex, and on-scene and transport times and distances. There were no significant differences between groups when compared by visual feedback period (Table 2).

Main Results

In the pre-feedback period, we analyzed 105 of 140 paired cases (75.0%); in the post-feedback period, 35 of 140 paired cases (25.0%) were analyzed (Figure).

Pre-feedback Period (n=105)

The proportion of correct depths during on-scene compressions (median, 41.9%; interquartile range [IQR], 16.1%-73.1%) was higher compared to the paired transport proportion (median, 8.7%; IQR, [2.7%-48.9%]). Paired analysis with the Wilcoxon signed rank test showed that the difference was significant ($p<0.0001$). The proportion of correct compression rates during on-scene CPR (median, 45.5%; IQR, [9.9%-60.7%]) was higher compared to the paired transport proportion (median, 11.1%; IQR, [5.8%-34.5%]). Paired analysis with the Wilcoxon signed rank test showed that the difference was significant ($p<0.0001$).

Table 1. Cohort demographic and clinical features.

Feature	Value
Age, mean (95% CI), y	65.6 (62.9-68.2)
Male, % of patients (95% CI)	67.4 (58.9-74.9)
First rhythm, median (%)[a]	
Ventricular fibrillation	39 (30.2)
Ventricular tachycardia	1 (0.8)
Nonshockable (pulseless electrical activity and asystole)	86 (66.7)
Not documented	3 (2.3)
On-scene care time, median (IQR), min	18.7 (11.2)
Estimated patient weight, mean (95% CI), kg	91.2 (86.3-96.1)
Distance from scene to hospital, median (IQR), km	5 (10)
CPR duration, median (IQR), min	
On-scene	7.7 (10.1)
Transport	2.2 (3.3)
Correct rate, median (IQR), %	
On-scene	45.8 (49.8)
Transport	11.5 (39.3)
Correct depth, median (IQR), %	
On-scene	48.3 (61.0)
Transport	9.8 (54.8)
Disposition, No. of patients (%)	
Died as inpatient	67 (51.9)
Discharged alive	33 (25.6)
Hospitalized at end of study	29 (22.5)

CPR, cardiopulmonary resuscitation; *IQR,* interquartile range; *CI,* confidence interval
[a], Documented by Gold Cross Ambulance personnel

Table 2. Cohort descriptive features by visual feedback period.

Feature	Pre-feedback (n=105)	Post-feedback (n=35)	*P*[a]
Age, median (IQR), y	66.0 (22.0)	66.5 (23.5)	.86
Male, %	67.4	67.6	.98
Time, median (IQR), min			
On-scene	19.2 (10.4)	18.3 (12.8)	.62
Transport	6.0 (5.0)	6.0 (6.1)	.78
Destination, median (IQR), km			
To scene	5.0 (6.7)	5.0 (8.3)	.40
To hospital	5.0 (10.0)	4.0 (11.7)	.21

IQR, interquartile range
[a] ,Comparison of medians with use of nonparametric tests (Wilcoxon signed rank test)

Post-feedback Period (n=35)

The proportion of correct depths during on-scene compressions (median, 75.7%; IQR, [36.3%-95.1%]) was higher compared to the paired transport proportion (median, 14.0%; IQR, [4.8%-90.8%]). The difference was significant (p<0.0001). The proportion of correct compression rates during on-scene CPR (median, 48.2%; IQR, [14.7%-62.4%]) was higher compared to the paired transport proportion (median, 19.0%; IQR, [9.5%-60.2%]). The difference was not significant (p=0.079).

Other Analyses

Effect of Visual Feedback on On-Scene and Transport CPR

Proportions of on-scene median correct rates and transport

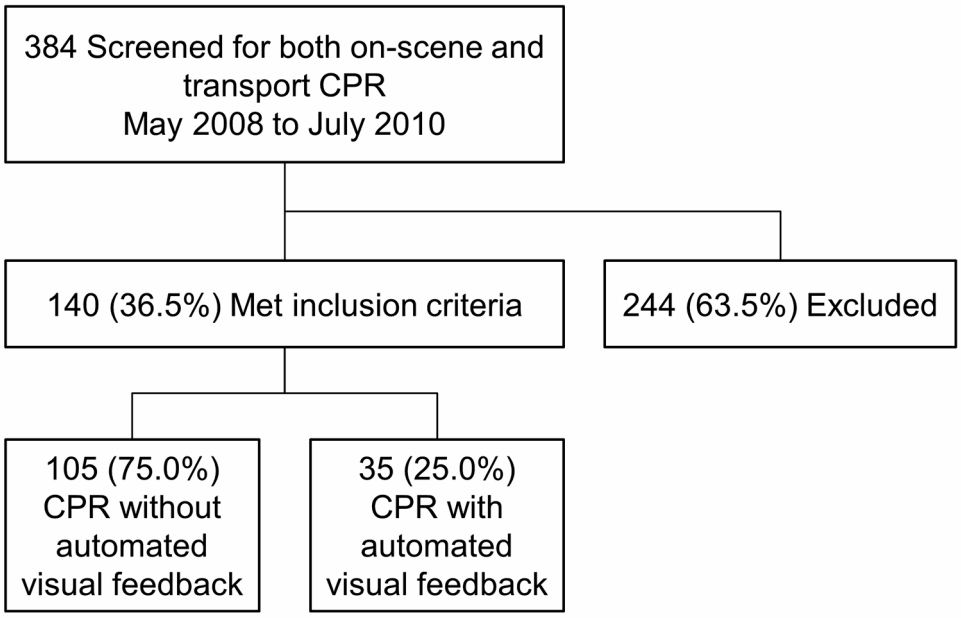

Figure. Patient flowchart. Cardiopulmonary resuscitation (CPR) was administered without automated visual feedback to 105 patients; CPR was administered with automated visual feedback to 35 patients.

median correct depths did not improve after the initiation of visual feedback (Kruskal-Wallis test; p=0.28 and 0.07, respectively). However, proportions of on-scene median correct depths and transport median correct rates improved significantly (p=0.0006 and p=0.03, respectively).

Effect of Visual Feedback on Mortality

Mortality data were complete for 100 of the 140 patients (71.4%). We categorized mortality as either "discharged alive" or "died as inpatient." In this subgroup, the Fisher exact test showed no statistically significant difference in survival after implementation of visual feedback (p=0.28, odds ratio, 0.48; 95% CI, [0.15-1.58]).

DISCUSSION

Summary of Major Findings

Our study showed that, without visual feedback technology, the depth and rate of compressions during CPR while transporting a patient were significantly worse than during on-scene resuscitation. However, both depth and rate were suboptimal, regardless of the environment where the resuscitation occurred.

Despite our expectation that visual feedback technology during CPR would assist in providing the correct rate and depth of compression, regardless of location, we showed that compression depth was statistically worse for patients receiving CPR while being transported in an ambulance compared to patients receiving on-scene CPR. The correct rate during transport compared to on-scene CPR was not significantly different; however, despite the study not having the power to detect a difference, the median absolute percentage difference of 29.2% is concerning. That is, the CPR rate during transport was nearly one-third worse than the rate during on-scene resuscitation despite its lack of statistical significance.

Further, a subgroup analysis was done on the 71.4% of patients for whom full mortality data existed. Visual feedback provided no statistically significant improvement in mortality as measured by discharge from the hospital.

Strengths and Limitations of the Study

This project had several important limitations. First, we did not account for provider fatigue as a factor in poor CPR performance. Data for this confounder are impossible to collect from transport records. Our suspicion is that on-scene fatigue was not a factor because our practice is to change providers every two minutes, but it could confound the transport phase results because often only one provider is in the patient compartment. However, this effect is likely small given that the median transport time was six minutes.

We did not account for the provider type and aerobic health of the provider. Our providers, as is likely true in most systems, include EMTs, paramedics, and firefighters who have a broad range of physical abilities.

Our study did not account or measure hands-off time as has been done in previous studies. Our analysis quantified only the periods when compressions were done in each respective resuscitation phase (on scene vs transport). Hands-off time has been clearly associated with increased mortality; however, our aim was to show the quality of what was delivered rather than the amount.

To our knowledge, the Zoll accelerometer has not been

prospectively validated with outcomes assessment (i.e., survival) in moving ambulances.

Comparison with Other Published Studies

To our knowledge, this study is the third showing how transport affects the quality of CPR delivered. Olasveengen et al[2] demonstrated similar findings with a focus on the rate and the compression ratio. A recent study found that patients achieving out-of-hospital return of spontaneous circulation (ROSC) experienced another cardiac arrest 38% of the time.[9] These high rates of rearrest in patients with ROSC show the need to not only anticipate the high potential for rearrest in those transported but the need to improve CPR quality during transport.

Inappropriate compression depth has been associated with worse outcomes.[5,10] In the present study, the difference between the proportion of correct depths during on-scene compressions (median, 75.7%) and the proportion of correct depths during transport (median, 14.0%) was 61.7%.

Debate about CPR devices and marketing of mechanical CPR devices has grown along with evidence of their potential efficacy.[11,12] The key element in the present study is that the on-scene environment is a relatively static environment in which to perform CPR compared to the more dynamic environment of the patient compartment in an ambulance. Although on-scene CPR may occur in challenging and austere locations, the on-scene environment does not include the types of external acceleration forces experienced in a moving ambulance.

An additional factor likely contributing to poor CPR performance in an ambulance is the change in rescuer posture. In the on-scene environment, the patient is often on the floor or on the ground, so that the rescuer can kneel beside the patient. In an ambulance, the rescuer must stand and lean because the patient is on a cot, fairly low to the floor. Studies have determined the ideal bed height for optimal compression quality and have shown that a rescuer's performance is worse in a standing position than in a kneeling.[13] However, secured ambulance cots are not adjustable.

We believe that future research needs to address how to create a more static environment for performing quality CPR during transport. Most patients in the present study had ROSC before transport and were presumed to have a much higher likelihood of survival. However, a concerted effort should always be made to stabilize a patient's condition before transport, but if rearrest occurs during transport, CPR must be resumed in the ambulance. If quality CPR cannot be provided during transport arrest, several questions need to be considered:

1. Should protocols mandate that EMS providers stop the ambulance if CPR resumption is necessary?
2. Should EMS providers have mechanical CPR devices at their disposal in anticipation of the need for CPR during transport?
3. Should the monitors be placed in an optimal visual position in the ambulance to take full advantage of the visual feedback markers?
4. Should clear audio feedback be provided at all times, augmenting the visual feedback?
5. Should extra crew members be in the patient compartment of the ambulance to serve as coaches?

Our study showed several interesting results. Clearly, the transport period, regardless of visual feedback, had a significantly worse quality of CPR rate and depth during compressions. On-scene administration of compressions of the correct depth improved significantly after implementing visual feedback; however, the other quality markers showed no improvement or marginal benefit.

CONCLUSION

Despite the presence or absence of a visual feedback tool during cardiopulmonary arrest, in a comparison with on-scene CPR, the quality of CPR delivered during transport was significantly worse. Further work should assess the effects of ambulance monitor locations, ambulance configurations to improve rescuer position, audio feedback systems or coaches, and mechanical CPR devices.

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Determinants of Success and Failure in Prehospital Endotracheal Intubation

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Introduction: This study aimed to identify factors associated with successful endotracheal intubation (ETI) by a multisite emergency medical services (EMS) agency.

Methods: We collected data from the electronic prehospital record for all ETI attempts made from January through May 2010 by paramedics and other EMS crew members at a single multistate agency. If documentation was incomplete, the study team contacted the paramedic. Paramedics use the current National Association of EMS Physicians definition of an ETI attempt (laryngoscope blade entering the mouth). We analyzed patient and EMS factors affecting ETI.

Results: During 12,527 emergent ambulance responses, 200 intubation attempts were made in 150 patients. Intubation was successful in 113 (75%). A crew with paramedics was more than three times as likely to achieve successful intubation as a paramedic/emergency medical technician-Basic crew (odds ratio [OR], 3.30; p=0.03). A small tube (≤7.0 inches) was associated with a more than 4-fold increased likelihood of successful ETI compared with a large tube (≥7.5 inches) (OR, 4.25; p=0.01). After adjustment for these features, compared with little or no view of the glottis, a partial or entire view of the glottis was associated with a nearly 13-fold (OR, 12.98; p=0.001) and a nearly 40-fold (OR, 39.78; p<0.001) increased likelihood of successful intubation, respectively.

Conclusion: Successful ETI was more likely to be accomplished when a paramedic was partnered with another paramedic, when some or all of the glottis was visible and when a smaller endotracheal tube was used. [West J Emerg Med. 2016;17(5)640-647.]

INTRODUCTION

Endotracheal intubation (ETI) performance by emergency medical services (EMS) personnel remains a heavily examined and debated issue for medical directors and prehospital care providers. Research on success rates in adults has demonstrated ranges from 77.2% to 98.5%.[1-4] Unfortunately, opportunities for clinical intubation are infrequent.[5] EMS educational programs have highlighted the need for greater frequency of ETI performance through clinical opportunities such as the operating suite.[6] Given the relatively few opportunities for practicing the procedure in some EMS systems, detailed patient selection and guideline criteria aimed at limiting difficult intubation attempts may increase the relative proportion of success.

We sought to determine prehospital ETI success rates and to identify the factors associated with success and failure in a single EMS system serving patients in both rural and semi-urban settings.

METHODS

This study was approved by our institutional review board. In this prospective, observational study of a single,

multisite ambulance provider, we analyzed prehospital patient care reports for adult and pediatric patients who underwent attempted ETI at any time for any cause from January through May 2010. For electronic medical record entry, this service uses the EMSPro (Zoll Medical Corp), which allows changes to be made to the electronic documentation record.

Documentation is made in the medical record by a paramedic whenever an intubation is performed. All EMS staff, systemwide, were trained before the beginning of data collection and were expected to complete necessary documentation points. Paramedics used the current NAEMSP (National Association of EMS Physicians) definition of an ETI attempt (laryngoscope blade entering the mouth).[7] The scope of practice in advanced airway management allows for only paramedic-trained staff to perform intubation. Agency protocol requires the gum elastic bougie to be placed through the cords during each attempt, with the partner placing the endotracheal tube over the gum elastic bougie, while the intubator continues to directly visualize the cords (no video laryngoscopy was used). There was evidence of some deviation from this practice in this sample. Intubation success was self-reported by the paramedic in the electronic medical record.

After reviewing the captured baseline data elements in the Zoll electronic medical record, the study team added airway-specific variables to the EMSPro documentation system (Box). The agency's quality improvement officer received email notification after each electronically recorded intubation encounter. He then completed telephone follow up with the treating paramedic if any data points were missing in the record.

The ambulance service in this study is a 10-site EMS agency throughout two Midwestern states that had 230 paramedic and nonparamedic (eg, emergency medical technician–basic [EMT-Basic]) part-time or full-time employees working during the study period. The population of each service area ranges from less than 20,000 to more than 100,000 persons. For the 5-month study period, all patient encounters involving at least one intubation attempt were included in the analysis.

Statistical Methods

We evaluated comparisons of features (both patient features and aspects of the EMS experience) between patients with successful intubation and those with unsuccessful intubation using the 2-sample t test, the χ^2 test, and the Fisher exact test. Associations with successful intubation were evaluated using logistic regression and were summarized with odds ratios (ORs) and 95% CIs. We built a multivariable logistic regression model using a stepwise selection process with the p-value set to <0.05 for a feature to be included in the model. The predictive ability of the features in the multivariable model was summarized using the area under the receiver operating characteristic curve. We performed statistical analyses were performed using the SAS version 9.2 software package (SAS Institute Inc). All tests were 2-sided and p-values <0.05 were considered statistically significant.

RESULTS

During the study period, which included 12,527 emergent ambulance responses, 150 patients (147 adults aged 18 to 94 years and 3 children aged <1 to 16 years) underwent 200 intubation attempts. Features of the last intubation attempt per patient are summarized in Table 1. Intubation was successful in most patients (n=113, 75%) but was unsuccessful in 25% (n=37). A comparison of features between patients with successful and unsuccessful intubation is shown in Table 2. Results of the univariate logistic regression models are summarized in Table 3. Smaller patient size by weight (p=0.03), a crew with two paramedics ("paramedic/paramedic") (p=0.01), the first intubation attempt (p=0.02), small endotracheal tube size (p=0.02), and a view of some (p=0.002) or all of the glottis (p<0.001) were significantly associated with successful intubation by univariate analysis.

Results of the multivariable logistic regression model are summarized in Table 4. A paramedic/paramedic crew was more than three times as likely to achieve successful intubation compared with a crew of one paramedic and one EMT-Basic ("paramedic/EMT-Basic") (OR, 3.30; p=0.03). A small endotracheal tube of 6, 6.5, or 7 inches was associated with a more than 4-fold increased likelihood of successful intubation compared with a large endotracheal tube (7.5 or 8 inches) (OR, 4.25; p=0.01). After adjustment for these features, our analysis showed that, compared with no or little view of the glottis, a partial ("some") or complete ("entire") view of the glottis was associated with a nearly 13-fold and a nearly 40-fold increased likelihood of successful intubation, respectively (OR, 12.98; p=0.001 and OR, 39.78; p<0.001). The area under the receiver operating characteristic curve for this model was 0.88, which indicates that the features in the model contained high predictive ability.

Rapid Sequence Intubation

Of the 37 patients who underwent attempted rapid sequence intubation (RSI), 27 (73%) had successful outcomes and 10 (27%) had unsuccessful outcomes. An entire view of the glottis was associated with a more than 8-fold increased likelihood of successful RSI compared with no, little, or some view of the glottis (OR, 8.33; p=0.03). After adjustment for view of the glottis, no other feature was significantly associated with RSI success.

DISCUSSION

Our 75% overall success rate per patient in one or more ETI attempts is similar to rates reported previously. However, many factors significantly affected successful placement. After controlling for these features, we found that the ability of paramedics to achieve at least "some" view of the glottis was the best predictor overall of the likelihood of a successful ETI. A successful ETI was achieved on the first attempt in 90

Table 1. Patient characteristics (n=150) and features of the EMS experience with intubation.

Feature	Value[a]
Patient characteristics	
Age, y	58.0 (19.5)
Weight, kg (n=148)	83.5 (25.6)
Sex	
Male	104 (69)
Female	46 (31)
Height, feet	(n=139)
4 to 4 ½	1 (1)
4 ½ to 5	2 (1)
5 to 5 ½	49 (35)
5 ½ to 6	80 (58)
6 to 6 ½	7 (5)
Features of EMS experience	
Crew	
Paramedic/EMT-basic	58 (39)
Paramedic/paramedic	92 (61)
Intubator experience, y (n=131)	5.9 (0.6-33.3)
Intubator experience, y	(n=131)
<1	7 (5)
1 to 4	53 (40)
5 to 9	25 (19)
≥10	46 (35)
Intubation attempts	
1	112 (75)
2	29 (19)
3	6 (4)
4	3 (2)
Cervical collar	
No	116 (77)
Yes	34 (23)
Rapid sequence intubation	(n=149)
No	112 (75)
Yes	37 (25)
Endotracheal tube size, mm, internal diameter	(n=149)
6	3 (2)
6.5	3 (2)
7	82 (55)
7.5	53 (36)
8	8 (5)
Glottis view	(n=139)
Entire	95 (68)
Some	19 (14)
Little	12 (9)
None	13 (9)
Stylet	(n=147)
Gum bougie	103 (70)
Wire/satin slip	38 (26)
Other	6 (4)

EMS, emergency medical services; *EMT*, emergency medical technician
[a]Values are mean (SD), median (range), or No. of patients (%)

Table 2. Features of patients with and without successful intubation.

Feature	Intubation group[a]		p-value
	Unsuccessful (n=37)	Successful (n=113)	
Patient characteristics			
Age, y	52 (15-94)	62 (18-92)	0.12
Weight, kilograms (n=148)	79 (54-181)	79 (29-181)	0.03
Sex			0.07
Male	30 (81)	74 (65)	
Female	7 (19)	39 (35)	
Height, ft	(n=34)	(n=105)	0.05
4 to 5 ½	8 (24)	44 (42)	
5 ½ to 6 ½	26 (76)	61 (58)	
Features of EMS experience			
EMS crew			0.009
Paramedic/EMT-basic	21 (57)	37 (33)	
Paramedic/paramedic	16 (43)	76 (67)	
Intubator experience, y (n=131)	5.0 (0.8-30.7)	7.1 (0.6-33.3)	0.22
Intubator experience, y	(n=35)	(n=96)	0.61
<1	1 (3)	6 (6)	
1 to 4	16 (46)	37 (39)	
5 to 9	8 (23)	17 (18)	
≥10	10 (29)	36 (38)	
Intubation attempts			0.03
1	22 (59)	90 (80)	
2	13 (35)	16 (14)	
3	2 (5)	4 (4)	
4	0	3 (3)	
Intubation attempts			0.01
1	22 (59)	90 (80)	
>1	15 (41)	23 (20)	
Cervical collar			0.10
No	25 (68)	91 (81)	
Yes	12 (32)	22 (19)	
Rapid sequence intubation		(n=112)	0.72
No	27 (73)	85 (76)	
Yes	10 (27)	27 (24)	
Endotracheal tube size, mm, internal diameter	(n=36)		0.02
6, 6.5, or 7	15 (42)	73 (65)	
7.5 or 8	21 (58)	40 (35)	
Glottis view	(n=30)	(n=109)	<0.001
Entire	8 (27)	87 (80)	
Some	4 (13)	15 (14)	
Little	5 (17)	7 (6)	
None	13 (43)	0	
Stylet	(n=34)		0.44
Gum bougie	27 (79)	76 (67)	
Wire/satin slip	6 (18)	32 (28)	
Other	1 (3)	5 (4)	

EMS, emergency medical services; *EMT,* emergency medical technician
[a]Values are median (range) or No. of patients (%)

Table 3. Univariate associations with successful endotracheal intubation.

Feature	Odds ratio (95% CI)	p-value
Patient characteristics		
Age, per 10-y increase	1.16 (0.96-1.40)	0.13
Sex		
Male	1.00 (reference)	
Female	2.26 (0.91-5.61)	0.08
Weight, per 10-kilogram decrease (n=148)	1.17 (1.01-1.34)	0.03
Height, feet (n=139)		
4 to 5 ½	1.00 (reference)	
5 ½ to 6 ½	0.43 (0.18-1.03)	0.06
Features of EMS experience		
EMS crew		
Paramedic/EMT-basic	1.00 (reference)	
Paramedic/paramedic	2.70 (1.26-5.76)	0.01
Intubator experience, per 1-y increase (n=131)	1.04 (0.98-1.10)	0.22
Intubator experience, y (n=131)		
<5	1.00 (reference)	
5 to 9	0.84 (0.31-2.31)	0.74
≥10	1.42 (0.58-3.49)	0.44
Intubation attempts		
1	1.00 (reference)	
>1	0.38 (0.17-0.83)	0.02
Cervical collar		
No	1.00 (reference)	
Yes	0.50 (0.22-1.16)	0.11
Rapid sequence intubation (n=149)		
No	1.00 (reference)	
Yes	0.86 (0.37-2.00)	0.72
Endotracheal tube size, mm, internal diameter (n=149)		
6, 6.5, or 7	1.00 (reference)	
7.5 or 8	0.39 (0.18-0.84)	0.02
Glottis view (n=139)		
None or little	1.00 (reference)	
Some	9.64 (2.36-39.36)	0.002
Entire	27.96 (9.00-86.94)	<0.001
Stylet (n=147)		
Gum bougie	1.00 (reference)	
Wire/satin slip	1.90 (0.71-5.03)	0.20
Other	1.78 (0.20-15.90)	0.61

EMS, emergency medical services; *EMT,* emergency medical technician

Table 4. Multivariable associations with successful endotracheal intubation in patients treated by EMS staff.

Feature	Odds ratio (95% CI)	p-value
EMS crew		
Paramedic/EMT-basic	1.00 (reference)	
Paramedic/paramedic	3.30 (1.13-9.69)	0.03
Endotracheal tube size, mm, internal diameter		
7.5 or 8	1.00 (reference)	
6, 6 ½, or 7	4.25 (1.37-13.20)	.001
Glottis view		
None or little	1.00 (reference)	
Some	12.98 (2.69-62.54)	0.001
Entire	39.78 (10.81-146.35)	<0.001

EMS, emergency medical services; *EMT,* emergency medical technician

patients (80%), whereas the success rate for all ETI attempts was 56% (113/200).

Frequency of Skill Usage

The need for the application of ETI skills was rare in this study population. The 150 patients requiring airway management in this sample represented only 0.01% of the 12,527 ambulance responses during the 5-month study period. Konrad et al.[8] found that anesthesia residents achieved a 90% success rate after a mean of 57 ETI cases; 18% of the residents still required assistance even after 80 attempts. A second study of anesthesia residents found an 88.9% success rate after 27 cases,[9] whereas another study evaluating "non-anesthesia trainees" defined a "good intubation" as requiring 47 prior attempts.[10]

In our study, 103 EMS providers attempted 200 total intubations (data on intubator were missing in 10 cases), which equated to 1.94 attempts per provider. The EMS agency employs 230 paramedics, which equates to 0.87 attempts per provider for the 5-month study period. There were no documented ETI attempts by 127 paramedics (55%). In the absence of clinical rotations, obtaining the number of cases or attempts recommended in the anesthesia-focused studies cited above would be unachievable for the average paramedic throughout a career.

Wang et al.[11] suggested that 15 to 25 ETI attempts in different clinical settings may be needed to achieve a 90% rate of successful intubation. Despite such evidence, national paramedic educational requirements remain at five intubations per student.

EMS Crew Configuration

Multivariable logistic regression showed that paramedic/paramedic crews were more than three times as likely to achieve successful intubation as paramedic/EMT-Basic crews (OR, 3.30; p=0.03). With medical guidelines limiting attempts to two per paramedic provider, paramedic/paramedic crews have twice as much ETI capacity (four attempts vs two attempts) as paramedic/EMT-Basic crews. However, in our study, paramedic/paramedic crews made 124 ETI attempts on 92 patients (1.35 attempts per patient), compared with 76 attempts on 58 patients (1.31 attempts per patient) by paramedic/EMT-Basic crews.

Glottis View

Both univariate and multivariable logistic regression showed significantly higher success rates when "some" or "all" of the glottis was viewed by the intubator. In a previous multivariable analysis, the inability to view vocal cords was also significantly associated with unsuccessful intubation.[12] Eliminating intubation attempts in patient populations with other important contributors to ETI failure (ie, larger patients requiring larger ET tubes) may increase the proportion of attempts in which full view of the glottis is obtained. External laryngeal maneuvers may assist in obtaining better glottis views.[13,14] (13,14). The proper external laryngeal techniques aimed at increasing views of the glottis include external laryngeal manipulation and BURP (backwards upwards rightwards pressure), both of which have been shown to improve the view of the glottis.[15] A 2006 report on bimanual manipulation indicated that it improved the view more than either cricoid pressure (CP) or BURP.[16].

CP is a controversial topic without clear consensus, but it is currently indicated for intubations in the medical guidelines of this EMS. When done incorrectly, CP can cause airway obstruction.[17,18] Retention of this skill has been shown to range from less than one month to more than three months .[19,20] Neither CP nor BURP was studied in this dataset, and neither technique is taught at the study site.

Patient Weight and Endotracheal Tube Size

By multivariable analysis, lower patient weight was a univariate predictor of ETI success, as was smaller tube size (6, 6.5, and 7 in). The success rate with tubes seven inches or smaller was 83%, vs 66% for tubes larger than seven inches, for an absolute difference of 17%. For the purposes of this

discussion, we associated endotracheal tube size with patient size. Increased weight was shown to be a key factor in another multivariable logistic regression model with a larger sample size (>650 patients).[12]

LIMITATIONS

This study has several limitations. Foremost is that the data collected on airway encounters were self-reported. The study team attempted to mitigate this effect by having direct telephone follow-up calls with the EMS crews if data elements were missing, but these calls could not be completed in all cases. Furthermore, although we attempted to follow up with the crews in a timely fashion (within several days of the ETI incident), an element of recall bias may remain. CP is a controversial topic and, as discussed, can be detrimental to ETI success. Our system does not practice this technique, but we did not query its use in our assessments. It is possible that paramedics could still use CP and it not be reflected. ETI also could be considered a rarely performed skill in the prehospital setting, which may lead to generalizability issues with these data.

CONCLUSION

In this EMS cohort of prehospital airway management cases, successful ETI was best accomplished when a paramedic was partnered with another paramedic, when the intubator had at least some view of the glottis, and when the intubator elected to use a smaller endotracheal tube. In our EMS, each paramedic is teamed up with either another paramedic or with an EMT-Basic. Our results suggest that the makeup of the prehospital care team (paramedic/paramedic vs paramedic/EMT-Basic) may affect the success of intubation. We hypothesize that a paramedic who performs intubation with another paramedic has a skilled partner or coach to provide additional guidance not available from an EMT-Basic during this challenging scenario. Additional work on evaluating backup airways and examining new intubation techniques and tools, such as video laryngoscopy, may also help increase success rates in the future.

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Prehospital Lactate Measurement by Emergency Medical Services in Patients Meeting Sepsis Criteria

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Introduction: We aimed to pilot test the delivery of sepsis education to emergency medical services (EMS) providers and the feasibility of equipping them with temporal artery thermometers (TATs) and handheld lactate meters to aid in the prehospital recognition of sepsis.

Methods: This study used a convenience sample of prehospital patients meeting established criteria for sepsis. Paramedics received education on systemic inflammatory response syndrome (SIRS) criteria, were trained in the use of TATs and hand-held lactate meters, and enrolled patients who had a recent history of infection, met ≥ 2 SIRS criteria, and were being transported to a participating hospital. Blood lactate was measured by paramedics in the prehospital setting and again in the emergency department (ED) via usual care. Paramedics entered data using an online database accessible at the point of care.

Results: Prehospital lactate values obtained by paramedics ranged from 0.8 to 9.8 mmol/L, and an elevated lactate (i.e. ≥ 4.0) was documented in 13 of 112 enrolled patients (12%). The unadjusted correlation of prehospital and ED lactate values was 0.57 ($p < 0.001$). The median interval between paramedic assessment of blood lactate and the electronic posting of the ED-measured lactate value in the hospital record was 111 minutes. Overall, 91 patients (81%) were hospitalized after ED evaluation, 27 (24%) were ultimately diagnosed with sepsis, and 3 (3%) died during hospitalization. Subjects with elevated prehospital lactate were somewhat more likely to have been admitted to the intensive care unit (23% vs 15%) and to have been diagnosed with sepsis (38% vs 22%) than those with normal lactate levels, but these differences were not statistically significant.

Conclusion: In this pilot, EMS use of a combination of objective SIRS criteria, subjective assessment of infection, and blood lactate measurements did not achieve a level of diagnostic accuracy for sepsis that would warrant hospital prenotification and committed resources at a receiving hospital based on EMS assessment alone. Nevertheless, this work provides an early model for increasing EMS awareness and the implementation of novel devices that may enhance the prehospital assessment for sepsis. Additional translational research studies with larger numbers of patients and more robust methods are needed. [West J Emerg Med. 2016;17(5)648-655.]

INTRODUCTION

Severe sepsis constitutes a major public health burden in the United States, with an estimated 750,000 individuals diagnosed annually, a mortality rate that approaches 30%, and associated annual healthcare costs of $17 billion.[1] Accelerated time to recognition and definitive treatment has been shown to significantly improve outcomes, and accordingly, a national campaign to develop, endorse, and implement corresponding practice guidelines appears to have reduced mortality among patients with sepsis in hospital settings across the country.[2, 3,4,5]

But recent reports highlight that 40%-60% of patients presenting to emergency departments (ED) with severe sepsis arrive via emergency medical services (EMS) transport, and that the volume of EMS encounters involving septic patients appears to be outpacing those for myocardial infarction (MI) and stroke.[6-9] EMS recognition and prehospital notification have proven successful in reducing adverse outcomes related to MI and stroke, and thus an analogous case has been made for augmenting the role of EMS in the early detection and care of patients with severe sepsis.[10-15]

Commentary about the promising role for EMS in sepsis detection has focused primarily on improving provider education and expanding prehospital diagnostics, with much recent attention given to point-of-care blood lactate testing.[10, 14, 16-18] The value of blood lactate as a risk stratification tool in sepsis has been demonstrated in ED settings, but the theorized advantage of moving this component of sepsis prediction upstream in the continuum of care remains largely untested.[17, 19-23] A handful of studies has established the feasibility of portable lactate meter use in ED triage and prehospital setting, but only one has specifically addressed the use of such devices by prehospital providers to aid in the recognition and early treatment of adult patients with sepsis.[16,17,24-28] There is a clear need for reports detailing EMS protocols for sepsis, demonstrations of their translation into practice and their association with patient outcomes.

The purpose of this pilot study was to acquire preliminary data and applied-setting experience that would inform the development and formal test of an EMS intervention to improve sepsis recognition through provider education and adjunct diagnostic tools. The specific objectives were the following: (1) to develop and deliver sepsis education for prehospital clinicians, with emphasis on recognition of systemic inflammatory response syndrome (SIRS) criteria; (2) to procure and place hand-held lactate meters and temporal artery thermometers (TATs) in our ambulances and establish protocols and training for their use; (3) to quantify how much sooner an initial blood lactate value could be available to providers in our health system if obtained in the prehospital setting; and (4) to examine, in patients meeting criteria for sepsis, the association between observing an elevated blood lactate (i.e. $\geq$ 4.0 mmol/L) in the prehospital setting and three specific outcomes: admission to an intensive care unit (ICU), hospital diagnosis of sepsis, and inhospital mortality.

METHODS

Setting

This prospective pilot study was a collaborative effort between an ambulance service and two hospital EDs belonging to a single health system in greater Minneapolis. The ambulance service provides 911 dispatch service, advanced life support, basic life support, and scheduled medical transport in 100 communities in and around Minneapolis-St. Paul, Minnesota. The agency employs 430 emergency medical technicians (EMTs) and paramedics and responds to approximately 90,000 calls annually across a 1,200 square mile coverage area. An electronic prehospital patient care record (ePCR; Imagetrend™) was fully implemented in early 2008. The two participating EDs – one located in a 639-bed tertiary hospital in Minneapolis and the second in an 86-bed hospital in a suburb of the Shakopee – handle a combined 75,000 emergency visits and approximately 500 patients who meet criteria for severe sepsis or septic shock annually.

Study funding did not allow for full-scale implementation of the project across our ambulance service, so a reduced-scale approach was devised. TATs and lactate meters were available only on ambulances used in the portion of the service area most likely to transport patients to the participating EDs, and only a subset of the system's paramedics/EMTs (hereafter, paramedics) received sepsis education and protocol training, with priority given to paramedics who primarily practiced in the defined study coverage area.

Devices

The hand-held whole blood lactate analyzer selected for use was the LactatePro (KDK Corp, Kyoto, Japan) which has been described previously.[24] Briefly, this FDA-approved, battery-powered device uses disposable test strips and produces a whole blood lactate value in 60 seconds. In this prehospital application, per device specifications, a capillary blood sample from a fingerstick was used for analysis. An FDA-approved temporal artery thermometer (TAT; TAT-5000, Exergen Corp., Watertown, MA) was used by paramedics to assess body temperature non-invasively. Use of this temporal artery scanner involves gently sliding the device across the forehead and then momentarily placing it on the neck area behind the ear lobe. Results are produced in less than five seconds. Ten study kits, each containing a TAT, a lactate meter, and a supply of lactate test strips, were assembled and placed on ambulances in the participating portion of the ambulance service area.

Provider Training

In June 2011, 37 paramedics attended a two-hour training session during which they received information about the scope of sepsis in the U.S., education about the risk factors and early signs and symptoms of sepsis, and a review of the objectives and protocol for the study. Attendees were also instructed on use of the study data collection tool and proper use of the devices, including a practical component. Hangtags displaying the study eligibility criteria and key aspects of the protocol were distributed. Six months after the start of the pilot, the same clinicians attended a brief study refresher course.

Study Protocol

Patients meeting the conventional definition of sepsis (i.e. two or more SIRS criteria plus evidence of infection) were targeted for study. Consideration for enrollment was triggered when paramedics encountered a patient with a

reported history of recent infection or when a recent infection was suspected. Patients were required to be ≥ 18 years of age, not pregnant, and destined for transport to one of the two participating hospitals. In patients meeting these initial criteria, paramedics then measured body temperature and ascertained heart rate and respiratory rate to further assess eligibility. Patients were enrolled if two or more of the following SIRS criteria were confirmed: (1) heart rate ≥ 90 beats per minute, (2) respiratory rate > 20 per min, or (3) body temperature < 36° C or > 38° C by TAT. In eligible patients, a prehospital lactate value was then determined using the lactate meter. Per device guidelines, the first drop of blood was discarded and the second drop used for analysis. The paramedics otherwise delivered standard care. Upon hospital arrival, ED staff was notified of the patient's enrollment in the study and an inhospital lactate test was encouraged but ordered at the physician's discretion. In both receiving hospital laboratories, enzymatic methods are used to determine the blood lactate value in venous blood that has been spun, separated, and refrigerated within 15 minutes. Paramedics were not instructed to report the prehospital lactate value to the ED physician, but were also not specifically prohibited from doing so. The institution's internal institutional review board approved the study protocol with a waiver of patient consent.

Data Collection and Definitions

Paramedics recorded study-specific prehospital data in a secure online study database accessible at the point of care. The study database was then linked with data from the hospital electronic health record (EHR) to obtain information on the following: ED lactate collection time and value, inpatient admission subsequent to ED care, sepsis diagnoses, length of stay, and mortality.

Prehospital clinicians categorized the type of infection and indicated the source of their knowledge or suspicion of infection as patient self-report, bystander report, or EMS observation only. An elevated lactate was defined as ≥ 4.0 mmol/L. Hospital admission was defined as admission to an inpatient unit after the ED encounter. Formal diagnoses of sepsis were determined by reviewing the International Classification of Diseases 9th Revision (ICD-9) hospital discharge codes, and included the following: septicemia (any 038), sepsis (995.91), severe sepsis (995.92), and septic shock (785.52). Time stamps were used to compute the time interval in minutes between the prehospital measurement of lactate and (1) patient arrival in the ED, (2) blood specimen collection in the ED, and (3) time the ED lactate value was posted in the hospital EHR.

Analysis

We described patient characteristics and prehospital findings using means and proportions. Hospital admission, sepsis diagnosis, mortality and mean length of stay were examined overall and by the presence or absence of an elevated prehospital lactate value (i.e. ≥ 4 mmol/L), with Fisher's exact test or a t-test used to evaluate differences by prehospital lactate group for the categorical variables and continuous variable, respectively. We computed unadjusted Pearson correlation coefficients to explore agreement between prehospital and ED values of lactate and body temperature. Time intervals were described using medians.

RESULTS

A total of 112 patients were enrolled between July 2011 and August 2013 (Figure 1). Prehospital lactate values ranged from 0.8 to 9.8 mmol/L with an elevated prehospital lactate documented in 13 patients (12%; Table 1). Only two of the 13 patients with prehospital lactate ≥ 4.0 mmol/L had lactate levels that remained ≥ 4.0 mmol/L when assessed by ED staff. Ambulance transport times ranged from 3 to 37 minutes with a mean of 19 minutes. One-third of the patients received intravenous fluids as part of prehospital care (Table 1), with only four patients receiving > 250cc normal saline. Half of the study patients received supplemental oxygen as part of prehospital care in order to achieve and maintain oxygen saturation levels > 94% per standard protocol.

Among the 88 patients who had lactate measured in the ED, the median (25th, 75th percentile) interval of time that elapsed between the prehospital lactate measurement and ED specimen collection was 64 minutes (50, 84; Figure 2). Within our system, the median interval of time between the paramedic assessment of blood lactate and the electronic posting of the ED-measured lactate value in the hospital EHR was 111 minutes (Figure 2).

Overall, 81% of study patients were hospitalized, 24% received a diagnosis of sepsis, and 3% died during hospitalization (Table 2). Subjects with prehospital lactate ≥ 4.0 were somewhat more likely to have been admitted to the ICU, to have been diagnosed with sepsis, and to have died during hospitalization than those with lactate levels < 4.0, but these differences were generally not statistically significant. Only 5 of the 27 patients who ultimately received a diagnosis of sepsis had a prehopsital lactate ≥ 4.0 mmol/L (19% sensitivity), while 77 of the 85 patients who did not receive a diagnosis of sepsis had a prehospital lactate < 4.0 mmol/L (91% specificity). Results from a sensitivity analysis using a prehospital lactate cut point of 2.5 mmol/L were similar (Table 2). Detailed data on the 13 subjects with prehospital lactate values ≥ 4.0 reveal that the two patients who ultimately died during the index hospitalization were among the oldest subjects, and had comparably low prehospital oxygen saturation levels (Table 3).

Although not systematically studied, we offer several qualitative comments regarding implementation of the selected devices. At the time the study was conducted, a lactate meter, 20-30 lactate test strips, and a TAT cost about U.S. $900. Study paramedics made no reports of malfunction

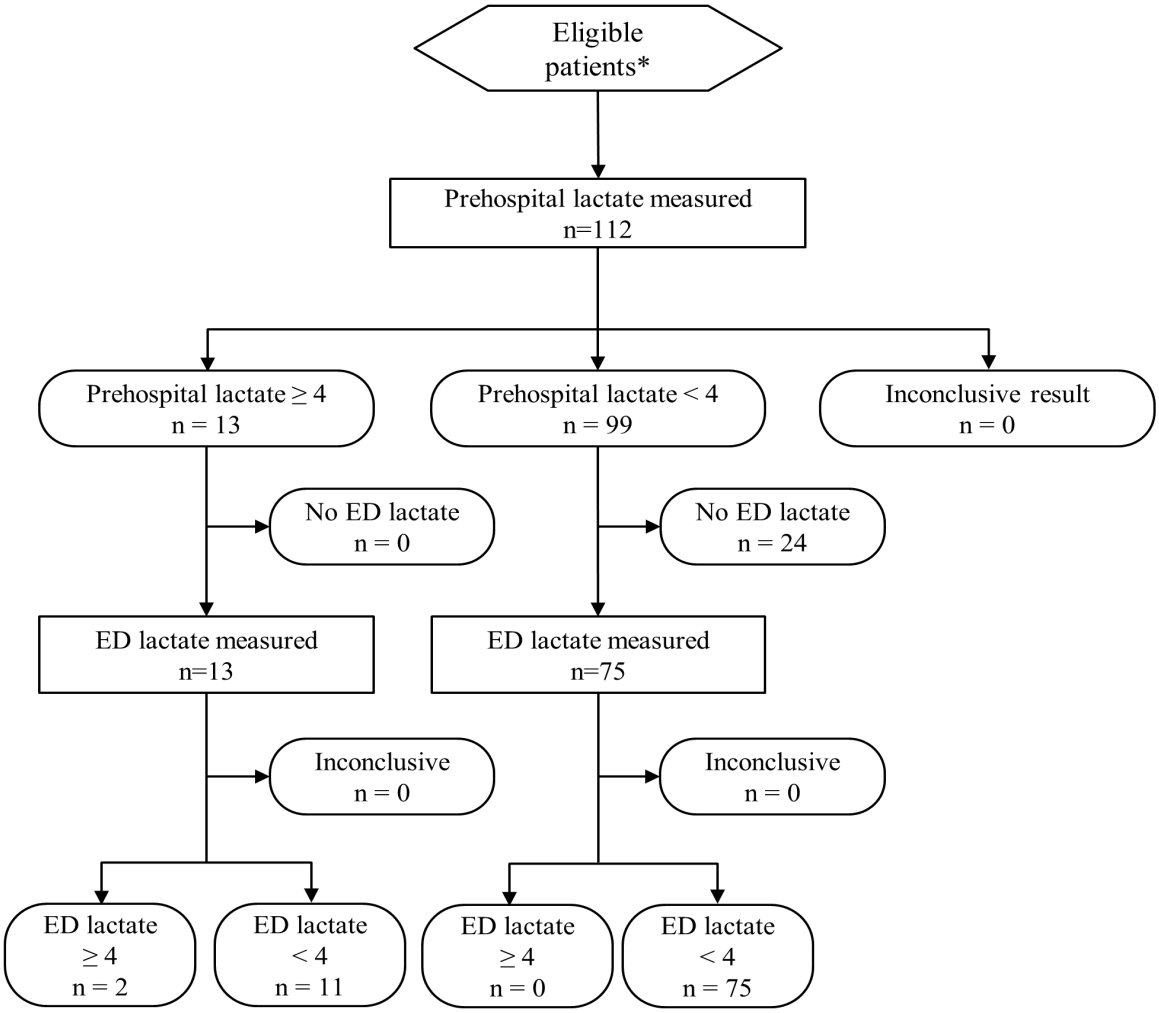

Figure 1. Flow diagram of patient prehospital and emergency department (ED) lactate measurements.

or difficulties in using the LactatePro, but the device has since been discontinued. As it is currently the only hand-held lactate analyzer approved for medical use in the U.S., this presents a significant barrier for EMS systems seeking to introduce lactate assessment. There were three cases where paramedics noted that the TAT would produce only an error message, one occurring in an extremely cold ambient temperature, a phenomenon that has been reported previously.[29]

DISCUSSION

A compelling case has been made for increasing EMS involvement in the recognition and care of patients with severe sepsis and septic shock, but we have identified only one report that has detailed the implementation of and preliminary experience with a specific sepsis-targeted EMS educational curriculum and treatment protocol.[10-15,25] The practical execution of EMS sepsis programs, particularly those that incorporate diagnostic tools not traditionally available in the prehospital setting, should be an area of focus for contemporary EMS research agendas. We educated a small set of EMS providers about sepsis and SIRS criteria, and equipped them with devices to measure body temperature and lactate level to facilitate a more complete prehospital assessment for sepsis.

This preliminary report describes outcomes in a small convenience sample of patients treated and transported by EMS who met established criteria for sepsis, a subset of whom had prehospital whole blood lactate values ≥ 4.0 mmol/L. As this cut point provides the definition of septic shock, one of our goals was to gain some early understanding of what EMS observation of this level of elevated lactate might warrant in terms of pre-arrival communications and/or augmented prehospital care.[30] We observed that only 2 of the 13 patients with prehospital lactate ≥ 4.0 mmol/L had lactate levels that remained ≥ 4.0 mmol/L when assessed by ED staff, and that 22% of patients with prehospital lactate < 4.0 mmol/L

Table 1. Patient characteristics and prehospital findings.

Variable	Patients (n=112)
Age, y	74 (22 - 100)
Age ≥ 75	58% (65)
Male	45% (50)
History of infection ascertained via	
Patient self-report	29% (32)
Bystander report	24% (27)
EMS observation only	47% (53)
Type of infection	
Respiratory	36% (40)
Gastrointestinal/abdominal	8% (9)
Skin/wound	15% (17)
Urinary tract	19% (21)
Unknown	22% (25)
SIRS Criteria	
Heart rate ≥ 90 bpm	78% (87)
Respiratory rate > 20 pm	77% (86)
Body temperature	
< 36°C or > 38°C	54% (61)
< 36°C	8% (9)
> 38°C	46% (52)
Prehospital blood lactate (mmol/L)	
Mean (SD)	2.6 (1.7)
Median	2.1
Range	0.8 - 9.8
Patients with value ≥ 4.0 mmol/L	12% (13)
Received prehospital IV fluids	33% (37)

SIRS, systemic inflammatory response syndrome; *SD*, standard deviation; *IV,* intravenous.
*Results are expressed as mean (range) or percent (n) unless otherwise indicated.

received a diagnosis of sepsis during subsequent hospitalization. Despite demonstration that values obtained by the LactatePro correlate highly with traditional lab-based enzymatic measures, growing concern about the use of capillary samples with hand-held lactate meters has led to an evolution in practice towards the preferred use of venous samples since the time of our study.[31-32] Furthermore, the limitations of single lactate values have been described, and it is clear that not all patients with sepsis mount a lactate response.[20,33,34] Seymour et al. documented that among 216 patients transported by EMS and diagnosed with severe sepsis in the ED, only 50% had ED lactate values ≥ 3.0 mmol/L.[34] Based on our experience, the notion of paramedics using a specified cut point of a single prehospital lactate value as an objective, singular trigger for pre-arrival alert processes, even in the presence of SIRS criteria, cannot yet be supported.

While not a panacea for definitively establishing the population of patients with sepsis in the prehospital setting, EMS evaluation of blood lactate in a variety of patients still has merit for three reasons: (1) it yields a marked reduction in time to a known lactate value; (2) it establishes an earlier initial value for serial assessment; and (3) it can assist in the identification of patients with cryptic shock (i.e. normotension concurrent with tissue level hypoperfusion). In our system, for example, acquisition of a prehospital lactate value would enable an emergency physician to recognize clearance or accumulation of lactate over the previous hour, rather than being limited to a single measurement taken at or near the time of ED arrival. And lactate change, to the extent that it reflects correction or exacerbation of tissue hypoxia, may have more diagnostic relevance than single values. In a Dutch study where blood lactate values were measured an average of 27 minutes apart during the prehospital phase of care, a decrease in lactate between the two time points was associated with decreased mortality.[16] Nguyen et al. also found that lactate clearance in the first six hours after ED arrival was inversely

Table 2. Primary outcomes, overall and by prehospital lactate value.

		Prehospital lactate ≥ 4.0 mmol/L			Prehospital lactate ≥ 2.5 mmol/L		
Variable	All (n = 112)	No (n = 99)	Yes (n = 13)	*p Value*[a]	No (n = 69)	Yes (n = 43)	*p Value*[a]
Hospital admission	81% (91)	81% (80)	85% (11)	0.74	77% (53)	88% (38)	0.14
Admitted to ICU	16% (18)	15% (15)	23% (3)	0.44	14% (10)	19% (8)	0.60
Diagnosis of sepsis	24% (27)	22% (22)	38% (5)	0.30	22% (15)	28% (12)	0.50
Length of stay[b] (days)	4.8 (3.7)	4.9 (3.8)	4.2 (2.2)	0.55[c]	4.8 (3.4)	4.8 (4.1)	0.95[d]
Death during hospitalization	3% (3)	1% (1)	18% (2)	0.04	2% (1)	5% (2)	0.57

ICU, intensive care unit.
Results are expressed as mean (SD) or percent (n)
[a]Fisher's exact test (categorical variables) or t-test, for difference by prehospital lactate category
[b]Among those admitted to inpatient hospital unit after emergency department encounter
[c]Mean difference 0.72 (95% CI: -1.65, 3.08)
[d]Mean difference -0.05 (95% CI: -1.62, 1.52)

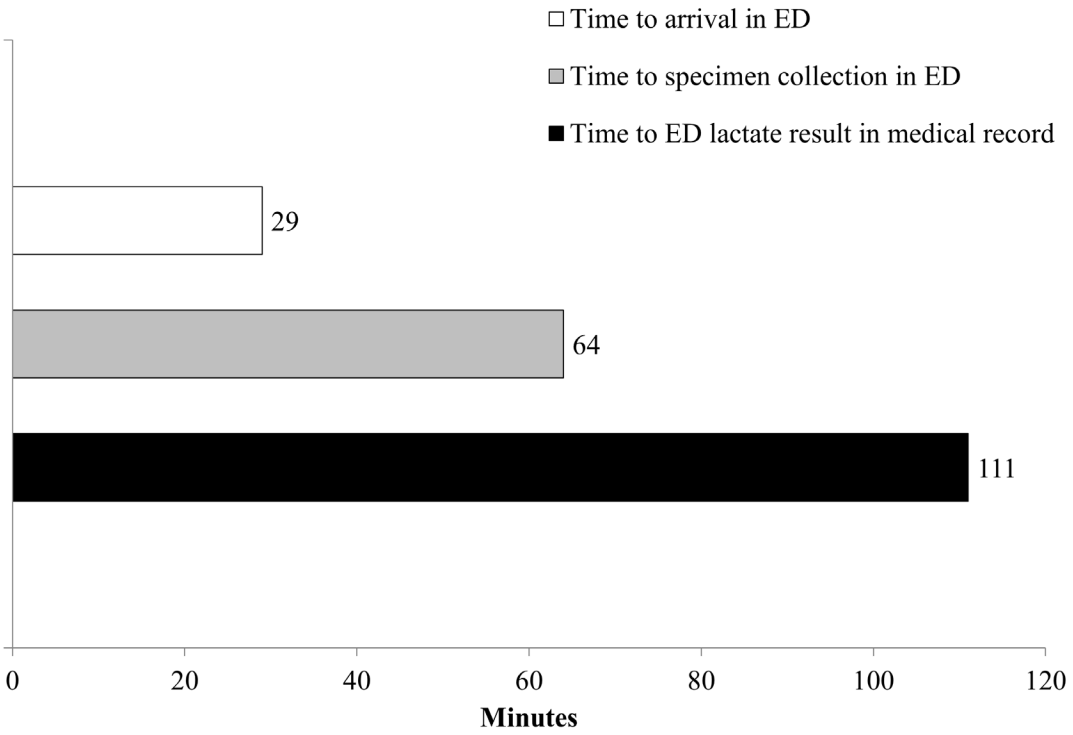

Figure 2. Median time interval (minutes) between prehospital lactate measurement and acquisition of emergency department (ED) lactate value.

associated with mortality.[20] The change in blood lactate between the prehospital and ED measure ranged from -7.9 mmol/L to +1.4 mmol/L in our patients, but given important differences in the methods used in each setting (e.g. the use of capillary versus venous blood), and prehospital interventions during transport, we were unable to interpret lactate change in our study with confidence. Nevertheless, we have demonstrated that the acquisition of early blood lactate for purposes of serial assessment can be extended into the prehospital setting.

While 81% of study patients were hospitalized after the EMS encounter, only a quarter of the study patients received a diagnosis of sepsis during their hospitalization despite being enrolled based upon conventional criteria for sepsis. Indeed, the sensitivity and construct validity of using ≥ 2 SIRS criteria in defining severe sepsis has recently been challenged, but there are several study factors that also may have influenced this result.[35] First, we made no attempt to validate the presence or suspicion of infection in study subjects. The source of information about infection was noted by paramedics as "EMS observation only" in nearly half of enrolled patients, so inaccuracies in provider perceptions may have resulted in the inclusion of study subjects who had no exposure to recent infection. Second, our definition of diagnosed sepsis included only cases with explicit diagnosis codes (i.e. 038, 995.91, 995.92, or 785.52), and did not include cases of implicit sepsis inferred by the combination of infection with organ dysfunction, as described by Filbin et al.[36] Third, inclusion in the study was driven strictly by the patient meeting defined, objective criteria, and did not take into account the paramedic's impression of acuity of illness. Pursuant to the common expression in sepsis "I'll know it when I see it," some latitude for clinical acumen and subjective impression may need to be incorporated into EMS sepsis recognition strategies to improve sensitivity, but this requires further study.

LIMITATIONS

As a pilot study, this work was subject to a number of limitations. There was no attempt to evaluate, measure, and document the acquisition of knowledge and skills related to provider education and training. Providing education and devices to only a small subset of our paramedics limited our capacity for patient enrollment. There was no systematic surveillance of EMS encounters to ascertain whether patients eligible for enrollment were missed by paramedics. There were very few patients with abnormal prehospital lactate values, which limited our ability to examine the relevance of elevated lactate, and the use of capillary versus venous blood samples in the prehospital and ED lactate measurements respectively, prevented rigorous assessment of lactate change. Hospital discharge codes were used to determine a diagnosis of sepsis without consideration for date of diagnosis, so some patients may have developed sepsis later in their hospital stay. Finally, we did not test a specific prehospital care intervention,

Table 3. Lactate values (mmol/L), prehospital findings, and hospital outcomes of enrolled patients with prehospital lactate ≥ 4.0 mmol/L.

			Lactate values		Prehospital findings							Hospital outcomes	
Patient	Age	Gender	Prehospital	ED	Infection type	HR	RR	Body temp	Lowest O2 saturation	Lowest SBP	IV fluids	ICD-9 Diagnosis codes for sepsis*	Inhospital death
1	92	F	5.7	2.2	Respiratory	152	40	99.9	77	102	Yes	S1, S3	Yes
2	86	M	9.7	3.3	Respiratory	130	45	101.1	72	92	Yes	S1, S3, S4	Yes
3	54	M	7.0	1.7	GI/abdominal	97	20	98.6	98	150	No	None	No
4	66	M	8.0	5.9	Other	111	34	99.9	98	150	Yes	S1, S2	No
5	22	F	4.6	1.6	Urinary	122	26	97.9	98	146	Yes	None	No
6	83	F	5.1	2.5	GI/abdominal	104	24	-	93	98	No	None	No
7	80	M	5.0	1.7	GI/abdominal	108	28	99.7	94	120	Yes	None	No
8	89	F	9.8	1.9	Other	106	22	97.7	97	128	No	None	No
9	80	M	4.7	1.8	Other	85	-	102.6	86	89	Yes	None	No
10	55	M	4.0	1.9	Respiratory	122	38	102.6	87	120	Yes	None	No
11	71	M	7.1	5.3	Other	120	22	-	90	69	No	None	No
12	80	F	4.6	0.7	Skin/wound	104	22	-	89	148	No	S1, S2	No
13	42	M	5.4	1.2	Skin/wound	116	41	102.0	96	115	No	S1, S2	No

ED, emergency department; *HR,* heart rate; *RR,* respiratory rate; *SBP,* systolic blood pressure; *IV,* intravenous; *ICD-9,* International Classification of Diseases 9th Revision; *GI,* gastrointestinal.
*S1 = Septicemia (038.xx), S2 = Sepsis (995.91), S3 = Severe Sepsis (995.92), S4 = Septic Shock (785.52)

as the objective was simply to compile early observations of protocol execution and device feasibility in our EMS system.

CONCLUSION

We attempted to install a test process in our ambulance service whereby EMS could augment the ED care of the septic patient through early recognition. The EMS protocol we piloted, which encompassed objective SIRS criteria, subjective assessment of infection, and body temperature and blood lactate measurements, did not achieve a level of diagnostic accuracy in identifying patients with severe sepsis or septic shock that would warrant pre-arrival alert and committed resources and response at the receiving hospital based on EMS assessment alone. This work provides a preliminary model for increasing EMS awareness of sepsis and implementing novel devices that can add to the completeness of an EMS assessment for sepsis, but additional translational research studies that include larger numbers of patients and more robust methods will be essential in shaping protocols for reliable, early detection of sepsis by EMS clinicians.

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Geospatial Analysis of Pediatric EMS Run Density and Endotracheal Intubation

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Introduction: The association between geographic factors, including transport distance, and pediatric emergency medical services (EMS) run clustering on out-of-hospital pediatric endotracheal intubation is unclear. The objective of this study was to determine if endotracheal intubation procedures are more likely to occur at greater distances from the hospital and near clusters of pediatric calls.

Methods: This was a retrospective observational study including all EMS runs for patients less than 18 years of age from 2008 to 2014 in a geographically large and diverse Oregon county that includes densely populated urban areas near Portland and remote rural areas. We geocoded scene addresses using the automated address locator created in the cloud-based mapping platform ArcGIS, supplemented with manual address geocoding for remaining cases. We then use the Getis-Ord Gi spatial statistic feature in ArcGIS to map statistically significant spatial clusters (hot spots) of pediatric EMS runs throughout the county. We then superimposed all intubation procedures performed during the study period on maps of pediatric EMS-run hot spots, pediatric population density, fire stations, and hospitals. We also performed multivariable logistic regression to determine if distance traveled to the hospital was associated with intubation after controlling for several confounding variables.

Results: We identified a total of 7,797 pediatric EMS runs during the study period and 38 endotracheal intubations. In univariate analysis we found that patients who were intubated were similar to those who were not in gender and whether or not they were transported to a children's hospital. Intubated patients tended to be transported shorter distances and were older than non-intubated patients. Increased distance from the hospital was associated with reduced odds of intubation after controlling for age, sex, scene location, and trauma system entry status in a multivariate logistic regression. The locations of intubations were superimposed on hot spots of all pediatric EMS runs. This map demonstrates that most of the intubations occurred within areas where pediatric EMS calls were highly clustered. By mapping the intubation procedures and pediatric population density, we found that intubation procedures were not clustered in a similar distribution to the pediatric population in the county.

Conclusion: In this geographically diverse county the location of intubation procedures was similar to the clustering of pediatric EMS calls, and increased distance from the hospital was associated with reduced odds of intubation after controlling for several potential confounding variables. [West J Emerg Med. 2016;17(5)656-661.]

INTRODUCTION

Pediatric emergency airway management entails low frequency, high risk procedures for providers in the emergency department and in the emergency medical services (EMS) system. Emergency physicians have the advantage of concentrating these relatively rare procedures among a smaller

group of providers compared to many EMS systems. In some EMS systems paramedics intubate a child once every 5-10 years, while in other systems where critical procedures are concentrated among a smaller group of providers, pediatric intubations happen once every 2-3 years for an individual medic.[1,2] Increased exposure to these critical procedures in practice likely enhances skill retention and promotes safety and efficacy.[3]

This study was prompted by the concept that if pediatric endotracheal intubations took place near clusters of pediatric calls, EMS agencies could station specific providers in those areas thus concentrating both general and critical pediatric patient exposure in a smaller group of providers. The primary objective of this study was to determine if endotracheal intubation procedures are more likely to occur in geographic clusters of pediatric calls. We also wanted to know whether pediatric intubations were more likely to happen at greater distances from the hospital potentially due to concern about risks of an unprotected airway during a longer transport. We hypothesized that intubation procedures would occur primarily among locations with high densities of pediatric EMS calls and would be relatively more common with greater transport distance.

METHODS

Study Design and Variables

This was a retrospective observational study including all EMS runs for patients less than 18 years of age from 2008 to 2014 in a geographically large and diverse Oregon county that includes densely populated urban areas near Portland and remote rural and wilderness areas. Our primary outcome was the geospatial association between clusters or "hot spots" of pediatric EMS runs and location of endotracheal intubation procedures. The variables collected in the dataset for the study included the following: address of the incident, type of location (home/school), primary impression, procedures performed during the call, transport priority (lights and sirens), ground distance travelled as recorded by the EMS providers, destination hospital, patient age and sex. ArcGIS version 10.2.1 (Redlands, CA) was used for all geographic information systems (GIS) analysis.

Human Subjects Review

The study was approved by our university's institutional review board (IRB #00010944), which provided a waiver of informed consent.

Study Setting/EMS System Characteristics

In this county both public fire and private transport services are dispatched to nearly all 911 calls. The county is served by several fire agencies including large urban and small rural agencies. Transport services are provided by a single private agency throughout most of the county with two small fire districts providing their own ambulance service. Ambulances are staffed with one paramedic and one EMT or Advanced EMT. Fire services have various staffing models based on the agency, but most EMS responses in the urban and suburban parts of the county have a fire crew with at least one paramedic. Paramedics in this county can intubate any age patient. Indications for intubation are broad and include respiratory insufficiency, altered mental state with airway compromise, and situations requiring positive pressure ventilation. Paramedics can use rapid sequence intubation for patients who do not have a gag reflex, using combinations of sedatives (etomidate or midazolam) and paralytics (succinylcholine, rocuronium, or vecuronium) depending on contraindications, medical director preference, and availability of these medications. The protocol for pediatric intubation at the time of the study called for using a bag valve mask (BVM) or a rescue device if two attempts at intubation failed. However, at the time of the study, the King laryngeal tube was the rescue device being used and it was not available in sizes suitable for most children under the age of eight. Providers did have access to oral and nasal airways in all pediatric sizes.

Geographic Information System (GIS) Analysis

We geocoded incident location addresses using the automated address locator created in the cloud-based mapping platform ArcGIS supplemented with manual address geocoding for remaining cases not coded using the automated method. Using these techniques we successfully matched over 95% of addresses. We then used the Optimized Getis-Ord Gi* spatial analysis feature in ArcGIS to map statistically significant spatial clusters (hot spots) of pediatric EMS runs throughout the county. This tool compares the location of the event of interest in the context of neighboring event locations using an optimized grid that defines the areas of interest. The Gi* statistic calculated for the feature of interest is the z-score and it represents the number of standard deviations from the expected mean number of spatial features per grid box. A relatively high z-score results when the local sum of event locations is higher in one grid box than expected and indicates relatively intense clustering of events or "hot spots." The tool calculates p-values for the likelihood of a hot spot existing in the grid box. After identifying the hot spots and associated z-scores we superimposed the location of all intubation procedures performed during the study period on the map of statistically significant spatial clusters of pediatric EMS runs.

Next, we displayed population density according to the five-year population estimate from American Community Survey published by the U.S. Census Bureau and displayed the number of residents in each census tract less than 18 years of age with intubation locations.[4] We displayed the location of fire stations in the county with intubation locations. We obtained fire station locations from the Oregon Metro Regional Land Information System.[5] Finally, we displayed the location of the intubation locations with the location of hospitals in the area. There are no well-established spatial

Table 1. Patient characteristics in geospatial analysis of pediatric emergency medical service runs and pediatric intubation.

Patient and call characteristic	Non-intubated patients n=7759	Intubated patients n=38	P-value
Mean age (SD)	10.6 (6.1)	13.0 (5.4)	0.014
Sex (% female)	43.6%	47%	0.89
Mean ground distance traveled in miles (SD)	15.9 (13.8)	10.4 (11.3)	0.014
Lights and sirens	8.9%	94.7%	<0.001
Scene is a home	34.0%	42.4%	0.32
Children's hospital destination	41.1%	52.6%	0.15

statistics for comparing the geospatial association between two groups of spatial clusters so we created maps to display all of the data visually to allow readers to make comparisons.

Non-GIS Analysis

We computed descriptive statistics for all patients in the cohort to compare those who were and were not intubated and identify associations between intubation and transport distance in addition to patient factors. We also conducted a logistic regression to determine if distance traveled from the scene to the hospital was associated with intubation after controlling for several potential confounders. The model for the logistic regression was developed based on *a priori* hypotheses of factors that could be associated with intubation considering the available data.

RESULTS

We identified a total of 7,797 pediatric EMS runs during the study period and 38 endotracheal intubations. In univariate analysis we found that patients who were intubated were similar to those who were not intubated in gender and whether or not they were transported to a children's hospital. Intubated patients were transported with lights and sirens more commonly and tended to be transported shorter distances (Table 1). Patients who were intubated were older than non-intubated patients. Table 2 shows the specific types of locations where all pediatric EMS runs and EMS runs where intubations took place.

Table 2. Location characteristics.

	Non-intubated patients n=7759	Intubated patients n=38
Home	2638	14
Medical clinic	410	2
Hospital	909	0
Police station	0	1
Road/street	690	11
Recreation/sports location	630	4
School/government area	534	1
Water (pool/river/lake)	17	1
Missing	977	5
Other	954	0

Figure 1 shows the location of intubations superimposed on hot spot analysis of all pediatric EMS runs with the map extent focused on the portion of the county where hot spots were concentrated. Thirty of the 38 intubations occurred within or immediately adjacent to an area where pediatric calls were statistically significantly clustered. (Map extent excludes four intubations.) Figure 2 displays the pediatric population density by census tract and shows that intubation locations and higher pediatric population density (larger circles) do not appear highly correlated spatially. Finally, Figure 3 shows the relation of fire stations and intubations demonstrating that there is at least one fire station within two miles (straight line distance) of all but one intubation on the map extent. The farthest east intubation, excluded from the displayed map extent, took place approximately five miles from the nearest fire station. Figure 4 displays the location of the acute care hospitals in the area and identifies the location of the two children's hospitals in the state.

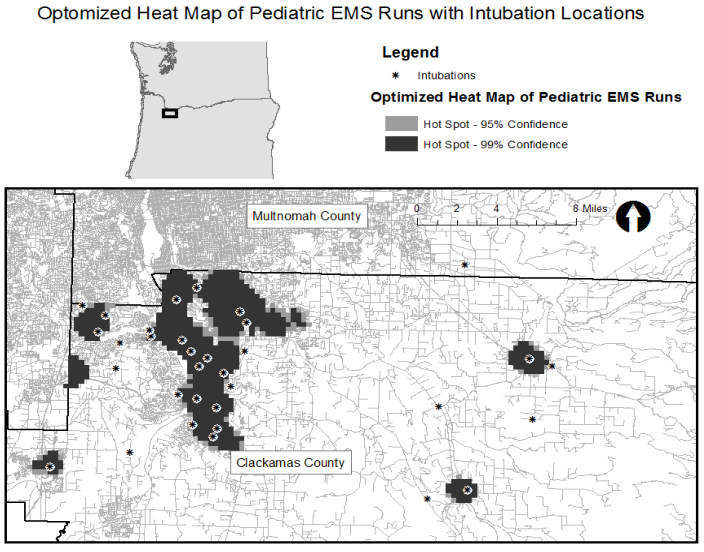

Figure 1. Optimized heat map of pediatric EMS runs with intubation locations
EMS, emergency medical services.

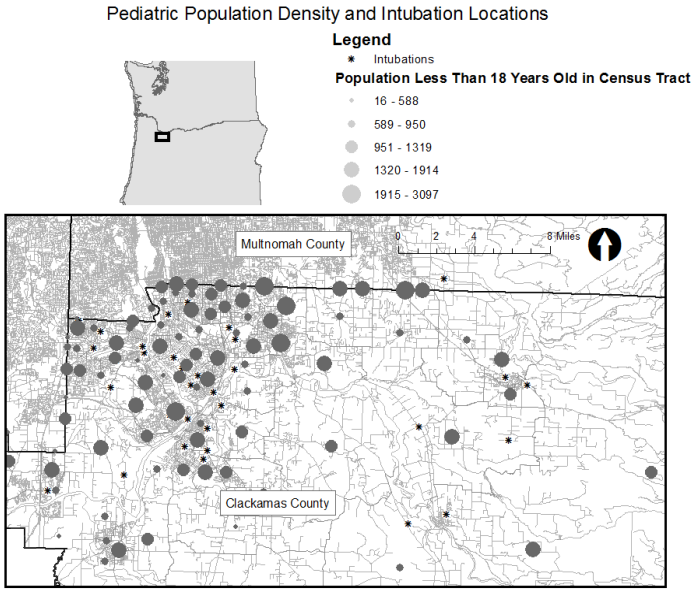

Figure 2. Pediatric population density and intubation locations.

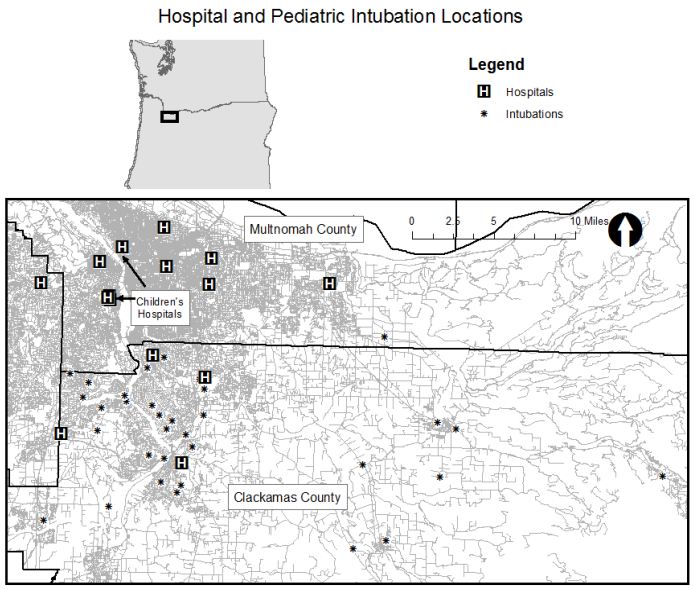

Figure 4. Hospital and pediatric intubation locations.

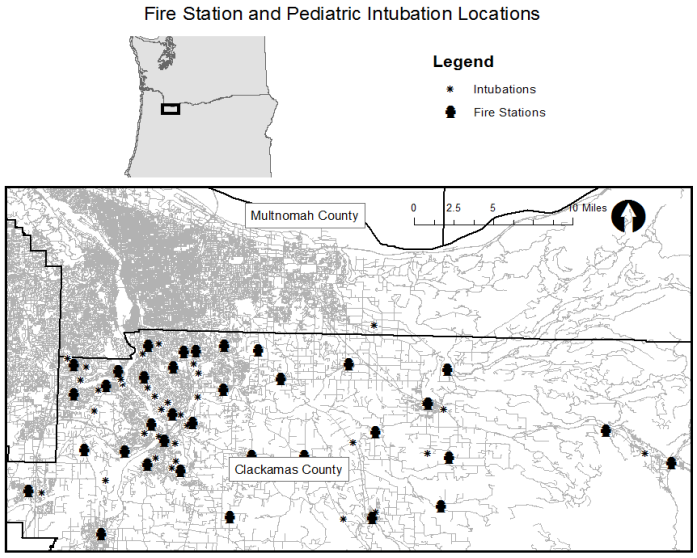

Figure 3. Fire station and pediatric intubation locations.

We performed logistic regression analysis with intubation as the dependent variable while controlling for age, miles traveled to the hospital, sex, home as the scene location, and trauma system entry status. We selected this model based on our *a priori* hypotheses of available data that could contribute to likelihood of intubation. We found the older patients, patients who were trauma system entries, and patients who were closer to the hospital tended to be intubated at higher rates. Results of this regression with 95% confidence intervals are displayed in Table 3.

DISCUSSION

We found that in this geographically diverse county pediatric intubation procedures occur close to spatial clusters of pediatric EMS runs. However, intubation procedures do not seem to cluster near higher densities of children in the general population. Finally, distance traveled to the hospital was not associated with increased odds of endotracheal intubation and in fact there was a trend towards decreased odds of intubation with increased distance.

Pediatric endotracheal intubation is rarely performed by individual providers and thus requires significant resources and training to maintain competency. In addition, there is evidence that pediatric endotracheal intubation may be no better than BVM ventilation, causes harm in some groups, and has high complication rates in the out-of-hospital

Table 3. Logistic regression analysis.

	Adjusted odds ratio	95% Confidence interval
1 year increase in age	1.081	1.01-1.16
Male sex	0.89	0.45-1.80
1 mile increase in distance to the hospital	0.96	0.93-1.0
Scene location was a home	1.63	0.79-3.35
Trauma system entry	8.26	3.37-20.27

environment.[6,7] The findings of this study suggest that it may be feasible to adapt airway management practices within an agency to reflect the geospatial distribution of the procedures. An agency could continue to train providers who work in areas where pediatric calls are clustered to intubate children while limiting practice in areas where intubation is unlikely to BVM ventilation or a supraglottic airway. This could promote patient safety while limiting training resources required of the agency. However, this model depends on a workforce that consistently services a particular area and may not apply to settings where fire providers frequently rotate from station to station or ambulances change coverage zones frequently. Further research is needed to validate the findings of this study in other populations and geographic areas.

We found that intubation procedures clustered more closely with pediatric EMS calls rather than the location of larger numbers of children in the community. There are relatively few studies that describe disparities in pediatric EMS care and utilization. A geospatial study identified increased use of EMS among asthmatic children with particularly high EMS utilization among asthmatic children from poor, black, and less-educated populations.[8] In addition, adults with lower socioeconomic status are more likely to use EMS.[9] It is possible that intubations cluster near EMS calls rather than the population because EMS may be used by a subset of the population that is more likely to suffer from critical illness and is thus more likely to require intubation. A previous geographic analysis found that pediatric pedestrian injuries are more likely in low income areas.[10] In addition, socioeconomic factors have been associated with death and healthcare utilization among asthmatic children further supporting the hypothesis that a subset of the pediatric population may be at higher risk for critical illness.[11,12] An alternate hypothesis is that patients in areas of higher socioeconomic status are more likely to be transported by private vehicle, even for a critical illness, and may be under-utilizing EMS resources. This has been suggested in one previous analysis.[13] Further investigations could explore the potential disparities and differences of EMS utilization in children in various populations and locations.

Finally, we hypothesized that intubation would be more likely to take place at greater distances from the hospital due to the potential perceived risks of an unprotected airway in a long transport. We found that this was not true and in fact there was a trend towards intubation happening closer to the hospital even after controlling for confounders including whether the patient was a trauma system entry. Previous data has suggested that children who require EMS care in rural areas are more likely to suffer from trauma, and are also more likely to have longer transports so it was important to control for this variable.[14] One possible reason for increased intubations closer to the hospital relates to level of training of staff on scene. A single transport agency covers the vast majority of calls in this county with equal staffing on all vehicles. However, fire department crews operating closer to the hospital are likely to have more professionals on staff and therefore more paramedics relative to more distant areas, which tend to be more rural and often have more volunteers. Relatively more paramedics on scene may make intubation more likely to take place.

We found that older patients were more likely to be intubated compared to younger patients. This may be due to paramedics having increased comfort intubating larger patients who are more adult-like since adults likely comprise the vast majority of airway training and field experience. Post-pubertal patients are generally "adult-like" in anatomy and physiology despite being less than 18 years of age. In some trauma systems patients 15 years and older are treated as adults.

LIMITATIONS

This study has several limitations to consider. First, this was a retrospective study based on what was documented in the chart by the treating providers. Next, this study was limited to a single EMS agency with specific geography and may not apply to other agencies. EMS agencies who consider adopting scope of pediatric intubation based on geography should conduct their own detailed geospatial analysis.

CONCLUSION

In this geographically diverse county, it appears that the location of intubation procedures is similar to the clustering of pediatric calls and that distance to the hospital was not associated with increased odds of intubation.

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The Medical Duty Officer: An Attempt to Mitigate the Ambulance At-Hospital Interval

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Introduction: A lack of coordination between emergency medical services (EMS), emergency departments (ED) and systemwide management has contributed to extended ambulance at-hospital times at local EDs. In an effort to improve communication within the local EMS system, the Baltimore City Fire Department (BCFD) placed a medical duty officer (MDO) in the fire communications bureau. It was hypothesized that any real-time intervention suggested by the MDO would be manifested in a decrease in the EMS at-hospital time.

Methods: The MDO was implemented on November 11, 2013. A senior EMS paramedic was assigned to the position and was placed in the fire communication bureau from 9 a.m. to 9 p.m., seven days a week. We defined the pre-intervention period as August 2013 - October 2013 and the post-intervention period as December 2013 - February 2014. We also compared the post-intervention period to the "seasonal match control" one year earlier to adjust for seasonal variation in EMS volume. The MDO was tasked with the prospective management of city EMS resources through intensive monitoring of unit availability and hospital ED traffic. The MDO could suggest alternative transport destinations in the event of ED crowding. We collected and analyzed data from BCFD computer-aided dispatch (CAD) system for the following: ambulance response times, ambulance at-hospital interval, hospital diversion and alert status, and "suppression wait time" (defined as the total time suppression units remained on scene until ambulance arrival). The data analysis used a pre/post intervention design to examine the MDO impact on the BCFD EMS system.

Results: There were a total of 15,567 EMS calls during the pre-intervention period, 13,921 in the post-intervention period and 14,699 in the seasonal match control period one year earlier. The average at-hospital time decreased by 1.35 minutes from pre- to post-intervention periods and 4.53 minutes from the pre- to seasonal match control, representing a statistically significant decrease in this interval. There was also a statistically significant decrease in hospital alert time (approximately 1,700 hour decrease pre- to post-intervention periods) and suppression wait time (less than one minute decrease from pre- to post- and pre- to seasonal match control periods). The decrease in ambulance response time was not statistically significant.

Conclusion: Proactive deployment of a designated MDO was associated with a small, contemporaneous reduction in at-hospital time within an urban EMS jurisdiction. This project emphasized the importance of better communication between EMS systems and area hospitals as well as uniform reporting of variables for future iterations of this and similar projects. [West J Emerg Med. 2016;17(5)662-668.]

INTRODUCTION

With a constantly increasing demand on the healthcare system, hospitals and emergency departments (EDs) are faced with increasing numbers of patients each year without a corresponding increase in resources. Hospitals are unable to handle the surges in demand for inpatient beds, which ultimately manifests as ED crowding.[1] A downstream consequence of ED crowding is the increase in time an ambulance waits to transfer a patient to an ED bed.[2] As a result, ambulances are prevented from returning to service to be available for the next emergency medical services (EMS) call. There have been attempts nationwide to alleviate these burdens on the healthcare system.[1,3,4] Although multiple studies have concluded that hospital-wide operational changes have a greater impact on ED crowding than attempts to divert ambulances to less busy EDs, the literature lacks consistent methods of defining and measuring intervals to determine the efficacy of policy changes on ED crowding and ambulance offload delay.[1,3,4]

The transport of emergency patients to EDs that are already overwhelmed contributes to a delay in patient offload and care transition.[5] The Baltimore City Fire Department (BCFD) is an urban EMS jurisdiction in Baltimore City, Maryland, that responds to over 150,000 requests for EMS services per year. ED crowding and ambulance offload delay are issues within this jurisdiction that have received the attention of the local government. The BCFD initiated the medical duty officer (MDO) position in an effort to reduce ambulance turnaround time through a more proactive and informed routing of ambulances. In addition to informing decisions about a particular transport destination, the MDO was authorized to actively communicate with hospital ED representatives in an effort to more evenly distribute the transport workload throughout the jurisdiction's hospitals, especially during times of significant ED crowding. The MDO position was a jurisdictional attempt to affect one component of the larger issue of ambulance demand and ED crowding.

It was hypothesized that any real-time intervention suggested by the MDO would be manifested in a decrease in the EMS at-hospital time, in-hospital recorded alert and diversion time and in the need for non-EMS units to wait on scene until a transporting unit was available.

METHODS

Jurisdiction

The studied jurisdiction is a combined fire-based EMS system serving an urban population of roughly 622,000.[6] EMS operations are carried out with 24 full-time advanced life support ambulances and four additional ambulances during peak hours. The jurisdiction responds to roughly 150,000 calls for service per year. EMS units transport to 11 area hospitals, which include two high level trauma centers and two Level II trauma centers, as well as specialty referral centers for eye trauma, hand/upper extremity trauma, hyperbaric medicine, neurotrauma, pediatric trauma, and burns.[7]

Medical Duty Officer

The MDO program was implemented on November 11, 2013, to proactively manage the city's EMS resources. A veteran EMS paramedic with several years of experience was assigned to the position of the MDO. This senior EMS officer was placed in the fire communications bureau from the hours of 9 a.m. to 9 p.m., seven days a week. The MDO staffing interval corresponded with times of increased requests for EMS. In addition to monitoring EMS unit availability, the EMS officer had the operational authority to suggest alternative hospital destinations in the event that one receiving facility was experiencing delays. The MDO monitored the computer-aided dispatch (CAD) system in real time and provided feedback to responding medic units about the relative availability of ED resources. Similarly, hospital EDs that experienced a temporary surge of activity could call into the MDO and request an "internal bypass." The internal bypass, once authorized, would temporarily reroute ambulances away from that ED.

Data management

All aspects of this study were completed with approval of the University of Maryland School of Medicine Institutional Review Board. This study uses data collected from the BCFD CAD system. The intervals analyzed using the CAD data include the following: response time (from dispatch to arrival on scene) and at-hospital times (from arrival at the hospital to back in service). The total number of incidents and hospital transports were also pulled from the BCFD CAD system. The data set was cleaned for all non-Baltimore City transport units. We only included at-hospital times if they could be matched with a valid hospital CAD designation.

The Maryland Institute for Emergency Medical Services Systems (MIEMSS) maintains data on hospital bypass and diversion. We downloaded information about MIEMSS alerts such as yellow alert, red alert and re-route directly from the public MIEMSS Region 3 County/Hospital Alert Tracking System (CHATS) website.[8] "Red alert" is used when a hospital has no available electrocardiogram-monitored beds. Hospitals request "yellow alert" status when the ED is subjectively overwhelmed. Yellow alert temporarily diverts all priority 3, or non-emergent, ambulance patients away from the ED.[9] Finally, "re-route" occurs when an EMS jurisdiction places a hospital on complete bypass due to unacceptable delays in care transfer. "Re-route" is unique in that it is an alert triggered by the EMS jurisdiction.

Like urban EMS jurisdictions, the BCFD dispatches fire suppression apparatus (engine and truck companies) to certain time-sensitive medical emergencies such as cardiac arrests and shootings. Fire response is also requested in the event of a protracted delay in transport unit arrival. The BCFD classifies this type of a response as a "medic stand-by." We therefore analyzed this interval as a surrogate marker for EMS system workload. The total time that

Table 1. Description of hospital bypass and diversion intervals collected and analyzed for this study.

Interval	Description	
Response time	Dispatch to arrival on scene	
At-hospital time	Arrival at hospital to back in service	
Suppression wait time	Time suppression units remained on scene until ambulance arrival	
Hospital alert time	Red alert	No ECG-monitored beds available
	Yellow alert	Diverts non-emergency ambulance patients away from ED
	Re-route	Complete bypass due to delays in care transfer from ambulance to ED staff

ECG, electrocardiogram; *ED,* emergency department

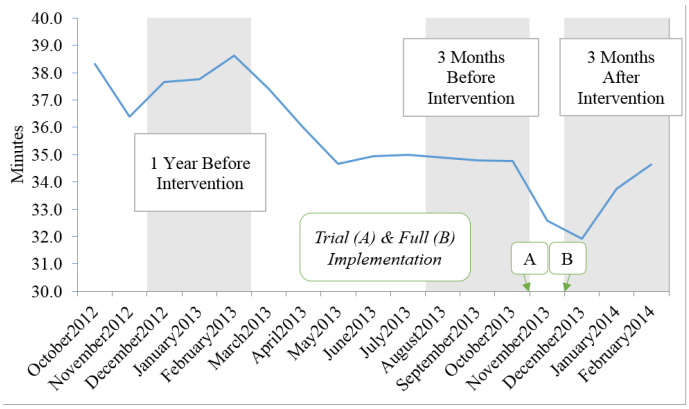

Figure 1. Mean at-hospital times, (time spent by ambulances at hospitals), October 2012-February 2014.

suppression units remained on scene until ambulance arrival is recorded as "suppression wait time."

A summary of the intervals collected and analyzed can be found in Table 1.

Data analysis

The data analysis used a pre/post intervention design to examine the MDO impact on the BCFD EMS system. The MDO program was implemented on November 11, 2013. We defined the pre-intervention period as August 2013 - October 2013. The washout period included the entire month of November 2013, during which the MDO was implemented as a trial. The post-intervention was defined as December 2013 - February 2014. We also compared the post-intervention period to the same time period from the previous year, December 2012 – February 2013, which is referred to as the "seasonal match control." The analysis focused primarily on the average at-hospital interval of BCFD EMS units. We examined the distribution of the at-hospital, response and suppression unit wait-time intervals for normality to determine if parametric methods were justified. We also created regression models to control for potential confounding variables captured in the dispatch data.

RESULTS

A total of 15,567 EMS calls occurred during the pre-intervention period. The total number of EMS calls during the post-intervention period was 13,921. There was a total of 14,699 EMS calls during the "seasonal match control" period. At-hospital and response times were normally distributed during our study period.

At-Hospital times

The average at-hospital time in pre-intervention period was 34.82 minutes (95% confidence interval [CI 34.57-35.08]) compared to 33.47 minutes (95% CI [33.23-33.70]) in the post-intervention period, representing a 1.35-minute (95% CI [1.01-1.70], p<0.0001) decrease. The average at-hospital time from the previous year December 2012 - February 2013 was 38.00 minutes (95% CI [37.69-38.31]), representing a 4.53-minute (95% CI [4.14-4.92], p<0.0001) decrease in the post-intervention period. The average at-hospital time while the MDO was off-duty during the post-intervention period was 31.99 (95% CI [31.74-32.24]) minutes or 1.48 (95% CI [1.14-1.82], p<0.0001) minutes shorter than on-duty times during the post-intervention period. The intervention decreased at-hospital intervals by 1.99 (95% CI [1.56-2.41], p<0.0001) minutes even after controlling for call volume and month of year (Table 2, Figure 1).

Response times

The average response time in the pre-intervention period was 10.15 minutes (95% CI [10.05-10.26]) compared to 10.04 minutes (95% CI [9.93-10.15]) in the post-intervention period, representing a 0.11 minute decrease (95% CI [-0.04-0.27], p=0.147). The average response time from December 2012 - February 2013 was 10.82 minutes (95% CI [10.71-10.94]), representing a 0.78 minute (95% CI [0.62-0.94], p<0.0001) decrease compared to the post-intervention period. The average response time while the MDO was off duty during the intervention period was 9.36 (95% CI [9.26-9.46]) minutes, or 0.68 minutes (95% CI [0.53-0.82], p<0.0001) less than response times during post-intervention on-duty times (Table 2).

Suppression Wait Time

The median suppression vehicle wait time in the pre-intervention period was 2.35 minutes (interquartile range [IQR 0.00-6.12]) compared to 2.05 minutes (IQR [0.00-5.68]) in the post-intervention period, representing a 0.30 minute decrease (p<0.001). The median suppression wait time from December 2012 - February 2013 was 3.28 minutes (IQR [0.11-7.99]),

Table 2. Response metric pre-intervention averages compared to post-intervention averages after a medical duty officer was hired to act as liaison between the Baltimore City Fire Department and area emergency departments.

Response Metric	Seasonal Match Control	Pre-Intervention	Post-Intervention	Off-Duty Post-Intervention
Time Frame	Dec 2012-Feb 2013	Aug 2013-Oct 2013	Dec 2013-Feb 2014	Dec 2013-Feb 2014
Mean At-Hospital times (min)	38.00**	34.82	33.47*	31.99**
Mean Response times (min)	10.82*	10.15	10.04	9.36**
Hospital Alert times—Yellow (hrs, total)	***	2593.96	1315.09	***
Hospital Alert times—Red (hrs, total)	***	1027.19	800.57	***
Hospital Alert times—Reroute (hrs, total)	***	316.73	99.07	***
Median Suppression Unit Standby times (min)	3.28**	2.35	2.05*	1.25**

*Statistically significant difference from pre-intervention period ($p<0.05$, 95% CI)
**Statistically significant difference from on-duty post-intervention time ($p<0.05$, 95% CI)
***Data unavailable

representing a 0.93 minute ($p<0.001$) decrease compared to the post-intervention period. The median suppression wait time while the MDO was off duty during the post-intervention period was 1.25 minutes (IQR [0.00-4.42]) or 0.8 minutes less than on-duty times ($p<0.001$, Table 2).

Hospital alert times

The total systemwide hospital alert time (yellow alert, red alert, or reroute) in pre-intervention period was 3,937 hours (2,593 yellow, 1,027 red, 316 reroute) compared to 2,214 hours (1,315 yellow, 800 red, 99 reroute) in the post-intervention period, representing a 1,723 hour decrease in the total number of alert time between the three-month pre- and post-intervention periods. (Table 2, Figure 2).

DISCUSSION

The MDO program was implemented to proactively manage the BCFD's resources for emergency medical response, which included both EMS and fire apparatus. The study was performed in a fire-based EMS jurisdiction that embraces an advanced life support response structure for both first response and transport requests. As utilization of healthcare increases nationally, EDs find themselves crowded and under staffed.[1] The transport of emergency patients to EDs that are already overwhelmed contributes to a delay in patient offload and care transition.[5] We analyzed the effect of the MDO program and proactive ambulance routing at reducing ambulance at-hospital time, MIEMSS-recorded alert and diversion time, and suppression wait time.

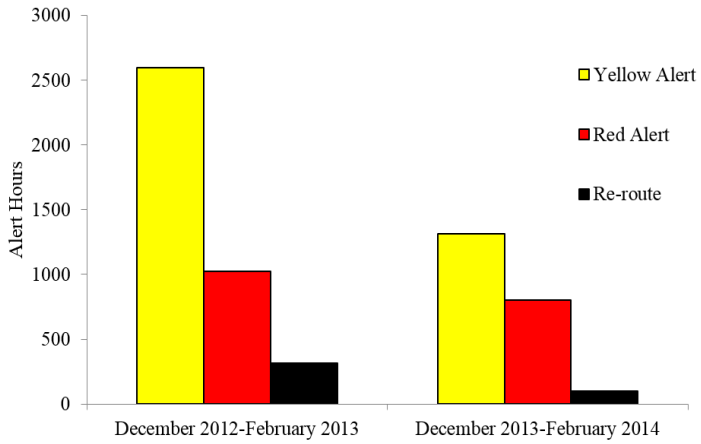

Figure 2. Number of total alert hours for 11 area hospitals.

The Spaite model of EMS time intervals defines ambulance "out-of-service interval" as the time from an EMS unit receiving the alarm to the time the unit has transferred patient care to ED staff and is again available for service.[10] Cooney et al. expanded the concept by defining ambulance "turnaround interval" as the time from unit arrival at the hospital to the time the unit leaves the hospital, which is how we define ambulance "at-hospital time."[4] Therefore, factors that affect ambulance at-hospital time also impact the ambulance out-of-service interval. Various factors can contribute to extended at-hospital intervals including lack of ED beds and lack of medical personnel to receive patient information.[2,4] Delaying ambulances at the hospital means they are not available for the next 911 call and therefore more ambulances are required in a given time period to achieve the same level of availability.[2,11] The analysis of ambulance at-hospital time revealed a statistically significant reduction in the three-month post-intervention period compared to the three-month pre-intervention period and seasonal match control. A further analysis showed a decrease in at-hospital time post intervention while the MDO was off duty. This brought into question the impact of systemwide policy changes that were occurring concurrently versus the direct impact of the MDO on at-hospital time (Figure 3). Of particular interest, the implementation of the MDO was temporarily linked to a reduction in outlying at-hospital intervals (Figure 4). Prior to the MDO program, it was not uncommon to have units at the hospital in excess of 120 minutes. The MDO program resulted in a tighter clustering of at-hospital intervals and a modest improvement in ambulance turnaround time. Theoretically, shorter at-hospital intervals means improved EMS efficiency and public safety since ambulances are available to be

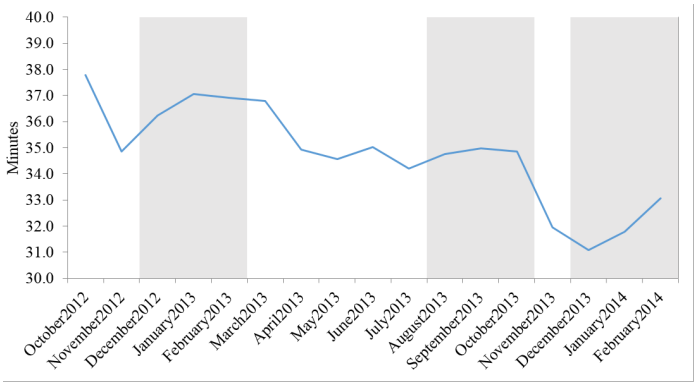

Figure 3. Mean at-hospital interval without medical duty officer on duty October 2012-February 2014.

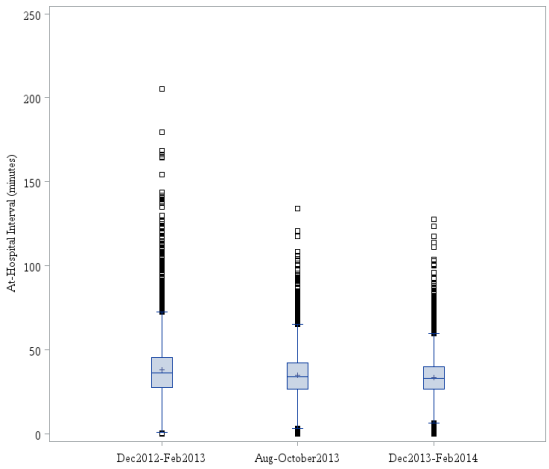

Figure 4. Reduction of outlying times and tighter clustering of at-hospital intervals in the time periods studied: pre-intervention period (August-October 2013), post-intervention (December 2013-February 2014) and "seasonal match control" (December 2012-February 2013).

dispatched on the next EMS call.[4,11]

Another measure of the impact on EMS and fire services is suppression wait time. The interval looks at the length of time a non-transporting fire apparatus was on the scene of an EMS call while waiting for the arrival of an apparatus with the ability to transport the patient, if necessary. Reduction of suppression wait time may theoretically increase the availability of fire apparatus for non-EMS related calls. It also represents the availability of EMS apparatus for EMS calls. If resources were appropriately available, it can be deduced that there would not be a need for suppression units to wait on-scene for the arrival of transporting units. There was a statistically significant reduction in suppression wait time post-intervention compared to both the three-month pre-intervention period and seasonal match control period. In addition, an analysis of the post-intervention MDO off-duty times actually showed a shortened suppression wait time than post-intervention MDO on-duty times.

To analyze the effect of the MDO upon the larger EMS system, we looked at the total number of hospital bypass and diversion hours. In the early 1990s, ambulance diversion programs were initiated in busy urban systems across the nation to begin to address the growing issue of ED crowding.[4] In the more recent years, ambulance diversion has been shown to have little effect on ED crowding since ED crowding has been attributed to bigger healthcare and hospital-wide issues.[1,4,3] However, diversion hours and alert times are still an important factor to analyze as markers of system efficiency since hospital-based policy changes have been shown to reduce ED crowding and therefore decrease ambulance diversion.[4] There is also a need for common variables, such as alert times, to have the ability to compare the efficacy of interventions and policy changes being made nationwide.[1] After implementation of the MDO program, there was just over a 1,000-hour reduction in total alert times from the three-month pre-intervention period to three-month post-intervention period. Unfortunately, we are limited in our ability to further investigate the data. In addition, we are unable to compare the alert hours when the MDO was on duty to when the MDO was off duty in the post-intervention period. Statewide alert data are not reported on an hourly basis and therefore could not be uniformly adjusted for the MDO time intervals. In the future, hospital alert times could be an effective means for determining the effect of interventions on the hospital system if we are able to further navigate and analyze the data.

There is a paucity of literature that addresses the topic of proactive dispatch as it relates to reduction in at-hospital times or related intervals. Ambulances represent a valuable resource to the community and extended at-hospital times have the potential to reduce ambulance availability.[2,5,4,11] Accordingly, it is imperative for EMS jurisdictions to consider strategies targeted to maintain their capacity for emergency response. The MDO program's findings are similarly relevant to EMS jurisdictions that deal with diversion and transport to multiple hospitals. Though MIEMSS maintains a statewide alert-reporting database, hospitals may tailor diversion criteria to fit their operational constrains. Despite recommendations against excessive ambulance offload times, the practice of timely patient offloading is unevenly enforced at area hospitals in our jurisdiction. The MDO program therefore represents one urban EMS jurisdiction's attempt to maintain real-time situational awareness and attempt to adopt a more proactive ambulance deployment strategy. Reductions in at-hospital, response times, suppression wait time and hospital alert times were modest, at best, and most likely reflect a temporally associated and jurisdiction-wide hospital collaboration initiative. Future iterations of this paper would apply the MDO program to other EMS jurisdictions and see if it has similar effects on the measured intervals without other factors confounding the results. If so, it would support the clinical

utility of this program. In addition, the cost effectiveness of the MDO program was not considered prior to implementation. Future iterations would add cost analysis to the program and determine if the fiscal impact of decreasing suppression wait time and increasing ambulance availability increases profit, even with the increased cost of staffing the senior officers of the MDO program. At this time there is no study that shows reducing ED crowding saves money.

Finally, it is difficult to argue that small reductions in response times equate to clinically meaningful results. Response time has been deemphasized as a measure of clinical efficacy, and it is cited in this study solely as a marker of EMS unit availability. In our EMS jurisdiction, the at-hospital interval represents the longest amount of time that a transport unit is effectively taken out of service. When viewed from a systemwide perspective, small improvements in the at-hospital interval can translate into improved ambulance availability. Even in the absence of clinically significant improvements, the authors believe there is value in tracking intervals and engaging hospitals in an effort to reduce at-hospital times. The MDO program has resulted in more regular communication between the EMS jurisdiction and area EDs, and the effects of inter-agency collaboration extend well beyond improvements in established time intervals. At a minimum, the results and limitations associated with this particular investigation reiterate the need for ongoing communication and consistent data collection between EMS units and the hospitals they serve.

The MDO project allowed for a uniform reporting of variables and time intervals. A consistent vocabulary is absolutely essential for ongoing and meaningful dialogue. Prior to inception, each hospital had a different way of scrutinizing the "at-hospital" interval. Fire department administrators resorted to manually charting the interval between ambulance arrival in the ED and eventual unit availability. The MDO project encouraged use of the intervals described in the Spaite model to ensure that stakeholders were measuring, analyzing, and understanding specific and uniform times.[10] The need for consistency in measurement cannot be overstated.

LIMITATIONS

Many limitations exist in the availability and recording of data used in this paper. The tracked intervals used begin and end when the provider, Fire Communications, or the EMS officer manually changes the unit's status in the CAD system. The lack of automated time stamps allows for inconsistencies in reporting. Furthermore, it is entirely possible that crews forgot to communicate the exact time of their arrival to fire communications and therefore under or overestimate actual intervals. The MIEMSS Alert System has no means of tracking when the MDO made destination changes or accepted internal bypass requests. Our jurisdiction also encountered challenges with consistent implementation of automated Wi-Fi-enabled reporting. The physical structure of some area hospitals, for a variety of reasons outside the BCFD's control, prevented the transmission of wireless time-stamp data. In addition, there is no research that directly links response times to improved health outcomes, or research that relates the quantity of alert hours to EMS efficiency.

BCFD units transport to 11 hospitals within their catchment area. Area hospitals did not report EMS time metrics in a uniform manner, nor was information shared with the EMS jurisdiction at the time of the study's inception. Therefore, the average at-hospital interval represents the only metric that is collected, reported, and analyzed at the jurisdictional level. To address the variability intrinsic to the reporting of "average" time intervals, the at-hospital interval was examined pre- and post-intervention as well as controlled for the volume of responses.

The study was not resourced to address the ancillary benefits of positioning an experienced EMS officer in fire communications. Units frequently used MDO for issues unrelated to hospital availability. Experienced MDOs reported fielding requests for "advice" on appropriate destination when medics in the field were faced with complicated questions about patient destination. Future studies might focus on the potential reduction in questions to medical control physicians or use a survey-based response system to more precisely characterize benefits and perceived MDO utility.

Finally, the city's MDO program was implemented during a time when there was increased scrutiny on EMS at-hospital times and multiple efforts had been made to outreach to city hospitals. A city-wide hospital collaboration group was convened to re-address the problem of at-hospital intervals and improve offload times. As a result, the MDO program is only one factor contributing to changes in the EMS system during the time frame studied in this paper.

CONCLUSION

A proactive deployment of a designated medical duty officer is associated with a small, contemporaneous reduction in average at-hospital times within an urban EMS jurisdiction. The clinical utility of the findings in this paper is debatable. However, this project highlights the importance of better communication between EMS systems and area hospitals as well as uniform reporting of variables. More research is required to determine the precise influence of a proactive EMS officer presence in the fire communications center on relevant EMS time intervals and hospital crowding.

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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: "Anticoagulation Reversal and Treatment Strategies in Major Bleeding: Update 2016"

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[West J Emerg Med.669–670.]

West J Emerg Med. 2016 May;17(3):264-70.
Anticoagulation Reversal and Treatment Strategies in Major Bleeding: Update 2016.
Christos S, Naples R.

Erratum in
West J Emerg Med. 2016 September;17(5):669-70. Dosage error in published figure; MEDLINE/PubMed Figure 3 is corrected and provided.

PMCID: PMC4899056 [PubMed - indexed for MEDLINE]

In the Review Article entitled "Anticoagulation Reversal and Treatment Strategies in Major Bleeding: Update 2016," published in the May 2016 issue of the *Western Journal of Emergency Medicine* (2016;17(3):264-70. DOI: 10.5811/westjem.2016.3.29294), there were the following errors in the published article.

Anticoagulant	Reversal/treatment options
Dabigatran	Idarucizumab 5.0g IV total dose [DOSAGE ERROR CORRECTED] (given as two separate doses of 2.5g [DOSAGE ERROR CORRECTED] 15 minutes apart) Alternatives if idarucizumab is unavailable Hemodialysis Activated charcoal 100g po/NG if ingestion time <2 hours 4F-aPCC (FEIBA)# 50 units/kg IV; *not to exceed 5000 units (*single dose only) Tranexamic acid 25mg/kg IV Desmopressin 0.3mcg/kg SQ or IV; limit to 2 IV doses given Increased risk of tachyphylaxis FFP: Not recommended rFVIIa: Not recommended

Apixaban	Activated charcoal 100g po/NG if ingestion time <6 hours 4F-PCC (KCentra / Octaplex)#^ 50 units/kg IV; not to exceed 5000 units (single dose only) Tranexamic acid 25mg/kg IV Desmopressin 0.3mcg/kg SQ or IV; limit to 2 IV doses given Increased risk of tachyphylaxis Andexanet alpha¥ 400mg IV bolus at 30mg/min followed by continous infusion at 4mg/min [DOSAGE ERROR CORRECTED] for 120 minutes FFP: Not recommended rFVIIa: Not recommended
Rivaroxaban	Activated charcoal 100g po/NG; if ingestion time <8 hours 4F-PCC (KCentra / Octaplex)# ^ 50 units/kg IV; not to exceed 5000 units (single dose only) Tranexamic acid 25mg/kg IV Desmopressin 0.3mcg/kg SQ or IV; limit to 2 IV doses given Increased risk of tachyphylaxis Andexanet alpha¥ 800mg IV bolus at 30mg/min followed by continuous infusion at 8mg/min [DOSAGE ERROR CORRECTED] for 120 minutes FFP: Not recommended rFVIIa: Not recommended

Figure 3. Reversal of direct oral anticoagulants (DOACs) in patients with significant bleeding.
IV, intravenous; *FFP*, fresh frozen plasma; *rFVIIa*, Recombinant human Factor VIIa; *PCC*, prothrombin complex concentrates; *FEIBA*, Factor Eight Inhibitor Bypassing Activity; *NG*, nasogastric
#Off label use.
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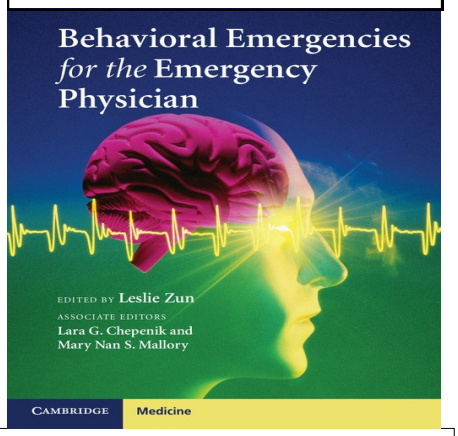

Selected Topics (Tentative)

- Queuing theory
- Innovative approach to disruptive pts
- Borderline
- Medically Integrated care
- International Agitation Guidelines
- Opioid Addiction
- Coalition update
- Standards for Psych EDs

- 10 Articles that changed my practice
- Self Injury
- Suicide update
- Malingering

- Helping violent crime victims with psychiatric illness

- Special Considerations for Older Adults With Behavioral Emergencies

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