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Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

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Contents continued on page iv

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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.

Table of Contents *continued*

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Table of Contents *continued*

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Dengue, Zika and Chikungunya: Emerging Arboviruses in the New World

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The arboviruses that cause dengue, chikungunya, and Zika illnesses have rapidly expanded across the globe in recent years, with large-scale outbreaks occurring in Western Hemisphere territories in close proximity to the United States (U.S.). In March 2016, the Centers for Disease Control and Protection (CDC) expanded its vector surveillance maps for *A. aegypti* and *A. albopictus*, the mosquito vectors for these arboviruses. They have now been shown to inhabit a larger portion of the U.S., including the heavily populated northeast corridor. Emergency physicians need to further familiarize themselves with these diseases, which have classically been considered only in returning travelers but may soon be encountered in the U.S. even in the absence of travel. In this paper, we discuss the presentation and treatment of dengue, Zika, and chikungunya, as well as special challenges presented to the emergency physician in evaluating a patient with a suspected arbovirus infection. [West J Emerg Med. 2016;17(6)671-79.]

INTRODUCTION

With increases in globalization come increases in the spread of disease to populations lacking native immunity. One of the earliest known incidences of this phenomenon in the New World was the introduction of smallpox and syphilis to Native Americans during colonization. In recent years, emerging infectious diseases have been reported with greater frequency. In 1999, West Nile Virus was first reported in New York[1] and quickly became endemic throughout the United States (U.S.). Local transmission of dengue occurred in Florida in 2009,[2] and in 2013 and 2014 a chikungunya epidemic spread rapidly through South America and the Caribbean.[3] We are now faced with a pandemic of Zika virus, which is quickly spreading through the tropical areas of the Western Hemisphere, with growing concerns that an outbreak could soon occur in the mainland U.S. Yellow fever is another important arbovirus transmitted by *Aedes* mosquitos, though an effective vaccine exists and massive vaccination campaigns in South America have prevented large-scale outbreaks in the Western Hemisphere during this century.[4] Emergency physicians (EP) are on the front lines of detection and treatment of these illnesses, though due to their rarity, many clinicians are unfamiliar with these disease processes. EPs must be vigilant in eliciting a careful travel history in any febrile patient and should not rely on basic triage screening. Given that vector-borne illnesses are endemic in virtually every region of the world, a positive travel history should prompt consideration of diagnoses including malaria, arboviruses, and other tropical infections. In this article, we will review the vectors, the diagnoses, and treatments of three of the most rapidly spreading arboviruses in the Western Hemisphere: dengue, Zika, and chikungunya[5-8] (Figure 1).

THE VECTORS

Mosquitos from the genus *Aedes*, specifically *A. aegypti* and *A. albopictus*, are responsible for the transmission of many arboviruses worldwide. Despite their likely initial origins as zoonoses, humans have become the primary amplifying host of these viruses, particularly in urbanized settings.[9] Transmission occurs when a mosquito bites an infected individual and then directly carries the virus to another person.

The *A. aegypti* mosquito has traditionally been

considered to be a much more efficient vector for the spread of these diseases due to several factors. *A. aegypti* has evolved to live its entire life cycle from larvae to adult in close proximity with its human hosts, strongly preferring to feed on humans even in the presence of other mammals. *A. aegypti* will bite several humans in the course of a single blood meal. This behavior can rapidly transmit a virus to multiple hosts in a short time frame, efficiently propagating disease. *A. albopictus* lacks this highly preferential coexistence with humans, living in a more varied environment. Because they feed on other dead-end hosts (i.e. dogs, cats, squirrels), this provides a hindrance to rapid disease amplification. *A. albopictus* has a greater tolerance for cold environments, and thus while it is a less efficient vector of disease, it can pose a threat to a larger geographic area.[10]

The transmission of these arboviruses in the Western Hemisphere was delayed by aggressive vector control campaigns in the 1960s and 1970s. However, these efforts have since lapsed, facilitating spread of the mosquitoes.[11] These mosquitoes have subsequently grown in their distribution in the U.S., and in March 2016 the Centers for Disease Control and Prevention (CDC) updated its vector maps to reflect this spread. *A. aegypti*, the more concerning of these vectors, is now suspected to inhabit the heavily populated northeast corridor[12] (Figure 2*).* This has increased concern among public health experts that these diseases may emerge in the continental U.S. in a more widespread fashion. Traditionally, EPs in the U.S. have considered these diseases only in the returning traveler; in the near future, however, dengue, Zika, and chikungunya may need to be considered in the absence of recent travel.

THE ARBOVIRUSES

Dengue

Background and Clinical Course

Dengue is the most prevalent and dangerous of the emerging arboviruses. According to the World Health Organization (WHO), it is the most rapidly spreading arbovirus worldwide and is endemic in every inhabited region of the world except for continental Europe.[13] A 2013 study estimated that 96 million clinically significant cases occur annually, a dramatic increase from 50 million in 2009.[14] Although most cases in the U.S. have been in returning travelers, sporadic outbreaks have occurred in Louisiana, Hawaii, Florida, and Texas.[15]

Dengue is a member of the flavivirus genus, which also includes yellow fever, West Nile, and Zika viruses. There are four distinct dengue virus serotypes, with type 2 considered to be the most virulent strain. Although the human-mosquito-human transmission cycle is the most prominent method of propagation, dengue can be transmitted vertically during pregnancy and via blood-borne transmission. Dengue is not transmitted via sexual contact or respiratory droplets.[5,16]

About 50% of dengue infections are symptomatic. The clinical presentation of dengue illness is widely varied and its course unpredictable, making diagnosis and treatment challenging. There are three distinct phases of symptomatic dengue that have been well described: febrile, critical and recovery[13,16] (Figure 3).

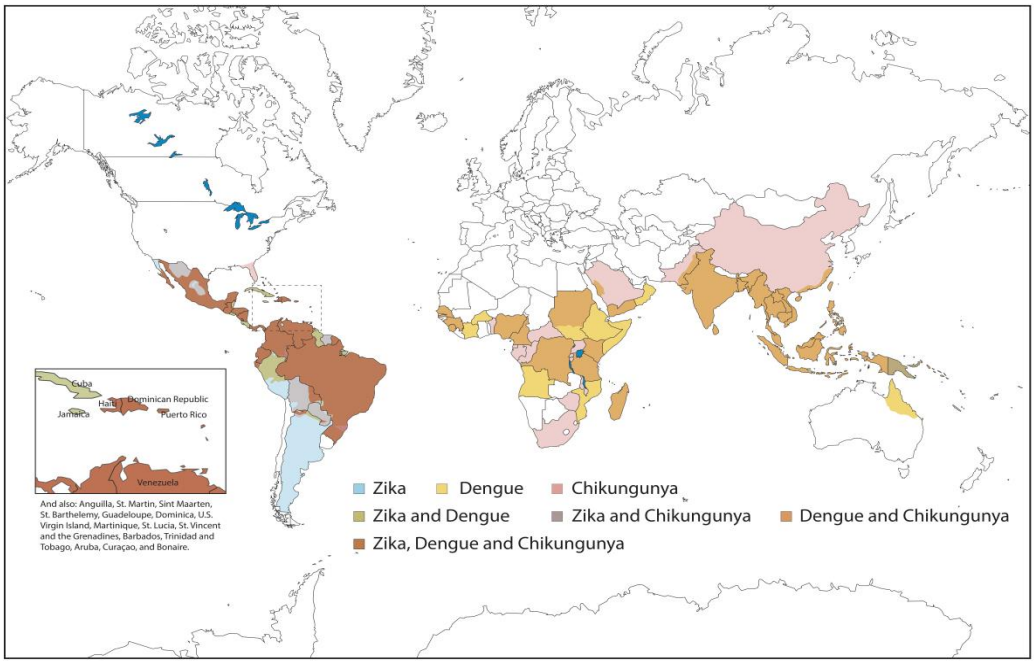

Figure 1. Map showing the estimated global distribution of dengue, Zika, and chikungunya.

Figure 2a **Figure 2b**

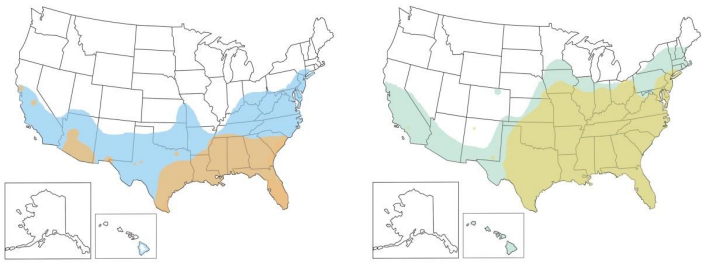

Figure 2a,b. In April 2015, the CDC updated its vector surveillance maps to depict that both *A. aegypti* and *A. albopictus* are now believed to inhabit a wider range of distribution in the U.S. Figure 2a illustrates the expansion of territory covered by *A. aegypti*; Figure 2b illustrates the expansion of *A. albopictus*. The range of both mosquitos has spread significantly to the north and west. Although the significance of this expansion in epidemiologic terms is unclear, it may place a greater proportion of the population at risk for exposure to emerging arboviruses such as Zika, particularly during warmer months.

Dengue Time Frame

Phase	Incubation	Febrile Phase							Critical Phase		Recovery phase
Time frame	3-14 days	3-7 days							1-2 days		3-5 days
Symptoms	None	Fever is present							Fever resolves		
		>Myalgias >Rash >Petechiae >Tourniquet test >Leukopenia >Mild bleeding						Warning signs may occur	>Capillary leak >Shock >Severe hemorrhage >Severe organ involvement		> Fluid Reabsorption >Diuresis
Testing			DENV IGM								
		DENV NS1 DENV PCR									
Day of illness	0	1	2	3	4	5	6+	7	8	9	10+

Figure 3. Three distinct phases of dengue infection have been described: incubation, febrile, and recovery. The critical phase, when patients may become unstable, typically occurs after defervescence of the fever. Although most patients will improve after the febrile stage, those who progress to the critical phase may display warning signs. By closely monitoring for these signs, clinicians can identify and appropriately disposition patients at higher risk for a more severe clinical course. The laboratory evaluation of dengue also varies based on the stage of infection and thus samples evaluating for both viral practices (PCR or NS1) and IgM levels should be ordered.
DENV, dengue virus; *NS1,* nonstructional protein 1; *PCR,* polymerase chain reaction
*PCR is expressed on the surface of infected cells.

Febrile Phase

The febrile phase typically lasts 2-7 days, with non-specific symptoms such as myalgias, arthralgias, headache, rash, nausea and vomiting.[17] The rash can range from a mild erythema to a pruritic, macular rash with small circular islands of spared skin classically described as "isles of white on a sea of red." Minor hemorrhagic manifestations such as petechiae and epistaxis may occur. Laboratory findings are nonspecific and can include hyponatremia, leukopenia, thrombocytopenia, and transaminitis.[13,16,18]

The majority of symptomatic patients will improve after the febrile stage. However, about 5% will progress to the critical phase, which occurs after the virus is cleared from the bloodstream and the fever resolves.[19] The absence of fever should not be reassuring to clinicians, as patients can rapidly deteriorate after defervesence.[13]

Critical Phase

The critical phase, which lasts 1-2 days, is marked by an increase in capillary permeability, thrombocytopenia, and possible progression to hemorrhage. Leaky capillaries lead to a loss of plasma volume, and its presentation can range from mild edema to pleural effusions, ascites and shock with end-organ damage. A severe hemorrhagic diathesis requiring transfusion may occur. Significant hemorrhage and capillary leak syndrome can occur concurrently or be independent of each other.[20]

Recovery Phase

The recovery phase, which lasts 3-5 days, occurs when the patient stabilizes and reabsorbs extravasated fluid. New complications may develop, including acute pulmonary edema, which can occur in the setting of excessive intravenous fluid (IVF) resuscitation.[13]

Challenges for the Emergency Physician: Diagnosis and Disposition

While the EP may not ultimately make the definitive diagnosis of dengue, it is important that they both consider the diagnosis in the appropriate patient, and determine which patients are at risk for a poor outcome and thus warrant admission. Left untreated, severe dengue carries a mortality rate of 20% that if properly managed can be reduced to less than 1%.[21] Thus, early recognition is crucial. Dengue should be considered in any symptomatic patient presenting within two weeks of returning from an endemic area. The most recent WHO guidelines published in 2009 are directed toward early recognition of susceptible patients and use a clear algorithm[13] (Figure 4). In these new guidelines, the previously used classifications of dengue fever, dengue hemorrhagic fever, and dengue shock syndrome have been replaced by the terms dengue without warning signs, dengue with warning signs, and severe dengue. This updated classification was designed to help clinicians make disposition decisions, and is thus particularly useful in the emergency department (ED). This

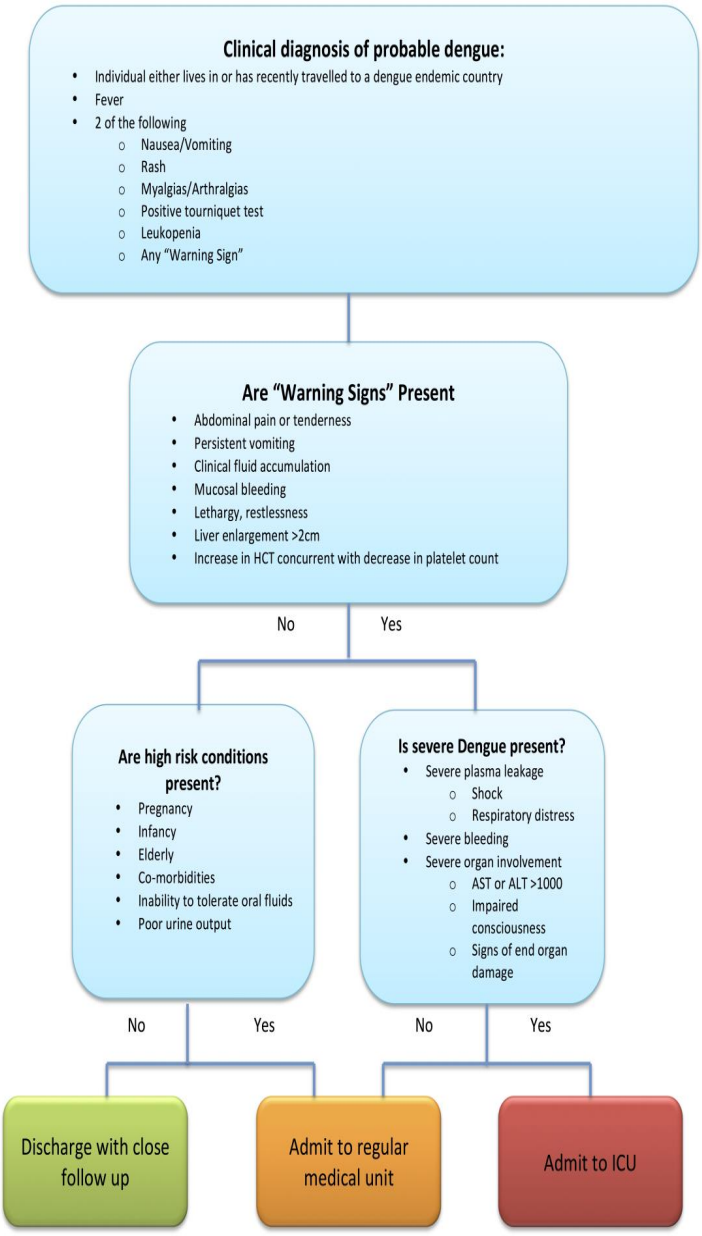

Figure 4. Management algorithm for dengue, adapted from Dengue Case Management, available at: http://www.cdc.gov/dengue/resources/DENGUE-clinician-guide_508.pdf.
HCT, hematocrit; *AST*, aspartate amino transferase; *ALT*, amino alanine transferase; *ICU*, intensive care unit
AST/ALT values are in units/liter.

revised classification system has shown increased sensitivity for identification of severe cases.[22]

Once considering dengue, the emergency medicine clinician must decide whether the patient is at risk of progressing to severe dengue. The WHO has identified both "risk factors" by history or demographics that make a patient more susceptible to severe dengue as well as clinical "warning signs" that signify deterioration towards the more dangerous critical phase.[13] When determining whether or not to admit a patient with suspected dengue, both must be considered.

The WHO favors a clinical diagnosis of "probable dengue" for any patient who lives in or has traveled to a dengue endemic area and has a history of fever and any two of the following: nausea/vomiting, rash, aches and pains, positive tourniquet test, (Figure 5) leukopenia, or "any warning sign."[13,23] Further information on the laboratory evaluation of dengue can be found in the testing section of this article.

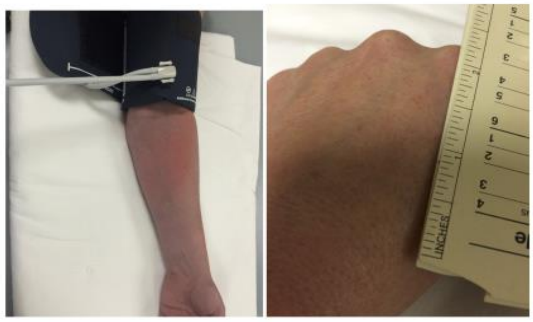

Figure 5. The tourniquet test, which is a marker of capillary fragility, is a quick and easy bedside study that can help physicians differentiate dengue from other illnesses, although it lacks both sensitivity and specificity. A blood pressure cuff is inflated to midway between the systolic and diastolic blood pressure and maintained for five minutes. A positive test is the presence of 10 or more petechiae per square inch. 16,19.

Risk Factors

Patients with risk factors such as pregnancy, chronic comorbidities (i.e. diabetes, organ failure, immunosuppression), and extremes of age are more likely to develop severe dengue and should be admitted, even if symptoms are mild.[13] Despite evidence that infection with one dengue serotype confers lifelong immunity against that serotype, it does not confer long-lasting protection against the other serotypes. It is in fact critical that the EP recognize a unique phenomenon of dengue: previous infection with a different serotype can paradoxically increase the risk for development of severe dengue.[16] The prevailing hypothesis for this phenomenon is dengue antibody-dependent enhancement (ADE). According to this hypothesis, circulating IgG antibodies form complexes with the virus during active infection, promoting uptake of the virus by macrophages where the virus replicates.[24,25] Consequently due to ADE, as the incidence of dengue continues to increase, clinicians may see more patients who have been re-infected with dengue and thus have more severe presentations with increased fatalities.[25]

Warning Signs

Patients will often display warning signs of severe dengue prior to progression to the critical phase. The

following warning signs identify patients who may be progressing towards severe dengue: abdominal pain or tenderness, persistent vomiting, clinical fluid accumulation, mucosal bleed, lethargy/restlessness, or liver enlargement > 2cm. An increasing hematocrit is also seen as a warning sign - as the plasma leaks into the extravascular spaces, hematocrit increases, signifying intravascular dehydration.[13,20] Recognition of these signs can be life saving.

The treatment of dengue is supportive and based on clinical stage and presence of warning signs. Patients should not be given aspirin or other non-steroidal anti-inflammatory drugs (NSAIDs) as they may complicate hemorrhage.[13] Neither are steroids recommended.[26]

A patient with no risk factors and no warning signs can be discharged if they are well appearing, tolerating oral intake, and are producing good urine output.[13] In the febrile phase, only dehydrated patients or those not taking adequate oral intake should receive intravenous fluids (IVF). Reliable short-term follow up must be ensured before discharging a patient; the CDC and WHO recommend daily follow-up visits through the critical period.[27]

Patients with any warning sign present should be admitted for observation and supportive care as the clinical deterioration in the critical phase can often occur rapidly. In the critical phase, IVF should be administered to maintain a urine output of at least 0.5 milliliters per kilogram per hour; however, excessive fluids can worsen plasma leakage.

Patients with severe dengue require admission to an intensive care unit for supportive care and monitoring. Severe dengue is present if any of the following are met: severe plasma leakage resulting in shock and/or fluid accumulation with respiratory distress; severe bleeding as evaluated by the clinician; or signs of severe organ involvement (i.e. aspartate transaminase (AST) or alanine transaminase (ALT) >1000, impaired consciousness, etc.). Early signs of plasma leakage include tachycardia and a narrowed pulse pressure. Transfusion of blood products should be driven by clinical presentation if needed.[28]

Zika

Background and Clinical Course

Zika virus, named after the Ugandan forest in which it was discovered, is a flavivirus closely related to dengue. It was first isolated in 1947 in a macaque monkey and shortly thereafter was recognized to cause an asymptomatic infection or mild febrile illness in humans. For decades, Zika was of little concern to clinicians. However, since a correlation between Zika virus infection and fetal microcephaly was discovered, Zika has received significant public health and media attention.[29] In February 2016, the WHO officially declared it a "Public Health Emergency of International Concern".[30]

Zika was relatively unknown outside small outbreaks in Africa and Southeast Asia until 2007, when a large outbreak occurred in Yap, a small island in Micronesia. According to serological data, 73% of the island's population was infected during the outbreak.[31] Outbreaks were subsequently noted to occur across the Pacific islands before eventually emerging in the Western Hemisphere in March 2015, when Brazil reported the first case of Zika virus in the Americas. By December 2015, Brazil suspected 1.3 million cases of Zika virus; by April 2016 Zika virus had spread to 33 countries and/or territories[32] (Figure 1). Until the recent reports of local Zika transmission in southern Florida, all cases reported in the U.S. had been linked to returning travelers or their sexual partners.[33] It is unknown at the time of this writing to what extent this disease will spread throughout the U.S.

Zika virus is spread by several mosquito species worldwide, but *Aedes* species are responsible for most outbreaks.[32] Although the primary mechanism of transmission is via an infected mosquito, there have been cases of sexual transmission to partners of returning travelers.[34,35] Blood-borne transmission is likely possible during the viremia stage, and transfusion-related infections have been reported in Brazil. It has also been isolated in urine, saliva, and breast milk of infected individuals, though no transmission from these sources have been identified to date.[36,37]

Once infected, the incubation period of Zika virus is not yet clearly defined but currently presumed to be less than two weeks. During viremia a mild illness can develop with symptoms such as fever, nonpurulent conjunctivitis, a maculopauplar rash (Figure 6), arthritis/arthralgias, headache, and vomiting.[32] Severe disease and complications requiring hospitalization are uncommon, and it has not been shown to cause a severe capillary leak syndrome or hemorrhagic fever.[36] It is estimated that up to 80% of infections are asymptomatic.[38] Like dengue, treatment is supportive. The symptoms are clinically indistinguishable from the febrile stage of dengue, so aspirin, NSAIDs and steroids should be avoided.[39]

Although the mechanism is not yet understood, a strong link has been established between maternal Zika virus infection and serious birth defects including microcephaly and other serious brain malformations.[40] Zika virus has been found in the amniotic fluid, brain tissue, and placenta of infants born with cerebral abnormalities during outbreaks,[37] and a proposed mechanism has been suggested.[41] Although there have been concerns that the correlation was inflated from over-reporting during outbreaks, in April 2016 the WHO declared a "scientific consensus that Zika virus is a cause of microcephaly."[42] The risk of fetal malformation is presumed to be highest when maternal infection occurs in the first trimester,[38] though adverse pregnancy outcomes have been associated with infections in all trimesters.[43]

Challenges for the Emergency Physician: Counseling Patients

The majority of patients with suspected Zika virus would

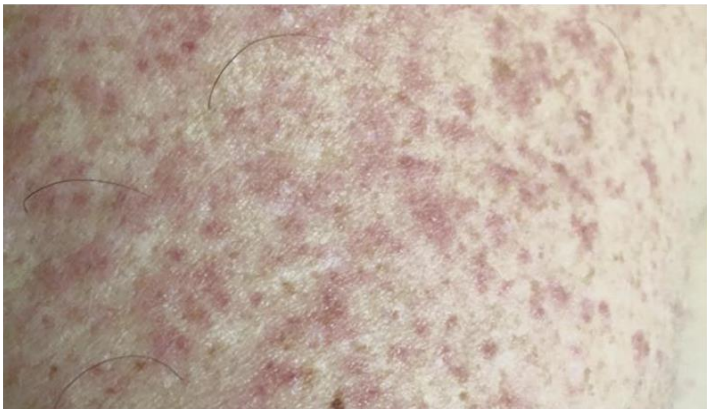

Figure 6. Rash on a patient with Zika infection.

be safe for discharge home from the ED. Thus, the EP should be prepared to directly counsel patients with suspected Zika virus regarding the risks of direct transmission and potential complications from the infection.

Women of Childbearing Age

In particular, women of childbearing age and pregnant women with suspected Zika should be counseled regarding the potential for birth defects. The CDC currently recommends that pregnant women avoid travel to areas affected by Zika. If travel cannot be avoided, strict mosquito protection precautions should be taken. Current recommendations for pregnant patients with Zika infection during pregnancy include serial ultrasounds performed every 3-4 weeks.[38] In light of this, pregnant patients with suspected Zika should have short-term obstetric follow up arranged prior to discharge.

Women with suspected Zika virus should wait at least eight weeks after the onset of their symptoms to have unprotected sex.[38] Prior infection with Zika virus is not a risk factor for birth defects; the increased risk is associated with active viremia.[44] Breast-feeding patients should be warned that Zika virus has been detected in breast milk, although no cases of transmissions have been reported to date.[37]

All Patients

The CDC currently recommends that all patients with suspected Zika virus should refrain from unprotected sex with women for six months. Individuals who have travelled to an endemic area, but did not develop symptoms should refrain for at least eight weeks after return.[45]
The time duration of potential risk from sexual transmission has not yet been confirmed, but viral particles have been detected in semen as long as 62 days after the onset of symptoms.[46]

Also of concern to the EP is the correlation between Zika virus infection and Guillain-Barre Syndrome (GBS). Several countries in the western Pacific and Americas have reported increases in GBS during outbreaks.[32] One case control study in French Polynesia reported an odds ratio of greater than 34 between previous Zika virus infection and GBS.[32] It is reasonable to counsel patients with suspected Zika of this potential risk so that they know to seek medical attention at the first symptoms of GBS.

Patients should also be counseled on responsible behavior to avoid spread of Zika virus via local mosquito vectors. Due to the high incidence of asymptomatic infection, the current CDC recommendations are that all patients wear mosquito repellant for three weeks after return from a Zika-infected area to prevent local transmission, particularly in areas with reported *Aedes* activity.[47]

Chikungunya

Background and Clinical Course

Chikungunya, an alphavirus of the *Togaviridae* family, is a mosquito-spread virus that causes a febrile illness characterized by severe arthralgias.[48,49]

Chikungunya was first isolated in Tanzania in 1953 in a febrile patient. It is named after a word in the local *Makonde* dialect that roughly translates to "that which bends up," referring to the stooped position patients with severe joint pain often develop.[50] For 20 years, it was a rarely reported disease; however, beginning in 2004 large-scale outbreaks were noted to occur throughout Africa and Asia.[51]
The first case of chikungunya in the Western Hemisphere was reported in 2013; by December 2015 it had rapidly spread to 44 countries and territories.[51,52] Studies of these epidemics found a notably high infectivity rate, ranging from 34-45%.[53] In 2014 chikungunya was locally transmitted in the U.S., with 11 cases reported in Florida.[54] (Figure 1)

The clinical presentation of chikungunya is similar to dengue and Zika; however, in contrast to these other diseases, the majority of people infected with chikungunya are symptomatic.[49] After an incubation period ranging from 1-12 days (typically 3-7 days), viremia occurs, and symptoms develop. The fever is typically high grade with a sudden onset. Arthralgia is present in nearly all cases and can be disabling. The pain is typically symmetric, worse in the morning, relieved by mild exercise but worsened by strenuous activity. The most common joints involved are ankles, wrists, and fingers. Migratory polyarthritis with effusions can also occur.[49,55] In about half of patients a maculopapular rash will develop, occasionally with vesiculobullous eruptions and ulcers.

As with the other illnesses discussed here, treatment for chikungunya is supportive. Acetaminophen is preferred for pain and fever control over NSAIDs due to its similarity in presentation with, and possible misdiagnosis of dengue.[49] Admission will rarely be required. During past epidemics, patients with symptoms severe enough to warrant admission typically have comorbid conditions.

Neurologic complications including meningo-encephalitis, seizures, and acute encephalopathy have been reported; such manifestations occur more often in children than adults.[48,56] Vertical transmission of chikungunya has been reported and is associated with a more severe presentation in the neonate.[49]

Challenges for the Emergency Physician: Long-term Complications

Most patients will have resolution of their symptoms in 1-3 weeks. However, chikungunya is unique in that severe arthralgias may persist for months to years. The WHO estimates this cohort to be about 10%,[55] but a study of the Reunion Island epidemic found that more than half of patients reported either recurrent or persistent rheumatic symptoms 15 months after infection. Risk factors for persistent symptoms include age over 45, comorbid conditions (i.e. diabetes, organ failure, immunosuppression), and severity of pain at the onset of symptoms.[57] The mechanism is not well understood, but may be linked to persistent circulating IgM antibodies.[58] Based on radiographic findings of erosive arthritis in joints of patients one year after infection, there is evidence that chikungunya infection may be a precursor to development of rheumatoid arthritis.[59,60] Persistent joint pain from chikungunya infection may respond to NSAIDs and should be the first-line therapy in the absence of contraindications.[49,55] Patients discharged from the ED with suspected chikungunya should be counseled regarding these known complications.

IDENTIFYING AND DIAGNOSING THE UNDIFFERENTIATED PATIENT

A thorough travel history should be obtained in all patients, particularly those presenting with febrile illness. In the ED the diagnosis of dengue, Zika, and chikungunya should all be made on clinical grounds. Given the long turnaround time, serum testing has no role in emergent management. However, given the significant overlap in clinical presentation and vector locations, particularly in the early stages of presentation, consideration of one of these entities should lead to further evaluation of the other two. The CDC, on both clinical and epidemiologic grounds, recommends this approach.[61]

Once malaria has been excluded, it is prudent to assume dengue as the leading differential diagnosis when determining a disposition in a patient who has traveled to an endemic area. Because dengue can progress quickly from a simple viral illness to a life-threatening condition, the search for dengue warning signs should always be considered even when Zika or chikungunya is strongly suspected. In all such patients, acetaminophen is preferred for pain and fever control over NSAIDs given the risk for hemorrhagic complications in dengue.

All patients who are discharged from the ED should be counseled on the potential complications associated with Zika and chikungunya until a definitive diagnosis has been determined.

All three of these entities are considered reportable conditions. Although commercial laboratory testing is available for dengue, Zika and chikungunya, most testing for Zika is currently done only through the CDC or state health departments. We recommend the following testing algorithm (Figure 7). If a patient has travelled to an area endemic for malaria, we strongly recommend malaria testing as well. Other illnesses such as yellow fever, typhoid, leptospirosis, and helminth infections should be considered on an individual basis if indicated by the travel history. Please refer to the CDC website for up-to-date testing recommendations, as guidelines may change due to the shifting nature of this pandemic.

PERSONAL PROTECTION IN ENDEMIC AREAS

The importance of personal protection in endemic areas cannot be emphasized enough, both as an issue to personal safety as well as a public health measure. The CDC currently recommends the use of an Environmental Protection Agency-registered insect repellant such as DEET or picaridin. These agents have been proven to be safe and effective for use in infants over the age of two months, and in pregnant or breast-feeding women. A list of approved agents can be found at https://www.epa.gov/insect-repellents. The treatment of

Emergency department testing	Send out testing
Malaria smear/POC test	Dengue
CBC	Dengue NS1 or PCR
Chem 7	Dengue IGM
LFTs	Chikungunya
PT/PTT	Zika
UA/Hcg	
CXR	

Figure 7. Proposed testing algorithm for the initial evaluation of a patient with suspected arbovirus infection. Depending on the region of travel, malaria and other native pathogens such as typhoid and leptospirosis also should be considered.
POC, point of care; *CBC*, complete blood count; *LFT*s, liver function tests, *PT/PTT*, prothrombin time/partial thromboplastin time; *UA/Hcg*, urinalysis/human chorionic gonadotropin, *CXR*, chest x-ray; *PCR*, polymerase chain reaction

clothing with permetherin is also recommended, and has been shown to be safe and effective.[62] Additional behavioral methods, such as the use of screens and mosquito netting, are also important.

The extent of the progression of the Zika epidemic into the continental U.S. remains uncertain at this time, but increasing globalization has weakened the traditional barriers that once contained diseases within regions. Patients with these novel diseases are likely to present first to the ED. Prompt recognition and treatment of these diseases will lead to both better provisions of care to individual patients, as well as assistance to public health officials with containing these outbreaks.

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Characterization of Chemical Suicides in the United States and Its Adverse Impact on Responders and Bystanders

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Introduction: A suicide trend that involves mixing household chemicals to produce hydrogen sulfide or hydrogen cyanide, commonly referred to as a detergent, hydrogen sulfide, or chemical suicide is a continuing problem in the United States (U.S.). Because there is not one database responsible for tracking chemical suicides, the actual number of incidents in the U.S. is unknown**.** To prevent morbidity and mortality associated with chemical suicides, it is important to characterize the incidents that have occurred in the U.S.

Methods: The author analyzed data from 2011-2013 from state health departments participating in the Agency for Toxic Substances and Disease Registry's National Toxic Substance Incidents Program (NTSIP). NTSIP is a web-based chemical incident surveillance system that tracks the public health consequences (e.g., morbidity, mortality) from acute chemical releases. Reporting sources for NTSIP incidents typically include first responders, hospitals, state environmental agencies, and media outlets. To find chemical suicide incidents in NTSIP's database, the author queried open text fields in the comment, synopsis, and contributing factors variables for potential incidents.

Results: Five of the nine states participating in NTSIP reported a total of 22 chemical suicide incidents or attempted suicides during 2011-2013. These states reported a total of 43 victims: 15 suicide victims who died, seven people who attempted suicide but survived, eight responders, and four employees working at a coroner's office; the remainder were members of the general public. None of the injured responders reported receiving HazMat technician-level training, and none had documented appropriate personal protective equipment.

Conclusion: Chemical suicides produce lethal gases that can pose a threat to responders and bystanders. Describing the characteristics of these incidents can help raise awareness among responders and the public about the dangers of chemical suicides. Along with increased awareness, education is also needed on how to protect themselves. [West J Emerg Med. 2016;17(6)680-83.]

INTRODUCTION

In 2007, Japan documented the first reports of chemical or detergent suicides, and 2,000 such suicides have been reported there since then.[1] Around the same time, incidents of chemical suicide, also known as detergent or hydrogen sulfide suicide, were reported in the United States (U.S.).[2-4] Internet websites provide detailed instructions on how to commit suicide by mixing household chemicals usually to produce hydrogen sulfide or hydrogen cyanide gas in an enclosed space.[1,2] Hydrogen sulfide is a colorless gas that is heavier than air, has a sweetish taste, and smells like rotten eggs.[5] Hydrogen cyanide gas has a faint, bitter almond odor and bitter burning taste.[3] High-level exposure to either chemical could result in immediate death.[3,5]

Because no one database is responsible for tracking chemical suicides in the U.S., the actual number of incidents is unknown. In 2011, using National Vital Statistics System (NVSS) and Google searches, Reedy, Schwartz, and Morgan

found that 30 chemical suicides occurred in the U.S. from 2008-2010.[4] Medical examiners confirmed the chemical suicides found in the NVSS.[4] In 2011, using chemical surveillance systems the Agency for Toxic Substance and Disease Registry (ATSDR) reported 10 chemical suicide incidents; however, this report focused only on incidents that occurred in vehicles.[6] The report also showed that chemical suicides were a threat not only to the person committing suicide, but to responders and innocent bystanders as well. Both reports indicated that their findings were most likely underestimates of the true frequency of chemical suicide incidents.[4,6]

Our report updates ATSDR's chemical suicide data by including three additional years of surveillance data (2011-2013) and other locations where chemical suicide incidents occurred. Through describing the characteristics of these incidents, we hope to raise awareness about potential exposure risks to responders and bystanders from chemical suicides incidents so that recommendations for preventative actions can be made to avoid exposure and exposure-related injuries associated with chemical suicides.

METHODS

This report used data from nine state health departments participating in ATSDR's chemical incident surveillance system, the National Toxic Substance Incidents Program (NTSIP), to determine the frequency of chemical suicides occurring during 2011-2013 (Figure 1). NTSIP is a web-based system that tracks the public health consequences (e.g., morbidity, mortality) from acute chemical releases. Reporting sources for NTSIP incidents typically include first responders, hospitals, state environmental agencies, and media outlets. The type of data NTSIP collects includes but is not limited to time, date, and day of the week event occurs, geographical location, factors contributing to the release, specific information on injured persons (age and sex), and type of personal protective equipment (PPE). For more information about the NTSIP database go to https://www.atsdr.cdc.gov/ntsip/state_partners.html. To identify chemical suicide incidents, open text fields were queried in the NTSIP comment, synopsis, and contributing factors variables for the following terms: *suicide, intentional, inhaled, death, die, kill, detergent*, and *household chemical*. Using SAS, we performed descriptive analyses to describe the chemical suicide incidents and identify the public health impact.

RESULTS

During 2011-2013, participating states reported a total of 9,398 acute chemical releases in the NTSIP database. Five states reported 22 chemical suicides or attempted suicides during 2011-2013 (Figure). Most of these incidents (95.5%, n=21) occurred in enclosed areas (i.e., vehicles, hotel rooms, bathrooms, or other rooms in a house). One incident occurred in a more open space where chemicals were mixed in a parking lot of a hardware store. These 22 chemical suicide incidents affected a total of 43 victims: 15 suicide victims who died, seven people who attempted suicide but survived, eight responders, and four employees at the coroner's office; the remaining nine were members of the general public or unknown victims (Table). The most frequently reported injuries were respiratory irritation, shortness of breath, and headaches. Of the 22 incidents, nine (41%) reported decontamination of victims, either on scene, at the medical facility, or at both locations. Of those nine incidents, one reported decontamination of additional victims but not the suicide victim (Table). None of the injured responders reported being a certified HazMat technician (one who is trained to handle hazardous materials (e.g. chemicals) or wearing appropriate PPE. Seven of the incidents included evacuations (Table). Approximately 54.5% of the incidents resulted in hydrogen sulfide releases, 18.1% resulted in chlorine gas, and none resulted in the release of hydrogen cyanide.

Illustrative Case Reports

New York

In 2013, the police department, the fire department, a HazMat team, local emergency management services, and the coroner's office responded to a chemical suicide that occurred in a private residence where the victim had mixed chemicals to produce hydrogen sulfide gas. Two police officers were exposed at the scene of the incident. The victim's body was transported to the coroner's office where off-gassing occurred and four employees were exposed. The following injuries were reported for exposed coroner employees (who were not at the scene): central nervous system issues, headaches, shortness of breath, and gastrointestinal problems. Responders suffered from central nervous issues, respiratory issues, skin irritation and headaches. Responders did not wear PPE or conduct decontamination procedures.

Tennessee

In 2011, an individual parked outside an outlet store, combined chemicals in a closed car, creating hydrogen sulfide gas. A warning sticker the victim had left on the vehicle alerted responders to a chemical hazard. The local fire department decontaminated the body and scene. No additional injuries were reported involving first responders.

DISCUSSION

Even though chemical suicides accounted for <1% of all incidents reported to NTSIP, they may have serious outcomes. Secondary contamination is a major concern associated with chemical suicides. This report of 22 incidents found an additional 21 people that were injured in addition to the person who committed or attempted to commit suicide by means of chemical release. As the New York case illustrates, if a person's skin or clothes are exposed to hydrogen sulfide, then others who come into contact with that person (bystanders or responders) can experience secondary contamination through off-gassing.[3,5] HazMat training and wearing proper PPE can help prevent

Table. Chemical suicides case characteristics, National Toxic Substance Incidents Program (NTSIP) 2011-2013.

Year	Incident location	Evacuation ordered?	Additional victims?	Victim decontamination location
2011	Vehicle	No	No	Scene
2011	Vehicle	No	No	Scene
2011	Vehicle	No	No	Scene/Medical facility
2011	Vehicle	Yes	Yes;1 emergency medical technician;1 police officer	Unknown*
2011	Vehicle	No	Yes; 2 police officers; 1 member of the general public	Scene (suicide victim was not decontaminated)
2011	Vehicle	No	Yes; 2 members of the general public	Scene/Medical facility
2011	Vehicle	No	No	Medical facility
2011	Vehicle	No	No	Medical facility
2012	Home	No	No	None
2012	Vehicle	No	No	None
2012	Unknown	No	No	Scene
2012	Vehicle	No	Yes; 1 member of the general public	None
2012	Vehicle	No	No	None
2012	Hotel	Yes	No	None
2013	Vehicle	No	Yes; 1 police officer	Unknown*
2013	Vehicle	Yes	No	Scene
2013	Hotel	Yes	No	None
2013	Dormitory room	Yes	Yes; 1 employee emergency responder; 5 unknown	None
2013	Home	Yes	Yes; 4 employees at coroner's office; 2 police officers	None
2013	Hardware store	No	No	Unknown*
2013	Campground	Yes	No	None
2013	Vehicle	No	No	None

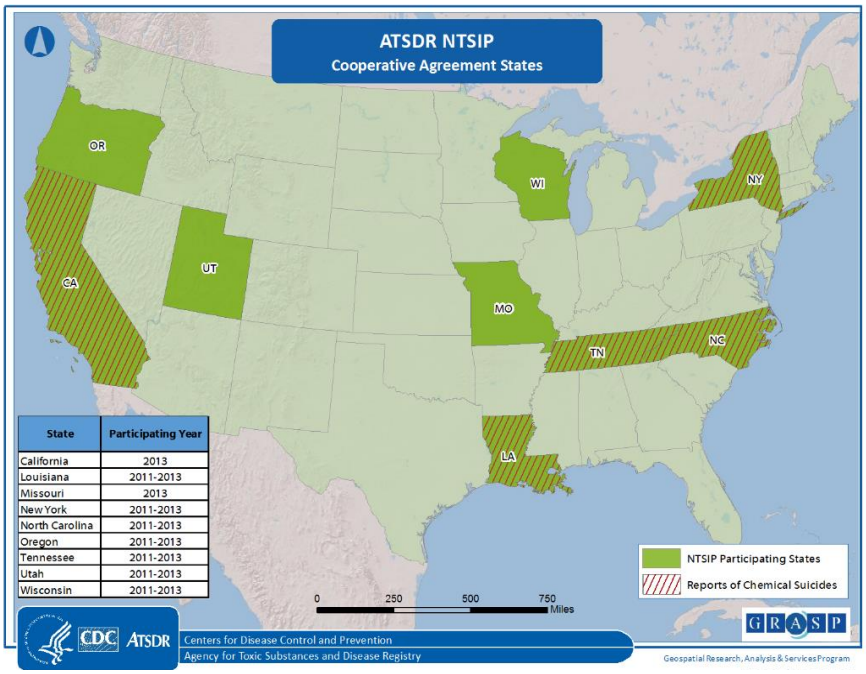

Figure. Participating National Toxic Substance Incidents Program (NTSIP) states and states reporting chemical suicides, NTSIP 2011-2013.

secondary exposure in responders.[7] Data in this report showed that none of the first responders were HazMat technician certified nor did they wear PPE when responding to the incidents. Therefore, training first responders to recognize a chemical suicide attempt and to take proper exposure precautions could reduce injuries associated with such incidents.

Another measure responders could take to prevent secondary exposure due to off-gassing is proper decontamination of the scene, exposed individuals, and corpses.[3,6,8] Rapidly removing contaminated clothing, flushing skin and hair with plain water for two to three minutes, and then washing with mild soap[3] can prevent further injuries for bystanders and responders who have been exposed. Double-bagging contaminated clothing, personal belongings, and corpses [3,6] can also prevent secondary exposure, as can transporting exposed individuals in a well-ventilated vehicle.[6]

Responders must be able to recognize signs that a chemical suicide has taken place so that they do not enter the hazardous environment unprepared. In some incidents, victims placed signs to warn that hazardous substances were on the premises.[6] Responders should survey the surroundings for any other visible signs that suggest a chemical suicide, such as open containers or attempts to seal windows, doors, or vents with tape.[8] Responders who are not certified HazMat technicians should wait to enter the hazardous environment until a certified responder arrives.

LIMITATIONS

The findings in this report are subject to two limitations. First, due to the limited number of states participating in NTSIP, the data might not be generalizable to the entire U.S. Second, the number of chemical suicides reported in this analysis is most likely an underestimate; some suicides may not have been reported or may have been missed through the key word searches.

CONCLUSION

Chemical suicide environments can pose a threat to responders and bystanders. Education is essential to raise awareness among responders and the public about the dangers of chemical suicides. Responders should be trained to recognize chemical suicide scenarios and to follow protocols to decrease exposure risk, including the appropriate use of PPE and decontamination of exposed persons including corpses. Members of the public also need to be able to identify chemical suicide situations and take steps to ensure their personal safety. Additionally, ongoing education and outreach efforts targeted to healthcare providers, public health practitioners, and others may lead to better strategies to recognize and prevent chemical suicide incidents.

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Are Usual and Customary Charges Reasonable?

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An editorial about the use of usual and customary charges for out-of-network benefit determinations. [West J Emerg Med. 2016;17(6)684-85.]

In State legislative offices throughout the country where the issue of out-of-network (OON) physician charges, balance billing, and plan benefits are being debated, the constant refrain from health plan representatives is that usual and customary (U&C) charges are an "unacceptable standard" for OON benefits. Nope, won't consider it, won't even discuss it: U&C charges are "off the table." Aside from the fact that, when one side in a negotiation takes something off the table at the start, it really is no longer a negotiation: is it reasonable to eliminate U&C charges from consideration?

It wasn't that long ago that health plans would allow (pay) a benefit based on the lesser of the physician's full charge or the 70th or 80th percentile of U&C charges based on the Ingenix database. Things changed when the Attorney General (AG) of New York got wind of the fact that health plans were deliberately manipulating the claims data[1] that generated this United Healthcare-owned database in order to cheat enrollees out of hundreds of millions of dollars in benefits for OON services, and sued several plans for this abusive tactic. Suddenly, having been caught with their fingers in the cookie jar, commercial health plans almost universally and simultaneously decided to abandon the U&C charge standard for OON benefits. The AG required several of these plans to fund the development of a new, independent U&C charge database called FAIR Health;[2] but since these plans were limited in their ability to manipulate the new database, most decided to rely on other standards where state regulations allowed. Most of the new standards for OON benefits are either based on a percentage of Medicare rates or on the plan's own highly arbitrary, black-box, "usual, customary and reasonable" rates,[1] all of which are considerably lower than (often less than half of) the 70th percentile of U&C charges. The plans rationalize this new approach in the following ways:

- It is necessary to keep premiums down.
- U&C charges are too high because there is nothing that keeps physicians from overcharging for their services, or consistently raising fees.
- Outlier physician charges distort U&C charge databases.
- It is a way to encourage enrollees to preferentially use in-network physicians.

Let's look at these arguments. Of course, limiting plan benefit payouts might keep premiums down, but so would limiting plan profits; yet profits and premiums have risen in lockstep.[3] Also, there is no evidence that limiting OON benefits has kept premiums from increasing, and in many cases enrollees are not getting the benefits that their premiums are supposed to secure. The argument that there are no economic factors keeping physician charges in check ignores the very real competitive forces that constrain physician charges.[4] Hospitals that contract with physicians for services want their physicians to be sensitive to their market. Physicians who charge high prices and refuse to contract with plans and discount their charges to health plan enrollees will have difficulty filling their offices or surgery schedules unless their skills, reputations, and services are exceptional and in great demand. It is true that outlier charges can distort U&C charge databases when the survey areas are small, or when large, high-charging physician groups dominate in their market; but these impacts can be easily mitigated by expanding the size of survey areas and maximizing the number of claims included. Lastly, as plans shrink the size of their networks to include fewer providers, enrollees may be forced outside of these narrow networks to obtain needed services from the most qualified physicians,[6] and they shouldn't be excessively penalized for doing so. Many narrow networks deliberately avoid contracting with emergency care providers,[1] relying instead on emergency departments and Emergency Medical Treatment and Labor Act (EMTALA) regulations to ensure their enrollees have access to emergency care, forcing these physicians to attempt to get reasonable payment after the fact as OON providers.

The concept behind using a U&C charge database for OON benefits is that these charges reflect the various forces that define

the reasonable market value of these services, including the cost of providing them. A physician who is providing services outside of a health plan network is usually not receiving any of the other considerations from a health plan in return for discounting their services to the plan's enrollees. These considerations might include a large referral base, faster payment, fewer denials of coverage, direct to provider payments, etc. Taking a large sampling of claims from physicians and looking at the range of charges (fees) for these services, then lopping off the highest 20 or 30% of these as "too far above the mean," allows for the identification of a "reasonable range of fees" that reflect the market value of these services. This is why this approach was used by plans in the past to determine what the reasonable benefit should be for OON services. Some plans still do this, but now most plans have decided they need to redefine "reasonable market value" to mean "whatever we think is reasonable."

You could argue that the market for physician services isn't really an open, fair, and competitive market, and you might be right in many areas of the country, but this is why the top 20% or 30% of charges are excluded from the "reasonable" standard for OON benefits. There is nothing logical or reasonable about allowing plans to make this determination independently, especially if physicians are prohibited by law or regulation from seeking to recover more than the amount that the plan "allows" for OON services. If plans want to set fees, they should be forced to go through the equivalent of a public utilities commission process;[8] otherwise they are using the government to steal those services from providers at an unwarranted discount. If anything should be off the table in these negotiations for an OON benefit standard and balance billing legislation, it should be offering plans a license to steal.

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A Call for Better Opioid Prescribing Training and Education

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Pain is the most common complaint in the emergency department (ED), and emergency physicians face unique challenges in making opioid-related treatment decisions. Medical students and residents experience significant variation in the quality of education they receive both about opioid prescribing as well as substance-use detection and intervention in the ED. To achieve a better standard of education, clinical educators will need to (a) develop a clearer understanding of the risk for aberrant opioid prescribing in the ED, (b) recognize prescribing bias and promote uptake of evidence-based opioid prescribing guidelines in their EDs, and (c) advocate for integrated opioid management and addiction medicine training formally into medical school curricula. [West J Emerg Med. 2016;17(6)686-89.]

INTRODUCTION

At the start of training, medical students crave and cherish each patient encounter, are idealistic about the healing power of medicine, and have peak levels of empathy and benevolence.[1] In their preclinical years, they are assessed by examinations that reinforce the principle that there is only one correct answer. Thus, many students enter the wards with the expectation that there is always a "correct answer" to handling difficult clinical situations. In the hospital, they begin to be challenged with complex clinical encounters that do not meet these expectations.[2]

The emergency department (ED), where the incidence of complex social situations is particularly high and providers are expected to make quick decisions with limited information, exposes students to many challenging patient interactions.[3] These interactions are further complicated by the fact that the emergency physician (EP) is expected to understand the episodic ED presentation in isolation, outside of the longitudinal care given by their usual providers. A particularly difficult clinical dilemma that students are likely to face in the ED is how to assess and manage patient analgesia requests that have the potential to result in opioid misuse. After spending some years in the hospital, nearly all residents and attendings become acquainted with the "drug-seeking patient" archetype characterized by a patient presenting with pain or symptoms, with that patient intending to solicit a prescription that will be misused or abused. At relatively more advanced stages of training, residents and attendings have likely developed their own unique approaches to these patient encounters.

For medical students in their early clinical training, this type of patient encounter is new and frustratingly equivocal. Voicing suspicion regarding aberrant medication-seeking behavior based on a patient's medical history, specific requests, or behaviors can be uncomfortable for students, as it can feel like patient profiling and contradict their perceived role as benevolent caretaker. Compounding this discomfort is the very appropriate, overwhelming fear of unnecessarily and wrongly prolonging patient suffering. Conversely, as students develop a more pragmatic impression of medicine and work on building clinical acumen, they recognize the existence of patient dishonesty as a part of opioid addiction and are concerned about the dangers of inappropriate opioid prescribing.

Students have not garnered enough wisdom to feel confident in their assessment of the "legitimacy" of patient analgesia requests, and thus rely on their clinical educators for guidance. However, students often experience greatly varying attending approaches to these patient encounters. EP prescribing behaviors vary along a spectrum, even within a single institution.[4,5] On one end of the spectrum, clinicians demonstrate a "sufferer" outlook toward these patients: giving credence to patients' subjective

pain reports, placing decision-making emphasis on the concern about undertreating pain, and demonstrating a high propensity to prescribe opioids. On the other end of the spectrum, providers will demonstrate a "seeker" outlook: exhibiting mistrust toward patients' self-reported pain and perhaps obtaining imaging to demonstrate lack of musculoskeletal pathology, placing decision-making emphasis on the risk for aberrant opioid use behavior and demonstrating a low propensity to prescribe opioids.

Medical students' varying experiences are not just anecdotal. In a national survey, at least 10% of EPs indicated they were less likely and 10% indicated they were more likely to prescribe opioids when they were presented with identical case scenarios.[6] Moreover, physicians were found to interpret patient behavior and statements like, "I need something strong" differently. Some physicians reported that they would be less likely to prescribe opiates after hearing this statement while others reported they would be more likely.[6]

Pain is subjective, but opioid prescribing decisions do not have to be altogether subjective and idiosyncratic. EPs have the potential to be role models and educators to the next generation of prescribers. While providing effective education on opioid prescribing is a responsibility that should be met by providers in all clinical settings, unique challenges make the ED a particularly difficult setting for making opioid prescribing decisions. In this paper, we advocate that EPs achieve a better standard of education on safe opioid prescribing by (a) developing a clearer understanding of the risk for aberrant opioid prescribing in the ED, (b) recognizing prescribing bias and promoting uptake of evidence-based opioid prescribing guidelines in their EDs, and (c) advocating for earlier integration of opioid management and addiction medicine training formally into medical school curricula.

STRATEGIES FOR STRENGTHENING OPIOID TRAINING

A. Developing a Clearer Understanding of the Risk of Aberrant Opioid Prescribing in the ED

The ED is a setting where prescriptions for short-term opioids are frequently provided. Pain has been found to be the most common patient complaint in the ED with two-thirds of all visits being related to pain.[7] Following a Joint Commission mandate in 2000 that hospitals better monitor and treat pain, rates of prescribing have overall increased, including in the ED where they were found to have nearly doubled over the past decade.[8,9] However, opioid prescribing rates in the ED have decreased in Veterans Affairs settings since 2011.[10] A recent cross-sectional study of 19 EDs estimates that 11.9% of all patients and 17% of discharged patients receive opioid prescriptions.[5]

Opioid prescriptions offered in the ED tend to be aligned with short-term treatment goals. EPs most commonly prescribe immediate-release combinations and are significantly less likely to prescribe high doses or large quantities of opioids, which are more strongly associated with morbid outcomes such as overdoses.[5] But what's the risk for misuse with short-term, low-dose opioids? And what factors are associated with a higher risk of misuse of short-term opioids?

There are few studies available that evaluate opioid use behaviors among patients discharged with opioids from the ED. One study does demonstrate that a percentage of those who are prescribed opioids progress to more frequent use; among patients who presented with low back pain and were prescribed opioids on ED discharge, 46% were still using opioid analgesia three months post-discharge.[11] In another study, 36% of patients who were discharged from the ED with an opioid prescription self-reported medication misuse (defined as either self-escalating dose, use of prescription for a reason beside pain, or obtaining additional prescription opioids without a prescription) at 30-day follow up.[12] In this study, there were no significant differences between opioid misusers and non-misusers with regard to gender, level of pain reported in the ED, amount of analgesia received at discharge, or discharge diagnoses.[13]

As EPs face the challenge of balancing their professional and moral duty to alleviate pain with their efforts to minimize opportunities for abuse of prescription opioids, more prospective studies on the degree to which short-term, low-dose opioid prescriptions lead to addiction are needed. Moreover, prospective studies could help identify risk factors that lead to misuse of or addiction to short-term, low-dose opioid prescriptions.

Findings from prospective studies would help better inform ED providers about the actual risks of different prescribing patterns, potentially leading to more evidence-based prescribing habits. This more robust evidence should then be shared in medical school classrooms to equip students with a clearer understanding of the physician role in the opioid epidemic. Findings would also provide students with evidence-based opioid-misuse screening tools to incorporate into their clinical algorithms for pain management decisions.

B. Recognizing Prescribing Biases and Promoting Uptake of Evidence-based Opioid Prescribing Guidelines in the Emergency Department

EPs should critically assess their individual prescribing patterns to limit individual biases and assess how well they reflect prescribing guidelines. There are multiple biases that impact ED prescribing patterns. ED opioid-prescribing decisions are known to vary by race: White patients who present to the ED are more likely to receive opioid analgesia than any other racial group.[13] Moreover, EPs were found to misidentify men as more likely to engage in aberrant behavior than women and place too much emphasis on patients' suspicious history or pain symptoms when clinical impressions were compared to objective criteria from state prescription drug monitoring programs (PDMPs).[14]

EPs must limit perpetuation of long-standing racial and gender-related biases in clinical treatment to the next generation of opioid prescribers. EPs should reduce implicit

bias by adapting their algorithms to emerging clinical guidelines and using evidence-based tools, including PDMPs to assess the risk of opioid misuse. Though recent studies have shown that PDMPs have not altered the average number of controlled substances prescribed per patient, providers perceived that PDMPs influenced their prescription decisions and felt more confident in their treatment decision after using these resources. [14]

There are many guidelines that have been produced for prescribing opioids for chronic pain, and many of these have been critically evaluated by authorities such as the Centers for Disease Control and Prevention, National Institute on Drug Abuse, and Substance Abuse and Mental Health Services Administration.[14] Some individual states and EP professional organizations have developed guidelines to inform the clinical practice of opioid prescribing. [16,17] Emerging opioid prescription guidelines have not yet been universally adopted by providers. This is likely related to limited awareness of new guidelines, physician uncertainty about the value of these guidelines and time constraints in keeping up with newly emerging recommendations.[19]

Hospital administrators should use strategies such as incorporating reminders and decision algorithms into electronic decision support systems or academic detailing to integrate clinical guidelines into everyday practice.[19] Evidence-based guidelines would reduce inter-provider variability in prescribing practices. Not only would this translate to patients receiving more uniform care experiences, it would help ensure that medical students and trainees receive more consistent, evidence-based training on safe opioid prescribing in the hospital setting. Moreover, by making a concerted effort to ensure that evidence-based guidelines are implemented in the ED, EPs would be setting an example and modeling necessary safer prescribing reform not just for medical students and residents, but also for other types of providers whose prescribing habits are likely contributing to the opioid epidemic.

C. Introducing and Integrating Opioid Management and Addiction Medicine Training Formally into Medical School Curricula

Individual EPs have tremendous potential to improve quality of opioid prescribing education by role-modeling evidenced-based prescribing approaches in the ED. However, education on opioid management should begin early, before medical students enter the wards. Residents have expressed sentiments of under-preparedness in making opioid prescription decisions.[20] These sentiments likely stem from inadequate training in medical school, as medical students experience significant variation in the quality of education they receive on drug abuse detection and intervention.[20] As these students and doctors in training are the next generation of providers inheriting the opioid epidemic, it is critical that clinical educators meet their need for earlier and better training on appropriate opioid prescribing.

The State of Massachusetts is beginning to recognize the need to aim interventions for managing the opioid crises at the roots. Massachusetts was the first state to develop a governmental initiative to reform opioid education for medical students and physicians in training, working with medical schools within the state to provide recommendations for and establish a commitment to medical school curriculum changes that would educate and train medical students on safe prescribing of opioids.[21] Massachusetts medical schools have welcomed the intervention and made reforms to their students' educational aims with one university already developing an educational strategy that will teach students how to identify patients at high risk for opioid misuse, how to treat pain in patients identified to be at high-risk for misuse, and how to manage substance use disorder chronically.[22] The educational strategy will be comprehensive and integrated throughout the four years of medical school with students receiving classroom teaching on the science of addiction. Students will also complete clinical training modules on how to discuss substance use with patients, assess patients' pain and symptoms, and use guidelines to come up with treatment decisions that maximize benefits and minimize harm.[22]

Educational strategies such as these will provide a structured, more evidenced-based foundation for medical students to begin developing their approach to preventing, diagnosing, and treating addiction. By incorporating such education into the formal curriculum, medical schools would be ensuring, rather than leaving to chance, that all students receive consistent, high-quality training on opioid use disorder prevention and treatment. National medical education accrediting bodies should develop similar initiatives to catalyze opioid education reform. As opioid use is a national problem, it is critical that the standard of education on safer opioid prescribing be raised uniformly across the United States.

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Alternative Destination Transport? The Role of Paramedics in Optimal Use of the Emergency Department

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Introduction: Alternative destination transportation by emergency medical services (EMS) is a subject of hot debate between those favoring all patients being evaluated by an emergency physician (EP) and those recognizing the need to reduce emergency department (ED) crowding. This study aimed to determine whether paramedics could accurately assess a patient's acuity level to determine the need to transport to an ED.

Methods: We performed a prospective double-blinded analysis of responses recorded by paramedics and EPs of arriving patients' acuity level in a large Level II trauma center between April 2015 and November 2015. Under-triage was defined as lower acuity assessed by paramedics but higher acuity by EPs. Over-triage was defined as higher acuity assessed by paramedics but lower acuity by EPs. The degree of agreement between the paramedics and EPs' evaluations of patient's acuity level was compared using Chi-square test.

Results: We included a total of 503 patients in the final analysis. For paramedics, 251 (49.9%) patients were assessed to be emergent, 178 (35.4%) assessed as urgent, and 74 (14.7%) assessed as non-emergent/non-urgent. In comparison, the EPs assessed 296 (58.9%) patients as emergent, 148 (29.4%) assessed as urgent, and 59 (11.7%) assessed as non-emergent/non-urgent. Paramedics agreed with EPs regarding the acuity level assessment on 71.8% of the cases. The overall under- and over-triage were 19.3% and 8.9%, respectively. A moderate Kappa=0.5174 indicated moderate inter-rater agreement between paramedics' and EPs' assessment on the same cohort of patients.

Conclusion: There is a significant difference in paramedic and physician assessment of patients into emergent, urgent, or non-emergent/non-urgent categories. The field triage of a patient to an alternative destination by paramedics under their current scope of practice and training cannot be supported. [West J Emerg Med. 2016;17(6)690-97.]

INTRODUCTION

Expanding the role of emergency medical services (EMS) has become an emerging topic of conversation given the need to expand local access to healthcare resources

for communities and their residents. It is estimated that in 2011, national emergency department (ED) visits totaled 131 million, or 421 ED visits per 1,000 population.[1] The total number of these ED visits that could be considered non-urgent has been difficult to determine, with numbers ranging from 4.8% to 90% of visits.[2] The criteria used to determine non-urgency of a patient presentation have proven difficult to establish with multiple reports using different definitions.

California Health and Safety Code Division 2.5, section 1797.52, requires that all patients who call 911 be taken to an acute hospital with a basic or comprehensive ED to receive further evaluation by medical staff.[3] However, it has been proposed that some 911 calls for low-acuity conditions could potentially be diverted to non-ED settings such as urgent care clinics or primary care offices, possibly reducing the crowding and long wait time seen in many EDs and, as a result, reduce the cost of healthcare.[4]

In July 2013, a report published by the Institute for Population Health Improvement, University of California Davis Health Systems underlined possible changes to the current California EMS system. Included in this report was the proposal that patients with specified conditions not needing emergency care could be transported to non-ED locations or alternative destination transport. The alternative destination locations listed included mental health facilities, urgent care clinics or primary care offices.[4] Multiple published national reports estimate that 11% to 61% of ambulance transports may not require immediate care in the ED.[5] Based on this report, the Emergency Medical Services Authority (EMSA) has initiated pilot programs in California to study the feasibility of alternative transportation. As of 2016, four pilot programs have been approved to study alternative transportation destinations in California.[6,7]

In those circumstances where EMS providers encounter patients who do not need advanced life support (ALS) level of care or evaluation at an ED, transportation to an alternative destination may be more cost effective. EMS systems with proper resources along with close medical oversight may be good candidates for implementation of such a program. However, the majority of research in this area has concluded that there is currently insufficient evidence to support widespread implementation of non-transport and alternative destination protocols.[5,8,9]

This pilot study aims to assess the accuracy of the paramedic's assessment of a patient's acuity level and identify areas of improvement in prehospital patient care. In addition, the findings from this pilot study could be used to address any deficiencies in paramedic training, which in turn could strengthen the programs for alternative transport destinations.

METHODS

Study Design and Setting and Selection of Participants

This is a prospective double-blinded study analyzing the responses recorded by paramedics versus licensed emergency physicians (EP) of patients transported to Arrowhead Regional Medical Center (ARMC) by licensed paramedics with Rialto Fire Department (RFD) between April 2015 and November 2015. RFD's California state-licensed paramedics serve a population of 101,109 in a 22.37 square mile urban setting located in San Bernardino County, the largest county in the United States. RFD responded to 7,617 calls for medical assistance in 2015. The RFD has 45 paramedics trained to provide ALS, including administering medications, establishing vascular access, advanced airway placement, cardiac rhythm interpretation and defibrillation. During the study period, RFD ambulances transported 1,720 patients to ARMC, of which 505 were randomly selected for this study.

ARMC is a 456-bed acute care hospital in Colton, California. ARMC is the only American College of Surgeons-verified Level II trauma center serving San Bernardino County.[10] ARMC ED is the second busiest in California and has an annual volume of more than 116,000 visits.[10] Additionally, more than 12 ground and air providers transport patients to ARMC. These providers operate within the 20,000 square miles of San Bernardino County and provide coverage for a mix of urban and rural communities with a total population of over 2.1 million.[11,12]

The EPs responsible for collecting data were board-certified in emergency medicine or senior level emergency medicine residents with completion of three or more years of training. The institutional review board of ARMC approved this study.

Data Collection and Processing

We calculated the degree of agreement between the paramedics' and EPs' evaluation of emergent, urgent, and non-emergent/urgent patient presentations transported by paramedics. Emergent conditions were defined as requiring immediate attention with threat of life. Urgent conditions were defined as requiring immediate attention without threat of life that could go to a non-ED facility. Lastly, non-emergent/non-urgent was defined as patients not requiring transportation.

The primary outcome was agreement on the acuity level assessed by paramedics and EPs, respectively. Agreement was defined as the same acuity level being assessed by paramedics and EPs. Under-triage was defined as a lower acuity assessed by paramedics but a higher acuity by EPs. Over-triage was defined as a higher acuity assessed by paramedics but a lower acuity by EPs. To decrease the variability of the outcome, this study was limited to one group of paramedics with similar education, regulatory oversight, and medical supervision. Furthermore, the geographic region and population sampling was also limited to one particular area.

Upon evaluation of each patient in the field, RFD

paramedics completed an evaluation form (Figure 1) indicating the chief complaint of the patient being transported, the body system affected, and the decision as to whether there was an emergent/urgent versus non-emergent/non-urgent condition. Each form was then placed in a sealed envelope and handed to the receiving EPs along with a corresponding blank evaluation form (Figure 2). The receiving EP would then complete the form immediately after physical evaluation and place both surveys in a large sealed envelope. The receiving EP had no knowledge of the responses recorded by RFD paramedics.

Statistical Analysis

We conducted all statistical analyses using the SAS software for Windows version 9.3 (Cary, NC). Descriptive statistics were presented as frequencies and proportions for categorical variable. We performed a crosstab analysis to assess the inter-rater reliability (Kappa statistic) between paramedics' and EPs' assessment on patients' conditions. All statistical analyses were two-sided. We considered p-value <0.05 to be statistically significant.

RESULTS

A total of 505 patients transported by EMS had surveys completed by both a paramedic and an EP who evaluated their acuity level and presenting chief complaint with the corresponding body system affected. Two surveys were excluded due to missing acuity evaluations by paramedics, which led to a final sample size of 503. Among these 503 patients, 251 (49.9%) were assessed to be emergent, 178 (35.4%) assessed as urgent, and the other 74 (14.7%) assessed as non-emergent/non-urgent by paramedics (Table 1). In comparison, the EPs assessed 296 (58.9%) patients as emergent, 148 (29.4%) as urgent, and 59 (11.7%) as non-emergent/non-urgent. Paramedics agreed with the EP regarding the acuity level assessment on 71.8% of the patient cohort. The overall under- and over-triage were 19.3% and 8.9%, respectively. There is a statistically significant difference between paramedics' and EP's assessment on patient's acuity level (p<0.0001, Table 1).

We conducted a crosstab analysis to identify the inter-rater agreement between paramedics' and the EPs' assessment on the same cohort of patients (Table 1). The inter-rater Kappa statistics was 0.5174, which indicated moderate inter-rater agreement between paramedics' and EPs' assessment on the same cohort of patients (n=503).

We conducted three subgroup analyses to identify the discrepancy between paramedics' and EPs' evaluation on patients' acuity level. The first subgroup analysis is considered as "over-triage," in which paramedics evaluated patients at a higher acuity level but the EPs' evaluations of the same cohort of patients were at a lower acuity level (Table 2). The four systems most frequently over-triaged by the paramedics were neurological (n=10, 22.2%), musculoskeletal (n=8, 17.8%), cardiovascular (n=6, 13.3%), and gastrointestinal (n=5, 11.1%).

The second subgroup analysis was considered as under-triage, in which paramedics evaluated patients as lower acuity level but EPs evaluated the same cohort of patients as a higher acuity level (Table 3). The four systems most frequently under-triaged by paramedics included musculoskeletal (n=25, 25.8%), gastrointestinal (n=20, 20.6%), neurological (n=14, 14.4%), and cardiovascular (n=13, n=13.4%).

The third and last subgroup analysis was considered as correct triage, where paramedics and EPs made the same assessment on the patient's acuity (Table 4). The top four most frequently correct triaged systems assessed by paramedics were neurological (n=73, 20.2%), musculoskeletal (n=68, 18.8%), cardiovascular (n=59, n=16.3%), and gastrointestinal (n=54, 15%).

DISCUSSION

The study aimed to determine the level of agreement between paramedics and EPs in their evaluation of the acuity of the patient and the physiological systems involved. Paramedics agreed with EPs on 71.8% of the patient cohort regarding the assessment of the acuity level. The overall over-triage rate was 8.9% and the under-triage

Table 1. Comparison of acuity assessment by emergency physicians and paramedics.

	EP assessment emergent	EP assessment urgent	EP assessment non-emergent/non-urgent	Column total	P-value
Paramedics assessment emergent	224 (89.2%)	25 (10%)	2 (0.8%)	251	<0.0001
Paramedics assessment urgent	62 (34.8%)	98 (55.1%)	18 (10.1%)	178	
Paramedics assessment non-emergent/non-urgent	10 (13.5%)	25 (33.8%)	39 (52.7%)	74	
Row total	296	148	59	503	

EP, emergency physician.
Overall agreement between paramedics' and EPs' assessment on patients' acuity level was 71.8% (224+98+39= 361 of 503, 71.8%).
Overall over-triage between paramedics' and EPs' assessment on patients' acuity level was 8.9% (25+2+18= 45 of 503, 8.9%).
Overall under-triage between paramedics' and EPs' assessment on patients' acuity level was 19.3% (62+10+25= 97 of 503, 19.3%).
**inter-rater Kappa=0.5174 between paramedics' and EPs' assessment on the same cohort of patients (n=503)

ARMC and Paramedic Fire Survey

Completed by **Licensed EMT-Paramedic ONLY**

Date: _____

Chief Complaint: _____

System: (check ONE or MORE if necessary)

- ☐ Allergic/Immunologic
- ☐ Cardiovascular
- ☐ Dermatological
- ☐ Endocrine
- ☐ Gastrointestinal
- ☐ Genitourinary
- ☐ HEENT
- ☐ Musculoskeletal
- ☐ Neurological
- ☐ Psychiatric
- ☐ Respiratory
- ☐ Toxicological

Additional Comments: _____

_____

Emergent or Urgent Complaint (check ONE):

- ☐ **Emergent**: Requires immediate attention and life is at risk
- ☐ **Urgent**: Requires immediate attention and life is NOT at risk, patient could go to NON-ED facility
- ☐ **Non-Emergent/Non-Urgent**: Does not require transport to hospital

Thank you for your participation. Please place completed survey in the provided envelope and keep with patient's chart.

Figure 1. Evaluation form used by paramedics to assess patient acuity.

ARMC and Paramedic Fire Survey

Completed by **Senior Resident (PGY-3, 4) or**

Attending Physician ONLY

Date: _____

Chief Complaint:

_____

System: (check ONE or MORE if necessary)

- ☐ Allergic/Immunologic
- ☐ Cardiovascular
- ☐ Dermatological
- ☐ Endocrine
- ☐ Gastrointestinal
- ☐ Genitourinary
- ☐ HEENT
- ☐ Musculoskeletal
- ☐ Neurological
- ☐ Psychiatric
- ☐ Respiratory
- ☐ Toxicological

Additional Comments: _____

_____

Emergent or Urgent Complaint (check ONE):

- ☐ **Emergent**: Requires immediate attention and life is at risk
- ☐ **Urgent**: Requires immediate attention and life is NOT at risk, patient could go to NON-ED facility
- ☐ **Non-Emergent/Non-Urgent**: Does not require transport to hospital

Thank you for your participation. Please place completed surveys in the provided envelope and place in the designated collecting box in the MICN or Resident's Lounge.

Figure 2. The Evaluation Form-Emergency Medicine provider

Table 2. Cases of over-triage* between paramedics' and emergency physician's assessment of patient's acuity level.

EMS system	Frequency (N=45)	Percent
Neurological	10	22.2%
Musculoskeletal	8	17.8%
Cardiovascular	6	13.3%
Gastrointestinal	5	11.1%
Psychiatric	4	8.9%
Toxicological	4	8.9%
Endocrine	3	6.7%
Allergic/immunologic	2	4.4%
Respiratory	2	4.4%
HEENT	1	2.2%

*Over-triage was defined as higher acuity assessed by paramedics but lower acuity by emergency physician.
EMS, emergency medical services; *HEENT,* head eyes ears neck throat

Table 3. Cases of under-triage* between paramedics' and EP's assessment of patient's acuity level.

EMS system	Frequency (N=97)	Percent
Musculoskeletal	25	25.8%
Gastrointestinal	20	20.6%
Neurological	14	14.4%
Cardiovascular	13	13.4%
Respiratory	7	7.2%
Endocrine	6	6.2%
Psychiatric	5	5.2%
Toxicological	4	4.1%
Allergic/immunologic	2	2.1%
Dermatological	1	1%

*Under-triage was defined as lower acuity assessed by paramedics but higher acuity by ED physician.
EP, emergency physician; *EMS,* emergency medical services

Table 4. Cases of agreement* between paramedic's and emergency physician's assessments of patient's acuity level

EMS system	Frequency (N=361)	Percent
Neurological	73	20.2%
Musculoskeletal	68	18.8%
Cardiovascular	59	16.3%
Gastrointestinal	54	15%
Respiratory	30	8.3%
Toxicological	24	6.7%
Endocrine	20	5.5%
Psychiatric	19	5.3%
Dermatological	6	1.7%
Allergic/immunologic	5	1.4%
HEENT	3	0.8%

*Agreement was defined as same acuity assessed by paramedics and emergency physician.
EMS, emergency medical services; *HEENT,* head eyes ears neck throat

rate was 19.3%. There is significant difference in paramedic and physician classification of the alternative destination for emergency evaluation. Based on this pilot study, there is room for improvement in evaluation of those urgent and non-emergent/non-urgent patients as assessed by paramedics.

Morganti et al explored the topic of expanding the range of EMS transport options and the difficulties posed by such a change in current policy.[5] This included the question of whether EMS providers can accurately identify patients who can be safely managed in a non-ED setting. Of special concern was the under-triaging of patients seeking access to emergency medical care. The reported under-triage rate in the current study was 19.3%, which was consistent with previous findings by Morganti et al, where they reported a wide range of rates (3% to 32%) of EMS personnel failing to recognize the severity of patients' problems.[5] This current study contributes to the literature by listing the four most frequently under-triaged systems by paramedics.

It is our goal to use the data from this pilot study to attempt to institute further training for paramedics to distinguish potentially emergent conditions from the urgent or non-emergent/non-urgent to prevent under-triaging. For example, this may include decision rules depending on patient's chief complaint, medical history, and age, which paramedics could use prior to labeling a patient as not requiring emergency room care.

However, many issues must be addressed to ensure the quality of alternative transportation and destination programs with patient safety as the upmost priority. EMS programs need to ensure implementation of continuous quality improvement of policies and procedures. One of the most essential steps is to develop educational programs for EMS personnel, physicians, and the community that encourage teamwork and improve compliance with established emergency medical dispatch criteria, particularly among the four systems most frequently associated with the 8.9% over-triage and 19.3% under-triage rate. Furthermore, any future studies and educational programs must ensure that alternative transportation and destination decisions are consistent with medical necessity and with consideration for patient preference and when the patient's condition allows. This may call for more oversight and supervision of paramedics if alternative destination becomes a reality. EP supervision could be also implemented

by using new technologies such as telemedicine.

A reduction in the use of EDs for non-emergency conditions, a practice that has often been suggested as contributing to the rising costs of healthcare, will ultimately require a multi-disciplinary approach. Diverse demographic and socioeconomic characteristics influence patients who contact 911 for ambulance transport, including a patient's perception of his own acuity level and of how quickly an urgent care or primary care physician could address his complaint.[1,5,13,14] Ultimately, the ED is a safety net for patients, especially for those without a primary care physician or patients with chronic medical problems who require treatments best addressed in the ED.[1] Many proposed solutions have been discussed that could potentially avoid crowding and over-utilization of the ED. Part of the solution will require the involvement of case management, individualized care plans and information sharing.[8,14,15]

Telemedicine services may also offer opportunities for supporting patient management in prehospital care. With the introduction of smartphones over the past decade, telemedicine services have grown in the U.S. and many hospitals have implemented their use.. The ability to interact remotely with patients and EMS personnel is applicable in many ED settings. Because this method of communication provides instant, high-quality medical consultation, the result is an improvement in prehospital patient care. It is well recognized within the medical community, including professional emergency medicine organizations, that scientifically supported introduction of telemedicine services may improve quality of care. Adoption of this technology, however, has been slow and in some cases impeded by resistance from some state licensing boards and the reluctance of some private and government payers to reimburse for such services.[16-18]

Lastly, legislators will also have to support appropriate compensation for EMS systems based on patient evaluation and treatment as well as on alternative destination transport. Currently, the Centers for Medicare & Medicaid Services (CMS) only reimburses transport that is both "reasonable" and "medically necessary," with the majority of Medicare-reimbursed ambulance calls involving transport to the ED.[5] Additionally, payment for 911 service EMS ground transport is tied to level of service (BLS versus ALS), with private insurances following the lead on reimbursements made by CMS.[5]

LIMITATIONS

This pilot study was subject to a few limitations that could potentially alter the outcome of our findings. We attempted to design a system that would allow EMS providers to make their evaluations without physician influence by having paramedics complete their forms prior to arrival to the ED. However, the current study does not take into account the influence on paramedics by the base station's contact with a mobile intensive care nurse and/or EP. Even if prehospital influence from base contact were removed, there were instances when paramedics were unable to complete their forms prior to arrival due to patient acuity, shorter travel times, and need for patient treatments and interventions. The result was that paramedics may have filled out the forms after being directed by a nurse or physician to a specific area of the ED based on acuity. This initial evaluation by a nurse or physician would likely influence (bias) the paramedic's evaluation of the patient.

Additionally, although EPs were directed to complete their evaluation forms after their own initial evaluation of the patient, many factors could alter their determination of acuity. The EP's evaluation could have been influenced by the paramedic's report and potential differential diagnoses offered, as well as by treatments administered (which may or may not have been necessary). The paramedic's framing of his patient encounter could also have influenced the EP.

Other factors that could have caused a discrepancy between paramedics and EP evaluation include changing chief complaints by the patients and evolving symptoms/signs. Clearly if a patient presents early on with minor symptoms in the field, a paramedic may determine a patient did not need emergent evaluation. However, during the transportation and waiting in the ED for a bed, the patient's condition might evolve into a more serious condition. By the time the patient is evaluated by a physician, the acuity status and/or chief complaint could drastically change through no fault of the paramedic or his/her training. Language barriers between the patients and paramedics may have also contributed to discrepancies between the acuity level evaluations. EPs have access to translation services that paramedics do not, which allows for additional information gathered on the patient's chief complaint and medical history.

There is also the question of the difference in the definitions for acuity used by physicians and paramedics. While we attempted to use the same language for emergent, urgent and non-emergent/non-urgent by including these definitions on the surveys, either the physician or paramedic could have relied soley on experience when treating a patient presenting with a seemingly benign complaint that then resulted in a critical diagnosis made by the EP. Unfortunately, given that the paramedics' job duties limit them to stabilizing and transporting patients to the ED for further evaluation, there is little opportunity for them to learn whether the patients ended up going home without any diagnostic testing or if their condition further deteriorated in the ED.

Lastly, although paramedics and physicians may have disagreed on their initial evaluations of patients, this may not have correlated with actual patient outcomes. No patient identifiers were included on either form completed by paramedics and physicians. This prevented tracking of a patient's hospital course, admission versus discharge, and overall determination of the actual etiology and acuity of the patient's chief complaint.

CONCLUSION

This pilot study demonstrates that there is a significant difference in paramedics' and physicians' assessment of patients into emergent, urgent, or non-emergent/non-urgent categories. Targeted education on field triage, strict protocols, direct supervision with medical monitors and utilization of telemedicine may improve EMS providers' triage diagnostic ability. Additionally, supervision by emergency physicians using new technologies, such as telemedicine, and a resolution to the isstue of lack of language translation services in the field may also improve paramedics' triage of patients .

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Utility of Chest Radiography in Emergency Department Patients Presenting with Syncope

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Introduction: Syncope has myriad etiologies, ranging from benign to immediately life threatening. This frequently leads to over testing. Chest radiographs (CXR) are among these commonly performed tests despite their uncertain diagnostic yield. The objective is to study the distribution of normal and abnormal chest radiographs in patients presenting with syncope, stratified by those who did or did not have an adverse event at 30 days.

Methods: We performed a post-hoc analysis of a prospective cohort of consecutive patients presenting to an urban tertiary care academic medical center with a chief complaint of syncope from 2003-2006. The frequency and findings for each CXR were reviewed, as well as emergency department and hospital discharge diagnoses, and 30-day outcome.

Results: There were 575 total subjects, 39.7% were male, and the mean age was 57.2 (SD 24.6). Of the 575 subjects, 403 (70.1%) had CXRs performed, and 116 (20.2%) had an adverse event after their syncope. Of the 116 people who had an adverse event, 15 (12.9%) had a positive CXR, 81 (69.8%) had a normal CXR, and 20 (17.2%) did not have a CXR as part of the initial evaluation. Among the 459 people who did not have an adverse event, 3 (0.7%) had a positive CXR, 304 (66.2%) had a normal CXR, and 152 (33.1%) did not have a CXR performed. Fifteen of the 18 patients (83.4%) with an abnormal CXR had an adverse event. Eighty-one of the 385 patients (21.0%) with a normal CXR had an adverse event. Among those who had a CXR performed, an abnormal CXR was associated with increased odds of adverse event (OR: 18.77 (95% CI= [5.3-66.4])).

Conclusion: Syncope patients with abnormal CXRs are likely to experience an adverse event, though the majority of CXRs performed in the work up of syncope are normal. [West J Emerg Med. 2016;17(6)698-701.]

INTRODUCTION

Syncope is a common symptom of what is most often a benign disease process, but it may be a marker for a life-threatening illness. Syncope accounts for 740,000 emergency department (ED) visits per year, an estimated 3% of all ED patient visits, of whom 32% get admitted to the hospital. Similarly, up to 50% of patients presenting to the ED with syncope are discharged home from the hospital without an identifying etiology.[1-3] This lack of diagnostic certainty often leads to over testing. Chest radiographs are among these commonly performed tests despite their uncertain diagnostic yield.

The workup for syncope is often confused with the work up of patients with chest pain or myocardial

ischemia. Yet, syncope is rarely associated with myocardial ischemia.[4-6] Prior studies have shown that other tests routinely used to evaluate ischemic etiologies of syncope, such as cardiac enzyme testing in syncope, are useful only in patients with concomitant signs and symptoms of cardiac ischemia or an electrocardiogram (EKG) suggestive of a ischemic etiology.[4-6] Similarly, the utility of other cardiac testing in syncope such as echocardiography may be limited to those patients with an audible murmur, a history of valvular disease, or CXR or EKG suggestive of cardiomyopathy.[6] CXR, routinely obtained in most standard cardiac "rule out" protocols as well, has unclear utility in assessing syncope for worrisome etiologies. As such, the objective of this study is to examine the frequency of abnormal CXRs, and begin to determine if CXRs have any diagnostic value.

METHODS

Study Design and Setting

This is a secondary analysis of a prospective, observational, cohort study conducted in an urban teaching hospital with an annual ED census of 55,000 as part of the original Boston Syncope Criteria study. Syncope was defined as a sudden and transient (<5 minutes) loss of consciousness, producing a brief period of unresponsiveness and a loss of postural tone, ultimately resulting in spontaneous recovery requiring no resuscitation measures. More extensive details have been reported elsewhere.[6-7] From September 2003 to June 2006 we studied consecutive patients presenting to the ED with syncope. Institutional review board approval was obtained prior to initiation of the study.

Selection of Participants

Inclusion criteria included patients aged 18 years or older who met our definition of syncope.

Exclusion criteria were persistent altered mental status, alcohol- or illicit drug-related loss of consciousness, seizure, coma, hypoglycemia, transient loss of consciousness caused by head trauma, or near syncope. We excluded patients with near syncope, including all patients without transient loss of consciousness, due to a lack of consensus regarding the definition of this entity.

Interventions

This study was observational; thus, the treating physicians were not directed to perform specific tests or work up. CXRs were ordered solely at the discretion of the treating physicians. All treatment decisions, including the necessity of a CXR, as well as the decision to admit the patient or not was at the sole discretion of the treating physician. An abnormal CXR was defined as a radiograph with findings consistent with congestive heart failure (CHF), pneumonia or pleural effusion.

Outcome Measures

The primary outcome was the distribution of abnormal CXRs by serious adverse event. Serious adverse events were defined as death, pulmonary embolus, stroke, severe infection/sepsis, ventricular dysrhythmia, atrial dysrhythmia (including SVT [supraventricular tachycardia] and atrial fibrillation with rapid ventricular response), intracranial bleed, myocardial infarction pacemaker/implantable cardiac defibrillator placement, percutaneous coronary intervention, or surgery, blood transfusion, cardiac arrest, alteration in antidysrhythmic therapy, endoscopy with intervention, or correction of carotid stenosis. Follow up was conducted at 30 days via telephone call and medical records review. In addition to review of in-hospital and post-discharge medical records, patients were queried as to whether they had additional testing following discharge to help avoid missing results of testing done outside of our institution. Findings were considered positive if based on the discharge summary the CXR was suggestive of the etiology of the patient's syncope or contributed to an adverse event during the patient's care.

Data Collection and Processing

A trained research assistant available 16 hours per day prospectively screened patients with complaints of syncope or loss of consciousness and reviewed daily patient logs to ensure completion of documentation and to identify missed off-hour patients. Patients were identified in the ED either by research assistants or by the physician caring for that patient, although the attending physician made the final decision of whether the patient met enrollment criteria. The treating physician obtained informed consent and enrolled the patient. Approximately 50% of questionnaires were completed on initial ED evaluation, with the remainder completed shortly afterward. A study investigator or trained research assistant carried out follow-up phone calls with a structured follow-up form and medical record review at 30 days after initial presentation to the ED to determine whether they had a further testing either in hospital or after discharge.

All enrolled patients had at least one episode of syncope meeting the above definition to be eligible for enrollment. All adverse outcomes or clinical interventions, such as CPR, stroke, or cardiac arrest were noted after spontaneous recovery from the initial syncopal episodes. Outcomes were determined by inpatient diagnosis, 30-day follow-up phone call, and subsequent medical records review.

Primary Data Analysis

We queried the acquired dataset for patients who did or did not receive a CXR as part of their evaluation, as

well as for whether they suffered a 30-day adverse event. Standard numerical analysis was used for reporting means and standard deviations.

RESULTS

There were 575 people in the cohort, of whom 39.65% were male, the mean age was 57.2 (SD 24.6), and 172 (29.9%) did not have a CXR performed at all (Table 1).

Out of the 575 subjects, 403 (70.1%) had a CXR performed, and 116 (20.2%) had an adverse event after their syncope. Of the 403 people who had CXR performed, 18 (4.5%) radiographs had abnormal findings. Among the 116 people who had adverse events, 20 (17.2%) did not have a CXR done, 81 (69.8%) had a normal CXR, and 15 (12.9%) had an abnormal CXR. Among the 459 people who did not have an adverse event, 152 (33.1%) did not have a CXR performed, 304 (66.2%) had a normal CXR, and 3 (0.7%) had an abnormal CXR. In the group of 15 that had an abnormal CXR and had an adverse event, 8 (53.3%) had CHF, 4 (26.7%) had pneumonia, 2 (13.3%) had CHF as well as pneumonia, and 1 (6.7%) had an effusion. See Table 2. Further hypothesis testing using standard frequentist approaches would be difficult to interpret given the low event rate, particularly in the setting of the study's limitations.

DISCUSSION

The costs related to syncope-related hospital admissions total over $2 billion per year in the United States, and a large portion of these costs are directly related to diagnostic testing.[1-3] Mendu and others found the yield for testing in syncope to be under 5%, with the exception of orthostatic blood pressure measurements.[8] Whether diagnostic tests, such as chest radiographs, have a similar lack of utility among ED patients with syncope remains unclear.

Abnormal CXRs were observed in 18 of the 575 patients (3.1% overall, or 4.6% of those who had a CXR done), and 385 of the 575 patients (67.0% overall, or 95.5% of those who had a CXR done.) Patients with an abnormal CXR were much more likely to have an adverse event than not (83.4% [60.0%-95.0%] vs. 16.7% [5.0% - 40.1%]), and were at increased odds of having an adverse event compared to the group that had a normal CXR (OR [18.77], 95% CI [5.3-66.4], $p<0.01$) by Fisher's exact test. All of the abnormal findings were from congestive heart failure, pneumonia, a combination of the two, or pleural effusion (Table 2). The majority of patients, however, either did not have a CXR performed (172/575, 29.9%) or had a normal CXR (385/575, 70.0%). In the subgroup of

Table 1. Distribution of CXR performance and whether the patient experienced an adverse event, as well as row and columns percents, with 95% confidence intervals.

	CXR Not performed	CXR normal	CXR abnormal	
No adverse event	152	304	3	459
	(33.1% [29.0% - 37.6%])	(66.2% [61.8 - 70.4%])	(0.7% [0.13% - 2%])	
	(88.3% [82.7% - 92.4%])	(79.0% [74.5% - 83.0%])	(16.7% [5.0% - 40.1%])	
Adverse event	20	81	15	116
	(17.2% [11.4% - 25.2%])	(69.8% [61.0% - 77.5%])	(13.0% [7.9% - 20.4%])	
	(11.6% [7.6% - 17.4%])	(21.0% [17.3% - 25.4%])	(83.4% [60.0% - 95.0%])	
	172	385	18	575

CXR, chest radiograph.

Table 2. Counts of abnormal CXR findings stratified by adverse event outcome, with row and column percentages with 95% confidence intervals.

	CHF	Pneumonia	CHF & pneumonia	Effusion	
No adverse event	1	2	0	0	3
	(33.3% [5.6% - 80.0%])	(67.7% [20.2% - 94.4%])	(0% [0% - 61.8%])	(0% [0% - 61.8%])	
	(11.11% [0% - 45.7%])	(33.3% [9.3% - 70.4%])	(0% [0% - 71.0%])	(0% [0% - 83.3%])	
Adverse event	8	4	2	1	15
	(53.3% [20.1% - 75.2%])	(26.7% [10.5% - 52.4%])	(13.3% [2.5% - 39.1%])	(6.7% [0% - 32.0%])	
	(88.9% [54.3% - 100%])	(66.7% [30.0% - 90.8%])	(100% [29.0% - 100%])	(100% [16.8% - 100%])	
	9	6	2	1	18

CXR, chest radiograph. *CHF,* congestive heart failure.

patients who ultimately had a 30-day adverse event, most CXRs were normal. The patients who did not have a CXR performed appear to be much different than the patients who did have a CXR performed, demonstrated in Table 1, which reflects discretionary physician ordering. But this research is a reflection of clinical practice; when emergency physicians elect to order CXRs, an abnormal CXR is associated with an adverse event. This suggests some modest utility in the CXR in the work up of syncope. An abnormal finding on CXR should inform clinical decision-making as those patients are likely to have an adverse event. We therefore encourage the judicious use of CXRs in the proper clinical scenario.

LIMITATIONS

There are a number of limitations to this study. The discretionary performance of CXRs is a limitation that certainly introduces bias. Table 1 demonstrates that patients who did not have a CXR performed were much less likely to have an adverse event compared to the groups that had a normal CXR, as well as abnormal CXR. But at the same time the discretionary ordering reflects actual clinical practice. It seems unrealistic if not unethical to mandate diagnostic studies with ionization radiation for patients for whom the treating team does not think it justifiable or potentially helpful. Other limitations include the use of a single institution for a test site, which may limit the generalizability of the conclusions of this study. Furthermore, the sample size of this cohort is relatively small, as was the abnormal CXR rate, and there was a lack of long-term follow up in these patients.

CONCLUSION

In ED patients with syncope, chest radiographs have modest diagnostic utility when ordered with discretion. Though the majority of patients who had an adverse event had a normal CXR, patients who had an abnormal CXR were at increased risk for an adverse event. When used in proper clinical context, there may be some information gained by performing a CXR in patients with syncope. A prospective study is needed to validate this conclusion. We recommend the judicious use of CXRs in the correct clinical setting.

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Variation of Blunt Traumatic Injury with Age in Older Adults: Statewide Analysis 2011-14

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Introduction: Traumatic injury is a leading cause of death and disability in adults ≥ 65 years old, but there are few epidemiological studies addressing this issue. The aim of this study was to assess how characteristics of blunt traumatic injuries in adults ≥ 65 vary by age.

Methods: Using data from the a single-state trauma registry, this retrospective cohort study examined injured patients ≥ 65 admitted to all Level I and Level II trauma centers in Pennsylvania between 2011 and 2014 (n=38,562). Patients were stratified by age into three subgroups (age 65-74; 75-84; ≥85). We compared demographics, injury, and system-level across groups.

Results: We found significant increases in the proportion of female gender, (48.6% vs. 58.7% vs. 67.7%), white race (89.1% vs. 92.6% vs. 94.6%), and non-Hispanic ethnicity (97.5% vs. 98.6% vs. 99.4%) across advancing age across age groups, respectively. As age increased, the proportion of falls (69.9% vs. 82.1% vs. 90.3%), in-hospital mortality (4.6% vs. 6.2% vs. 6.8%), and proportion of patients arriving to the hospital via ambulance also increased (73.6% vs. 75.8% vs. 81.1%), while median injury severity plateaued (9.0% all groups) and the proportion of Level I trauma alerts (10.6% vs. 8.2% vs. 6.7%) decreased. We found no trend between age and patient transfer status. The five most common diagnoses were vertebral fracture, rib fracture, head contusion, open head wound, and intracranial hemorrhage, with vertebral fracture and head contusion increasing with age, and rib fracture decreasing with age.

Conclusion: In a large cohort of older adults with trauma (n= 38,000), we found, with advancing age, a decrease in trauma alert level, despite an increase in mortality and a decrease in demographic diversity. This descriptive study provides a framework for future research on the relationship between age and blunt traumatic injury in older adults. [West J Emerg Med. 2016;17(6)702-8.]

INTRODUCTION

Older adults (≥65 years old) will comprise over 20% of the U.S. population by the year 2030; traumatic injury, including falls, is a leading cause of death and disability in this age group.[1] Healthy People 2020, an initiative by the U.S. Department of Health and Human Services (HHS) that sets 10-year goals for disease prevention and health promotion, has declared it a national priority to reduce the rate of emergency department (ED) visits from falls in the elderly.[2] However, despite the ubiquity of traumatic injury in older adults and its national recognition as a major public health issue, there is surprisingly little published about the epidemiology of blunt traumatic injury in this population.

While there are well documented differences in patterns of traumatic injury by age, the bulk of work on this topic has compared older adults as a collective to younger adults.[3] Little work has been done on the influence of gradations of age on blunt traumatic injury over 65 and on system-level factors that may influence these trends. Most of the literature on older adults and traumatic injuries is based on old data from the 1980s-1990s, from foreign countries like the United Arab Emirates, Australia, or Canada, focuses on prehospital triage criteria, or only evaluates hospital readmissions.[4-15]

The aim of this study was to identify how characteristics of blunt traumatic injuries in adults ≥ 65, treated at an accredited trauma center in Pennsylvania (PA) between 2011 and 2014, vary by age. As the population of adults >65 continues to increase, accurate data on the rates and patterns of traumatic injury in this group are essential to improve understanding of the burden of blunt trauma in this vulnerable population. Such knowledge may increase our ability to prevent, screen, and treat trauma in older adults.

METHODS

This study is a retrospective observational analysis of data collected from older adults hospitalized at trauma centers in PA from 2011-2014.

Data

We obtained data from the Pennsylvania Trauma System Foundation (PTSF). Trauma centers are required to report utilization data to PTSF as a requisite for trauma center accreditation in PA; and as such, all trauma centers are strongly incentivized to accurately report information. Trained healthcare professionals entered the data in real time, and the data were abstracted and subject to review by trained PTSF auditors on a quarterly basis.

Subjects

Patients were eligible if they were ≥ 65 years old and were admitted to an accredited trauma center for blunt traumatic injury in the state of PA between January 1, 2011, and December 31, 2014. Blunt injuries are defined as injuries from a blunt object or from collision with a blunt surface, such as falls and motor vehicle collisions (MVCs).

In the absence of established age strata in the ≥65 year old groups, we established our own cut-offs: 65-74, 75-84, and ≥85. These groups divided the data into roughly three equal parts, allowing similar levels of power to facilitate inter-group comparisons.

Variables

We compared demographic, injury, and system-level variables across the age groups. Demographic variables included age, sex, race, ethnicity, insurance type, and pre-existing conditions (PECs). Injury variables included mechanism of injury (MOI) (as determined by external injury code, or e-code), diagnosis (as determined by ICD-9 code), place of injury, injury severity score (ISS), death in-hospital, and discharge destination. System variables included mode of transport to hospital, transfer status (which included both transfer into and out of a hospital), and trauma alert level (I, II, III, or trauma consult, with I being the highest level of alert possible and consult being the lowest level of alert possible at a given facility).

Statistical Analysis

To compare demographic variables, injury characteristics, and system variable across age groups, we performed bivariate analysis using Kruskal-Wallis for continuous variables and chi-squared or Cochran-Armitage test of trend for categorical variables where appropriate. All analysis was done using STATA software version 14.0. We considered a two-tailed alpha value of less than .05 to be statistically significant. We did not adjust for multiple comparisons.

This study was deemed exempt by the institutional review board, as this was publicly available, de-identified data.

RESULTS

Of the 38,562 admissions meeting criteria, 28.8% were 65-74 years old; 36.6% were 75-84 years old; and 34.6% were≥85 years old (Table 1). We found significant increases in the proportion of female gender, (48.6% vs. 58.7% vs. 67.7%), white race (89.1% vs. 92.6% vs. 94.6%), and non-Hispanic ethnicity (97.5% vs. 98.6% vs. 99.4%) across advancing age across age groups, respectively. Ten PECs had a frequency of ≥10%. From most to least frequent, these were hypertension (HTN), coronary artery disease (CAD), psychiatric disease, thyroid disease, arthritis, reversible anticoagulant therapy, dementia, antiplatelet therapy, congestive heart failure (CHF), and cerebrovascular disease (CVD). All of these PEC significantly increased with age ($p<0.001$), except for psychiatric disease, which decreased with age ($p<0.001$).

Falls were the most common mechanism of injury and increased with age (69.9% vs. 82.1% vs. 90.3%, $p<0.001$, Table 2). MVCs, the second most common mechanism of injury, decreased with age ($p<0.001$). As age increased, median injury severity stayed the same (9.0) while the 75th percentile decreased (14.0 vs. 13.0 vs. 12.0), but in-hospital mortality increased (4.6% vs.

Table 1. Demographic characteristics (including co-morbidities) by age group (all comparisons listed are significant with p <0.001) in study of blunt traumatic injury in adults over 65.

	65-74		75-84		≥85	
Age group	N	(%)	n	(%)	n	(%)
Number	11,0888	(28.8)	14,115	(36.6)	13,359	(34.6)
Female	5,390	(48.6)	8,279	(58.7)	9,042	(67.7)
Race						
White	9,876	(89.1)	13,068	(92.6)	12,635	(94.6)
Black	718	(6.5)	601	(4.3)	417	(3.1)
Asian	113	(1.0)	125	(0.9)	82	(0.6)
Other/unknown	381	(3.4)	321	(2.2)	225	(1.7)
Ethnicity – Hispanic	274	(2.5)	199	(1.4)	84	(0.6)
Pre-existing conditions*						
Hypertension	7,433	(67.1)	10,607	(75.2)	10,599	(79.3)
Coronary artery disease	2,608	(23.5)	4,456	(31.6)	4,414	(33.0)
Psychiatric disease	2,778	(25.1)	3,133	(22.2)	3,003	(22.5)
Thyroid disease	1,828	(16.5)	3,080	(21.8)	3,453	(25.9)
Arthritis	1,593	(14.4)	2,538	(18.0)	2,741	(20.5)
Reversible anticoagulant	1,227	(11.1)	2,692	(19.1)	2,338	(17.5)
Dementia	489	(4.4)	2,087	(14.8)	3,577	(26.8)
Antiplatelet therapy	1,245	(11.2)	1,905	(13.5)	1,796	(13.4)
Congestive heart failure	910	(8.2)	1,698	(12.0)	2,224	(16.7)
Cerebral vascular disease	979	(8.8)	1,719	(12.2)	1,664	(12.5)

*Pre-existing conditions present in >10% of the sample are included in this table

6.2% vs. 6.8%). In all age groups, the majority of injuries took place at home. The five most common diagnoses in descending order were fracture of the vertebral column; fracture of the rib(s), sternum, larynx, and trachea; intracranial hemorrhage (ICH); open wound of the head; and facial contusion. The proportion of vertebral column fractures and facial contusions increased with age (p<0.001), while the proportion of rib and surrounding structures fractures decreased with age (p<0.001). No trend was observed between age and ICH (p=0.564) or age and open head wound (p=0.306).Most patients, regardless of age, were brought in via ambulance or fire rescue (Table 3), and this increased significantly with age. Conversely, patients arriving via private vehicle or walk-in decreased (p<0.001). No trend was observed between age and the proportion of patients transferred (p=0.283). Trauma alert level decreased with increased age (p<0.001).

DISCUSSION

Our study examined how demographic, injury, and system-level characteristics of blunt traumatic injuries vary by age in adults ≥ 65 years old treated at a trauma center in PA from 2011-2014 and found that trauma alert levels trend downward with age, while in-hospital mortality trends upward.

Demographics

The vast majority of older adults (95%) receiving care at a trauma institution in PA were white and non-Hispanic; females were also overrepresented (67%), especially as age increased. These characteristics increased with age. According to the U.S. Census, Pennsylvania's total population is 83% white and 78% non-Hispanic, so it appears that minority groups were underrepresented in the injury data.[16] However, an examination of PA census data at a more granular level revealed the racial, ethnic, and gender proportions of the current study accurately reflect the demographics of PA, in that ~95% of PA residents ≥85 are white and non-Hispanic.[17] Therefore, it may be that the racial discrepancies seen in the current study were less likely due to racial or ethnic

Table 2. Injury characteristics by age group.

	65-74		75-84		≥85	
Age group	n	(%)	n	(%)	N	(%)
Injury mechanism						
Fall	7,749	(69.9)	11,589	(82.1)	12,058	(90.3)
MVC	2,332	(21.0)	1,864	(13.2)	872	(6.5)
Place of injury						
Home	5,887	(53.1)	8,538	(60.5)	8,004	(59.9)
Street/highway	2,752	(24.8)	2,206	(15.6)	1,069	(8.0)
Public building	736	(6.6)	976	(6.9)	623	(4.7)
Residential institution	440	(4.0)	1,402	(9.9)	3,113	(23.3)
Other/unspecified	1,273	(11.5)	993	(7.0)	550	(4.1)
ISS median (IQR)	9.0	(5.0-14.0)	9.0	(5.0-13.0)	9.0	(5.0-12.0)
Diagnosis**						
Fracture of vertebral column without mention of spinal cord injury	2,497	(22.5)	3,209	(22.7)	3,298	(24.7)
Fracture of rib(s), sternum, larynx, and trachea	2,795	(25.2)	2,948	(20.9)	2,646	(19.8)
Intracranial hemorrhage*	1,316	(11.9)	1,888	(13.4)	1,586	(11.9)
Open wound of head (excluding eye)*	2,172	(19.6)	3,176	(22.5)	3,063	(22.9)
Contusion of face, scalp, and neck except eye(s)	2,167	(19.5)	2,746	(19.4)	2,690	(20.1)
Died in hospital	509	(4.6)	877	(6.2)	902	(6.8)

*Not statistically significant
**Diagnoses present in > 10% of the sample were included in this table.
MVC, motor vehicle collision; *ISS,* injury severity score; *IQR,* interquartile range.

Table 3. System characteristics by age group (trauma alert Level I is the highest possible alert level, alert Level II is the second highest, and alert Level III and trauma consult are the lowest possible alert levels at a given facility).

	65-74		75-84		≥85	
Age group	n	(%)	n	(%)	n	(%)
Mode of transport						
Ambulance or fire rescue	8,160	(73.6)	10,698	(75.8)	10,830	(81.1)
Private vehicle or walk-in	2,262	(20.4)	2,727	(19.3)	1,937	(14.5)
Other/unknown	666	(6.0)	690	(4.9)	592	(4.4)
Transfer (in or out)*	3,617	(32.6)	4,676	(33.1)	4,288	(32.1)
Trauma alert called						
I	1,177	(10.6)	1,154	(8.2)	898	(6.7)
II	2,956	(26.7)	3,311	(23.5)	2,842	(21.3)
III or trauma consult	4,163	(37.6)	6,051	(42.9)	6,353	(47.6)

* Not statistically significant

discrepancy in trauma center use and more likely a reflection of the skewed distribution of racial demographics of older adults, a trend that may reflect larger societal issues related to health status and longevity.

Several of the most common PECsare known intrinsic risk factors for fall; CAD, CVA, and arthritis have been shown to increase the risk of falling.[18] While some PEC increase risk, other PEC, such as thyroid disease and reversible anticoagulant therapy, may worsen damage after a trauma and contribute to increased ISS. For example, chronic hyperthyroidism has been shown to increase risk of fracture, while levothyroxine, a common medication for thyroid disease, has also been implicated in increasing fracture risk.[19] Reversible anticoagulant therapy, which many older adults take for thrombosis prophylaxis and treatment, exacerbates the effects of a fall by leading to persistent bleeding. Further analysis is needed to determine whether certain PEC are associated with higher mortality or ISS for the patients in this dataset. If an association is found, these findings may suggest that the medical and public health communities could benefit from a universal screening program for those on anticoagulants or a re-evaluation of the risk-benefit ratio of such therapy.

Injury patterns

While the injury patterns seen here generally match broad trends seen elsewhere, there are several differences worth noting. Compared to earlier data from a similar study by Richmond et al. that used the same Pennsylvania Trauma Outcome Survey (PTOS) data source from 1988-1997, the proportion of older adults being injured by falls has grown dramatically: 49.2% vs. 69.9% for age 65-74; 64.2% vs. 82.2% for age 75-84; and 81.1% vs. 90.3% for ≥85, (Figure 1).[6] Similarly, the proportion of MVCs has decreased dramatically: 30.4% vs. 21.0% for age 65-74; 21.7% vs. 13.2% for age 75-84; and 9.2% vs. 6.5% for ≥85 (Figure 1). In-hospital mortality rates have also decreased from >10% in Richmond's study to <6% in the current study, though the general trend of increased mortality with increased age persists (Figure 2).[6] Richmond's study did not report median ISS, but the mean ISS for that cohort was 11.7, which is higher than the mean ~7 or median 9.0 ISS seen in the current study. One possible explanation for the increase in falls and simultaneous decrease in MVCs, injury severity, and in-hospital mortality might be successful public health campaigns that have instituted car safety measures, such as airbags and increased seat belt use, both of which could contribute to the decrease in ISS and in-hospital mortality. While one could make the point that older adults may drive less than younger adults, which could influence injury patterns, we would assert that the MVC injuries noted here reflect both MVC drivers and passengers.

System patterns

We observed no relationship between age and the proportion of patients transferred in or out. However, all age groups in this study had transfer rates approximately three times that seen in injured adults ≥70 in another recent study.[10] It is unclear why our data would have a transfer rate three times that of data for a similar study. One possible explanation might be that the Ichwan study looked at traumatic injuries taken via ambulance to all hospital types, not just to trauma centers, while the current study looked only at injuries taken to a trauma center. As such, the average ISS in our study may have been higher than that of the Ichwan study.

Trauma alert level trended down as age increased ($p<0.001$). At first glance, this decrease in trauma level may seem appropriate, given that the ISS IQR also decreased with age. However, previous work has suggested that older adults with traumatic injuries may be systematically under-triaged, regardless of their injury severity.[12, 20-23] Another possible explanation for the increased mortality among older adults, including those with lower injury severity, has suggested that older adults may require a unique set of triage criteria due to their unique physiologic reserve.[20, 23-26]

Our study has many strengths. For example, it uses a large, statewide data sample that is mandatory, collected in real time, and regularly audited by trained professionals. These strengths help assure the study is adequately powered, avoids recall bias, and has a low rate of erroneous information.

LIMITATIONS

This study has several limitations. The data for this study only include one state, PA, and therefore our findings may not be generalizable to other populations. Furthermore, since PTOS only records information on patients admitted to a trauma center, we were unable to compare patients to those treated at a non-trauma center. Finally, to protect patient privacy the PTOS database does not allow for patient linkage. As such, it is possible that some patients may appear in the database multiple times or that the same injury may appear more than once if a patient was transferred between trauma centers. We attempted to minimize these effects by reporting transfer data and by excluding non-blunt injuries, such as burns, which we surmised might have a high rate of transfer to specialty centers and therefore a high rate of repeat entry in the database.

CONCLUSION

Our study found that, for older adult trauma patients, trauma alert levels trend downward with age, but in-hospital mortality trends upward. When compared to earlier studies that used the same dataset, it is clear that mechanisms of injury are changing: falls now cause the vast majority of injuries in older adults seen at trauma centers while MVCs are responsible for a decreasing percentage of injuries in this population. This study identified multiple areas upon which to focus injury prevention and public health research for older adults, including triage appropriateness, impact of pre-existing conditions, and possible barriers to trauma center care.

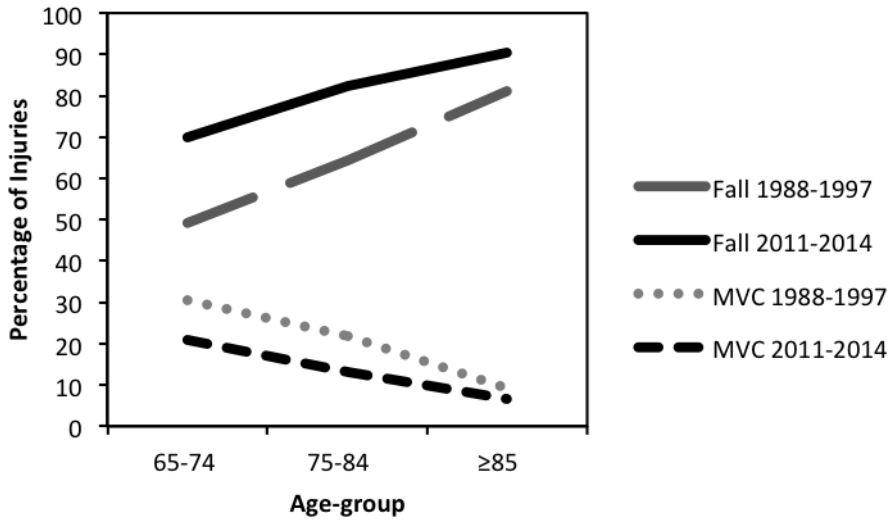

Figure 1. Change over time in injury mechanism from Richmond et al. study (using the same Pennsylvania trauma data source from 1988-1997) to current study (2011-2014).
MVC, motor vehicle collision.

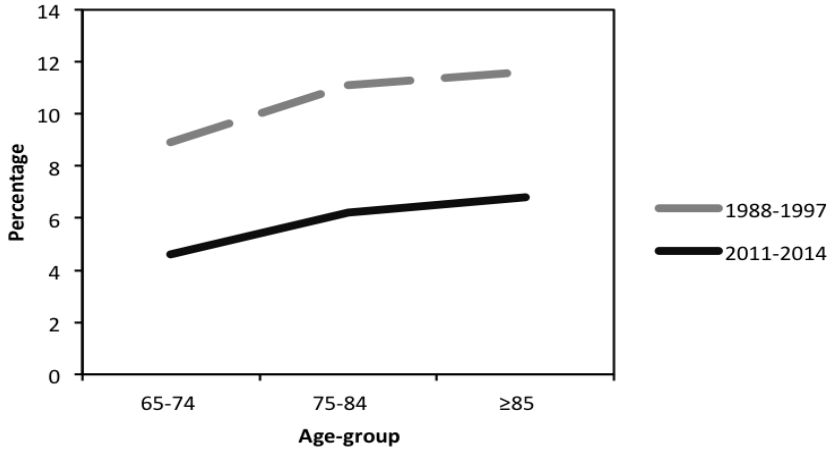

Figure 2. Change over time in in-hospital mortality rate from Richmond et al. study (using the same Pennsylvania trauma data source from 1988-1997) to current study (2011-2014).
MVC, motor vehicle collision.

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Somnambulism: Emergency Department Admissions Due to Sleepwalking-Related Trauma

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Introduction: Somnambulism is a state of dissociated consciousness, in which the affected person is partially asleep and partially awake. There is pervasive public opinion that sleepwalkers are protected from hurting themselves. There have been few scientific reports of trauma associated with somnambulism and no published investigations on the epidemiology or trauma patterns associated with somnambulism.

Methods: We included all emergency department (ED) admissions to University Hospital Inselspital, Berne, Switzerland, from January 1, 2000, until August 11, 2015, when the patient had suffered a trauma associated with somnambulism. Demographic data (age, gender, nationality) and medical data (mechanism of injury, final diagnosis, hospital admission, mortality and medication on admission) were included.

Results: Of 620,000 screened ED admissions, 11 were associated with trauma and sleepwalking. Two patients (18.2%) had a history of known non-rapid eye movement parasomnias. The leading cause of admission was falls. Four patients required hospital admission for orthopedic injuries needing further diagnostic testing and treatment (36.4%). These included two patients with multiple injuries (18.2%). None of the admitted patients died.

Conclusion: Although sleepwalking seems benign in the majority of cases and most of the few injured patients did not require hospitalization, major injuries are possible. When patients present with falls of unknown origin, the possibility should be evaluated that they were caused by somnambulism. [West J Emerg Med. 2016;17(6)709-12.]

INTRODUCTION

Sleepwalking (somnambulism) is a state of dissociated consciousness, in which the affected person is partially asleep and partially awake.[1,2] There is pervasive public opinion that sleepwalkers are protected from hurting themselves. There have been few scientific reports of trauma associated with somnambulism,[3,4] and there are no published investigations on the epidemiology or trauma patterns associated with somnambulism.

Somnambulism typically occurs at the transition from deep non-rapid eye movement (NREM) sleep before it progresses to REM sleep.[1] It is therefore regarded as a disorder of impaired arousal. Most deep NREM sleep is in the first third of the night, so that the somnambulistic event usually occurs one to three hours after sleep onset, but ends when arousal is complete and full wakefulness is reached. It is generally followed by a rapid return to sleep. The patient exhibits complete amnesia of the episode upon awakening.[1,5,6] He may notice changes in the household (overturned furniture, flowerpots) or have personal injuries (scratches, wounds) after the episode.

In the average population, about 2-3% of adults sleepwalk.[7] Disorders of arousal are especially common in

childhood; 15% of children aged 2.5 to 6 years are estimated to have sleepwalked at least once, in comparison with 6% of children aged 6 to 11 years. The prevalence decreases significantly with age, because slow-wave sleep is most abundant in children.[1,8,9] However, all factors that increase the amount of deep sleep (drugs [especially psychotropics], sleep deprivation, stress, restless legs syndrome, sleep disordered breathing, thyrotoxicosis or pregnancy) can provoke a parasomniac episode.[10,11]

Our study aims to provide insight into the type of injuries that may be encountered associated with sleepwalking and provide demographic information about patients with emergency department (ED) admissions due to sleepwalking-related trauma.

METHODS

For this retrospective chart review, we screened the computerized database (E-Care, ED 2.1.3.0, Turnhout, Belgium) of all ED admissions to University Hospital Inselspital, Bern, Switzerland, from January 1, 2000, until August 11, 2015, (n=620,000) for trauma cases associated with somnambulism (key words "Schlafwandler," "schlafwandeln" [English: "sleepwalker" and "sleepwalking"). A catchment area of about two million people is covered by the ED of University Hospital Berne, a Level I trauma center for adults > 15 years. The ED is a self-contained, interdisciplinary unit and treats approximately 500 multi-injured patients (Injury-Severity-Index >16) per year; about 40% of patients are admitted for surgical reasons and about 30% of patients are admitted to the hospital.[12] Demographic data (age, gender, nationality) and medical data (mechanism of injury, final diagnosis, hospital admission, mortality and medication on admission) were extracted from the patient records, anonymized, double-checked for documentation errors and included in our investigation.

RESULTS

Out of 620,000 ED admissions, 11 trauma admissions were associated with a reported history of sleepwalking. For characteristics and injury patterns see the table.

The mean age was 39 years (range, 16 to 77 years); four patients were female and seven were male (36.4% vs. 63.6%). The leading cause of admission was a fall (mostly from bed, stairs or windows). Two patients (18.2%) had a history of known NREM parasomnias. The most common co-morbidity was epilepsy (n=6, 54.5%). None of the patients was on psychotropic drugs at admission. Seven patients (63.6%) were managed in the outpatient setting. Four patients (36.4%) required hospital admission because of orthopedic injuries needing further diagnostic testing and treatment. These included two patients with multiple injuries (18.2%). None of the admitted patients died.

DISCUSSION

Trauma associated with somnambulism is rare but may be potentially life threatening.

Previously identified factors that initiate sleepwalking include drugs and psychotropic medications.[10] In one of the earliest reports (1979), Charney et al. showed an association between use of neuroleptic medication and sleepwalking.[13] There are other published reports that psychotropic medications can induce a somnambulistic episode.[4,14,15] None of our trauma patients was on psychotropic medications at admission. However, given the potential risk of triggering sleepwalking episodes, psychotropic medications should be used with caution in susceptible patients.

Table. Patient characteristics and traumatic injuries associated with somnambulism.

Age	Gender	Outpatient setting	Injuries
63	M	Yes	Multiple contused facial lacerations
77	F	Yes	Thoracic haematoma
38	M	No	Severe head injury, serious craniofacial injuries, third degree open fracture of the femur, cervical spinal dislocation at the fifth and sixth cervical vertebral bodies, soft tissue injuries
26	F	Yes	Contusion of the ribs and right knee
43	M	No	Intra-articular distal radius fracture, contused laceration facial
59	F	No	Cerebral concussion, luxation fracture of the facet joint of the sixth and seventh cervical vertebral bodies with neuroforaminal stenosis and epidural haematoma, fracture of the skull (parietal left and temporal right) and of the left lateral orbital wall, exophthalmos left.
23	M	Yes	Minor head injury, temporoparietal excoriation, fracture of the left clavicle
16	M	Yes	Upper back contusion
16	F	Yes	Contusion of the right ankle joint and sternum, superficial cuts on left lower leg
20	M	Yes	Shoulder luxation on the left side
53	M	No	Paraplegia below thoracic vertebral body 10, pneumothorax on the left side, aspiration on the right side

*n=11

Although 2-3% of adults do sleepwalk,[7] the very low number (n=11) of sleepwalking-associated accidents out of about 620,000 ED admissions seems to confirm the pervasive public opinion that sleepwalkers are protected from hurting themselves. Nevertheless, our study shows that life-threatening injuries associated with somnambulism may occur.

The rare incidence of trauma in sleepwalkers combined with emergency physicians' lack of awareness of the danger of somnambulism may cause the diagnosis of somnambulism to be missed in patients presenting with falls of unknown origin. Obtaining a detailed history from the patient as well as from the family may be the only possibility to establish the diagnosis of sleepwalking. In our patients, only a small minority of patients had a known previous history of sleepwalking. Under-diagnosed cases of somnambulism, together with medications that potentially initiate sleepwalking, may lead to preventable injuries. In patients with known sleepwalking, avoidance of sleep deprivation and medications or substances associated with disorders of arousal like alcohol, psychotropic and hypnotic medications is essential.[10] Additionally, given the limited treatment options of sleepwalking, it is necessary to educate susceptible patients about risk-mitigation strategies to prevent injuries.

LIMITATION

Our study is limited to patients older than 15 years because children are not treated in our ED. Given the higher prevalence of somnambulism in younger children than in adults, evaluation of sleepwalking accidents in a pediatric population would be important.

As with all retrospective studies involving medical records, there is no guarantee that all patients in the large database were found and correctly reported. Another limitation to our study is the small number of sleepwalking-associated trauma cases that could be reported despite screening of a large patient population. Our investigation aims to promote awareness to the topic of sleepwalking-associated injuries and might stimulate further research on a topic that has not been extensively studied so far. Prospective investigations of patients with somnambulism and trauma should be conducted to identify further, potentially preventable, risk factors.

CONCLUSION

Although sleepwalking seems benign in the majority of cases and most of the few injured patients will not require hospitalization, major injuries are possible. Injuries related to sleepwalking may be potentially overlooked and a high index of suspicion is important. When patients present with falls of unknown origin, the possibility of a somnambulistic cause should be considered. In patients at risk of sleepwalking, the use of psychotropic medications has to be closely evaluated.

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Telehealth-Enabled Emergency Medical Services Program Reduces Ambulance Transport to Urban Emergency Departments

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Introduction: Emergency medical services (EMS) agencies transport a significant majority of patients with low acuity and non-emergent conditions to local emergency departments (ED), affecting the entire emergency care system's capacity and performance. Opportunities exist for alternative models that integrate technology, telehealth, and more appropriately aligned patient navigation. While a limited number of programs have evolved recently, no empirical evidence exists for their efficacy. This research describes the development and comparative effectiveness of one large urban program.

Methods: The Houston Fire Department initiated the Emergency Telehealth and Navigation (ETHAN) program in 2014. ETHAN combines telehealth, social services, and alternative transportation to navigate primary care-related patients away from the ED where possible. Using a case-control study design, we describe the program and compare differences in effectiveness measures relative to the control group.

Results: During the first 12 months, 5,570 patients participated in the telehealth-enabled program, which were compared against the same size control group. We found a 56% absolute reduction in ambulance transports to the ED with the intervention compared to the control group (18% vs. 74%, $P<.001$). EMS productivity (median time from EMS notification to unit back in service) was 44 minutes faster for the ETHAN group (39 vs. 83 minutes, median). There were no statistically significant differences in mortality or patient satisfaction.

Conclusion: We found that mobile technology-driven delivery models are effective at reducing unnecessary ED ambulance transports and increasing EMS unit productivity. This provides support for broader EMS mobile integrated health programs in other regions. [West J Emerg Med. 2016;17(6)713-20.]

INTRODUCTION

Background

Emergency medical services (EMS) plays a vital role in the appropriate prehospital management of the nearly 250 million 911 callers each year.[1] Both emergency departments (ED) and EMS agencies are increasingly resource-constrained, threatened by the increasing number of ambulance transports often associated with non-urgent complaints.[2] Most EMS protocols require the transport of all 911 patients to the ED and lack incentive to transport patients to possibly more appropriate settings. As a result, resource costs are high through unnecessary transport and ED care for non-urgent primary care

patients. A nationwide study estimated that the proportion of medically unnecessary EMS transports has increased 31% from 1997 to 2007 (from 13% to 17%), supporting the need for alternative models of EMS prehospital care.[3]

The American College of Emergency Physicians concludes that ambulance non-transport as well as transportation to alternate destinations may be appropriate for non-urgent patients.[4] The same report contends that EMS systems choosing to implement such options "should develop a formal program to address these alternatives" and should occur only under physician oversight, combined with adequate education of EMS providers and a strong quality management system. Approximately 7% of EMS agencies serving the 200 largest cities in the U.S. have implemented policies allowing EMS-initiated non-transport of patients.[5] However, there is a limited amount of research determining the safety and effectiveness of these programs.[6]

Programs that combine non-traditional techniques and technologies to redeploy units and more appropriately align patients to alternative destinations are conceptually termed "mobile integrated health" (MIH) or "community paramedicine" (CP). The difference in the models is the deployment of personnel and technology. Mobile integrated health involves technology utilization, and is defined as "the provision of healthcare using patient-centered mobile resources in the out-of-hospital environment".[7] Community paramedicine describes the expansion of EMS personnel roles and responsibilities more broadly in public health and healthcare delivery.[8] Collectively, these are alternatives to traditional EMS treat-and-transport models. Alternative models tend to emphasize technology, non-ambulance-based transportation, and broader paramedic roles and responsibilities to "reduce total cost of care, provide more patient-centered care, and reduce the burden on EDs".[9] Most patient-centered alternative models include technology to support telehealth. Telehealth has typically been performed in rural areas or for specialized diagnoses, providing care remotely to patients that otherwise would not receive any. Formally, telehealth is the use of electronic communication to facilitate patient care between a patient and a provider working at a distance.[10-11]

Significance

Non-urgent, primary care-related incidents severely hamper the current emergency medical care system. The potential benefits of an alternative mobile integrated health program include enhancement of resource utilization, reduction of unnecessary ED visits that contribute to crowding and access to care.[12] Schaefer et al. reported a 7% reduction in ED use and 3.5% increase in community clinic use in the post-phase implementation of an alternate destination program for selected non-urgent patients.[13] In a similar evaluation of an alternate destination program in the United Kingdom, Snooks et al. reported reduced waiting times, increased patient satisfaction, enhanced resource utilization, and shortened cycle times for ambulance services.[14] Other studies have shown the safety of alternate methods of transport (e.g., taxi) and effectiveness of physician-directed destination programs to reduce crowding.[15-16]

Although there are a few documented studies of EMS alternative programs and telemedicine pilots, these are often in rural settings or in small demonstration projects.[17] Other emergency researchers have pointed to a significant need for more comparative effectiveness studies of large-scale MIH programs.[18]

Study Objective

The objective of this research is to compare the effectiveness of an alternative EMS telehealth delivery model relative to traditional EMS care in a large urban, American city.

METHODS

Study Design

We developed an observational case-control study between two groups of patients who placed emergency medical calls to 911. The intervention group (ETHAN patients) incorporated telehealth with community paramedicine, and dispositioned patients to the most appropriate level of care (e.g., hospital ED, local safety net clinic with prepaid taxi voucher, or referrals to primary care). The control group was comprised of traditional EMS patients treated and transported to local EDs per standard protocol. We measured the effect differences across a number of different measures.

Study Setting

With a population of more than 2.2 million, the City of Houston covers an area of over 600 square miles in Southeast Texas. The city's emergency medical services (EMS) is a division of the Houston Fire Department. Houston EMS receives over 250,000 emergency calls every year. As a fire-based EMS department, a two-person unit will respond to all EMS calls in one of the 63 ambulances, 89 engines, 39 ladder trucks, or 35 medic response vehicles located at 93 fire stations across the region. EMS services benefit all of the city's residents, and frequently support those most in need, such as low-income mothers and children, the elderly, and Medicaid and minority populations. The program serves the region's primary EMS population, which is comprised of approximately 30% Medicaid enrollees and 20% indigent patients.

This demand for emergency services has steadily risen over the past decade and continues to increase. Recognizing the rising costs of treating patients with non-emergent conditions, the City of Houston Department of Health and Human Services, received funding from the 1115 Medicaid Waiver pool to develop an intervention program (ETHAN), aiming to reduce the number of potentially unnecessary ambulance transports and ED visits. Initial investment of $500,000 was used for capital equipment, including the telehealth and tablet hardware and software. Approximately

$1,000,000 per year for five years will also be used to cover all operational expenses of the program. The proposal was to incorporate telecommunications technologies to triage patients with non-life-threatening, mild or moderate illnesses via telemedicine with an emergency physician at the Houston Emergency Center. The EMT/paramedic on the scene would be responsible for making the determination of whether or not the situation warranted a triage intervention. If not, and the patient met inclusion criteria listed below, they would be eligible to be enrolled into the program. The paramedic would then activate ETHAN through an online call button on the tablet, which contacts the emergency physician in the base station immediately for a consultation. If the treating physician determines that the patient did not need immediate medical attention, the patient receives a referral for an appointment and follow-up care at a participating clinic the same or following day.

Sample Determination and Participant Selection

Sample size was calculated assuming 80% power and significance level 0.05, for continuous data. We chose reduction in ambulance transportation as our primary effect, and aimed to detect a difference of 0.10 between ambulance transports for our intervention participants, assuming that the base rate of transport was 78%. We calculated a necessary sample size of approximately 2,000 total patients in both the case and control groups.

Each patient who received the intervention was matched retrospectively with a similar patient identified in the patient care record (PCR) system as a control. The patients were matched during the same period, based on individual factors, including similar primary care chief complaints, age, and gender. We matched 100% of the cases with controls, to have the identical size samples in each group. This study design allowed us to compare outcomes (e.g., % ambulance transport, as well as other clinical, economics, patient satisfaction) relative to a similar set of traditional EMS patients.

Patients selected for the program had to meet inclusion criteria, as determined by the field paramedics at time of triage. Inclusion criteria for this study were patients with full mental capacity presenting with chief complaints that were primary-care related. The most common complaint categories system were "abdominal pain," "sick," "injury/wound," and "other pain." Patients had to consent to speaking to a physician, have no obvious emergency present and vital signs within reasonable limits, and they had to be ambulatory and mobile. Inclusion criteria included the following:

- Full history and physical exam, no emergency
- Ages > 3 months
- Ability to communicate and to speak English
- Vital signs are age appropriate and within normal limits
- Chronically ill patients or persons over age 65 years may not have a fever
- Ability to care for self
- Transported in a passenger vehicle
- Pediatric patients must have access to a pediatrician.

We excluded patients if there were any urgent issues such as chest pain, acute neurological changes, or altered mental status. Other exclusion criteria included the following:

- Ongoing difficulty breathing
- Chest pain or discomfort

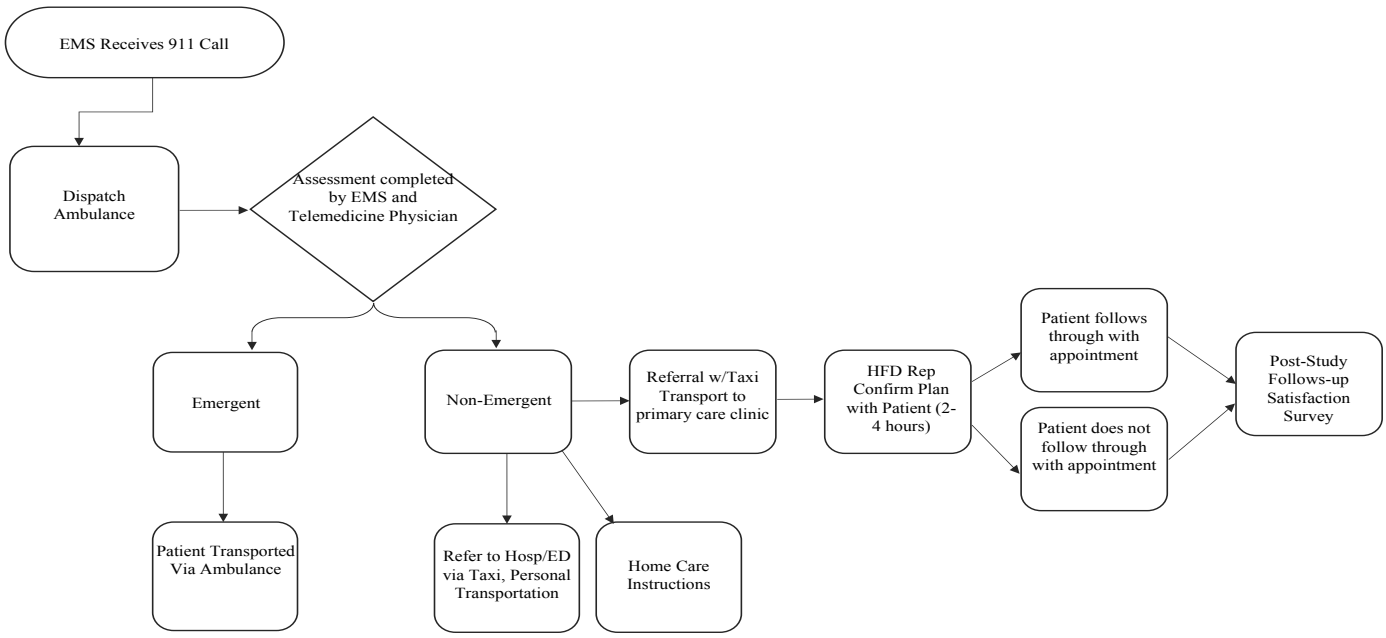

Figure. Study of intervention protocol flow chart.
EMS, emergency medical services; *ED,* emergency department; *HFD,* Houston Fire Department

- Any acute neurological change
- Syncopal episode in the past 24 hours
- Temperature of >100.3 if chronically ill or 65+
- Non-trivial traumatic injury in a patient <18
- Any pediatric patient when non-accidental injury or neglect is suspected
- Any pediatric patient <18 years who has no legal guardian on site
- Any patient who refuses to participate

Intervention Protocol

The intervention consists of the following three components: 1) telehealth capabilities between the paramedic, patient, and an EMS physician; 2) patient navigation and scheduling to contracted safety net clinics, if possible; and 3) taxi transportation and social service follow-up post incident. The intervention initiates when the first responding apparatus arrives at the incident scene, and the crew assesses the patient to make an initial determination as to the emergent status of the patient's condition. The figure shows the study protocol flowchart.

All EMS units carried tablets to connect the patient with an emergency physician via HIPAA-compliant and secure video teleconferencing software. Telehealth services involved synchronous communication with the patient through video conferencing on the tablet. The emergency physician was able to access the patient's medical record created at the scene, including patient's demographics, vital signs, medical history, allergies, medications, and chief complaint. Although the community health information exchange system was available, the lack of available data for most patients prevented it from being used to access the previous hospital records of patients. The physician consulted with the patient through the tablet, and made a determination of preliminary diagnoses and treatment options.

The EMS physicians were board-certified emergency physicians who practice at local hospitals EDs and contracted for part-time shifts at the Houston Emergency Center specifically for telehealth calls. There are approximately 16 physicians employed, all with at least five years of experience and practice in one of the local hospitals. All except for the program director (who was also an MD) were contracted part-time employees working at least one shift, and the hourly compensation was between $160-$200. There was one physician on duty at all times from 8 am to 9 pm, five days per week, and 10 am to 6 pm during the weekends. Physicians were given a desk with both a computer enabled with camera and access to multiple software solutions, including the EMS patient care record (PCR) system, a clinic scheduling system, taxi activation links, and the health information exchange. All physicians were municipal employees under the City of Houston, and were covered for liability and malpractice under the city's sovereign immunity law.

Training for the telehealth and navigation program lasted four hours, where the physicians were given technical training and instructions on the goals and objectives of the study. During the training period, the physicians test all technology components, observe multiple calls in progress, and then take calls under the supervision of a more experienced physician. Following this training, they were independent going forward, although weekly feedback and outcomes were shared by the program director.

While the video encounter was taking place, the field crew remained on scene to assist the physician with any additional information needed, such as taking a new set of vital signs or palpating the patient's pain site. The physician, in consultation with the patient, made the final determination regarding patient disposition. Patient's preference and input often led to the disposition to an ED rather than a clinic (although in a taxi versus ambulance). We saw no differences in patient diagnosis for those dispositioned to the ED versus a clinic.

The median number of minutes for a telehealth call was eight minutes, but ranged from 2-40 minutes (interquartile range). Since the ability to speak English was an inclusion criterion, all telehealth calls were in English as well.

Outcome Measures

The objective of this study was to explore the relative effectiveness of a large MIH program focused on primary care-related patients, relative to traditional EMS. The primary outcome measure was utilization, measured as the proportion of ambulance transports to the ED. Ambulance utilization is considered important as it impacts local hospital EDs' crowding, wait times, and access.

Another primary outcome metric was unit productivity, as that ultimately influences total cost of care. This was calculated as the total "back in service" time, measured by the difference in minutes between when the unit was dispatched and the unit became available to respond to a subsequent incident. Generally, the quicker the unit is available and put back in service, the more productive the crew and the ambulance. Utilization is greater if units terminate the call after initial review and observation, rather than disposition to an ED, which often requires long transport and transition times. While cost was not directly studied here, an ongoing health economics study is estimating the program's total cost of care. Secondary measures we chose to include were quality of care (measured by mortality rates), and the experience of care (measured as post-incident patient satisfaction).

Primary Data Analysis

We extracted all patient demographics, interventions, treatment times, dispositions, and outcomes data from the PCR system used by Houston Fire Department. We obtained all patient data in the program from January 1, 2015, through December 31, 2015, and de-identified the data after abstraction. Data were validated in a database using scripts to ensure completeness of data for all cases. We used both operational and information systems personnel at Houston Fire Department

to ensure that all extracted data for both cases and controls were accurate and complete prior to inclusion in the dataset for analyses. We used descriptive analyses to determine frequencies and central tendencies. Continuous outcomes, unless otherwise stated, were compared between treatment groups with t tests. Time data were highly skewed and therefore the nonparametric Mann Whitney U test assessed median differences. We used SPSS to perform data analysis (SPSS Statistics, version 23, Armonk, NY: IBM Corp.).

This comparative effectiveness study was reviewed and approved by the institutional review board at the University of Texas Health Science Center at Houston.

RESULTS

During the study period, 5,570 patients participated in the intervention program. There were 288,000 total EMS calls during that period. Table 1 shows the descriptive characteristics of the patients in the intervention and the matched control group.

Table 1. Descriptive characteristics of intervention patients and control group in a study comparing the effectiveness of an alternative EMS telehealth delivery model relative to traditional EMS care.

Measure	Intervention	Control
Race/ethnicity		
White	17%	15%
Black/African American	58%	60%
Hispanic/Latino	17%	20%
All other	8%	5%
Matched measure		
Median age, IQR, y	44 (10)	45 (10)
Sex % female	55%	51%
Top 3 chief complaints		
% “Abdomen pain”	15%	17%
% “Sick”	25%	29%
% “Breathing”	20%	18%

EMS, emergency medical services, *IQR,* interquartile range

We found a statistically significant change in alternative transport options, with a 56% absolute decrease in transport to the ED (74% for control group vs. 18% for intervention; $P<.001$). In the control group, the 26% (which did not go to the ED) ended up as non-transports. Of the non-ambulance transports, most intervention patients (n=3,293, 72% of non-transports) were offered a pre-paid taxi ride to go to a local hospital ED independently. Approximately 83% of these actually used the taxi and presented to the ED (2,733). This disposition was appropriate where patients might need care not offered by a clinic, but were not emergent enough to require immediate ED care.

There were 458 patients (8%) scheduled into one of the geographically proximate safety net clinics, usually within the day or next business day. The EMS physician was successful in securing appointments for 100% of these patients, although only 55% of them actually presented to the clinics (i.e., 45% no-show rate). There was patient follow up by telephone within a week to inquire about their appointment, and most reported their symptoms subsided as reason for missing appointment. Based on the diagnosis, we had no reason to believe that mortality was a cause for patient no-show. Fourteen patients made a follow-up call after referral to the primary care clinic for an incident within a two-day time period (<.2%), resulting in a subsequent EMS response. The remainder were referred to the patient’s own primary care physician or home care, refused care, or were provided home care instruction only. Approximately 7% (259 patients) declined to speak to an EMS physician by telehealth in the intervention group, or refused referrals to clinics, or technical or other issues prevented one of the other dispositions. Of these, technical issues represented only around 50 calls, which was primarily due to lack of wireless cellular signal in certain regions of the city. Table 2 presents the disposition rates for the intervention.

Table 2. Patient disposition intervention in an emergency telehealth and navigation program (ETHAN).

Patient disposition	N	% of total
Hospital ED with taxi	3,293	59%
Ambulance transport to ED	1,013	18%
Clinic referral with taxi	458	8%
Referral to PCP or home care	419	8%
Others (refusals, technical issues; no transport or referral)	387	7%
Total Sample	5,570	100%

ED, emergency department; *PCP,* primary care provider

Patient satisfaction was recorded by follow-up telephone services from the City of Houston Health and Human Services caseworkers for both ETHAN and non-ETHAN patients. We attempted to contact 100% of the intervention patients by telephone, but we received approximately 10% completed survey response rate, primarily due to inactive or erroneous telephone contact information. We sampled 10% of the control group to ensure the same sample size. There was no difference in “overall satisfaction with care delivered by EMS,” with ETHAN patients reporting an 88% overall patient satisfaction rating for the EMS response, compared to 87% for the non-intervention group (p=.25). There were 10 survey questions, but the satisfaction rating used here was based on the response to the question “Overall, on a scale of 1 – 100

Table 3. Outcome differences comparison in a pilot program that integrates mobile technologies and alternative patient navigation to improve EMS utilization and outcomes.

Outcome category	Measure	Control group	ETHAN (Intervention)	P
Ambulance utilization	Disposition to ED by ambulance (% ambulance transport)	74%	18%	<.001
Unit productivity	Total back in service time median minutes (IQR)	83 (20-140)	39 (27-90)	<.001
Quality of care	Mortality	0%	0%	na
Experience of care	Patient satisfaction	87%	88%	.250

ETHAN, Emergency Telehealth And Navigation Program; *ED,* emergency department; *IQR,* interquartile range

(where 100 is the best), how would you rate your level of EMS care?"

Since these were primary care-related incidents, there were zero mortalities reported in either of the groups during the prehospital phase for either the intervention or control groups, and consequently there was no significant differences in that measure between groups.

Most significant were the differences in EMS productivity. The median response time (from EMS notification from 911 to unit back in service time) was 39 minutes for ETHAN patients, and the median response for the control group was 83 minutes. This 44-minute reduction in medians between the groups is statistically significant (Mann Whitney $P<.001$). This equates to approximately 2.1 times greater utilization (dispatches per day) for the EMS unit than the standard EMS control group, resulting in significantly lower cost of care. Table 3 summarizes the outcome results.

LIMITATIONS

There are several limitations to this study. An important one is the lack of randomization. Given the nature of the study and the practicality of EMS response, we used a case-control observational design. There are obvious inherent limitations in the selection of the control group, although we made every effort to match the patients based on age, gender, approximate dates, and chief complaint In addition, this study uses data extracted from multiple components of a PCR system. As with all patient record systems, the accuracy and quality of the data entered by field crews may be inaccurate or incomplete. We incorporated multiple special precautions for ensuring data quality and validity of the dataset to mitigate this limitation, including oversight from both operational and information technology personnel at the fire department.

Another limitation is that this study represents only a small subset of total EMS calls in this large city (roughly 1.9% of all calls in 2015). Since it was designed as a pilot study to assess feasibility and relative effectiveness on measures of ambulance utilization and EMS productivity, future period will use greater sample sizes. Lack of comprehensive data on post-EMS response outcomes is also a limitation. Although we found no reported deaths, we were not able to do a comprehensive search of all patients that might have died after the EMS response. We were not able to determine the effect of the ETHAN program on ED crowding across more than 60 hospitals with 1.4 million ED visits. Finally, there were few technical limitations of this telehealth system, although a very small subset of calls were aborted due to poor wireless cellular signals required to use the paramedics' tablets in patients' homes. As wireless networks continue to improve in the region, this should be less of an ongoing problem over time.

DISCUSSION

To our knowledge, this study represents one of the largest, urban efforts at integrating mobile technologies and alternative patient navigation to improve EMS utilization and outcomes. As suggested by other researchers, there is a clear need for more effectiveness studies from mobile integrated health programs in emergency medicine, to explore their development and the results they produce. The results presented here offer insight into the overall effectiveness of a large-scale program currently underway.

As populations continue to grow, municipal resources shrink, and hospital EDs continue to have limited capacity, the demand on traditional EMS will create significant problems. Alternative models, through mobile integrated health and community paramedicine, offer potential to improve EMS utilization while maintaining quality of care and better aligning patients with the appropriate level of care. Around the country, multiple demonstration projects are underway, but little evidence exists to support their impact on care delivery.

In this research, we found that the integration of a telehealth-based initiative with patient navigation to more appropriate care levels, creates significant reduction in ambulance-enabled ED utilization. Specifically, we found that the program resulted in a median 44-minute reduction in the unit back in service time (39 vs. 83 minutes). This equates to roughly 2.12 times greater productivity. We also observed a significant reduction in ED ambulance transports, from 74% to only 18%. These results come with little or no significant impact on clinical quality or patient satisfaction.

This study confirms that potentially unnecessary ambulance transports to the ED can be significantly reduced, which has significant financial and utilization impact on EMS agencies. We surmise that use of community paramedicine combined with telehealth and other mobile technology has potential to improve both EMS agency and overall emergency system capacity.

There are interesting financial consequences of this

research. According to the Centers for Medicare and Medicaid, of the 107 funded "Health Care Innovation" awards, which recently ended their three-year funding term, only a few involve EMS.[19] Based on our findings, we suggest that a significantly greater number of programs be implemented in rural and urban, large and small communities, to create meaningful change nationwide.

Implementing these programs will not be easy, and there are a number of barriers to alternative EMS models. Lack of reimbursement for non-ED transports is clearly significant. Medicare currently does not provide reimbursement unless the patient is transported to the ED.[20] Although researchers have called for payment policy reform to include broader ranges of EMS transport options, they have not yet been adopted.[21] In addition, the lack of reliable field triage criteria and paramedic assessment of medical necessity creates barriers.[22-27] However, technological advancements such as telemedicine, real-time telemetry, and electronic health information exchange (HIE) have made it feasible for paramedics in the field and remotely located physicians to accurately assess, safely manage, and determine resource-efficient courses of action for patients.[28-29] Reimbursement mechanisms for more proactive, alternative models of EMS deployment as well as telehealth will also need to be developed.

The evolution of mobile integrated health programs in EMS has developed rapidly. Within the last five years, dozens of programs have evolved to reduce ED utilization, unnecessary ambulance transports, and improve overall outcomes. The productivity gains we observed in this study should offer evidence to support further innovations in EMS as well as change in policy and reimbursement practices. We contribute to the literature by providing comparative effectiveness research from one of the largest EMS agencies in the country.

CONCLUSION

A telehealth-enabled emergency medical services program reduced unnecessary ambulance transports by 56% to urban emergency departments, and put paramedic units back in service an average of 44 minutes faster.

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Endotracheal Tube Cuff Pressures in Patients Intubated Prior to Helicopter EMS Transport

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Introduction: Endotracheal intubation is a common intervention in critical care patients undergoing helicopter emergency medical services (HEMS) transportation. Measurement of endotracheal tube (ETT) cuff pressures is not common practice in patients referred to our service. Animal studies have demonstrated an association between the pressure of the ETT cuff on the tracheal mucosa and decreased blood flow leading to mucosal ischemia and scarring. Cuff pressures greater than 30 cmH_2O impede mucosal capillary blood flow. Multiple prior studies have recommended 30 cmH_2O as the maximum safe cuff inflation pressure. This study sought to evaluate the inflation pressures in ETT cuffs of patients presenting to HEMS.

Methods: We enrolled a convenience sample of patients presenting to UMass Memorial LifeFlight who were intubated by the sending facility or emergency medical services (EMS) agency. Flight crews measured the ETT cuff pressures using a commercially available device. Those patients intubated by the flight crew were excluded from this analysis as the cuff was inflated with the manometer to a standardized pressure. Crews logged the results on a research form, and we analyzed the data using Microsoft Excel and an online statistical analysis tool.

Results: We analyzed data for 55 patients. There was a mean age of 57 years (range 18-90). The mean ETT cuff pressure was 70 (95% CI= [61-80]) cmH_2O. The mean lies 40 cmH_2O above the maximum accepted value of 30 cmH_2O ($p<0.0001$). Eighty-four percent (84%) of patients encountered had pressures above the recommended maximum. The most frequently recorded pressure was >120 cmH_2O, the maximum pressure on the analog gauge.

Conclusion: Patients presenting to HEMS after intubation by the referral agency (EMS or hospital) have ETT cuffs inflated to pressures that are, on average, more than double the recommended maximum. These patients are at risk for tracheal mucosal injury and scarring from decreased mucosal capillary blood flow. Hospital and EMS providers should use ETT cuff manometry to ensure that they inflate ETT cuffs to safe pressures. [West J Emerg Med. 2016;17(6)721-5.]

INTRODUCTION

Endotracheal intubation is a common intervention in critical care patients undergoing helicopter emergency medical services (HEMS) transportation. A standard adult endotracheal tube (ETT) is secured at its distal end in the trachea using an inflatable cuff. This cuff serves to minimize aspiration risk and provides a seal to allow for delivery of a positive pressure gradient. The pressure in an ETT cuff must be high enough to occlude the lumen of the trachea in order to serve these primary functions.

Excess pressure, however, may increase the risk of damage to the tracheal mucosa.[1-3] ETT cuff pressures (ETTCP) that exceed the capillary perfusion pressure of the mucosa upon

which the cuff is pressing may prevent the flow of blood through those capillaries and lead to mucosal ischemia.[2,3] Animal and human studies have demonstrated that ETTCP in excess of 30 cmH_2O may cause decreased blood flow to the tracheal mucosa in as little as 25 minutes.[1-3] While guidelines for inflation pressures exist, [4] available equipment to measure cuff pressure is not routinely used in all settings, and even experienced operators are prone to over-inflation.[5-7]

We hypothesized that in patients intubated by referral EMS agencies or referral hospitals, the initial cuff pressure measured by the HEMS crew would be within the accepted safe range.

Reduction in tracheal blood flow as a consequence of higher-than-recommended ETTCP has been associated with ischemic lesions to the trachea.[8] Identifying the frequency at which patients are presented for transfer with ETTCP higher-than-recommended safe values will allow modification of practice.

METHODS

Study Design and Setting

We performed a prospective cohort study of patients intubated by referring agencies, both hospitals and EMS agencies, who presented for critical care transport by UMass Memorial Life Flight. The study was approved by the University of Massachusetts Medical School Institutional Review Board.

Selection of Participants

This study was performed at UMass Memorial Life Flight, a critical care transport service based in Worcester, MA, between 2013 and 2014. Patients who were intubated by referring agencies (hospitals or EMS agencies) and transported by helicopter were consecutively included in the study. We excluded patients if they were prisoners at the time of transfer, or if they had been intubated with non-cuffed ETTs.

Methods and Measurements

In all patients intubated prior to initial LifeFlight contact, a baseline ETT cuff pressure reading was obtained at the time of initial assessment. If the pressure was in excess of 25mmH_2O, it was lowered to that pressure. Pressure measurements, inflation, and deflation of the ETT cuffs were performed using the Posey Cufflator™ endotracheal tube inflator and manometer (Posey Company, 5635 Peck Road, Arcadia, California 91006-0020 USA), a commercially available device. The maximum measurement on this device is >120 cmH_2O (see Figure 1).

Data Collection

Data were collected by critical care paramedics and nurses and entered at the time of measurement into a data collection form created for the purpose of the study. These data were then transcribed to a computer database for analysis.

Figure 1. Posey Cufflator™ endotracheal tube inflator and manometer.

Outcome Measures

The primary endpoint of the study was the ETTCP of ETTs placed by referral agencies.

Data Analysis

This study is an observational cohort of a series collected to analyze the change in pressure of ETT cuffs with altitudinal changes in flight. This paper represents a pre-planned subgroup analysis of the initial ETTCP of patients intubated prior to UMass Memorial Life Flight arrival. The original study was planned for 110 patients based on a pre-hoc power calculation. We analyzed the data analyzed at midpoint (55 patients) and found them to be significant for this cohort. The data was entered into and analyzed using Microsoft Excel 2013 (Microsoft Corporation, Redmond, WA) and a Web-based statistical analysis tool for the one-sided T test. For the purposes of analysis of the data, we treated manometer readings at the maximum on this analog manometer (>120 cm H_2O) as equal to 120 cmH_2O.

RESULTS

At the time data analysis was begun, 60 records had been entered into the database. One record was excluded for incomplete data (missing the initial cuff pressure). We

excluded four additional records as the patients were not intubated prior to the Life Flight crew's arrival and were intubated by the crew. The remaining 55 patients were analyzed (see Figure 2).

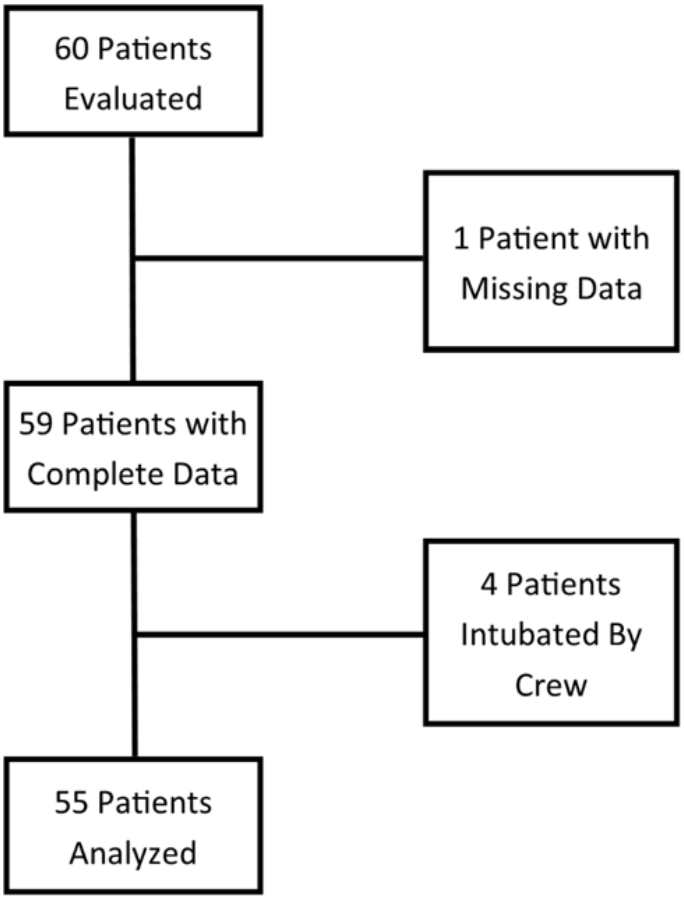

Figure 2. Flow chart of study patient selection and reasons for exclusion from analysis.

Table. Characteristics of subjects in study analyzing endotracheal tube (ETT) cuff pressures in patients arriving to the emergency department via helicopter emergency medical services.

Characteristics	Result
Age (years), mean (95% CI)	57 (51-62)
Minimum age	18
Maximum age	90
Gender, n (%)	
Male	35 (64)
Female	20 (36)
Nature of case, n (%)	
Trauma	10 (18)
Medical	45 (81)
ETT size	
Mode	7.5
Minimum ETT size	6.0
Maximum ETT size	8.5

CI, confidence interval

The table lists the characteristics of the analyzed cases. The mean age of patients was 57, ranging from 18 to 90. Male patients predominated by a small margin. More cases were related to medical conditions as opposed to traumatic conditions. The most common ETT size was 7.5 with sizes ranging from 6.0 to 8.5.

Initial ETTCP ranged from 15 cmH_2O to >120 cm cmH_2O. The mean pressure measurement was 70 cmH_2O, 40 cmH_2O higher than the accepted maximum safe value of 30 cmH_2O ($p<0.0001$, 95% CI for the difference= [31-50]). The mode was >120cmH2O. Of the measurements, 8 (14.55%) were below the accepted maximum safe value of 30 cmH_2O, 47 (85.45%) above that value. Figure 3 shows the distribution of results.

DISCUSSION

The vast majority of endotracheal tubes transported by our critical care HEMS crew had a dangerous level of cuff over-inflation. Less than 15% of the measurements found pressures within acceptable ranges and the most common value was at the upper limit of the manometer's range. Pressures such as this have been shown in animal studies to cause tissue ischemia to the tracheal mucosa.[2,3]

Evidence for the harm of over-inflation of ETT cuffs is not limited to animal studies. A 1984 study by Seegobin found blanching of tracheal mucosa on tracheoscopy in patients whose ETTCP exceeded 40 cm H_2O.[1] This blanching suggests decreased blood flow and ischemia to those regions. A 2013 paper by Touat et al used tracheoscopy on newly extubated patients to evaluate the degree of injury with a tracheal ischemia score. They found that ETTCP > 30 cm H_2O was associated with an elevated tracheal ischemia score.[8] This demonstrates that the issue persists despite the introduction of modern high-volume, low-pressure cuffs.

Less severe complications related to over-inflation of ETT cuffs include hoarseness, sore throat and hemoptysis.[8] More severe complications include post-intubation stridor,[9] tracheal stenosis[10] and even reports of tracheal rupture.[11,12] One study by Kastanos demonstrated a 10% rate of development of tracheal stenosis and that this demonstrated a statistically significant association with elevated ETTCP.[10]

The prevalence of over-inflated ETTCP has been reported several times and yet persists. The reports have covered clinical environments including the prehospital environment,[6,7,13] the emergency department (ED),[13] the peri-operative environment,[14,15] and the intensive care unit (ICU).[16,17]

Many clinicians rely on pilot-balloon estimation of cuff pressures. The inaccuracy of this technique has been demonstrated many times.[9,14,18,19] One study evaluated the

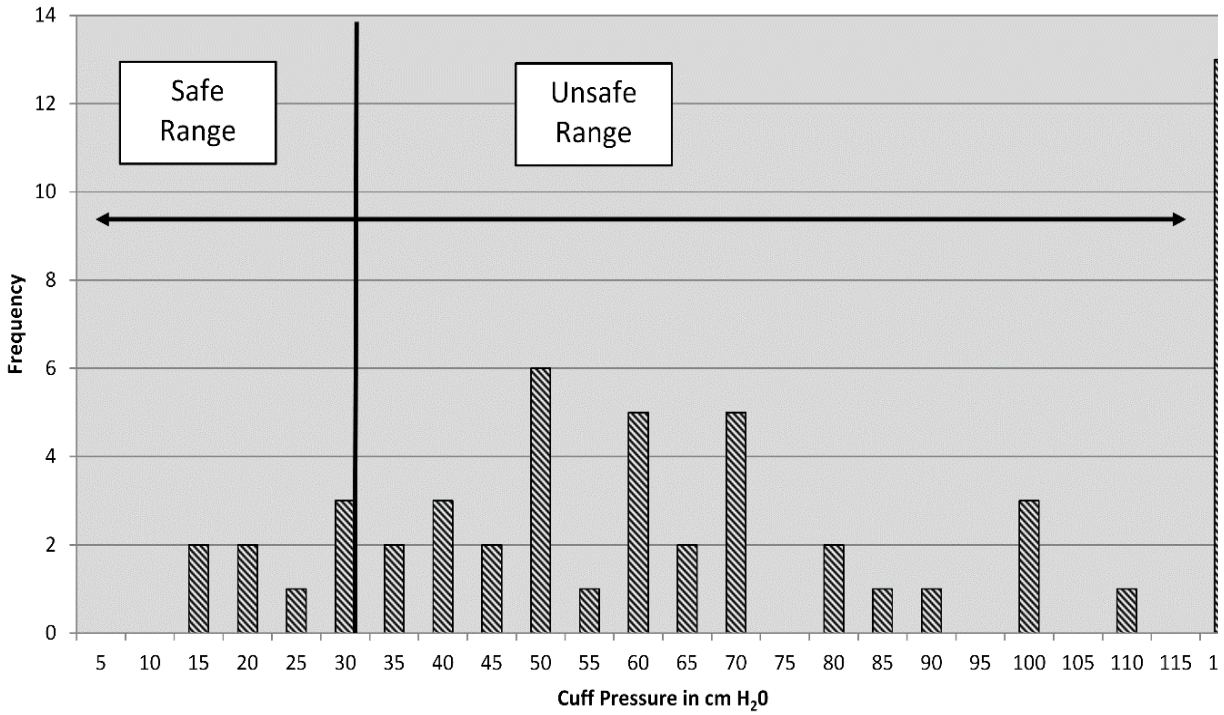

Figure 3. Distribution of initial endotracheal tube cuff pressures.

accuracy of this method by certified nurse anesthetists and anesthesiologists as well as students. They found that fewer than one-third of the cuffs were inflated to an appropriate range. Further, they failed to demonstrate a difference in the accuracy of cuff inflation when stratified by provider experience.[14]

Techniques for using various-sized syringes as pressure-relief valves have been published over the years.[20,21] This technique is analogous to the pilot-balloon technique in that a syringe is left connected to the pilot balloon, allowing the air pressure in the cuff to move the syringe plunger when it is too high. While the early reports favored this technique, a more recent report has found it lacking.[22]

In this study each of the abnormal pressures was normalized prior to flight. Had the pressures not been normalized the risk of tracheal injury might have been even higher. Several papers have demonstrated that ETTCP is affected by altitude changes[23] when patients are transported by aeromedical transport modes.[24-27] This analysis of patients presenting for HEMS transport demonstrated that the majority began with pressure outside the safe range. Our data suggest uncorrected pressures could lead to severe worsening pressures as the patient is brought to altitude, increasing the risk of severe complications.

LIMITATIONS

This dataset is limited by possible confounding variables that were not collected by the data collection forms. It is possible that identification of whether the intubation was performed by hospital staff or field EMS personnel may have identified a tendency toward over-inflation by one of those groups. Additionally, for those cases intubated in a hospital setting, delineating whether they were done in the ED, ICU, or operating room, may have also allowed for more stratification of the data. Finally, the question of who specifically inflated the cuff, be they physician, nurse, or respiratory therapist, may also have elucidated some associations that could potentially have suggested further research.

The fact that these data were collected from a single HEMS system may tend to limit the degree to which they can be generalized. Possibly offsetting this limitation is the fact that the subjects included in the study originated from multiple EMS systems and multiple referral hospitals across a five-state area, providing a greater cross-section than may be inferred from the single HEMS service.

CONCLUSION

In conclusion, we present additional evidence that current standard practice in EMS agencies and referral hospitals in our HEMS system leads to frequently elevated ETTCP. These pressures place the patient at risk for complications from the ETT. Clinicians should move to routine measurement of ETTCP in all intubated patients.

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Blog and Podcast Watch: Neurologic Emergencies

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Introduction: The *WestJEM* Blog and Podcast Watch presents high quality open-access educational blogs and podcasts in emergency medicine (EM) based on the ongoing ALiEM Approved Instructional Resources (AIR) and AIR-Professional series. Both series critically appraise resources using an objective scoring rubric. This installment of the Blog and Podcast Watch highlights the topic of neurologic emergencies from the AIR series.

Methods: The AIR series is a continuously building curriculum that follows the Council of Emergency Medicine Residency Director's (CORD) annual testing schedule. For each module, relevant content is collected from the top 50 Social Media Index sites published within the previous 12 months, and scored by eight board members using five equally weighted measurement outcomes: Best Evidence in Emergency Medicine (BEEM) score, accuracy, educational utility, evidence based, and references. Resources scoring ≥30 out of 35 available points receive an AIR label. Resources scoring 27-29 receive an honorable mention label, if the executive board agrees that the post is accurate and educationally valuable.

Results: A total of 125 blog posts and podcasts were evaluated. Key educational pearls from the 14 AIR posts are summarized, and the 20 honorable mentions are listed.

Conclusion: The *WestJEM* 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. This series provides an expert-based, post-publication curation of educational social media content for EM clinicians with this installment focusing on neurologic emergencies. [West J Emerg Med. 2016;17(6)726-33.]

BACKGROUND

Despite the rapid rise of social media educational content available through blogs and podcasts in emergency medicine (EM),[1] identification of quality resources for educators and learners has only received preliminary progress.[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, are often unsure how to identify quality online resources specifically for asynchronous learning and III credit.

To address this need, the Academic Life in Emergency Medicine (ALiEM) Approved Instructional Resources (AIR) Series and AIR-Pro Series were created in 2014 and 2015, respectively, to help EM residency programs identify quality online content specifically on social media.[6,7] Using an expert-based, crowd-sourced approach, these two programs identify trustworthy, high-quality, educational blog and podcast content. This *WestJEM* Blog and Podcast Watch series presents annotated summaries written by the editorial Board from the AIR and AIR-Pro Series.

This installment from the AIR Series summarizes the highest scoring social media educational resources on neurologic emergencies.

METHODS

Topic Identification

The AIR series is a continuously building curriculum based on the CORD testing schedule (http://www.cordtests.org/).

Inclusion and Exclusion Criteria

A search of the 50 most frequently visited sites per the Social Media Index[9] was conducted for resources relevant to neurologic emergencies, published within the previous 12 months. The search, conducted in December 2015, included blog posts and podcasts, and those written in English were included for our scoring by our expert panel.

Scoring

Extracted posts were scored by eight reviewers from the AIR Editorial Board, which is comprised of EM core faculty from various U.S. medical institutions. The scoring instrument contains five measurement outcomes using seven-point Likert scales: Best Evidence in Emergency Medicine (BEEM) score, accuracy, educational utility, evidence based, and references (Table 1).[8] More detailed methods are described in the original description of the AIR series.[7] Board members with any role in the production of a reviewed resource recused him/herself from grading that resource.

Data Analysis

Resources with a mean evaluator score of ≥ 30 points (out of a maximum of 35) are awarded the AIR label. Resources with a mean score of 27-29 and deemed accurate and educationally valuable by the reviewers are given the honorable mention label.

RESULTS

We initially included a total of 125 blog posts and podcasts. We describe key educational pearls from the 14 AIR posts and list the 20 honorable mentions (Table 2).

AIR Content

1. Simon E. Reversal of Anticoagulation in a True Emergency. EM Docs. (November 10, 2015). http://www.emdocs.net/reversal-of-anticoagulation/

This blog post reviews anticoagulants such as vitamin K antagonists, director thrombin inhibitors (DTIs), and factor 10a inhibitors as well as their mechanism of action, pharmacokinetics, reversal agents, and management strategies.

Take-Home Points

Vitamin K antagonists, such as warfarin, can be reversed by vitamin K, fresh frozen plasma (FFP), and prothrombin complex concentrate (PCC). FFP infusions can be limited by the rate of infusion and the large volume required, in comparison with PCC which has neither of these limitations. PCC is indicated to urgently reverse warfarin in a major hemorrhagic event.

DTIs, such as dabigatran, block free thrombin and clot-bound thrombin and lack specific reversal agents. [Editorial note - since this blog publication, an antibody reversal agent, idarucizumab, has been made available]. Hemodialysis can clear approximately 35% of this drug, and PCC has a potential role in reversal, although it lacks significant evidence at this point. Also lacking evidence at this time is the recommendation by the American College of Cardiology Foundation and the American Heart Association (AHA) for transfusion of packed red blood cells and FFP to reverse hemorrhagic events while on DTIs. For reversal of Factor 10a inhibitors, such as rivaroxaban, apixaban, and fondaparinux, PCC shows promise, and a specific reversal agent is reportedly in development.

2. Long, B. Controversies in the Diagnosis of Subarachnoid Hemorrhage. EM Docs. (November 20, 2015). http://www.emdocs.net/controversies-in-the-diagnosis-of-subarachnoid-hemorrhage/

The most recent guidelines by the American College of Emergency Physicians and the AHA recommend a non-contrast head computed tomography (CT) followed by lumbar puncture as the gold standard for diagnosing a subarachnoid hemorrhage (SAH). Recent advances have changed the diagnostic approach to SAH. This post reviews the strengths and limitations of different diagnostic

Table 1. Approved Instructional Resources - (AIR) scoring instrument for blog and podcast content with the maximum score of 35 points.

Tier 1: BEEM rater scale	Score	Tier 2: content accuracy	Score	Tier 3: educational utility	Score	Tier 4: evidence based medicine	Score	Tier 5: referenced	Score
Assuming that the results of this article are valid, how much does this article impact on EM clinical practice?		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)?		Are the authors and literature clearly cited?	
Useless information	1	Yes, many concerns from many inaccuracies	1	Not required knowledge for a competent EP	1	Not EBM based, only expert opinion	1	No	1
Not really interesting, not really new, changes nothing	2		2		2		2		2
Interesting and new, but doesn't change practice	3	Yes, a major concern about few inaccuracies	3	Yes, but there are only a few (1-2) educational pearls that will make the EP a better practitioner to know or multiple (>=3) educational pearls that are interesting or potentially useful, but rarely required or helpful for the daily practice of an EP.	3	Minimally EBM based			3
Interesting and new, has the potential to change practice	4		4				4	Yes, authors and general references are listed (but no in-line references)	4
New and important: this would probably change practice for some EPs	5	Minimal concerns over minor inaccuracies	5	Yes, there are several (>=3) educational pearls that will make the EP a better practitioner to know, or a few (1-2) every competent EP must know in their practice	5	Mostly EBM based			5
New and important: this would change practice for most EPs	6		6		6		6		6
This is a "must know" for EPs	7	No concerns over inaccuracies	7	Yes, there are multiple educational pearls that every competent EP must know in their practice	7	Yes exclusively EBM based	7	Yes, authors and in-line references are provided	7

BEEM, best evidence in emergency medicine; *EP,* emergency physician; *EBM,* evidence-based medicine.

Table 2. Blog posts and podcasts receiving an Honorable Mention on the topic of neurologic emergencies.

Title	Date	Author	Website URL
Podcast 155 – Status Epilepticus with Tom Bleck	August 13, 2015	Weingart S	http://emcrit.org/podcasts/status-epilepticus/
Treatment of Seizures in the Emergency Department: Pearls and Pitfalls.	December 17, 2015	Hernandez R, Silverberg M	http://www.emdocs.net/treatment-of-seizures-in-the-emergency-department-pearls-and-pitfalls/
Episode 73 Emergency Management of Pediatric Seizures. Emergency Medicine Cases	December 1, 2015	Richer L, Mikrogianakis A, Kilian M, Helman A	https://emergencymedicinecases.com/emergency-management-of-pediatric-seizures/
Ultrasound for Optic Nerve Sheath Diameter	December 30, 2015	Alerhand S	http://www.emdocs.net/ultrasound-for-optic-nerve-sheath-diameter/
Head Injury in Kids	March 7, 2015	Unknown	http://www.resus.com.au/blog/head-injury-in-kids/
Phenobarbital monotherapy for alcohol withdrawal: Simplicity and power	October 18, 2015	Farkas J	http://emcrit.org/pulmcrit/phenobarbital-monotherapy-for-alcohol-withdrawal-simplicity-and-power/
Concussion in Sports: Sidelines and Emergency Department Evaluation and Management	September 22, 2015	Bamman M, Williamson K, Urumov A	http://www.emdocs.net/concussion-in-sports-sideline-and-emergency-department-evaluation-and-management/
Assessing and Managing Delirium in Older Adults.	July 17, 2015	Shenvi C	http://www.aliem.com/delirium-in-older-adults/
Endovascular therapy helps in ischemic stroke, again (ESCAPE)	March 27, 2015	Rali P, Titoff I	http://pulmccm.org/main/2015/randomized-controlled-trials/endovascular-therapy-helps-in-ischemic-stroke-again-escape/
Christmas Comes Early for Endovascular Therapy in Stroke	February 12, 2015	Radecki, R	http://www.emlitofnote.com/?p=3316
Stroke Thrombolysis. Life in the Fast Lane	January 11, 2015	Nickson, C	http://lifeinthefastlane.com/ccc/stroke-thrombolysis/
Ischemic Stroke Treatment Archive	November 9, 2015	Rezaie, S	http://rebelem.com/ischemic-stroke-treatment-archive/
The Subarachnoid Enigma	May 9, 2015	Orman, R	http://blog.ercast.org/the-subarachnoid-enigma/
Pediatric Stroke: EM-Focused Highlights	August 25, 2015	Slama, R	http://www.emdocs.net/pediatric-stroke-em-focused-highlights/
Cerebral Venous Thrombosis	August 15, 2015	Nickson, C	http://lifeinthefastlane.com/ccc/cerebral-venous-thrombosis/
Episode 17 Part 1: Emergency Stroke Controversies	January, 2015	Himmel W, Selchen D, Chartier L, Helman A	https://emergencymedicinecases.com/episode-17-part-1-emergency-stroke-controversies/
SGEM#137: A Foggy Day – Endovascular Treatment for Acute Ischemic Stroke	November 21, 2015	Spiegel, R	http://thesgem.com/2015/11/sgem137-a-foggy-day-endovascular-treatment-for-acute-ischemic-stroke/
The Approach to the Dizzy Patient	November 17, 2015	Hill J, McKean J, Knight B	http://www.tamingthesru.com/blog/bread-and-butter/dizziness?rq=stroke
Stroke and TIA: Pearls and Pitfalls	May 29, 2015	Ferguson W, Crane D, Lo A	http://www.emdocs.net/stroke-and-tia-pearls-and-pitfalls/
Tissue, Not Time, for Stroke	September 18, 2015	Radecki, R	http://www.emlitofnote.com/?p=3229

TIA, transient ischemic attack

approaches including these three clinical decision rules: CT followed by lumbar puncture (LP), CT alone if performed in less than six hours from headache onset, and CT angiography.

Take-Home Points

The Ottawa SAH clinical decision tool approaches 100% for ruling out SAH, but has poor specificity and currently lacks external validation. According to the most current literature, the risk of SAH is less than 1% after a negative non-contrast head CT performed within six hours of headache onset as interpreted by a neuroradiologist. CT angiography performed after a non-diagnostic CT may increase the sensitivity of ruling out SAH and may be reasonable for patients where LP is not feasible. After a negative non-contrast head CT, cerebrospinal fluid (CSF) xanthochromia can also be used to diagnose a SAH, but it can take 2-12 hours to develop. Thus, xanthrochromia may be absent if the LP is performed less than 12 hours after headache onset. Differentiating between a traumatic LP and a SAH can be difficult and no externally validated studies exist to support a specific cut-off. As there are diagnostic problems with each of the possible SAH work-ups, CT alone, CT+CT angiography, CT+LP, shared decision-making should be applied.

3. George W, Kulkarni M. Endovascular Stroke Therapy: Is this the New Standard? EM Docs. (September 8, 2015). http://www.emdocs.net/endovascular-stroke-therapy-is-this-the-new-standard/

This blog post reviews the most recent literature regarding endovascular treatment for acute ischemic stroke. The results, limitations, and responses to each of the following studies are discussed: MR CLEAN, EXTEND-IA, ESCAPE, SWIFT PRIME, and REVASCAT.[10-14] The blog authors acknowledge that these studies seem promising for improving stroke outcomes but heed caution that providers should be wary of its use outside of selected study populations.

Take-Home Points

The most recent studies regarding endovascular therapy for acute ischemic stroke (MR CLEAN, EXTEND-IA, ESCAPE) show improved outcomes compared to tissue plasminogen activator (tPA) alone in the select population studied. Earlier studies (MERCI, SYNTHESIS, MR RESCUE) failed to show true benefit of endovascular intervention. The AHA and the American Stroke Association have endorsed endovascular therapy in their most recent guidelines by stating that there is clinical benefit only in patients with large vessel occlusions and salvageable brain tissue.

4. Rezaie, SR. Minor Head Trauma in Anticoagulated Patients: Admit for Observation or Discharge? Rebel EM. (July 20, 2015). http://rebelem.com/minor-head-trauma-in-anticoagulated-patients-admit-for-observation-or-discharge/

This blog reviews the controversial disposition for head trauma patients on warfarin or clopidogrel after an initial negative head CT due to the concern for delayed intracranial hemorrhage. The author critically appraises the 2012 prospective observational multicenter study on traumatic intracranial hemorrhages in patients with pre-injury warfarin and clopidogrel use.[15]

Take-Home Points

Routine head CTs in head-injured patients with current warfarin or clopidogrel use should be performed, even in well-appearing patients. As delayed traumatic intracranial hemorrhage in head-injured patients on therapeutic warfarin is rare, this post reports he/she may be discharged home after an initial negative head CT. They require, however, clear discharge instructions and close follow up. No patients on clopidogrel had a delayed intracranial hemorrhage. Though no firm evidence-based medicine recommendations exist, patients may require 24-hour hospital observation if they have any of the following: difficulty accessing emergent medical care secondary to poor functional capacity, long travel times, or no friend/family member to observe them should they medically deteriorate. Patients with supratherapeutic anticoagulation, blunt head trauma, and a negative initial head CT were not explicitly discussed in the literature reviewed, but this post recommends a low threshold to admit for frequent neurological checks, repeat INR (international normalized ratio) measurements while holding anticoagulation, and possibly a repeat head CT if any neurologic decline develops.

5. Chan, T. ALiEM-Annals of EM Journal Club: Clinical Decision Rule for Subarachnoid Hemorrhage. Academic Life in Emergency Medicine. (January 20, 2014). http://www.aliem.com/journal-club-clinical-decision-rule-subarachnoid-hemorrhage/

This blog features a live Google Hangout with Dr. Jeff Perry and Dr. Ian Stiell, the lead authors of "Clinical decision rules to rule out subarachnoid hemorrhage for acute headache" published in JAMA 2013.[16] Clinical decision rules discussed by the paper were outlined. Topics discussed by the authors include the following: How a patient's location in the emergency department (ED) may bias his/her workup; the approach to counseling patients about the role of the LP for ruling out SAH; and the value of a radiology resident's interpretation of CT in ruling out SAH.

Take-Home Points

For headache patients, providers must avoid framing bias and not let the patient care location (i.e. fast track area) influence the work up. For SAH, shared decision-making with patients should be used after a negative head CT obtained within six hours of headache onset, because the SAH rate is extremely low. In significantly anemic patients, however,

blood may appear isodense on CT and increase the likelihood of a falsely negative interpretation. Although inexperienced CT interpreters may miss a small SAH, there were no major adverse outcomes in the study's cohort.

6. Crucco, A. SGEM#112: Bang Your Head – Paediatric Concussions. Skeptics Guide to Emergency Medicine (March 22, 2015). http://thesgem.com/2015/03/sgem112-bang-your-head-paediatric-concussions/

This blog review includes two studies on the management of pediatric concussions and relates each to a clinical case. Two clinical questions are addressed: Is there benefit to recommending strict rest after a child has a concussion?, and is there benefit to using intravenous hypertonic saline as a therapy for pediatric concussive pain? The author evaluates each study with the blog's 11-point "Quality Checklist for Randomized Clinical Trials."

Take-Home Points

In children with concussions, two days of strict rest, as defined by no school, work, or physical activity, followed by a gradual return to activity is preferred over five days of rest followed by a gradual return to activity. Hypertonic (3%) saline should not be used for treatment of moderate to severe concussion in pediatric patients until higher quality studies support its use.

7. Spyres, M. Swaminathan A. Seizure, "Answers". EM Lyceum (December 9, 2014). http://emlyceum.com/2014/12/09/seizure-answers/

This thoroughly referenced resource discusses ED patients with seizures, specifically regarding first- and second-line medications, decision for neuroimaging, and diagnosis of pseudo-seizures.

Take-Home Points

Based on the current best available evidence, intravenous (IV) lorazepam, intramuscular (IM) midazolam, and per rectum (PR) diazepam are equally reasonable first-line medications for seizures depending on the route available. Patients with first-time seizures do not universally require neuroimaging in the ED, but those with an abnormal mental status, focal neurologic deficits, trauma, immunocompromised status, or focal seizures should prompt emergent imaging. Pseudo-seizures (or psychogenic nonepileptic seizures) have a number of distinctive features that help to differentiate them from true seizures, including prolonged duration, pelvic thrusting, side-to-side head movements, and absence of postictal confusion.

8. Kreitzer, N. Swaminathan A. Spinal Cord Injury "Answers". EM Lyceum (April 14, 2015). http://emlyceum.com/2015/04/14/spinal-cord-injury-answers/

This well-referenced blog review focuses on various topics related to spinal cord injuries, including optimal imaging modality, management of compression fractures, cervical spine clearance after a negative CT of the cervical spine, and treatment of neurogenic shock.

Take-Home Points

CT imaging is superior to plain films of the spine particularly in regard to the assessment of potential cervical spine injuries. There is limited evidence to guide management of neurogenic shock but using norepinephrine as a first-line medication appears reasonable. Elderly patients with compression fractures and an absence of neurologic symptoms can be discharged home if they are able to ambulate and safely perform their daily activities of living. There are multiple options for cervical spine clearance after a negative cervical spine CT including urgent magnetic resonance imaging (MRI), immobilization and follow up, and immobilization with delayed flexion-extension films. [Editorial note: Early evidence suggests that there is little additional value in obtaining flexion-extension films after a negative CT in neurologically intact, awake, adult patients.[17,18]]

9. Swaminathan A, Junck E. SGEM#106: O Canada-Canadian CT Head Rule for Patients with Minor Head Injury. Skeptics Guide to Emergency Medicine. (February 3, 2015). http://thesgem.com/2015/02/sgem106-o-canada-canadian-ct-head-rule-for-patients-with-minor-head-injury/

This 34-minute podcast and blog post summarizes the two minor head injury decision instruments (New Orleans and Canadian). The review begins with a case and then reviews each decision tool. The authors then discuss more in depth the studies the tools were derived from, and compare and contrast these instruments.

Take-Home Points

Both the Canadian and New Orleans head CT decision tools are highly sensitive for positive CT findings and clinically important brain injuries. The Canadian CT Head Tool had higher specificity and may be more clinically applicable as it is designed to predict clinically significant brain injuries.

10. Spampinato N. Post Lumbar Puncture Headaches. Rebel EM. (March 31, 2015). http://rebelem.com/post-lumbar-puncture-headaches/

This blog post reviews the prevention and treatment of post-LP headaches. Evidence-based techniques and preventative measures are reviewed to help minimize this disabling complication.

Take-Home Points

Post-LP headache prevention techniques include the following: using smaller 20–22 gauge spinal needles, positioning the needle bevel parallel to the dural fibers, replacing the stylet before withdrawal of the spinal needle, and minimizing the number of LP attempts. Per the evidence reviewed, post-LP headaches are not affected by bed rest, the volume of cerebrospinal fluid removed, the patient position, and IV fluids prior to the LP. Finally, IV and oral caffeine do seem to improve post-LP headaches, but these headaches have a high recurrence rate.

11. Huang, D. PEM Pearls: Migraine Treatment for Pediatric EM Patients. Academic Life in Emergency Medicine. (August 31, 2015). http://www.aliem.com/migraine-treatment-for-pediatric-em-patients/

This blog review provides an in-depth analysis of the evidence for pediatric headaches and migraine therapies. This topic is important for clinicians, because three-fourths of pediatric patients diagnosed with primary headaches are diagnosed with migraines.

Take-Home Points

For pediatric migraines, the preferred medication is prochlorperazine for children older than six years. Compared to metoclopramide, prochlorperazine decreases repeat visits as well as the need for rescue medications, admission rate, disposition time, and hypotensive events compared to chlorpromazine. Diphenhydramine can be used to reduce akathisia or dystonic reactions, but it does cause increased sedation. Additionally, IV fluids, acetaminophen, or ibuprofen in conjunction with caffeine are effective. For persistent headaches, triptans can be used in the ED. In contrast, narcotics lead to significantly increased return visits and are not recommended.

12. Orman, R. Swaminathan, A. Neurogenic Shock. ER Cast. (August 18, 2015). http://blog.ercast.org/spinal-shock/

This 18-minute podcast and accompanying blog post discusses the presentation, diagnosis, and evidence-based management of neurogenic shock.

Take-Home Points

Neurogenic shock is a form of distributive shock in patients with spinal cord injuries typically seen in patients with injury at or above T4. It is caused by a lack of sympathetic tone and presents with bradycardia and hypotension. Treatment is directed at maintaining a mean arterial pressure of over 85 mm Hg with fluid resuscitation and vasopressors (typically norepinephrine).

13. Sobolewski B. Why We Do What We Do: Benzodiazepines as First Line Therapy for Status Epilepticus. (October 25, 2015). http://www.pemcincinnati.com/blog/why-we-do-what-we-do-benzodiazepines-as-first-line-therapy-for-status-epilepticus/

This evidence-based review discusses the use of benzodiazepines for status epilepticus as well as comparing lorazepam, midazolam, and diazepam in pediatrics patients older than four weeks with seizures.

Take-Home Points

There are several options to treat status epilepticus, which include lorazepam 0.1 mg/kg IV (maximum dose 4 mg), diazepam 0.2 mg/kg IV (maximum 8 mg), and midazolam (10 mg for > 40 kg, 5 mg for 13 – 40 kg, or 0.2 mg/kg for weight <12 kg). In head-to-head comparisons, no single benzodiazepine truly outweighs the others. The final medication recommendation depends on the patient's access. If there is IV/intraosseous (IO) access, lorazepam is a viable option. If there is no IV/IO access, then consider IM midazolam. Rectal diazepam can be administered if IV/IO and IM access is difficult. Importantly, more than two doses of benzodiazepines increases the risk of respiratory depression.

14. Butterfield M, Jeang, L. Can Giant Cell Arteritis Be Ruled Out in the ED? EM Docs. (November 14, 2015). http://www.emdocs.net/can-giant-cell-arteritis-be-ruled-out-in-the-ed/

This evidence-based blog post provides a thorough review of the utility of history, clinical exam, laboratory tests, and imaging in the evaluation of temporal arteritis.

Take-Home Points

Clinically ruling out temporal arteritis is difficult. Of the historical factors evaluated, the only one with significance is age as temporal arteritis is rare in patients younger than 50 years old. Even the American College of Rheumatology definition of temporal arteritis itself was designed to differentiate it from other vasculidites, and is less applicable to patients in the ED. Little evidence exists to support laboratory tests such as serum ESR or CRP to rule out temporal arteritis. Imaging studies such as MRI and ultrasound may be useful if positive, but also lack a high enough sensitivity to rule out temporal arteritis. Ultimately, the diagnostic work up for temporal arteritis is challenging, and the physician should maintain a low index of suspicion for starting steroids and arranging a temporal artery biopsy.

CONCLUSION

The *WestJEM* Blog and Podcast Watch series serves to identify educational quality blogs and podcasts for EM clinicians through its 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 clinicians filter the rapidly published multitude of blog posts and podcasts. Limitations include the search only includes content produced within the last 12 months from the top 50 Social Media Index sites. While these lists are by no means a comprehensive analysis of the entire Internet for these topics, this series provides a post-publication accreditation and curation of recent, online content to identify and recommend high quality, educational social media content for the EM clinician.

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Pilot Point-of-Care Ultrasound Curriculum at Harvard Medical School: Early Experience

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Introduction: Point-of-care ultrasound (POCUS) is expanding across all medical specialties. As the benefits of US technology are becoming apparent, efforts to integrate US into pre-clinical medical education are growing. Our objective was to describe our process of integrating POCUS as an educational tool into the medical school curriculum and how such efforts are perceived by students.

Methods: This was a pilot study to introduce ultrasonography into the Harvard Medical School curriculum to first- and second-year medical students. Didactic and hands-on sessions were introduced to first-year students during gross anatomy and to second-year students in the physical exam course. Student-perceived attitudes, understanding, and knowledge of US, and its applications to learning the physical exam, were measured by a post-assessment survey.

Results: All first-year anatomy students (n=176) participated in small group hands-on US sessions. In the second-year physical diagnosis course, 38 students participated in four sessions. All students (91%) agreed or strongly agreed that additional US teaching should be incorporated throughout the four-year medical school curriculum.

Conclusion: POCUS can effectively be integrated into the existing medical school curriculum by using didactic and small group hands-on sessions. Medical students perceived US training as valuable in understanding human anatomy and in learning physical exam skills. This innovative program demonstrates US as an additional learning modality. Future goals include expanding on this work to incorporate US education into all four years of medical school. [West J Emerg Med. 2016;17(6)734-40.]

INTRODUCTION

The use of point-of-care ultrasound (POCUS), or bedside ultrasound, has expanded across many medical and surgical specialties.[1] While ultrasound has a traditional role in radiology, obstetrics-gynecology, and cardiology, advances in technology have facilitated the integration of POCUS into a

wider variety of fields such as emergency medicine, critical care, anesthesia, and rheumatology, among others.[2] Incorporation of POCUS training into post-graduate medical education has increased and it is now a component of emergency medicine residency that is required by the Accreditation Council for Graduate Medical Education.[3]

As focused ultrasonography takes a more prominent role in medical care, there is increasing interest in introducing it earlier at the undergraduate medical education level. Multiple reports to date describe the feasibility of introducing US into medical school curricula. Such efforts have been well received by students who report a high level of satisfaction with ultrasonography as well as interest in additional training and incorporation of bedside US during medical school education. Efforts have also shown that POCUS introduced during anatomy and the physical exam course show promise to increase students' knowledge.[4-16]

A 2014 report by Bahner et al described the state of ultrasound education in U.S. medical schools. In 82/143 medical schools that responded to the survey, 62.2% reported some level of US training in their medical education curriculum. The majority of respondents (78.9%) agreed that US should be part of the undergraduate medical education though only 18.6% reported it was a priority at their institution.[17] A few schools have reported on their successful experiences of integrating US into a vertical four-year medical school curriculum.[18-20] To date, fully developed POCUS programs are limited to a small number of medical schools and there are no national guidelines as use of bedside ultrasound spreads into additional medical student curriculum.

Objectives

The objectives of our study were the following: 1) determine the feasibility and barriers of integrating a POCUS curriculum into the first- and second-year medical school curriculum at our institution and 2) determine student-perceived values and attitudes toward point-of-care ultrasonography in the medical school curriculum.

METHODS

This was a pilot study to assess the feasibility and student response of introducing bedside ultrasonography into the existing curriculum during the 2013-14 academic year. A multi-disciplinary team of instructors represented by emergency medicine, radiology, internal medicine, anatomy and physiology, cardiology, pediatrics, rheumatology, and physical medicine and rehabilitation contributed to the development and integration of a new POCUS curriculum.

Curriculum development

Before initiation of this pilot ultrasound curriculum, student exposure to US was limited. Many students were unaware that US was being used as an educational tool at other medical schools. A core group of multi-disciplinary faculty with ultrasound expertise (JR, DD, MJK) met with the anatomy and physical diagnosis course directors (TV, CM, FS) to create a set of potentially feasible educational objectives based on the allotted time that was provided for the pilot US sessions. This group created an outline and reading materials to provide students prior to each scheduled session, structured the didactic and hands-on components of the sessions, identified and organized multi-disciplinary POCUS instructors and clinical instructors across all four affiliated teaching hospitals to be available for these sessions, and arranged US equipment access. This group created post-curriculum surveys to obtain student feedback after the sessions. "Train-the-trainer" sessions to standardize teaching by residents and fellows to faculty level teaching were also provided (JR, MJK) prior to each medical student session. The hands-on sessions were primarily taught by resident and fellow physicians with significant oversight by a core group of attending-level physicians. Faculty representation from each discipline varied depending on the topic; for instance, abdominal sessions were largely taught by faculty in emergency medicine and radiology, while musculoskeletal sessions were taught primarily by faculty from internal medicine, emergency medicine, and rheumatology.

Ultrasound into the first-year anatomy course

We introduced US into the first-year anatomy class during the 2013-14 year. A 40-minute introductory lecture to the class using case-based examples and a basic introduction to US was followed by four hands-on ultrasound sessions. Sessions included basic anatomy of the neck, vascular structures, thorax, cardiac system, abdomen, and musculoskeletal. These sessions were held over a three-month period during the anatomy course. The hands-on sessions were held at the same time and in parallel with the gross dissection lab. Groups of 4-6 students rotated through 10-15 minute hands-on US sessions. The sessions were run in a separate space of the anatomy lab. One student in each group acted as a model while the remaining students acquired focused images of the anatomic structures being dissected during the lab session. US instructors ranged from resident to attending- level physicians from a variety of specialties. Learning objectives were distributed to instructors prior to each session. US teaching sessions for the resident level instructors, prior to student teaching, were conducted to ensure a high level of quality and consistency among instructors. Given the limited allotted time for each station, a checklist of certain anatomical structures and their ultrasound orientation views were emphasized in the short stations. Table 1 provides a brief overview of the anatomy labs sessions.

Second-year physical diagnosis course

At our institution, second-year students are divided among

Table 1. Ultrasound curriculum for PGY (postgradutae year)-1 anatomy lab sessions.

Session	Objective
1. Neck	Identify carotid artery, jugular vein, and the thyroid; sono-anatomic difference between internal jugular vein and carotid artery
2. Cardiac	Identify basic cardiac views and orientation of heart chambers and valves
3. Abdomen	Identify relationship and orientation of liver, gallbladder, kidney, Morison's pouch, diaphragm, spleen, aorta, vena cava
4. Musculoskeletal	While included joints and tendons of shoulder and elbow, due to time constraints the focus was placed on joints and tendons of the hand and digits, such as metacarpophalangeal joint, metacarpal bones, phalanx bones, flexor and extensor tendons.

the four affiliated teaching hospitals for a year-long course in the physical exam. This pilot curriculum took place at one of the four designated course sites and included all 38 students at that single site. During the first half of the course, four four-hour sessions were held: 1) introduction to ultrasound; 2) the evaluation of the neck and thyroid; 3) the musculoskeletal exam; and 4) the abdominal exam. Each session started with a brief didactic session (10-15 minutes) with the majority of the time spent on hands-on instruction. Students were divided into groups of four and physical exam skills were taught in parallel with ultrasonographic correlation. Instructors taught physical exam skills along with US skills including image acquisition, interpretation, and correlation into the physical exam. Clinical instructors who were able to teach physical exam skills but unable to teach the ultrasound skills portion were paired with an ultrasound instructor who provided the US teaching. Learning objectives were distributed to instructors prior to each session. Ultrasound and physical exam teaching sessions for the resident-level instructors, prior to student teaching, were held to standardize a high level of quality among instructors. Table 2 shows the focused goals of each session and the content that was covered.

Students completed a post-curriculum survey of the US sessions to determine the perceived value and attitudes toward the sessions. Survey assessment was obtained using a five-point Likert scale (1, strongly disagree; 5, strongly agree), and results are reported as means with standard deviation.

Second-year ultrasound selective

Additionally, an advanced session was offered to students during the second half of the physical exam course. Students are offered a variety of "selectives" during the spring of the physical exam course meant to prepare them for their clinical rotations. An ultrasound "selective" was offered to students during the 2013-14 year. This was offered to the same subset of students who took part in the US sessions as part of the physical diagnosis course. A total of 12 students participated in the advanced US session. This session was offered four times during the course to keep the student-to-instructor ratio low. Each three-hour session started with a brief lecture reviewing basics of US machine image acquisition and orientation. Students were subsequently introduced to the focused assessment with sonography in trauma (FAST) examination. Following the didactic portion, the instructor took students to the emergency department where the small groups incorporated basic abdominal and cardiac imaging into the history and physical exam of a patient volunteer. Students completed a brief pre- and post-curriculum survey meant to assess knowledge acquired as well as overall experience and satisfaction with the advanced session. Students were assessed on such questions

Table 2. Ultrasound curriculum for PGY (postgraduate year)-2 physical exam course.

Session	Ultrasound skill objective	Physical exam skill objective
1. Introduction to ultrasound	Introduction to machine, basic terminology, transducer types, basic scanning techniques, orientation, and planes of view Sonographic appearance of fluid, soft tissue, air, bone, vessels, and distinguish arterial from venous vessels	Basic approach to distinguishing arteries from veins
2. Abdominal ultrasound	Demonstrate and visualize ultrasound appearance of liver, kidney, gallbladder, spleen, bladder, bowel, diaphragm, aorta, vena cava	Examine and percuss liver and spleen borders, assess for Murphy's sign, palpate aorta
3. Neck and thyroid ultrasound	Evaluate normal and abnormal thyroid ultrasound, carotid artery, jugular vein, arterial and venous waveforms	Palpate borders of thyroid, assess jugular venous pressure
4. Musculoskeletal ultrasound	Demonstrate and visualize ultrasound appearance of muscle, tendon, bone, nerve Perform physical exam maneuvers while visualizing bones, tendons, nerves, joints (shoulder, hand, wrist, knee, and ankle)	Inspection, palpation and physical exam maneuvers of the shoulder, knee, and ankle

as listing the basic views of the FAST exam, identifying basic cardiac views, cardiac chambers, as well as very basic questions on US physics and the appearance of fluid on US.

Ethics

This study was deemed to be non-human research by the Harvard Medical School Institutional Review Board and was approved by the Harvard Medical School Academy.

RESULTS

First-year anatomy course

All first-year anatomy students (n=176) participated in the lab sessions. The short hands-on sessions proved to be a feasible addition to the course and 91% of students agreed or strongly agreed that the ultrasound sessions were a positive addition to the course.

Second-year physical exam course

Thirty-three out of a total of 38 students (87% response rate) completed a post-assessment survey of the US sessions. The post-assessment survey was distributed immediately after the session and it is unclear why five surveys were not completed or went missing. Using a five-point Likert scale, 94% of students either agreed or strongly agreed with the statement that they would like to see US incorporated into the medical school curriculum. Eighty-five percent of students agreed or strongly agreed that they would benefit from expanded ultrasound experience during all four years of medical school, and 97% of students agreed or strongly agreed that it is important for them to learn basic US skills during medical school. Eighty-eight percent of students agreed or strongly agreed that the US sessions both allowed them to more effectively learn the physical exam; 88% of students agreed with the statement "visualizing anatomy by ultrasound gave me more confidence in my physical exam skills." Ninety-four percent of students felt that the US component should continue in the physical exam course. In addition, 91% of students agreed or strongly agreed that US should be given additional time throughout the four-year medical school curriculum. Table 3 shows average student responses.

Advanced ultrasound selective

Twelve students participated in the three-hour US "selective." All students completed a pre- and post-assessment survey. All students were able to correctly list the standard four views that make up the FAST examination following the session. Additionally, when shown an image of the right upper quadrant (Figure), no students were able to correctly identify the three structures prior to the session, while 11/12 students correctly identified all three structures in the post-assessment survey. All students increased their confidence in their ability

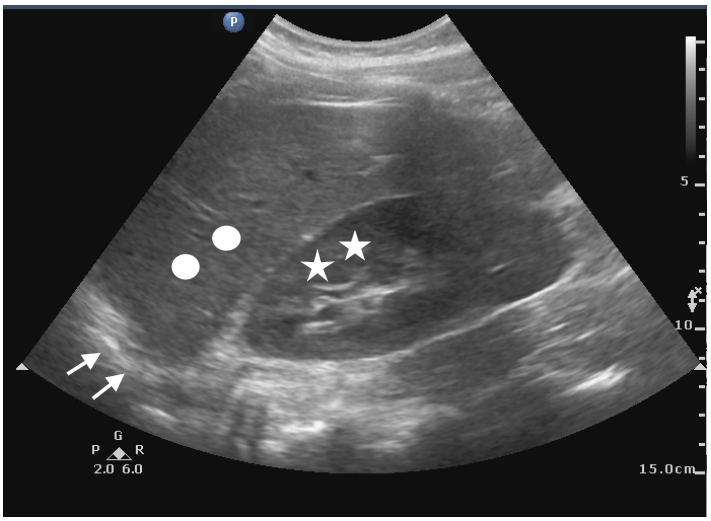

Figure. Assessment of students' ability to identify basic structures in right upper quadrant. Liver marked with circle, kidney with stars, and diaphragm with arrows.

Table 3. Average post-session PGY (postgraduate year)-2 student responses on scale from 1-5 (reported with standard deviation) given after physical exam course incorporating ultrasound.

Assessment question	Response
I would like to see ultrasound integrated into my medical education	4.52 (0.62)
Ultrasound has the ability to enhance my medical training in the pre-clinical courses	4.45 (0.62)
Ultrasound has the ability to enhance my medical training in the clinical years	4.67 (0.6)
I would benefit from continued ultrasound exposure throughout all four years of medical school	4.39 (0.74)
It is important for me to learn basic ultrasound skills during medical school	4.61 (0.56)
The addition of ultrasound to the physical diagnosis curriculum helped me more effectively learn physical exam skills	4.36 (0.92)
Visualizing anatomy by ultrasound gave me more confidence in my physical exam skills	4.33 (1.0)
Ultrasound should continue to be a part of the physical diagnosis course in the future	4.55 (0.67)
I would like to see ultrasound given more time throughout all four years of medical school	4.36 (0.82)

1=Strongly disagree
2=Disagree
3=Neither agree or disagree
4=Agree
5=Strongly agree

to perform both a FAST exam as well as a focused cardiac exam following the session. Following the sessions, all 12 students agreed or strongly agreed that US skills are important to learn during medical school.

DISCUSSION

As POCUS has taken a more prominent and diverse role throughout medical and surgical specialties, there has been increasing interest in introducing it earlier in medical training. Several studies have shown bedside ultrasonography to be a feasible addition to medical school education with a handful of schools reporting successful integration of a vertical curriculum over four years.[4,11]

Currently the Liaison Committee on Medical Education (LCME) does not include POCUS as mandatory for medical student education; however, it is clear that various technologies and digital resources have changed the way that students learn. Just as e-learning, simulation, and the instructional methodology of the "flipped classroom" has made its way into medical school education, POCUS has great potential to add blended learning to optimize student learning and retention. Furthermore, early exposure to learning US skills will help prepare students for future clinical work.

There have been multiple reports demonstrating that students' understanding of anatomy and physical exam skills improve with the incorporation of US. Students also improve specific physical exam skills such as measuring liver size and detecting cardiac murmurs with the addition of focused ultrasound.[21-24] Dinh et al recently reported their findings that a first-year curriculum into a physical diagnosis course may improve overall physical examination skills.[25]

Our initial ultrasound pilot program integrated into the first- and second-year curriculum for the 2013-14 academic year was well received by students. For a small subset of 12 students who took an advanced selective during the second year, a brief three-hour session may improve both confidence in performing exams as well as knowledge of image acquisition and interpretation. Throughout the pilot program, students overwhelmingly desired additional US sessions.

Despite positive student feedback, many challenges remain in the introduction of POCUS education into the medical school curriculum. Others have described limitations of time, space, financial resources, as well as trained faculty.[4,17] At our institution, we are fortunate to have expertise in POCUS from a variety of specialties and only through a multidisciplinary effort involving emergency medicine, radiology, internal medicine, anatomy and physiology, cardiology, physical medicine and rehabilitation, and rheumatology have our initial efforts been successful. In a review of other programs, our effort seems to be unique in the number of disciplines actively involved in the planning and teaching efforts. Faculty time is often scarce and it took considerable effort to find well-trained, enthusiastic instructors to keep our student-to-instructor ratio at the goal of 4:1. To expand efforts in the pre-clinical as well as clinical years, future training of instructors is necessary. Focused "train-the-trainer" sessions led by expert POCUS faculty for residents and fellows interested in teaching, which occurred prior to the medical student sessions, allowed us to expand the number of our instructors as well.

We faced similar limitations in financial resources as described at other institutions as well. Our medical school does not yet own any US machines. Thus, we relied largely on equipment from other departments and in-kind use of equipment through vendor sources to meet the needs for the student sessions. Significant time and effort was required to arrange enough US systems for each session. Lack of equipment available in between sessions limits the opportunity for students to pursue self-directed learning for further reinforcement. Furthermore, access to US machines is limited on medical and surgical floors in the hospitals. For students to retain and use skills learned early in training, US machines must be available to students in clinical rotations. Similarly, trained faculty in POCUS, while expanding, remains limited across our clinical sites. In order to fully grow as a program, we must continue to advance knowledge and skills across all of our four affiliated hospitals.

We also faced challenges defining the most appropriate fit for our US curriculum and continue to better define the best fit as our program matures. Time in the medical student curriculum is limited and there are many competing interests. US programs may be offered as electives rather than core components of the curriculum.[26] While still working to define the best fit and areas for growth for the US curriculum, this pilot program was successful only through significant open and collaborative dialogue between the ultrasound core faculty and many members of the Harvard Medical School faculty.

This effort was successful only after considerable discussion on multiple levels within Harvard Medical School, from individual course directors, course planning committees, and the dean of medical education. Only through initiating discussion across many hospital and multiple levels of curriculum development, were we able to obtain initial success for this pilot program. While attending large curriculum planning meetings was helpful to create an initial presence in the medical school, it was equally important to meet with and identify individual course directors to find time and space in the curriculum for our sessions. As we develop, we continue to engage educators at multiple levels within the medical school curriculum as well as at the various hospitals affiliated with the medical school. All such efforts are done in parallel as we hope to expand on our initial success to involve more hospitals as well as a greater presence in the four-year curriculum.

LIMITATIONS

Our results are limited by the subjective nature of the data. Our outcomes using rating scales from student questionnaires are inherently limited. Future work should

focus on observed skills and knowledge in the context of ultrasound education. We realize the subjective nature of our results are limited and hope to expand on initial efforts to examine stronger outcomes of students' skills and competency from the introduction of US into the medical school curriculum. Due to financial and time constraints both of faculty as well as limited time in the student curriculum, we were unable to develop more objective outcome measures in this pilot study. We hope to develop a more substantial and objective evaluation process, which is essential as curricula develop and expand. As curricula mature and are more fully integrated into undergraduate medical education, there remains the need for guidelines to help focus future work.

The costs associated with an ultrasound program, from faculty time, time in the curriculum, as well as costs of machines, are substantial. To convince administrators the costs are worthwhile, we do hope to participate in future work examining the skills, knowledge, and ultimately improved clinical care that may come from the introduction of an ultrasound curriculum.

Furthermore, while a single institution and results are limited to our school, students at Harvard have courses at four primary hospitals and our efforts did involve discussion with multiple pre-clinical and clinical sites. We did only introduce the US sessions to a single site as part of the second-year physical exam course further limiting our experiences in the second-year curriculum. We also relied on multiple levels of instructors from residents to attending-level providers from a variety of specialties. While we worked hard to standardize each lesson plan, further work is needed to ensure a high quality of consistent teaching across all sessions. Despite these limitations, we feel our efforts offer lessons to other programs at early stages of developing an ultrasound curriculum in medical school education.

CONCLUSION

Our pilot efforts have shown that integration of bedside ultrasonography into the pre-clinical medical school curriculum is well received by students. We used didactics and small group hands-on teaching sessions led by a multi-disciplinary team of instructors to introduce ultrasound sessions into the medical school curriculum. Medical students perceived the US curriculum as valuable in better understanding human anatomy and learning physical exam skills. Within our pilot study, students uniformly expressed the desire for an expanded ultrasound curriculum. Further work aims to collect more objective data to guide national guidelines as further ultrasound programs develop and mature in medical student education.

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U.S. Food and Drug Administration: Review for the Emergency Physician of Approval Process and Limitations

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INTRODUCTION

Emergency physicians (EP) frequently are exposed to promotion for drugs and devices through professional organizations and meetings, journals, and direct-to-consumer pharmaceutical advertising (DTCPA). To provide optimum patient care through evidence-based medicine, it is critical to be aware of the processes that regulate these drugs.

Though it is uncommon for ED patients to request specific drugs or treatments for emergency conditions, it is not uncommon for patients taking newly marketed drugs with unfamiliar mechanisms of action and side effects to present to the ED. The U.S. Food and Drug Administration (FDA) rate of approval of new drugs is increasing moderately, from 22 in 2006, to 45 in 2015.[1] This requires the prudent EP to query drug databases for interactions with standard ED treatments, or run the risk of new interactions. Furthermore, nonspecific symptoms may be side effects of new medications, with which the practicing EP is unfamiliar.

The FDA is responsible for strictly regulating the safety and effectiveness of drugs produced by the pharmaceutical industry. The FDA has experienced increasing pressure to fulfill this regulatory role despite the increasing pace of development of medical devices and medications[2] and a budget that is a fraction of other government agencies. For example, the FDA has only 1.8% of the U.S. Department of Agriculture's budget.[3,4] This balancing of public health protection and efficiency led Congress to pass the Prescription Drug User Fee Act (PDUFA)[5] that enabled direct pharmaceutical company subsidization of the FDA review process. The regulatory agency is partially funded by the companies it is charged with regulating. In addition, although the FDA relies on congressional oversight to safeguard 25% of products and services consumed in the U.S.,[6] robust lobbying influences regulation of these products, which enhances pharmaceutical industry profits.[7]

Despite precautions taken by the FDA, limited funding and external pressure to expedite approval of advanced medical therapies has led to compromises in drug safety. Properly prescribed drugs result in over 100,000 deaths annually, with prescription drugs among the top 10 causes of death, more than each of lung disease, diabetes, AIDS or automobile fatalities.[8] In 2012 there were approximately 4.2 billion prescriptions written, worth some $326 billion dollars.[9] Almost 7% of hospitalized patients have a serious adverse drug reaction with a fatality rate of 0.32%.[10]

This paper reviews the FDA's position in government, limitation of powers and relations with the pharmaceutical industry. These factors have broad influence on the population of patients seeking care in ED.

Center for Drug Evaluation and Research and Marketing

The Center for Drug Evaluation and Research (CDER) is the branch of the FDA concerned with the review of over-the-counter and prescription drugs.[11] CDER's main objective is to evaluate new drugs before they are sold, and provide doctors and patients with information needed to use the medicines wisely. The FDA does not develop, test or manufacture drugs, but instead reviews full reports of clinical studies to determine benefit-to-risk relationship and approval.[12]

Although known as the "consumer watchdog," concerns of drug safety and timeliness of the FDA review highlight challenges with the current system. This includes an underdeveloped Adverse Effect Reporting System, which is meant to continue surveillance and study of drugs after release in the market, as well as poor enforcement of direct-to-consumer advertising constraints.[12] Title 21 of the Code of Federal Regulations (CFR) is reserved for the FDA and outlines rules published in the Federal Register by executive departments and federal government agencies related to DTCPA.[13]

The need for improved surveillance and study of drugs after approval can be seen with the recent safety labeling changes for fluoroquinolones announced by the FDA in May

2016, when it was reported that the "side effects associated with fluoroquinolones generally outweigh the benefits for patients." The drug is linked to "disabling and potentially permanent side effects" involving the musculoskeletal and central nervous systems, peripheral neuropathy and cardiovascular complications. Despite these risks and because of challenges associated with post-marketing surveillance, companies such as Bayer, the creator of ciprofloxacin (a type of fluoroquinolone), is still profiting from sales of this drug.[14,15]

DTCPA started in 1981. The U.S. and New Zealand are the only countries that allow these advertisements to include product claims.[16] DTCPA funding from pharmaceutical companies expanded from $791 million in 1996 to $5.4 billion in 2006. The average American television viewer sees nine drug advertisements daily, which equates to about 16 hours per year. This far exceeds the time spent with a primary care physician.[17]

The FDA requires DTCPA to be "fairly balanced" with respect to benefits and risks, to only discuss FDA-approved indications and to explain all possible negative health outcomes whenever the name of the drug is included in the advertisement.[18] When the FDA believes that an advertisement is misleading, it sends a regulatory letter to the pharmaceutical company. However, since 2002 the FDA has been required to send a draft of the letter to the Department of Health and Human Services for legal review. This substantially increases the time between identifying a violation and notifying the pharmaceutical company. Therefore, many of these letters arrive after the advertisements have already finished airing.[19]

In 2009 59 federal employees were responsible for reviewing 71,759 industry submissions of both DTCPA (radio, television, print, Internet, billboards and direct mailings) and direct-to-physician (DTP) promotional material (detailing brochures that pharmaceutical representatives share with office physicians). As explained above, the FDA can issue a notice of violation through a warning letter when a company violates DTCPA laws. Additionally, it could seek criminal prosecution for repeated violations. However, there are no such known cases.[17]

In November 2015, the American Medical Association (AMA) proposed a ban on DTCPA due to the negative effects on public health and need for transparency on drug pricing. This reflects DTCPA's role in raising demand for costly drugs despite debate regarding clinical effectiveness in many patients.[16] However, the DTCPA ban proposed by the AMA is unlikely to be implemented because of the profits gained from off-label use of drugs. For example, Pfizer paid $430 million to settle a claim for fraudulent promotion of the anti-seizure medication Neurontin (gabapentin) when the drug was advertised for non-FDA approved uses such as treatment for neuropathic pain, attention-deficit hyperactivity disorder and as an analgesic for migraine headaches, among others. At the same time, the company made approximately $2.7 billion in sales in a single year, with 90% of the profit from unapproved uses of the drug.[20] These unapproved uses highlight the consequences of delayed or lax enforcement.

Despite concerns regarding DTCPA, there are studies suggesting that such advertising can be beneficial to patients. There is evidence that DTCPA is a motivating factor for patients to express health concerns to their physician, improve awareness of medical conditions and adhere to prescribed treatments.[21] A telephone survey of 3,000 adults found that 35% discussed a DTCPA with their physician and 25% of those visits resulted in a new diagnosis.[22] These findings should be taken into consideration when discussing possible amendments to DTCPA as a promotional tool.

DTCPA drives ED visits and can increase costs, as seen with asthma medications Advair, Asmanex, Singulair and Symbicort,[23] but has also been shown to improve care specifically in Medicaid-enrolled pediatric patients with asthma.[24] However, other studies suggest that there are no resulting health benefits from DTCPA.[25] Low-income patients may be particularly influenced by DTCPA.[26] As EPs care for a disproportionate share of disadvantaged patients, they need to be aware of the influence of the FDA drug approval process.

Patents

The Uruguay Rounds Agreements Act (Public Law 103-465) extended the duration of U.S. patents from 17 to 20 years beginning with the date of first filing the patent application.[27] This gives manufacturers of brand-name drugs sole market rights while in effect. On average, approximately 10 years elapse between the time a patent is obtained and the time the drug is approved, leaving the company about half of the patent time to exclusively market a new drug.[28] Once the patent expires, 80% of brand-name sales can vanish in a year as generic brands reach the market.[29]

However, in many cases, generic brands can fail to reach the market due to reverse payment patent settlements, or "pay-for-delay" agreements, in which brand-name pharmaceutical companies pay generic competitors to *not* sell cheaper, alternative products. This limiting of competition results in $3.5 billion in higher drug costs every year; restricting these agreements would reduce federal debt by $5 billion over 10 years.[30,31] The conversion of the top 20 drugs from brand-name to generic, in terms of yearly sales and length of delay, was postponed by an average of five years by "pay-for-delay" agreements; and drug companies accrued a combined $98 billion before generic brands were sold. There are reported to be 142 brand-name drugs associated with "pay-for-delay" deals since 2005.[32] Because of this, the "pay-for-delay" phenomenon has become a prioritized concern for the Federal Trade Commission in recent years.[30,31]

Drug companies can file multiple patents in an attempt to extend drug patent life. When a generic drug is challenged in court, the FDA is required by law to freeze approval for 30 months unless the case is settled before that time. The FDA has no authority to litigate patent infringement law.[33] Members of Congress often tag patent extensions onto

bills that favor companies that have contributed to their campaigns. For example, in 2002 Bayer took advantage of campaign contributions to extend its monopoly on Cipro by six months. Three of the four congressional sponsors who approved the bill were among the leading recipients of pharmaceutical company campaign contributions in previous years. Bayer had spent $3.7 million on lobbying efforts for two years, but was able to make $358 million extra profit due to the patent extension.[34,35]

Additionally, drug companies file new patents on drugs that are minimally changed compared to the previous version. For instance the company can change the isomer of the drug or change the delivery system to extend patents. In 2008 chlorofluorocarbon, used in inhalers for medications such as albuterol, were banned due to harmful effects on the ozone.[36] This mandate forced companies to switch to hydrofluoroalkane (HFA)-compatible valves, elastomers and surfactants, all of which allowed for new patents and dramatically increased prices compared to the previous generic brand. The newer HFA metered-dose inhaler (MDI) jumped in price ($42-54) compared to the previous chlorofluorocarbon MDI ($13-17).[37] Similarly, a device used to administer ipratroprium is associated with 17 separate patents creating a 58-year patent protection lifetime for this medicine. The concept of "evergreening," defined by Beall et al. as lengthening exclusivity of a product without demonstrating a comparable therapeutic benefit, incentivizes repetitively amending pharmaceutical devices and directing research funding toward promotion of "patentable ideas" instead of medicinally advantageous products.[38]

It has been argued, however, that the profits made from these drugs through patent extensions are necessary to continue funding further development of life-saving treatments. Ensuring profits is especially important due to increasing research expenses, which by 2000 rose to more than $800 million in pre-approval costs per drug.[39] One method of promoting patent extension is altering formulas to reduce frequency of use, which improves patient adherence to prescribed medications. An example of this can be seen with new extended-release formulas made for the antidepressant Prozac and diabetes medication Glucophage.[40] This reinforces the idea that extending market exclusivity can in some cases incentivize innovations that result in improved uses and efficacy of drugs.

PDUFA and the 21st Century Cures Act

In 1992 Congress passed the Prescription Drug User Fee Act, which enabled pharmaceutical company subsidization of the FDA review process. Before PDUFA was passed, taxpayers alone paid for product reviews through budgets provided by Congress.[41]

Pharmaceutical companies pay an application fee for new drug evaluation, the cost of which has risen from $100,000 in 1993 to $2,374,200 per drug in 2016. Product fees are paid annually for previously approved drugs and devices and have increased from $6,000 in 1993 to $144,450 in 2016. In addition, each approved manufacturing facility is assessed an "establishment fee" annually of $585,200 (in 2016) to further support the FDA budget. [42] PDUFA is, therefore, a crucial source of revenue and disincentivizes Congress to fund the FDA. [43]

With this increased external source of funding, the PDUFA has undoubtedly accomplished its goal of shortening approval times. In 1987 the median approval time for a new drug application (NDA) or biologic license application (BLA) was 29 months. This number fell to 17 months within the first two years of PDUFA.[41] This shortened approval time also influenced the number of new drugs that were first introduced in the U.S. In the 1980s only 2-3% of new drugs came from the U.S. This number jumped to 60% in 1998.[44] The proportion of drugs reviewed and eventually approved rose from 60% in the early 1990s to 80% by 2000.[45] In 2000, a *Los Angeles Times* report stated that the FDA felt it was being pressured for not only faster reviews on decisions, but also more drug approvals.[46]

The 21st Century Cures Act, passed in July 2015, sought to further accelerate approval times for new products. Before the Cures Act, approximately one-third of new drugs were approved on a single trial with a median sample size of 760 patients. More than two-thirds of new drugs were approved on studies that lasted six months or less, even though these drugs are designed to be taken for much longer periods of time. The majority of drugs were approved within six to 10 months once FDA review began. The Cures Act now seeks to further shorten this approval time by instructing the FDA to use even "shorter or smaller clinical trials" for devices and to rely on evidence from "clinical experience" including "observational studies, registries and therapeutic use," instead of randomized controlled trials. The FDA is now depending more on biomarkers and surrogate measures rather than actual clinical end points. The FDA already uses surrogate endpoints in about half of new drug approvals.[47]

Furthermore, medical devices have been criticized for lack of rigor compared to drug evaluations. New laws have redefined evidence to include case studies, registries and articles in the medical literature rather than clinical trials. Although informed consent generally is considered to be of utmost importance in the medical community, a clause in the 21st Century Cures Act adds an exception to informed consent for drug and device trials in which "proposed clinical testing poses no more than minimal risk." It remains poorly defined who determines this minimal risk.[47]

Despite these challenges, the FDA has made noteworthy accomplishments with drug oversight. Currently, the average FDA review time is 40, 70 and 174 days faster than Japan, Canada and Europe respectively. From 2004-2013, 75% of drugs approved in these countries, in addition to Australia, had already been authorized by the FDA.[48] Therefore, effective

and potentially life-saving drugs may often be first available to patients in the U.S. due to the FDA's regulatory model.

Lobbying and the UCS Survey

The top 20 pharmaceutical companies along with their two trade groups – Pharmaceutical Research and Manufacturers of America (PhRMA) and Biotechnology Industry Organization – lobbied on over 1,600 pieces of legislation between 1998 and 2004. From January 2005 to June 2006 the pharmaceutical industry disclosed spending $182 million on federal lobbying and has 1,274 registered lobbyists in Washington D.C.[49]

An example of potential conflict of interest through lobbying can be seen with Wilbert "Billy" Tauzin, who represented Louisiana from 1980 to 2005, and became the chair of the House Committee on Energy and Commerce. He crafted the Medicare Prescription Drug, Improvement and Modernization Act of 2003, which prevented Medicare from negotiating for lower prescription drug costs and banned re-importation of drugs from developed-world countries. After the bill passed, Tauzin announced retirement from Congress and took a job as the CEO and chief lobbyist for PhRMA along with an approximate salary of $2 million annually.[50]

These political pressures may have influenced FDA activities, according to the results of the Union of Concerned Scientists (UCS) survey, published in the *Institute of Science in Society.*[51] It showed:

- "18.4% claimed they 'have been asked for non-scientific reasons to inappropriately exclude, or alter, technical information or their conclusions in FDA scientific documents.'
- 17% had been asked 'to provide incomplete, inaccurate or misleading information to the public, regulated industry, media, or government officials.'
- 40% expressed concern of the consequences if they expressed their concerns regarding public health safety in public.
- 47% think that the FDA routinely provides complete and accurate information to the public
- 61% knew of cases where Department of HHS (Health and Human Services) or FDA appointees inappropriately injected themselves into FDA determinations of actions
- 81% agreed that the public would be better served if the independence and authority of FDA post-market safety systems were strengthened."

Institute of Medicine on Safety

The Institute of Medicine (IOM) is a nonprofit organization created by Congress to advise the federal government on health issues. In September 2006, the IOM issued a report on drug safety discussing the FDA and the pharmaceutical industry's lack of accountability to adequately address public health concerns. These issues were partially attributed to limited resources and a suboptimal organizational culture at CDER, as well as an absence of regulatory authority and leadership.[12]

Several recommendations were made to improve the review process. It was proposed that an FDA commissioner with experience and qualifications to lead a science-based agency be selected for a six-year term. The report also suggested that guidance from the Department of HHS would improve morale, professionalism, transparency and integrity of the system. Separation of FDA finances from pharmaceutical companies was also proposed to avoid potential conflicts of interest during the drug review process. It was also recommended to post at least Phase 2 through Phase 4 clinical trials at www.clinicaltrials.gov along with results regarding effectiveness and safety.[12]

The IOM report supported legislation that would enhance FDA authority through restriction of DTCPA as well as better enforcement of fines, warnings and drug approval withdrawals. It was suggested that there be a mandatory evaluation of drugs five years post approval via efficacy and safety reports submitted by drug sponsors. Finally, to support all of the above modifications, it was proposed that Congress should significantly enhance FDA staff and funding.[12]

Other Ideas

A 2006 article published in the *New England Journal of Medicine* by Dr. Alastair Wood also developed other solutions to many of the issues faced by the FDA and the drug-approval process. With respect to the absence of long-term safety data and head-to-head comparisons, the article proposes providing an extended period of patent exclusivity for drugs that have Phase 4 commitments completed, demonstrate continued safety or show improvement over the same class of drugs on the market as opposed to "non-inferiority."[52]

He also recommended an extended period of exclusivity for predefined highly demanded and high-risk drugs that clearly demonstrate a "first in class" status. To solve the issues of surrogate markers not equating to clinically meaningful endpoints, the article proposes limited exclusivity for drugs that have been evaluated using surrogate endpoints and extended exclusivity only to drugs that have produced clinically meaningful outcomes. Finally, the article reinforced the importance of limiting accelerated approval exclusively to life-saving drugs, penalizing pharmaceutical companies who attempt to influence the FDA, rewarding FDA employees for reporting such attempts and encouraging patients to report adverse complications.[52]

CONCLUSION

The FDA must find a balance between hasty drug approvals and meeting demands of advancements in science and technology. Strengthening the authority of the FDA is vital to maintaining integrity and transparency. This translates to distancing individuals and companies that are being regulated from the review process of medical drugs and

devices from which they profit. Perhaps most importantly, it is necessary for Congress to develop a plan to properly fund the FDA so that they have the resources to fulfill their responsibilities of protecting public health and safety. Without these reforms, the "watchdog" function will continue to be inadequate to the task.

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Why the Watchdog Won't Bite: U.S. Food and Drug Administration Challenges

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For many years before I retired, I gave a talk and wrote an essay about New Drugs and Devices.[1] Each year I learned more about interpreting the medical literature and more about the United States Food and Drug Administration (FDA).

I was curious about why so many drugs were approved, only to be found useless – or worse, harmful – in practice, and even pulled from the market. I was fascinated by drugs that were approved despite offering no advantages over what was already available. I was mystified about a system in which the fox seemed to be guarding the henhouse. I read books by former editors[2] in which they admitted that the pharmaceutical industry controlled medical journal content in innumerable and unimaginable ways.

It took a disaster to bring the FDA into existence. The so-called "Massengill massacre" in 1937 caused deaths in more than 100 patients who took "elixir sulfanilamide," which had used the poisonous diethylene glycol as an excipient. This stimulated the U.S. government to give the FDA power to oversee data for the approval of drugs, as well as many foods, medical devices, and cosmetics.[3]

Its finest hour may have come in 1962 when a stubborn physician/pharmacologist, Frances Oldham Kelsey, insisted on seeing better safety data for a drug used widely in Europe to treat "morning sickness" before she would allow it to be approved in the U.S. When the tragedy of thalidomide became known, the FDA was lauded for its cautious reasoning.[4]

During the 1980s' AIDS epidemic, the FDA was vilified by activists who initially misunderstood its function.[5] It is not the job of the FDA to develop and test new drugs, or to set their prices, but to evaluate the data presented to it by drug manufacturers and cautiously recommend approval or no approval. The Prescription Drug User Funding Act (PDUFA) of 1992 started shifting the manner in which the FDA was funded. Requiring commercial entities to pay for their own oversight agency sounds like an odd way to do business, but it is not uncommon in the U.S. where agencies such as Customs and Immigration Services (CIS) and the Federal Communication Commission (FCC) also pay for their own oversight.[6]

The FDA is an imperfect watchdog. Its bite is not quite toothless, but it does little damage. Eli Lilly's olanzapine (Zyprexa®) has been implicated in hundreds of deaths and thousands of cases of metabolic syndrome; fines were paid, but no one went to jail.[7] Purdue Pharmaceuticals used fabricated data to get its long-acting oxycodone (OxyContin®) approved, and thousands of people became addicted and died; fines were paid, but no one served jail time.[8] Rofecoxib (Vioxx®) was approved because Wyeth withheld data from the FDA showing that its drug quadrupled the risk of myocardial infarction; a fine was paid, but no one served jail time.[9]

Can we anticipate any major change? It is unlikely as long as the pharmaceutical industry controls the purse strings – not only of the FDA but of the government. There are more than two pharmaceutical lobbyists for every representative in Washington, D.C.[10] The recent price rise in lifesaving drugs like epinephrine and naloxone show how powerless the government is in preventing patient harm.

The article in this month's *West*JEM by Zuabi et al. is based on a talk that I developed about 10 years ago but was seldom asked to give. When I gave it at the American Academy of Emergency Medicine Scientific Assembly in 2016, *West*JEM Editor-in-Chief Mark Langdorf was in the audience and became intrigued. I was unable to dedicate the time to write the article but sent all of my references and resources, and this article was what came out of it. They did a great job of synthesizing my talk into a fascinating article, far better than I could have. I congratulate the authors.

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Use of Physician Concerns and Patient Complaints as Quality Assurance Markers in Emergency Medicine

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Introduction: The value of using patient- and physician-identified quality assurance (QA) issues in emergency medicine remains poorly characterized as a marker for emergency department (ED) QA. The objective of this study was to determine whether evaluation of patient and physician concerns is useful for identifying medical errors resulting in either an adverse event or a near-miss event.

Methods: We conducted a retrospective, observational cohort study of consecutive patients presenting between January 2008 and December 2014 to an urban, tertiary care academic medical center ED with an electronic error reporting system that allows physicians to identify QA issues for review. In our system, both patient and physician concerns are reviewed by physician evaluators not involved with the patients' care to determine if a QA issue exists. If a potential QA issue is present, it is referred to a 20-member QA committee of emergency physicians and nurses who make a final determination as to whether or not an error or adverse event occurred.

Results: We identified 570 concerns within a database of 383,419 ED presentations, of which 33 were patient-generated and 537 were physician-generated. Out of the 570 reports, a preventable adverse event was detected in 3.0% of cases (95% CI = [1.52-4.28]). Further analysis revealed that 9.1% (95% CI = [2-24]) of patient complaints correlated to preventable errors leading to an adverse event. In contrast, 2.6% (95% CI = [2-4]) of QA concerns reported by a physician alone were found to be due to preventable medical errors leading to an adverse event (p=0.069). Near-miss events (errors without adverse outcome) trended towards more accurate reporting by physicians, with medical error found in 12.1% of reported cases (95% CI = [10-15]) versus 9.1% of those reported by patients (95% CI = [2-24] p=0.079). Adverse events in general that were not deemed to be due to preventable medical error were found in 12.1% of patient complaints (95% CI = [3-28]) and in 5.8% of physician QA concerns (95% CI = [4-8]).

Conclusion: Screening and systemized evaluation of ED patient and physician complaints may be an underutilized QA tool. Patient complaints demonstrated a trend to identify medical errors that result in preventable adverse events, while physician QA concerns may be more likely to uncover a near miss. [West J Emerg Med. 2016;17(6)749-55.]

INTRODUCTION

Medical error is a correctable cause of morbidity and mortality. In 1991, the Harvard Medical Practice Study found that nearly 3.7% of admitted patients suffered complications from treatment, two-thirds of which were due to errors in care, and a significant portion of these were preventable.[1,2] This landmark study prompted intense national scrutiny of medical errors, which remain a significant burden.[3,4] Recent data indicate that the incidence of adverse events attributable to medical error among hospitalized patients may be increasing. Existing evidence supports a compelling argument for emergency departments (ED) to have systems in place to perform root cause analysis of potential errors, and to implement systemic corrections to improve care when such errors are found.[5]

Although it is clearly worthwhile to uncover medical error within the ED, an ideal marker for efficient error correction has yet to be uncovered. Twice each month, the ED quality assurance (QA) team screens all cases that meet certain empirically selected criteria, such as death within 24 hours, transfer from initial floor bed to ICU within 24 hours, physician self-reported concerns, nursing incident reports or cases that generate physician or patient complaints. These surrogates are often used as routine metrics in emergency medicine QA and although they are often perceived as the gold standard, they remain largely unvalidated expert opinion.[6]

A quantitative analysis evaluating the utilization of physician and patient complaints has not been studied. The presence of an integrated, readily accessible electronic error reporting system has facilitated the study of such measures in one urban tertiary care ED. The objective of this study was to determine whether systematic screening and evaluation of documented patient and physician QA concerns is a useful tool for identifying physician errors resulting in either an adverse or near-miss event.

METHODS

Study Design and Setting

We conducted a retrospective cohort study of consecutive patients presenting to an urban, tertiary care academic medical center ED with an annual volume of ~57,000 patients between January 2008 and December 2014. This ED maintains a QA database linking all patient and physician complaints to all patients.

To facilitate QA audits, a secure web-based platform was implemented in 2008 to automate a number of the reporting processes that were previously carried out by hand or through the use of photocopied patient documentation. The automated QA dashboard performs nightly sweeps of the computerized ED patient log to identify cases that meet predetermined criteria for QA review including deaths within 24 hours of ED arrival, return visits within 72 hours requiring hospitalization and floor admissions transferred to ICU within 24 hours, as well as cases involving high-risk procedures, such as endotracheal intubation or procedural sedation. There is a mechanism in place where physicians can flag cases for review on the QA dashboard. Alternatively, patients are able to report complaints through the hospital's patient relations office. After automatic identification, or identification via a physician concern or patient complaint, the cases are assigned randomly to a physician reviewer from within the ED who was not involved in the care of the patient. To ensure that all reviewers receive similar numbers and a similar distribution of types of cases, cases are assigned with load balancing. A case detail page containing key demographic and operational data elements as well as relevant clinical data associated with the case is extracted from relevant hospital databases. The electronic scanned copy of all of the paper documentation associated with each case is captured from our billing process and stored in the electronic dashboard database.

The reviewers are notified automatically by email when a new case has been assigned to them. They are then able to log onto the QA dashboard and securely review the case documentation. Reviewers are also able to assess relevant records from the patients' online medical records through embedded links in the case detail page.

After reviewing the case documentation, reviewers are then asked to respond to a series of seven standardized questions with answers formulated by a standardized Likert scale (see Figures 3 and 4 for examples), adding additional text comments as needed. If after case analysis, the reviewer has concerns about possible errors, adverse events or other quality issues, the case is referred for discussion by the full QA committee. At bimonthly meetings, the committee makes the final determination about whether error or adverse events occurred based on committee consensus. At the conclusion of each review and remediation process, all data elements are entered into the QA dashboard archive to be used for reference, quality improvement and research.

Definition of Terms

The hospital's institution-wide definition of medical error is the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. An adverse event is defined as unintended physical injury and/or physiologic insult resulting from or contributed to by medical care (including the absence of indicated medical treatment), that requires or prolongs hospitalization, and/or results in permanent disability or death that cannot be solely and definitively due to the progression of the patient's underlying condition. Adverse events caused by medical error are termed preventable adverse events. Near-miss events are medical errors that do not result in an adverse event.[7]

Selection of Participants

We included all patients presenting to the ED during the specified period. Patient complaints refer to post-visit telephone or written complaints brought before the department chairs. Patient complaints are initially prescreened by an experienced evaluator and those not pertaining to possible medical error, such as complaints related to billing, creature comfort, communication, nursing related complaints and waiting times were eliminated. If a potential QA issue is present, the case is referred to the QA committee as illustrated in Figure 1. The ED has an electronic error reporting system that allows attending physicians or QA directors from all departments to register a concern or identify a potential QA issue via an easily accessible online form for subsequent review as illustrated in Figure 2. For lack of a better term, these "physician complaints" are then entered into an automated electronic QA database that interfaces with a commercially available HIS system that randomly assigns the patient and physician concerns to members of the QA panel to be reviewed by physician evaluators not involved with the patient's care as described above.[8]

Outcome Measures

The ED dashboard system lends itself to a one-click "flag" system for QA referral so any practitioner can easily identify a case for QA review. Once identified, the ED chair or QA director will review the complaint and, assuming it is related to quality improvement (QI), it will be entered into a QA database and undergo systematic review by a 20-member QA committee. The committee is comprised of emergency physicians and nurses who then give a final determination as to whether or not an error occurred. Ultimately, we compared the incidence of error and adverse events from flagged cases that initially linked both patient and physician complaints to more traditional markers, including 72 hour returns and floor to ICU transfer from our institution.

Data Collection and Processing

Physician evaluators are emergency medicine attending physicians who are trained via an online module and undergo an initial double review to evaluate cases for the occurrence of an error, adverse event, or a near-miss event. Cases are reviewed independently by reviewers who

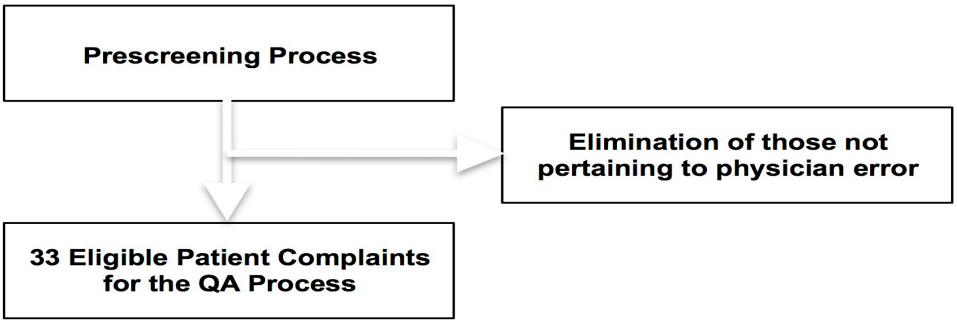

Figure 1. Patient complaints are prescreened to identify possible medical errors or adverse events. *QA,* quality assurance.

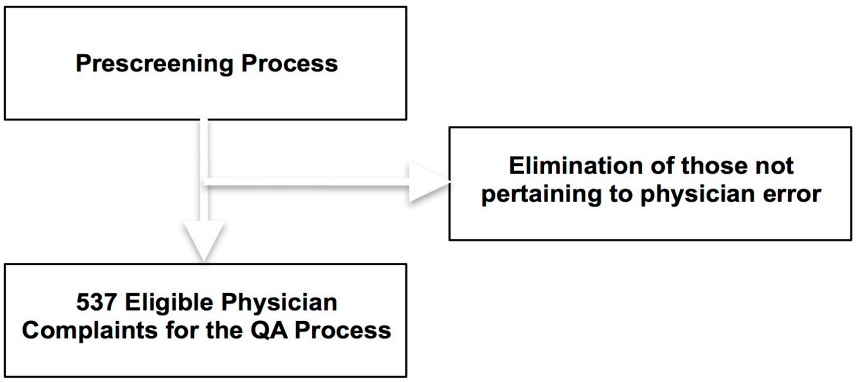

Figure 2. Physician reports are prescreened to identify possible medical errors or adverse events. *QA,* quality assurance.

are not involved in the care of the given patient. Reviewers use a structured tool to determine the presence of error and adverse events using an eight-point Likert scale. A level of four, (corresponding to moderate error with resulting consequences that had the potential to compromise care, but which did not compromise care) or greater warrants full committee review. See Figures 3 and 4 for representatives of the Likert scale and a description of the first two of eight questions evaluated. The evaluating physician presents the case to the QA committee at their monthly meeting and the committee makes a final determination as to whether or not an error and/or adverse event occurred for each case.[9]

The ED's QA committee is formally integrated into the hospital's overall QA operations. Depending on outcomes of the review, the ED QI committee then refers its results for departmental corrective action and/or further action depending on the type of error. The findings may be forwarded for internal review, chief review, chairmen of departments review, hospital wide board of director review, or finally to the medical board or risk management services. See Figure 5 for a detailed schematic of the overall QI system and its integration into the hospital wide infrastructure.

Statistical Analysis

Data were extracted from the QA database and entered into a Microsoft Excel 2003 (Redmond, WA) database program. We reported The rate of preventable adverse events, near-miss events and overall adverse events for patient and physician concerns with corresponding 95% confidence intervals using a Fishers-exact test. This method uses mathematical simulation to determine the likelihood of our findings occurring by chance. Results are reported as percentages.

RESULTS

We identified 570 complaints within a database of 383,419 ED presentations, of which 33 were patient-generated and 537 were physician-generated. In the combined total complaints physician errors that led to a preventable adverse event were detected in 3.0% (95% CI = [1.52-4.28]). Further analysis revealed that 9.1% of patient concerns correlated to preventable errors leading

#1 : Were Error(s) made by the ED team?

Score	Description	Performance Level	QA Response
1	No Error	Perfect	No Reviewer feedback to team necessary, no QA committee review necessary
2	Judgment calls that the reviewer may not have made but can accept; with no apparent consequences	Minor Flaws	
3	Possible errors in care of little consequence that did not compromise care in any appreciable way		Reviewer gives feedback to team, but no QA committee review necessary
4	Moderate errors with resulting consequences that had the potential to compromise care, but which did not appear to compromise care	Moderate Flaws	Discussion in QA committee with appropriate feedback and +/- remediation
5	Moderate errors with resulting consequences that may have compromised care		
6	Major errors that with consequences that compromised care but where the overall care was within the standard of care	Major Flaws	
7	Major errors that resulted in compromised care and which violated the standard of care		
8	Major errors that grossly violated the standard of care	Egregious	

Figure 3. Standardized tool used by reviewers to determine presence of medical error in quality assurance cases.
QA, quality assurance.

#2 Were there Adverse Event(s) resulting from the care of the ED team?

Score	Description	Performance Level	QA Response
1	No Adverse Event occurred	No Error / No Harm	No Reviewer feedback to team necessary, no QA committee review necessary
2	An event may have occurred that had the capacity to cause injury, but did not reach patient	Near Miss	
3	An event occurred that may have reached the patient, but did not cause harm		Reviewer gives feedback to team, but no QA committee review necessary
4	Circumstances or events required additional monitoring or screening tests (e.g., telemetry, serial physical examinations or lab test) but did not require additional treatment	Monitoring Only	Discussion in QA committee with appropriate feedback and +/- remediation
5	An event occurred that resulted in the need for treatment or intervention, and caused temporary patient harm/injury/need for additional treatment	Minor	
6	An event occurred that resulted in initial (if outpatient) or prolonged hospitalization and caused temporary patient harm/injury/disease progression	Moderate	
7	An event occurred that resulted in permanent patient harm/injury/disease progression	Major	
8	An event directly contributed to death of patient (n.b., do not check if patient death was unrelated to event)	Death	

Figure 4. Standardized tool used by reviewers to determine presence of adverse event(s) in quality assurance cases. *QA,* quality assurance.

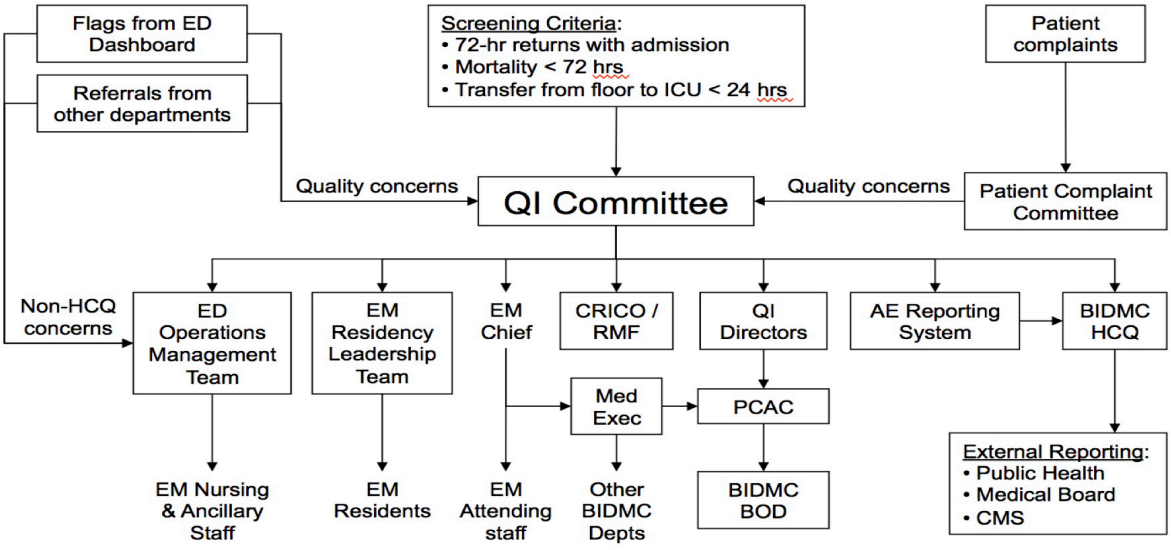

Figure 5. Structural schematic of how quality assurance issues are referred to different departments within the hospital. *QI,* quality improvement; *CRICO,* malpractice insurance program; *RMF*, risk management facility; *BOD;* board of directors; *PCAC,* Department Chiefs Quality Assurance Committee; *HCQ*, health care quality; *EM*, emergency medicine; *ED*, emergency department.

Table 1. Comparison of percentage of physician reports and patient complaints reviewed by the QA committee that identified a preventable adverse event or near-miss event.

	Patient complaints; n=33 error rates	Physician concerns; n=537 error rates	P-value
Preventable adverse event	3(9.1%)	14(2.6%)	0.069
Near miss event	3(9.1%)	65(12.1%)	0.79
Overall adverse event	4(12.1%)	31(5.8%)	0.136

QA, quality assurance.

to an adverse event (95% CI = [2-24]). In contrast, 2.6% of complaints made by a physician alone were found to be preventable medical errors leading to an adverse event (95% CI = [2-4] p=0.069). Near-miss events (errors without adverse outcome) showed a trend to be more accurately reported by physicians, with medical error found in 12.1% of physician-reported cases (95% CI = [10-15]) and in 9.1% of those reported by patients (95% CI = [2-24] p=0.79). Adverse events in general that were not deemed to be due to preventable medical error were found in 12.1% of patient complaints (95% CI = [3-28]) and in 5.8% of physician complaints (95% CI = [4-8]) (Table 1).
When compared to our departmental near-miss and adverse event rates for 72 hour returns, floor to ICU transfers and procedural sedations; the use of patient and physician complaints as markers is comparable to the more standard metrics listed below. For 72 hour returns our near-miss rate is 10.2%, with an overall adverse event rate of 8.6%. Our floor to ICU transfer rate is 10.2% with a corresponding overall adverse event rate of 8.5%. We do not have data on preventable adverse event rates for these other markers at this time (Table 2).

DISCUSSION

There is an ongoing need to improve and find new and more informative ED-based QA markers for clinical error, especially preventable error resulting in harm. In our study, we examined two markers, physician concerns and patient complaints to gauge their utility in routine QA review of ED patient care. We found the overall error rate was within expected ranges, 12.1% in those cases referred by patients and in 5.8% of those cases referred by physicians. When compared to more standard metrics such as floor to ICU transfer or 72 hour returns, physician and patient complaints appear to perform well in our initial analyses; however, we were not able to identify statistically significant differences between physician reports and patient complaints in identifying preventable adverse events or near-miss events. Physician reports had a trend towards a lower incidence of identifying adverse events associated with error when compared to patient complaints.

Medical error has received increased national attention over the last 20 years. Anderson et al. showed an overall incidence of error at 0.13% in ED care.[6] Overall, there is a dearth of high-quality evidence describing the incidence of error and adverse events in the ED.[10] The Anderson study, reviewing only physician complaints about ED patient care, found that 22.6% of the errors identified were identified by complaints and 19.9% of adverse events were identified by complaints, although the proportion that were preventable was not reported.[6]

Prior investigations suggest that systematic evaluation of physician complaints have been shown to have a high yield for detecting error.[6] Patients complaints, however, have yet to be formally evaluated. Peer review may be a logical approach for discerning error and adverse events among physicians in medicine given the requisite specialized knowledge base and expertise. Therefore, one could assume that physician complaints would be a superior primary source for uncovering adverse events and error in

Table 2. Comparison between standard metrics versus physician reports and patient complaints of identifying adverse events and near misses.

	Near miss rate	Adverse event rate
72-hour returns	10.2%	8.6%
Floor to ICU transfer	10.2%	8.5%
Procedural sedation	1.9%	0%
Physician complaints	12.1%	5.8%
Patient complaints	9.1%	12.1%

ICU, intensive care unit

medicine, yet there is limited literature looking at physician complaints as a marker for QA. Recent investigations suggest that physician complaints have a high yield for detecting error.[6] Paradoxically, the ability of our patients to recognize physician error without the requisite training in medicine was studied here and found to be a useful QA metric. It is possible that subjective involvement of the patient, although open to bias, may be more useful than objective evaluation in recognizing error.

Finally, we looked at preventable adverse events, which is a patient-centered outcome. Patient complaints appeared to provide useful information in identifying preventable adverse events. The ultimate goal of such detection is to implement system-based changes to decrease future error. Our findings show promise for tracking both physician and patient complaints as high-yield markers of QA-relevant events.

LIMITATIONS

By using an initial single physician pre-screener for each patient complaint, relevant cases may have been missed since this is an inherently subjective process. To mitigate this potential limitation, we reviewed a random sample of patient complaint cases that were not brought for QA committee review and found these cases involved complaints that do not pertain to physicians (such as lack of warm blankets) or involve ancillary staff (which is another area deserving further scrutiny). We also used a single institution for a test site, which may limit the generalizability of the conclusions of this study. Lastly, the sample size of this study was small especially for the patient complaint side, perhaps implying hesitancy on the part of the patient to report possible error. Such a small sample size may lead to statistical errors. The study is likely underpowered and may contribute to a type 1 error, where a true difference may not be identified. Finally, there was lack of long-term follow up in these patients, which may have been another opportunity to identify further errors or adverse outcomes. Further research with larger sample sizes should be performed when possible.

CONCLUSION

Screening and systematic evaluation of ED patient complaints and physician concerns may be an underused and efficient QA tool. Patient complaints may accurately identify medical errors that result in preventable adverse events. Physician concerns may be more likely to uncover a near miss that did not lead to an adverse event. Both patient and physician complaints may be useful QA metrics for identifying error in ED care when compared to routine metrics such as 72 hour returns and floor to ICU transfer.

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Adapting the I-PASS Handoff Program for Emergency Department Inter-Shift Handoffs

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Introduction: Academic emergency department (ED) handoffs are high-risk transfer of care events. Emergency medicine residents are inadequately trained to handle these vital transitions. We aimed to explore what modifications the I-PASS (illness severity, patient summary, action list, situation awareness and contingency plans, and synthesis by receiver) handoff system requires to be effectively modified for use in ED inter-shift handoffs.

Methods: This mixed-method needs assessment conducted at an academic ED explored the suitability of the I-PASS system for ED handoffs. We conducted a literature review, focus groups, and then a survey. We sought to identify the distinctive elements of ED handoffs and discern how these could be incorporated into the I-PASS system.

Results: Focus group participants agreed the patient summary should be adapted to include anticipated disposition of patient. Participants generally endorsed the order and content of the other elements of the I-PASS tool. The survey yielded several wording changes to reflect contextual differences. Themes from all qualitative sources converged to suggest changes for brevity and clarity. Most participants agreed that the I-PASS tool would be well suited to the ED setting.

Conclusion: With modifications for context, brevity, and clarity, the I-PASS system may be well suited for application to the ED setting. This study provides qualitative data in support of using the I-PASS tool and concrete suggestions for how to modify the I-PASS tool for the ED. Implementation and outcome research is needed to investigate if the I-PASS tool is feasible and improves patient outcomes in the ED environment. [West J Emerg Med. 2016;17(6)756-61.]

INTRODUCTION

Handoffs are unique, high-risk transfer of care events. Breakdown in communication is the leading root cause of sentinel events reported to The Joint Commission (TJC).[1] In a large multicenter study, resident physician handoffs had a baseline medical error rate of 24 errors per 100 admissions and a preventable adverse event rate of four events per 100 admissions.[2] Due to the importance of handoffs, the Accreditation Council for Graduate Medical Education (ACGME) has built an emphasis on teaching and assessing handoff competency into its Next Accreditation System.[3] Furthermore, the Association of American Medical Colleges (AAMC) has highlighted the importance of handoffs in medical education with the inclusion of handoffs as one of the 13 Core Entrustable Professional Activities for Entering Residency.[4]

The largest multicenter handoff study conducted to date used a bundle of interventions that included standardized education, the "I-PASS" mnemonic and an electronic handoff

tool. After implementation, the study demonstrated a 26% overall reduction of medical errors in the inpatient pediatric setting.[2] Smaller studies have shown some success in improving compliance with standardization and others have shown improvement in time of handoff or user satisfaction with the new handoff process.[5-8]

Academic emergency medicine (EM) training centers present unique barriers to safe handoff processes. ED inter-shift handoffs involve coordination of care for highly complex patients under significant time constraints.[9-11] Academic EM training centers require specialized educational interventions to teach and assess provider handoffs across the continuum of medical education.

We aimed to determine what modifications the I-PASS mnemonic and education bundle required to be adapted to the ED setting. We used a mixed-methods needs assessment that included literature review, focus groups and a survey. Using a conceptual framework, we sought to delineate the distinctive features of ED handoffs. We then further explored with participants these unique features in the context of the I-PASS education bundle. Finally, we attempted to obtain a consensus of modifications the I-PASS mnemonic would require to be acceptable for use in the ED setting.

METHODS

Settings and Participants

This mixed-methods needs assessment was conducted at an academic ED with approximately 50,000 patient visits per year. Twenty-four core faculty and 33 residents constitute the three-year EM residency program. There are also 10 adjunct emergency physicians who function as attendings in the ED. The handoff care team includes residents, attendings, charge nurses, and occasionally midlevel providers. The senior resident at each change of shift leads the handoff. The pre-existing handoff process is semi-standardized and consists of using the Situation, Background, Assessment and Recommendations (SBAR) mnemonic to organize the verbal handoff presentation. The written handoff notes are documented from the verbal presentation in the electronic medical record EPIC and do not use a standardized format. Residents, attendings, midlevel providers and charge nurses were invited to participate in the focus groups by email invitation. Only residents and attendings were invited to participate in the survey because they were most frequently involved in patient handoffs in the acute side of the ED. Midlevel providers primarily staff the ED observation unit. Participation was voluntary and confidential. The institutional review board approved this research study.

Study Protocol

Literature Review Protocol

We searched PubMed and Google Scholar using the search terms "ED Handoff," "Emergency Department Handoff," "Handoffs," "Inter-shift Transition of Care," "Standardized Handoffs," "Standardized ED Handoff," "Implementation of Standardized Handoffs," and "Standardization of Inter-shift Handoffs." We identified 23 articles. Our study team reviewed the articles and created a summary of each article. All members of the research team shared comments and impressions on how the literature related to our project.

Focus Group Protocol

We used open-ended questions designed to investigate what participants felt were the crucial elements of ED handoffs and how these could be incorporated into the I-PASS system. Two examples of open-ended questions include the following: "If we started using this mnemonic [I-PASS] in our ED, what if anything would you recommend changing to make sure it meets our needs?" and "If a standardized sign-out process was adopted, what outcomes would you hope could be improved by implementing the process?" To a large extent, we allowed focus group discussions to proceed naturally. The facilitator participated as necessary to clarify responses and ask follow-up questions relevant to understanding the barriers and promoters of effective ED handoffs. The facilitator also directed the conversation to ensure participants addressed how key elements of the ED handoff could be incorporated into the I-PASS system. We asked participants to remember and comment on their cumulative experiences in all the EDs in which they have clinically worked. We asked about other EDs in order to increase the external validity and not be institution-specific. Due to multiple study investigators being known to the participants, a facilitator who was new to the culture and not known to the participants facilitated the focus groups. The facilitator underwent over 10 hours of training on grounded theory methodology and focus group facilitation strategies, including both independent study and mentored discussion and practice.

We used theoretical sampling strategy to recruit groups of inter-professional clinical providers who currently participate in handoffs in our ED. After collecting the initial focus group data, we continued the theoretical sampling process by integrating a midlevel provider into the focus group sessions. Early data analysis suggested that the midlevel provider perspective could lend crucial insight into the handoff phenomenon. We were able to include a midlevel provider in a subsequent focus group.

Focus group size ranged from four to eight individuals. Each focus group included individuals who had not previously participated. We conducted the focus groups in October and November 2014. Two of the four focus groups were composed of a mixed group of residents, attendings and charge nurses. One of these focus groups also included a physician assistant. The other two focus groups included only residents and attendings.

Survey Protocol

Survey Content and Administration

We conducted a literature review of previous surveys

done on ED handoffs and identified one study as a model.[12] We based the first half of the survey questions on this study. Since there were not previous studies done on adapting the I-PASS system to the ED setting, for the second half of the survey we created open-ended questions that probed participants for how this new system would be best adapted to the ED setting. The survey instrument underwent content review to improve clarity along with cognitive interviews for validation of content and response process. We conducted the survey during November and December of 2014. The survey was administered through SurveyMonkey® and participants included residents and attendings.

Data Analysis

We used a grounded theory approach along with a constructivist/interpretivist paradigm to evaluate the perceptions of clinical providers who participate in the handoff process in the ED.[13-16] We used theoretical sampling, an iterative process, and a constant comparative method of data analysis. Our primary aim was to delineate the unique features of ED handoffs and then determine if these unique features could be incorporated into the I-PASS education bundle. Finally, we attempted to develop a consensus of modifications that the I-PASS mnemonic and education would require to be acceptable for use in the ED setting.

Data analysis began with reviewing notes taken from focus group sessions and then analyzing the hand transcription of focus group audio. Participant data was de-identified. Two team members separately analyzed and coded the data using an iterative process of theme and subtheme identification. To ensure the trustworthiness and credibility of data analysis we compared focus group transcripts with observer notes, along with the hand-transcribed session notes. We used a separate process for the data from the survey. We disabled the IP address tracking to ensure that none of the responses in the SurveyMonkey® survey was linked to a particular individual. Two team members analyzed and coded survey data using an iterative process of theme and subtheme identification. Team members compared the focus group and survey theme and subtheme identification by performing triangulation with the goal of obtaining a deeper understanding of the handoff process.

RESULTS

Focus group participants suggested adapting the patient summary to include anticipated disposition of patient. If necessary, the verbal handoff should include events leading to ED presentation and ED course as part of the patient summary. Participants generally agreed that including illness severity initially was important. Additionally, participants commented that the action list helped to frame the role of the oncoming team by "[a]llow[ing] the listener to frame what their role in the patient's care will be – to 'watch,' to 'follow up labs and dispo' or 'start from scratch.'" Summary by receiver also had suggested modification of application to the ED handoff process. Since each patient handoff in the ED is brief, the majority of participants agreed that the summary of each patient should be included after all patients were presented. Thus, the summary provides one or two sentences for each patient as part of an overall summary of all the patients included in the ED handoff. The table summarizes the themes and subthemes identified through our focus groups and survey.

Twenty-two of 31 residents (71%) and 22 of 32 (68%) attendings responded to the survey. Two residents and two attendings were not included in the survey due to conducting this research study. The survey was analyzed independently from the focus groups, and results yielded no significant content additions to the themes and subthemes identified in the focus groups. However, the survey did yield several wording changes to reflect contextual differences.

Themes from all qualitative sources converged to suggest changes for brevity and clarity. See Figure for a summary of the modifications to the I-PASS mnemonic. At the end of each of the focus group sessions, participants were read back the suggested changes to the I-PASS tool by the facilitator. A dominant theme included *acceptance of change* (Table) -- most participants agreed that the I-PASS tool would be well suited to the ED setting.

DISCUSSION

The I-PASS bundle of interventions used in the multi-center trial, in the inpatient pediatric setting, included a robust set of standardized education curriculum, job aids and formalized processes to ensure residents and faculty were adhering to the I-PASS method of handoffs.[2] The major components included two hours of didactic presentations, one hour of simulation, a collection of job aids, faculty

I	Illness severity	Stable, "watcher," unstable
P	Patient summary	Summary statement with anticipated disposition If necessary also include: Events leading to ED presentation ED course
A	Action list	Pending results/consults To do list
S	Synthesis by receiver	Asks questions
(S)	Summary by receiver (after all patients are presented)	Summarize each patient Restate key action/to do items

Figure. Emergency department-adapted I-PASS (illness severity, patient summary, action list, situation awareness and contingency plans, and synthesis by receiver).

Table. Themes, subthemes and discussion of ED adaptation of I-PASS, a mnemonic (illness severity, patient summary, action list, situation awareness and contingency plans, and synthesis by receiver) for patient handoff.

Themes and subthemes	Representative quotes	Discussion for ED adaptation
Time		
Time + order	"I think we need to do it at the end of all the patients and have it be very brief, otherwise our sign out will be too long"	Summary by Receiver should wait until all the patients' handoffs have occurred and should be very brief.
	"A disadvantage to I-PASS would be a longer signout, due to the mnemonic as a whole or because of a specific aspect"	Important to engage and educate residents and staff to reinforce goal of I-PASS and consider timing previous signout and comparing to I-PASS signout.
Time as environment	"I think we need a blocked out time for sign out – it is already a long process because we are constantly being interrupted by nursing staff, which throws everything off and then things get missed… maybe the signing out team goes to a separate area for signout so we aren't interrupted"	Important to engage and include nursing staff in the handoff process in order to minimize interruptions.
Time + safety	"Need uninterrupted time in quiet space to allow for safer transition handoffs"	Important to optimize staffing and space to provide protected time for handoff.
Order		
Storytelling – how	"For patient summary, we can keep it shorter – for example, we don't need the full hospital course, just a brief synopsis of ED care"	Shorten Patient Summary for ED setting and lead with disposition to help frame presentation.
Storytelling - content	Benefit of I-PASS is "pointed action plan rather than nebulous recommendations"	Agreement that the I-PASS system helps to provide specific items to follow up and plan.
	"Allows the listener to frame what their role in the patient's care will be: to 'watch', to 'follow up labs and dispo' or 'start from scratch'"	Agreement that I-PASS system provides a useful structure to frame the oncoming team's role in the patient's care. Assists the team to create a shared mental model.
Culture		
Ways of thinking	"I-PASS is more aligned with ED thinking"; "[previous process] never made sense to me. I-PASS seems very similar to what I am doing now without any particular training"	
	I-PASS as "more like real life what we need to know; less artificial"	
Ways of learning	The last two S's in your [mnemonic] are meaningless without seeing the patient. You cannot truly know what is 'going on' if you have not laid eyes on it."	
	"Training people. Sticking to the script"; "Everyone learning it and getting acclimated"; "Forcing providers to consistently use it"; "Everyone adopting or trying to give sign out in this way to someone who doesn't like it"	
	"Learning a new system is usually inefficient until all users are up to speed."	

SBAR, Situation Background Assessment Recommendation.

Table. Continued.

Themes and subthemes	Representative quotes	Discussion for ED adaptation
Reticence to change	"[I-PASS is] not helpful at all… Don't need another mnemonic"; "Don't really like it that much"; "Don't really like mnemonics. Would not use it". "Dislike either [mnemonic device]. Like to just tell about the patient. Say what is important"	
	"culture of individuality, old habits, hard to practice and implement change when you're already tired"	
Acceptance of change	" I like it. It seems easy and useful"; "I-PASS would need to demonstrate better utility than SBAR*"	
	"Seems reasonable to try, as long as it doesn't increase duration of the sign-out"	
Environment	"My concern isn't the mnemonic, honestly. It's everything else. (Frequent interruptions, people insisting on giving prolonged 'one liners' on patients who are discharged, etc.)"	
How tools are used	"I feel like [I-PASS] should have a written component though… by the passer or the receiver. With multiple patients often being handed off, its easy to cross wires with plans"	Necessary to have both a verbal and written structure and process for the I-PASS system in the ED.
	"I-PASS would need to demonstrate better utility than SBAR*, but even so, may not be used properly"; or, inability to fully integrate existing tools into current culture: "I like it [I-PASS] and think you could make it work if it was incorporated into our system rather than making an extra 'note' or boxes that you have to fill out"	Success depends on education, training and reinforcement of any handoff process, especially when new residents start the year. Engage faculty with the handoff process. Incorporation of I-PASS into the existing unique culture and environment can be important for acceptance of new process.
Team Dynamics and interactions	"The last two letters however force the idea of recapping key points."	
	I-PASS as an advantage because it "incorporates… closed loop communication"; "I-PASS provides clear communication"	

SBAR, Situation Background Assessment Recommendation.

development resources and faculty observation tools to assess resident handoffs. The education included known best practices of communication including the TeamSTEPPS™ model. In addition to education on known best practices, there is specific education and training on the I-PASS mnemonic that was created by the study group.[17]

The purpose of our study was to explore whether the I-PASS mnemonic could be adapted to the ED setting. If a modified ED I-PASS mnemonic could be developed, then only minor modifications would be required to adapt and then pilot the original I-PASS bundle of interventions in the EM provider setting. Our qualitative findings demonstrate that the I-PASS mnemonic may be acceptable in the ED setting with certain modifications to accommodate the time constraints and dynamic nature of patient care within the ED.

We identified three major themes that influence modifications to the I-PASS handoff: time, order and culture. Multiple participants commented that the patient summary and summary by receiver required modification for use in the ED.

This mixed-methods needs assessment is the first to explore if the I-PASS handoff system could be used in the ED setting. Our literature review demonstrated that there has been limited research of ED handoff improvement bundles. Due to cost and complexity, none of these ED

studies have demonstrated a reduction in medical errors due to the transition-in-care intervention. However, the I-PASS bundle of interventions has been shown to reduce medical errors during handoffs in the inpatient pediatric setting. Our research provides qualitative evidence that the I-PASS bundle of interventions could be adapted for use in the ED. Future research will be needed on the feasibility of adapting these interventions and to determine if using a modified I-PASS bundle reduces medical errors related to inter-shift handoffs in the ED setting.

LIMITATIONS

This mixed-methods study is limited by the single center. Although we asked participants to rely on their cumulative experiences in all prior clinical settings in exploring their perceptions regarding ED handoffs, future studies assessing the impact of the I-PASS intervention in the ED setting should include multiple centers to ensure external validity. We made efforts to ensure thematic saturation and data credibility, but it is possible there are additional relevant themes that were not uncovered by our study. Although the sampling and focus group structure was designed to facilitate inter-professional discussion, additional themes may have been uncovered if groups were separated by discipline.

CONCLUSION

A standardized handoff system may address concerns about ED inter-shift handoff safety, efficiency, and effectiveness. With modifications for context, brevity, and clarity, the I-PASS system appears well suited for application to the unique, time-sensitive ED setting. This study is important because it provides qualitative data in support of using the I-PASS tool in the ED environment and concrete suggestions for how to modify the I-PASS tool for the ED. Implementation and outcome research is needed to investigate if use of the I-PASS tool is feasible and improves patient outcomes in the ED environment.

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First Report of Survival in Refractory Ventricular Fibrillation After Dual-Axis Defibrillation and Esmolol Administration

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There is a subset of patients who suffer a witnessed ventricular fibrillation (VF) arrest and despite receiving reasonable care with medications (epinephrine and amiodarone) and multiple defibrillations (3+ attempts at 200 joules of biphasic current) remain in refractory VF (RVF), also known as electrical storm. The mortality for these patients is as high as 97%. We present the case of a patient who, with a novel approach, survived RVF to outpatient follow up. [West J Emerg Med. 2016;17(6)762-5.]

INTRODUCTION

Ventricular fibrillation (VF) is a potentially fatal dysrhythmia associated with acute myocardial infarction.[1] It is well accepted that the longer a patient has to wait for defibrillation, the higher the risk of mortality.[1] Patients who suffer VF have a decreased risk of mortality with early, definitive care.[2] However, there is a subset of patients with VF arrest who remain in VF refractory ventricular fibrillation (RVF) despite standard pharmachotherapy (epinephrine and amiodarone) and multiple defibrillations (three or more attempts at 200 joules (J) of biphasic current, also known as *electrical storm*.[3] The mortality for these patients can be as high as 97%.[3] We present the case of a patient who received a novel approach to treatment and survived electrical storm to discharge and successful outpatient follow up.

CASE REPORT

A 67-year-old, 85 kg man with a prior history of left anterior descending artery (LAD) stent placement was brought by emergency medical services (EMS) to the emergency department (ED) of an academic, community-based hospital. He complained of numbness in his left arm that radiated into his chest. He took 325 mg of aspirin 20 minutes prior to EMS arrival, and EMS gave a single 0.4 mg sublingual nitroglycerin while in transport with full relief of pain. Electrocardiogram (ECG) performed by EMS showed normal sinus rhythm. As the patient was undergoing his initial nursing assessment, he reported that he "felt funny;" his upper extremities began to shake, and then he became unresponsive with agonal respirations, followed by apnea. At this point, no pulse was present and the monitor displayed VF. Chest compressions were started and he received biphasic defibrillation at a dose of 200 J. The first attempt at intubation was esophageal, so the endotracheal tube was promptly removed and ventilation resumed via bag-valve mask (BVM) with excellent chest wall rise. The resuscitation continued with administration of epinephrine 1 mg intravenous bolus approximately every three minutes with four total doses given. In addition, he received a total of 450 mg of amiodarone. The patient received a total of five defibrillation shocks, the first four at 200 J and the fifth at 300 J, biphasic.

After failing to successfully terminate the VF in the first 15 minutes, it was decided to attempt dual axis defibrillation and esmolol administration, so a second defibrillator was brought to the room. A STAT request was made for pharmacy to send esmolol. The paddles of the second defibrillator were placed in an anterior – posterior central position (Figure 1). Coordination of dual discharge using the original pads and the additional second device and pads occurred "on the count of 3," and 300 J were simultaneously delivered from each device in the 15th minute of resuscitation. There was no change from VF with this intervention, so CPR continued. While cardiopulmonary resuscitation (CPR) was performed, the patient received a bolus of 80 mg of esmolol IV push and

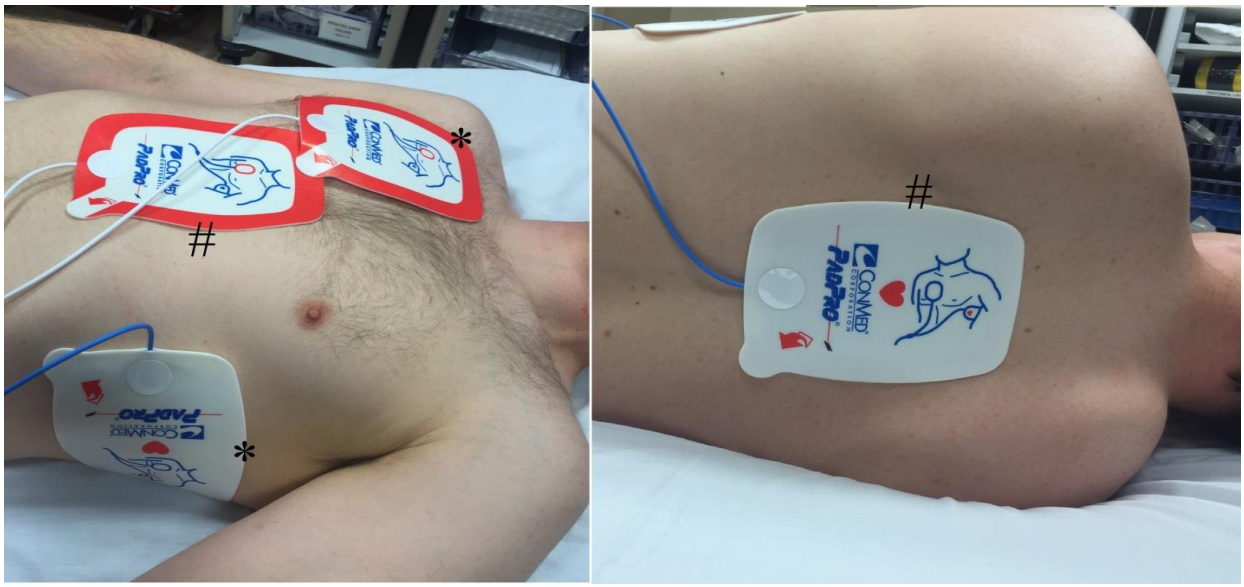

Figure 1. Reproduction of pad placement for dual-axis shock. Pads marked with the asterix (*) show the standard placement of pads, whereas the pads marked with the octothorp (#) signify the anterior-posterior placement for the second set of pads.

an infusion of 0.1 mg/kg/hr was initiated at the 18th minute of the resuscitation attempt. After allowing time for the esmolol to circulate with CPR, there was persistent VF, and a second simultaneous dual defibrillatory shock was delivered after 21 minutes of resuscitation in the same manner as the first. With that attempt, there was return of spontaneous circulation with a room air pulse oximetry of greater than 90%.

A second attempt at intubation was initiated at the 23rd minute of the resuscitation attempt, but was aborted when the patient became more alert with the insertion of the laryngoscope. Following resuscitation, the ECG demonstrated atrial fibrillation with 2-5 mm ST elevations in leads I, AVL, and V2-V6 consistent with an ST-segment elevation myocardial infarction (STEMI). Laboratory analysis showed a mild hypokalemia, mild elevation in Troponin I, and mild anemia. A repeat ECG approximately 30 minutes after the resuscitation, and just prior to going to the catheterization laboratory, was still consistent with a STEMI (Figure 2). At this time the patient was awake, speaking in full sentences, and was breathing room air with stable vital signs. He received a heparin bolus and drip and was successfully transferred to the catheterization laboratory where, with minimal sedation, he was found to have a mid-left anterior descending (LAD) lesion. A drug-eluting stent was placed.

The patient had an otherwise uneventful inpatient stay and was discharged on hospital day 4. He was seen again one week later in the outpatient cardiology clinic. He complained of some chest wall soreness, and mild dyspnea on exertion, but otherwise felt well. At follow up with the patient after completion of cardiac rehabilitation, he had no known long-term sequela and was riding his bicycle over eight miles a day. He provided permission for this case report.

DISCUSSION

The American Heart Association last updated their recommendations for the treatment of VF in 2015.[4] These guidelines recommend the use of well-performed CPR, initial supplemental oxygen via BVM with consideration of advanced airway management via endotracheal intubation or supraglottic airway device, defibrillation, epinephrine, and amiodarone. The guidelines also make reference to considering the reversible causes, known as the 5 H's and T's (hypovolemia, hypoxia, hydrogen ion [acidosis], hyper-/hypokalemia, hypothermia, toxins, tamponade (cardiac), tension pneumothorax, coronary thrombosis and pulmonary thrombosis).[4] The case presented goes beyond these guidelines, and may be described as a refractory case of VF secondary to electrical storm.[5-6] The current case failed to respond to this standard approach to therapy. As a result, the approach to treatment went beyond these guidelines.

Part of the problem with trying to define a treatment for RVF, or electrical storm, is that the formal definition of these conditions are still in debate.[5-7] As early as 2000, "electrical storm" was described as multiple bouts of VF that required not only multiple attempts at defibrillation, but sympathetic blockade in addition to antiarrhythmic pharmacotherapy.[7] We propose that using the term RVF in the context of resuscitation will allow practitioners to move beyond the standard Advanced Cardiac Life Support (ACLS) guidelines for this almost universally fatal condition[4] and think about other ways to care for the patient in these circumstances. Although this proposal will exclude even more rare cases of RVF, such as premature ventricular contractions (PVCs) or Brugada syndrome which require completely different treatment strategies, the most common cause of RVF is ischemia.[3]

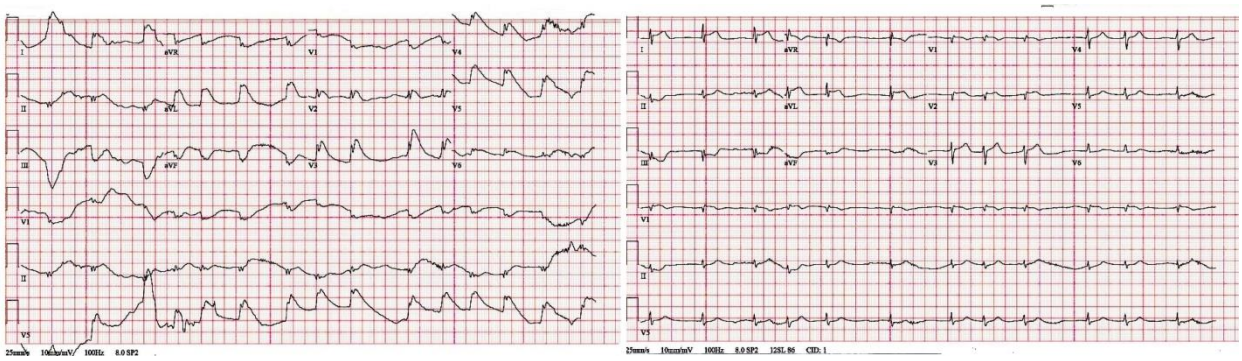

Figure 2. To the left, the electrocardiogram (ECG) immediately following resuscitation. To the right, the ECG approximately 30 minutes after resuscitation.

The use of dual-axis shock is not a new concept in the treatment of RVF. Hoch described five cases of double-axis external shocks as a successful intervention for RVF as early as 1994.[8] These cases were all performed in the electrophysiology suite, had standard single-axis defibrillator shocks administered over 20 times without success, but were converted back to a normal sinus rhythm after dual-axis defibrillation.[8] In 2013, Leacock described the first case of successful RVF conversion in the ED after failure of ACLS protocols with two dual-axis defibrillation shocks.[9] In 2015, Cabañas reported on 10 cases of refractory VF treated with double-axis external defibrillation in the prehospital setting. Three of these patients had return of spontaneous circulation (ROSC), but none survived to discharge with their protocols.[10] Although the guidelines call for no higher than 200J of biphasic energy and 360J of monophasic energy, multiple studies have shown no ill effects with higher dose shocks, even as high as 720 J (monophasic) delivered using two defibrillators.[9]

It is thought that electrical storm leading to RVF is beta-adrenergic myocardial hyperstimulation that can lower VF threshold and widen ischemic injury. In the setting of cardiac arrest, the patient not only has a swell of endogenous catecholamines, but is also receiving exogenous epinephrine every 3-5 minutes.[6] Several studies report on survival with positive neurological outcome through the use of standard class III antiarrhythmics with subsequent administration of short-acting beta blockers.[6-7, 11-12]

This case is unique in reporting successful treatment of RVF with the combination of dual-axis shock with beta-blockade. McGovern and McNamee proposed this combination in 2015, wherein a sequence of standard ACLS treatment is followed by simultaneous dual defibrillation from two different axes across the chest, then esmolol, and finally a repeat dual shock.[13]

This index case describes the first successful use of dual-axis defibrillation and esmolol administration with the patient surviving to hospital discharge and outpatient follow up, and we urge more study in its use in an attempt to delineate correlation versus causation. By recognizing RVF early in the resuscitation process, we may be able to deliver a dual-axis shock sooner and also stabilize the myocardium with beta-blockade.

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Application of Circumferential Compression Device (Binder) in Pelvic Injuries: Room for Improvement

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Introduction: The use of a noninvasive pelvic circumferential compression device (PCCD) to achieve pelvic stabilization by both decreasing pelvic volume and limiting inter-fragmentary motion has become commonplace, and is a well-established component of Advanced Trauma Life Support (ATLS) protocol in the treatment of pelvic ring injuries. The purpose of this study was to evaluate the following: 1) how consistently a PCCD was placed on patients who arrived at our hospital with unstable pelvic ring injuries; 2) if they were placed in a timely manner; and 3) if hemodynamic instability influenced their use.

Methods: We performed an institutional review board-approved retrospective study on 112 consecutive unstable pelvic ring injuries, managed over a two-year period at our Level I trauma center. Our hospital electronic medical records were used to review EMT, physician, nurses', operative notes and radiographic images, to obtain information on the injury and PCCD application. The injuries were classified by an orthopaedic trauma surgeon and a senior orthopaedic resident. Proper application of a pelvic binder using a sheet is demonstrated.

Results: Only 47% of unstable pelvic fractures received PCCD placement, despite being the standard of care according to ATLS. Lateral compression mechanism pelvic injuries received PCCDs in 33% of cases, while anterior posterior compression (APC) and vertical shear (VS) injuries had applications in 63% of cases. Most of these PCCD devices were applied after imaging (72%). Hemodynamic instability did not influence PCCD application.

Conclusion: PCCD placement was missed in many (37%) of APC and VS mechanism injuries, where their application could have been critical to providing stability. Furthermore, to provide rapid stability, pelvic circumferential compression devices should be applied after secondary examination, rather than after receiving imaging results. Better education on timing and technique of PCCD placement at our institution is required to improve treatment of pelvic ring injuries. [West J Emerg Med. 2016;17(6)766-74.]

INTRODUCTION

Pelvic ring injuries carry a high burden of mortality and morbidity.[1] Life-threatening retroperitoneal hemorrhage can occur due to shearing of pelvic vessels as well as bleeding from fractured bone ends,[2] contributing to morbidity. However, it is postulated that early pelvic stabilization may help prevent exsanguination by decreasing pelvic volume and limiting inter-fragmentary motion, permitting stable clot formation. Use of a noninvasive pelvic circumferential compression device (PCCD) to achieve this effect has become commonplace, and has become a well-established component of Advanced Trauma Life Support (ATLS) protocol[3] (Figure 1). Both commercial binders and traditional sheeting techniques seem to be effective in reducing pelvic volume[4,5] (Figure 2). Pelvic binders are used not only at major trauma centers, but in prehospital and pre-transfer settings.[6] Pelvic fractures classification has an important role in the decision of whether or not to place a PCCD. The Young and Burgess classification looks at pelvic fractures in terms of the mechanism of injury: anterior posterior compression (APC, open book), lateral compression (LC), vertical shear (VS) or combined mechanism (CM). Stable injuries include APC1 and LC1, while LC2, LC3, APC2, APC3, VS and CM are unstable injures.[7,8,9] In the Young and Burgess classification, increasing numbers signify increasing severity of pelvic ring injury (Video 1). PCCDs are indicated for APC, VS, CM and LC3 lateral compression mechanisms. Their use in other LC injuries is not helpful, but the drawbacks are few if any.[10,11,12,13,14,15]

The purpose of this study was to evaluate 1) how consistently a PCCD was placed on patients who arrived at our hospital with unstable pelvic ring injuries; 2) if they were placed in a timely manner; and 3) if hemodynamic instability influenced their use.

METHODS

We used an institional review board approved-retrospective study using data collected from our Level I trauma center. Detroit Receiving Hospital (Detroit Medical Centre/Wayne State University) is an urban hospital with 120,000 annual emergency department (ED) visits, and is noted as being America's first verified Level I trauma center. The hospital's protocol for care of pelvic ring injuries included standard ATLS guidelines. A primary survey is followed by a secondary survey that includes physical assessment of pelvic stability, and upon detection of an unstable pelvic injury, a clamped sheet or PCCD is placed. The trauma codes are run either by general surgery or the emergency physicians, and orthopaedic residents or staff act as consultants during trauma codes and are summoned to the trauma bay. All patients get an initial anterior-posterior trauma pelvis radiograph, and most trauma codes get a computed tomography (CT) of the

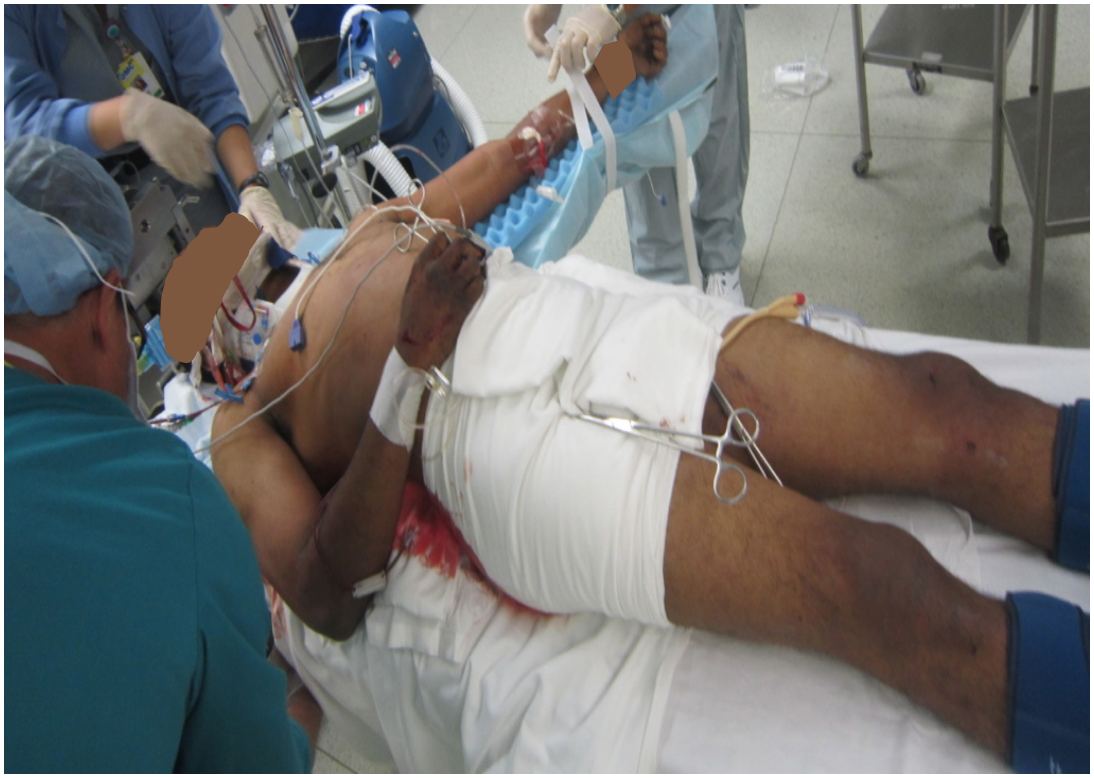

Figure 1. Use of a noninvasive pelvic circumferential compression device (PCCD) has become commonplace, and has become a well-established component of ATLS protocol.

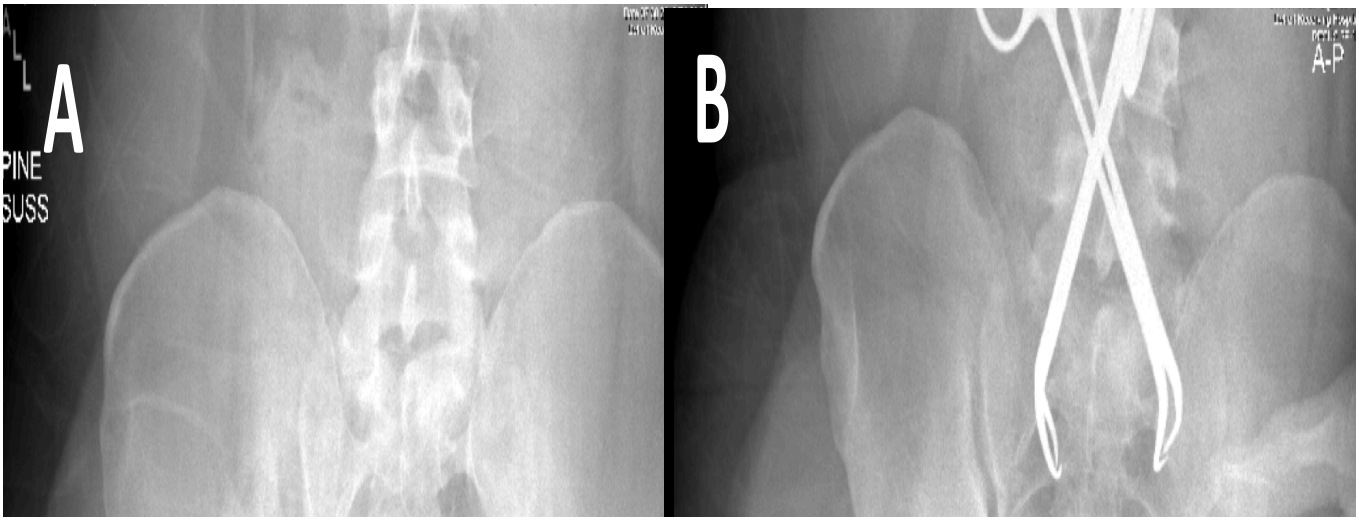

Figure 2. Both commercial binders and traditional sheeting techniques seem to be effective at reducing pelvic volume. A: Before application of pelvic binder, B: After application of pelvic binder. Note significant reduction in displacement with smaller pelvis volume.

abdomen and pelvis as well. If the patient was transferred with a PCCD in place, it was left in place until definitive management was performed.

This study included 112 consecutive patients with unstable pelvic ring injuries that were managed at our institution over a two-year period; we excluded patients with stable injuries from the study. Patients ranged in age from 18 to 86 years, with an average age of 41+15 (median 41) years. Of the patients, 35 (31%) were women and 77 (69%) were men. Every patient included in the study underwent surgical fixation.

We reviewed the chart, ED attending, resident and nurses' notes, radiographss and CTs. Injuries were classified by an orthopaedic traumatologist and a senior orthopaedic resident. In the case of discrepancy the case was discussed and a consensus reached. We noted when and if a PCCD was applied, whether it was placed prior to x-rays, prior to or after CT or not at all. We also recorded the patients'vitals upon arrival, and their ATLS hemorrhage class. The ATLS hemorrhage class is based on heart rate (HR), blood pressure (BP), respiratory rate, mental status and urinary output. As all patents do not fall strictly into categories (mental status was not clearly recorded for all patients and urinary output changes during resuscitation), we based our classification on HR, BP, and any other information we could garner from the ED notes including transfusion. Patients were thus classified as class 1 to 4 hemorrhage but for comparison between groups we listed the patient as hemodynamically stable or unstable. Class 1 was felt to be stable and Classes 2, 3 and 4 were considered unstable.

All patients presenting with pelvic fractures should have had a PCCD placed according to ATLS protocol, which recommends PCCD or sheet placement in unstable pelvic fractures after physical pelvic examination, before interpretation of radiographic results. However, if an LC mechanism was identified by the physician, not placing a PCCD would not have been harmful to the care of the patient. Thus, we separated the cases by mechanism into two groups APC, VS and CM (group 1) and LC (group 2).

RESULTS

We classified patients' injuries according to the Young and Burgess classification scheme, with their vital signs and hemorrhage class, hemodynamically stable or unstable (Tables in appendix).

Pelvic circumferential compression devices were used in 47% (55/112) of the patients. Patients who we identified as having either an APC or VS type injury comprised 69% (38/55) of the patients treated with a PCCD. Conversely, 31% (17/55) of patients had PCCDs placed for partial or complete LC injuries. Of the 57 pelvic ring injuries not managed with a PCCD, 40% (23/57) had an APC or VS mechanism, and 60% (34/57) had an LC mechanism (Table 1). We missed placing

Table 1. Mechanism of injury vs binder placement.

Mechanism of unstable pelvic injuries	PCCD placed	PCCD not placed	Total of PCCD placed and not placed
APC/ VS	38	23	61
LC	17	34	51
APC/VS and LC Total	55	57	112

APC, anterior posterior compression; *VS,* vertical shear; LC, lateral compression; *PCCD,* pelvic circumferential compression device.

a PCCD in 38% of unstable APC or VS (23/61) mechanism patients and 67% (34/51) of unstable LC mechanisms.

Timing of PCCD Placement

Application of the PCCD occurred prior to a radiograph at our institution in six patients; 38 patients had the PCCD placed between taking an AP pelvic radiograph and the CT. Four patients had PCCDs placed after the CT scan and seven patients were transferred to our hospital with a PCCD prior to arrival. As all patients had unstable pelvic injuries in this series, it is safe to say that that we picked up an unstable pelvic injury from the secondary survey and applied a PCCD in only 6/112 patients. The unstable injury was recognized and treated with a PCCD after radiograph in 38/106 patients and after CT in 4/68 patients who were eligible for PCCD placement.

Vitals Signs and Hemorrhage Class

We further assessed if PCCD placement was influenced by hemodynamic instability at presentation (Table 2 and Table 3). Patients were classified by hemodynamic shock class, with Class 1 being stable and Classes 2, 3 and 4 signifying hemodynamically unstable patients. Classes 2, 3 and 4 patients were grouped together to form a "hemodynamically unstable" group, for comparison with the Class 1 patients, who were labeled "stable" (Table 2, 3). Thirty patients classified with hemodynamic instability had a PCCD placed, and there were 25 patients with hemodynamic instability without PCCD placement placed. These groupings were then used in a Student's t-test, comparing the distribution of stable and unstable fractures for patients who had pelvic binders applied and those who did not. While the patients without binders tended to have more stable injuries, the t-test showed that there was no statistically significant difference between the patients with and without PCCDs (p=.301). Another t-test was performed comparing the groups with and without binders, but by discrete hemodynamic shock category, rather than just stable and unstable injuries. While this showed a slightly improved p-value, it still lacked significance (p=.247), indicating no significant relationship between hemodynamic shock class and the choice of PCCD placement with respect to our data.

DISCUSSION

The use of PCCDs in the treatment of pelvic injuries has become the standard of care,[3] particularly in APC and VS injury mechanisms. Their benefits include lifesaving hemorrhage control,[5,10,11] decreased mortality,[10] reduced transfusion requirement,[5,10,11] pelvic fracture reduction/stabilization,[5,10,11,15], length of hospital stay,[5,10,11] pain control, low risk, non invasive, easy to apply and cheap.[5,10,11,12,13,14,15] In patients who were transferred to another institution with a pelvic ring injury, applying a PCCD led to significantly decreased transfusion requirements whether they were hemodynamically stable or unstable prior to transfer.[5] The drawbacks of using PCCD are few, if any, even with LC mechanisms.[10,11,12,13,14,15] They allow adequate exposure if laparotomy or angiography are indicated.[6] PCCDs are more effective if placed accurately at the level of the greater trochanters and not higher on the abdomen, which is the most common error[16] (Figure 3 and Figure 4, Video 2). Although there are several different types of commercially available binders, there is no evidence to show superiority of one particular model even over pelvic sheets, which are commonly used.[5] There are complications associated with their use, such as pressure sores, tissue necrosis and nerve palsy,[7] especially if they are left on for a prolonged period of time. Pelvic binders may mask the "severity" of the pelvic injury on CTs, particularly APC patterns.[17] It is rare to completely hide any injury, but it does happen.[17,18] This is not a reason to avoid PCCD usage but an example of how efficient they are at accomplishing their goal. For the trauma team, one should be aware that a CT with a PCCD placed without prior imaging may not be diagnostic of the injury.[17] For the treating surgeon, a fluoroscopic exam under anesthesia in a controlled environment (the operating room) is an important adjunct in this situation.[17] We don't recommend removing the PCCD to do a radiograph in a hemodynamically unstable patient. Important limitations of pelvic binders are that they do not control VS fractures and do not stop arterial bleeding; therefore, access to provide embolization is vital. It is important to place binders expediently in patents with pelvic hemorrhage, and the reason for this study. We did not find any previous studies looking at the timing of PCCD placement in ED patients in relationship to radiographs and CTs, except one looking at how well PCCDs reduce and can mask pelvic injuries.[17]

We found that despite ATLS teaching of PCCD placement, on any unstable pelvic injury at our institution we only accomplished this in 47% (55/112) of such cases in this series. When we looked at just APC or VS injuries, the rate of use improved to 63% of cases (38/61). This still left a significant number of patients (37% [23/61]) without a PCCD placed for an APC or VS mechanism.

For LC mechanisms where the indication for a PCCD is questionable except in the LC3 mechanism we found that PCCDs were placed in 33% of cases. The fear of using PCCDs in LC mechanisms is that they will over-compress the fracture and could lead to further injury, and so some controversy exists with these injuries.[12] The general feeling is that a PCCD should be placed in any unstable mechanism so that emergency physicians or early responders do not have to make any decisions based on radiographs or the CT. If that is the case ,we missed 67% of cases of LC injuries where a PCCD should have been placed. However, many emergency physicians, general surgeons and residents can read radiographs, classify pelvic injuries, and may have elected not to place the binder in the LC mechanisms. Nonetheless, according to ATLS procedure, pelvic binder placement should

Table 2. Young and Burgess (Y and B) classification vitals signs and shock class (with binder).

Patient binder placement	Y and B class	Pulse on arrival	BP	Shock class hemodynamically stable/unstable
1	APC3	70	108/50	1 Stable
2	APC2	117	117/68	2 Unstable
3	APC3	78	102/80	1 Stable
4	APC2	78	156/95	1 Stable
5	APC3	80	90/60	2 Unstable
6	APC2	121	80/52	3 Unstable
7	LC3	120	60/30	4 Unstable
8	APC2	122	147/102	2 Unstable
9	APC2	92	124/78	1 Stable
10	LC3	83	105/56	1 Stable
11	APC3	98	148/108	1 Stable
12	LC3	107	119/90	2 Unstable
13	APC2	83	132/82	1 Stable
14	LC3	80	157/86	1 Stable
15	APC2	80	125/65	1 Stable
16	LC2	86	110/80	1 Stable
17	APC3	100	155/96	2 Unstable
18	APC3	70	90/58	2 Unstable
19	APC3	90	120/86	1 Stable
20	APC2	105	114/68	2 Unstable
21	LC3	92	134/74	1 Stable
22	APC3	130	60/	4 Unstable
23	APC3	128	103/86	3 Unstable
24	APC2	106	96/66	2 Unstable
25	LC3	70	135/90	1 Stable
26	LC3	109	60/30	4 Unstable
27	LC3	145	96/66	3 Unstable
28	LC2	76	130/90	1 Stable
29	APC3	50	105/60	1 Stable
30	LC2	120	131/78	2 Unstable
31	LC2	71	130/90	1 Stable
32	APC3	100	103/59	2 Unstable
33	APC3	87	130/68	1 Stable
34	APC3	90	209/188	1 Stable
35	APC3	86	93/64	1 Stable
36	APC3	87	172/94	1 Stable
37	LC1	121	122/71	2 Unstable
38	LC3	92	116/74	1 Stable
39	APC3	125	98/47	3 Unstable
40	APC3	137	170/130	2 Unstable
41	APC3	93	133/100	1 Stable
42	APC3	113	110/80	2 Unstable
43	APC3	138	139/70	2 Unstable

APC, anterior posterior compression; *LC,* lateral compression.

Table 2. Continued.

Patient binder placement	Y and B class	Pulse on arrival	BP	Shock class hemodynamically stable/unstable
44	APC3	120	124/85	2 Unstable
45	LC1	111	139/95	2 Unstable
46	APC2	67	213/114	1 Stable
47	LC3	105	199/85	2 Unstable
48	APC3	147	97/71	3 Unstable
49	APC2	86	140/70	1 Stable
50	APC3	120	70/50	4 Unstable
51	APC2	65	137/70	1 Stable
52	APC3	101	132/71	2 Unstable
53	LC2	109	101/75	2 Unstable
54	APC2	150	120/70	3 Unstable
55	APC3	140	90/60	3 Unstable

APC, anterior posterior compression; *LC,* lateral compression.

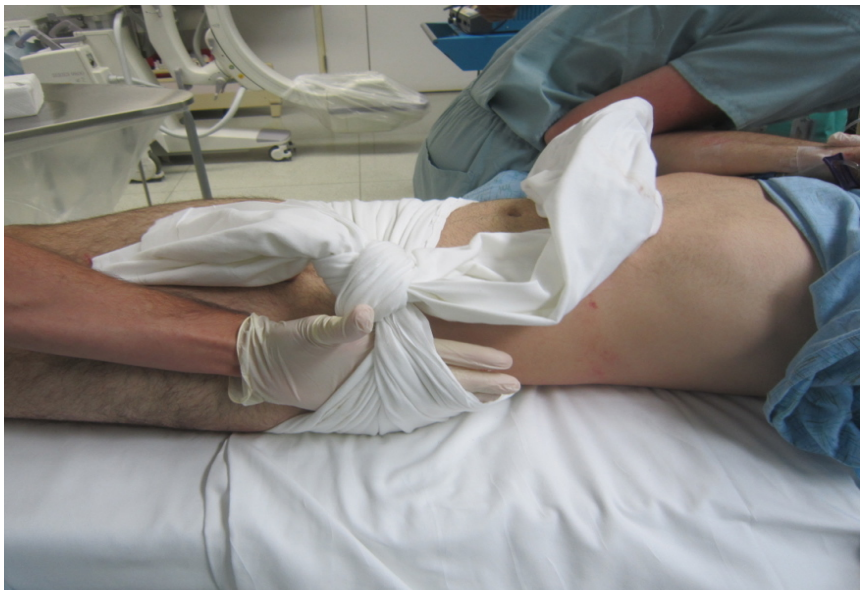

Figure 3. Poorly applied pelvic circumferential compression device: too loose, too low and should not be tied.

occur before radiograph interpretation.

We found that when PCCD devices were placed, they were done so after imaging, either after radiograph and before CT (38), or after the CT(4). Only six patients had the PCCD placed after clinical examination, and prior to radiograph. Thus, we may need to reinforce that an exam of the pelvis should be done in the secondary survey and that if a pelvic injury is suspected, a PCCD should be placed immediately. We are not sure if our staff missed identifying the injury on exam of the pelvis, were hesitant to place a binder until after imaging, or were uncomfortable placing a PCCD.

The quality of the binder placement was variable. We were not able to rate every case of PCCD application; we did find that many were placed high on the ilium rather than over the greater trochanters, which is a common error.[16] We did not notice any specific complications as most of them were removed within six to eight hours.

We found that hemodynamic instability was not a great predictor of PCCD placement in our patients.

LIMITATIONS

This study was limited by its retrospective and observational design, as well as sample size. However, we were able to get an idea of how often PCCDs were applied

Table 3. Young and Burgess (Y and B) classification vitals signs and shock class (without binder).

Patient no binder	Y and B class	Pulse on arrival	BP	Shock class hemodynamically stable/unstable
1	APC3	98	158/107	1 Stable
2	APC3	86	114/54	1 Stable
3	LC2	106	87/42	3 Unstable
4	LC3	109	147/112	2 Unstable
5	LC3	119	152/82	2 Unstable
6	APC2	154	98/58	3 Unstable
7	LC3	66	122/86	1 Stable
8	LC3	97	110/60	1 Stable
9	LC3	76	104/43	1 Stable
10	APC2	86	114/54	1 Stable
11	LC3	133	91/47	3 Unstable
12	APC2	106	96/50	2 Unstable
13	LC2	113	117/78	2 Unstable
14	LC2 BILAT	105	130/94	2 Unstable
15	LC2	96	178/100	1 Stable
16	APC3	81	142/96	1 Stable
17	LC2	90	93/70	2 Unstable
18	LC3	94	97/49	2 Unstable
19	LC2	94	117/85	1 Stable
20	LC2	94	97/49	2 Unstable
21	LC3	140	90/50	3 Unstable
22	LC2	140	68/43	4 Unstable
23	LC2	108	121/85	2 Unstable
24	LC2	77	90/68	1 Stable
25	LC2	82	103/53	1 Stable
26	APC3	157	53/52	4 Unstable
27	APC2	84	130/75	1 Stable
28	LC2	85	127/83	1 Stable
29	LC2	87	112/82	1 Stable
30	LC3	84	144/107	1 Stable
31	APC3	106	84/50	2 Unstable
32	APC3	114	147/120	2 Unstable
33	APC3	90	140/180	1 Stable
34	LC2	77	130/73	1 Stable
35	LC2	87	133/92	1 Stable
36	APC2	64	121/78	1 Stable
37	LC2	86	100/60	1 Stable
38	LC2	86	104/63	1 Stable
39	APC2	68	110/72	1 Stable
40	LC2	125	142/95	2 Unstable
41	LC2	81	118/82	1 Stable
42	LC2	104	108/68	2 Stable
43	LC2	150	103/81	3 Unstable

APC, anterior posterior compression; *LC,* lateral compression.

Table 3. Continued.

Patient no binder	Y and B class	Pulse on arrival	BP	Shock class hemodynamically stable/unstable
44	APC2	85	159/107	1 Stable
45	APC2	105	100/75	2 Unstable
46	APC2	67	160/83	1 Stable
47	LC2	74	114/85	1 Stable
48	APC3	105	156/92	2 Unstable
49	APC2	79	138/97	1 Stable
50	LC2	90	152/87	1 Stable
51	LC2	110	148/76	2 Unstable
52	APC3	126	1037/97	2 Unstable
53	APC3	70	120/75	1 Stable
54	LC2	120	90/60	3 Unstable
55	APC2	92	134/78	1 Stable
56	APC3	98	137/68	1 Stable
57	APC3	99	140/70	1 Stable

APC, anterior posterior compression; *LC,* lateral compression.

Figure 4. Poorly applied pelvic circumferential compression: It is too high on the belly and should be at the level of the greater trochanter.

when indicated at our institution. We will continue to educate the frontline physicians in this apparatus, how to place it and the timing of application (Video 1,2). Others have also noted variability in knowledge, use and application of PCCDs.[5] The authors acknowledge that no formal study of inter-observer agreement was performed for the radiographic classification of the injuries, but diagnosis were discussed when there was a discrepancy and a consensus was reached. We also did not ascertain whether placement of a PCCD and the timing of PCCD placement affected patient outcomes. Our numbers were low for this type of comparison and other groups have studied this, as mentioned in the discussion. [5,10,11,12,13,14,15]

CONCLUSION

The current ATLS teaching is placing a PCCD expediently with suspected pelvic instability. At our institution we missed

application of a PCCD in 37% of APC/VS mechanisms and 67% of LC mechanisms (which may still have some controversy). We could be more effective at diagnosing these injuries during our secondary survey instead of waiting for the plain radiograph or CT. There is a need to educate and reeducate the frontline providers on the timely placement of PCCDs.

Video 1. Identifying pelvic ring injuries and the Young and Burgess classification.

Video 2. Application of a Pelvic Binder using a common sheet.

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Autoinjectors Preferred for Intramuscular Epinephrine in Anaphylaxis and Allergic Reactions

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Introduction: Epinephrine is the treatment of choice for anaphylaxis. We surveyed emergency department (ED) healthcare providers regarding two methods of intramuscular (IM) epinephrine administration (autoinjector and manual injection) for the management of anaphylaxis and allergic reactions and identified provider perceptions and preferred method of medication delivery.

Methods: This observational study adhered to survey reporting guidelines. It was performed through a Web-based survey completed by healthcare providers at an academic ED. The primary outcomes were assessment of provider perceptions and identification of the preferred IM epinephrine administration method by ED healthcare providers.

Results: Of 217 ED healthcare providers invited to participate, 172 (79%) completed the survey. Overall, 82% of respondents preferred the autoinjector method of epinephrine administration. Providers rated the autoinjector method more favorably for time required for training, ease of use, convenience, satisfaction with weight-based dosing, risk of dosing errors, and speed of administration (p<0.001 for all comparisons). However, manual injection use was rated more favorably for risk of provider self-injury and patient cost (p<0.001 for both comparisons). Three participants (2%) reported a finger stick injury from an epinephrine autoinjector.

Conclusion: ED healthcare providers preferred the autoinjector method of IM epinephrine administration for the management of anaphylaxis or allergic reactions. Epinephrine autoinjector use may reduce barriers to epinephrine administration for the management of anaphylaxis in the ED. [West J Emerg Med. 2016;17(6)775-82.]

INTRODUCTION

Anaphylaxis is a serious allergic reaction that frequently involves multiple organ systems, is rapid in onset, and may cause death.[1] The management of anaphylactic reactions occurs most commonly in the emergency department (ED), placing emergency care providers on the front line of medical intervention for these patients.[2,3] Epinephrine is the treatment of choice for anaphylaxis,[4] and delayed administration of epinephrine has been associated with increased risk of death.[5]

Much attention has been focused on the need to improve healthcare delivery and reduce preventable adverse events, including medication errors.[6] A recent review found that medication errors were most common in the prescribing and administering phases and occurred across all patient age spectrums.[7] Important sources of error, particularly in neonatal and pediatric patients, were physician inexperience and dosing

errors (including 10- and 100-fold dosing errors).[7] Most serious adverse reactions, including fatalities, associated with epinephrine are a result of improper dosages.[8] The urgent need of epinephrine administration to a patient with anaphylaxis can result in errors at any stage of the medication-use process: medication ordering, dosing, and administration.[9,10]

Several factors contribute to the risk of errors. Epinephrine has historically been supplied in 1:1,000 and 1:10,000 formulations. Both formulations are used in the ED, but the low frequency of epinephrine use in a high-stress context can lead to errors in choosing the correct formulation. The use of a ratio (1:1,000 or 1:10,000) as an expression of drug concentration is uncommon, and the conversion of the ratio to milligrams poses an additional cognitive step. This additional calculation can lead to dosing errors of multiple orders of magnitude. Furthermore, epinephrine can be administered through subcutaneous, intramuscular (IM), or intravenous injection, with increasing bioavailability and greater potential toxicity.

Although autoinjector use may reduce the risk of dosing errors, autoinjector epinephrine is more costly.[11] Furthermore, patient injury[12] and injury due to inadvertent autoinjector administration of epinephrine into the finger of the person delivering the medication have been reported in both lay people and healthcare providers.[13,14]

Many patients with anaphylaxis are not treated with epinephrine in the ED.[3,4,15] While the reasons for this remain poorly understood, we believe that the underestimation of the severity of anaphylaxis, lack of familiarity with the dosing of epinephrine, and fear of complications secondary to inappropriate dosing may be contributing factors.

In our institution, epinephrine autoinjectors (EpiPen 0.3 mg and EpiPenJr 0.15 mg; Mylan Specialty, LP) were made available in automated dispensing cabinets in November 2008 for ED use in anaphylaxis treatment. Before this date, only ampules of epinephrine were available, from which epinephrine was drawn for manual IM injection for anaphylaxis or allergic reactions. After the introduction of epinephrine autoinjectors, we had the distinct opportunity to assess healthcare provider satisfaction, perceptions of safety, experiences, and preferred delivery method of IM epinephrine administration. Further, we hypothesized that understanding provider perceptions could provide information that would indicate the method of epinephrine administration associated with fewer barriers to use. Thus, the objective of the study was to examine healthcare providers' preferences and perceptions about the optimal mode of epinephrine delivery with respect to safety, effectiveness, ease of administration, convenience, and cost for the two methods of epinephrine administration in management of anaphylaxis and allergic reactions.

METHODS

Design and Setting

This study adheres to the guidelines for standardized reporting of survey research[16,17] and guidelines for reporting observational studies (Strengthening the Reporting of Observational Studies in Epidemiology [STROBE]).[18] This study was approved by the Mayo Clinic Survey Research Center. We developed the survey instrument in collaboration with staff at our institution's survey research center. Input from an expert on survey design was obtained to design the research tool. We incorporated appropriate survey methodology addressing non-random sampling, questionnaire layout, wording of the questions, and piloting. Two emergency physicians on staff, one pharmacist, and one nurse participated in the pilot testing and refinement of the survey, as well as the final survey. All known eligible participants were invited to complete the survey, which was administered by the research survey center to maintain masking to investigators and participant confidentiality. The full survey is included in the Appendix. The survey was distributed to ED healthcare providers between April 28 and June 16, 2011. Our institution is an academic tertiary care and referral center with approximately 73,000 annual ED visits and an admission rate of 30%. Approximately 20% of the ED patients are younger than 18 years.

Participants

Participants in the study consisted of healthcare providers, including ED pharmacists, emergency medicine (EM) residents, ED physician assistants, ED nurse practitioners, ED nurses, and ED staff physicians who work at the ED of Mayo Clinic Hospital - Rochester, Saint Marys Campus. We compiled a distribution list of email addresses for all ED providers (N=217), and then verified the status of each person using the internal employee directory. A recruitment email was sent to all ED provider staff; all responses were collected anonymously. After the initial invitation, three reminder emails were sent to nonresponders. No respondents contacted the primary investigator about content questions.

Variables and Measurements

Data collection included participant demographic characteristics and questions regarding the participant's perceptions of and experiences with use of epinephrine administration through an epinephrine autoinjector or manual injection for patients with allergic reactions or anaphylaxis. The assessment regarding the two injection methods included questions on ease of use, convenience, satisfaction with weight-based epinephrine dosing, risk of dosing errors, cost to patient, speed of administration, and risk of self-injury. Respondents were asked to place their answers as electronic marks on a scale of 0 to 100.

The initial survey was piloted on a small sample of the target population to identify whether respondents understood the questions and instructions and whether the meaning of questions was the same for all respondents. After feedback, we refined the survey and sent it to the final group of participants.

Data Collection

REDCap (Research Electronic Data Capture),[19] a secure Web-based research application hosted at Mayo Clinic in Rochester, Minnesota, was used to collect and manage data.

Statistical Analysis

We did not perform a sample size calculation because a finite number of ED providers could be queried. Frequencies and proportions for categorical variables were used to describe participant characteristics. These characteristics were compared among occupations using Kruskal-Wallis or Fisher exact tests. We summarized responses to the questions asked for both epinephrine autoinjector and manual injection with mean (SD) and median (interquartile range) as appropriate and compared them using Wilcoxon signed rank tests for paired data. Statistical analyses were performed by a statistician using SAS software package version 9.3 (SAS Institute Inc). *P* values <0.05 were considered statistically significant. We performed a subgroup analysis of the providers who reported experience with both autoinjector and manual injection techniques, and a subgroup analysis of nurses only, because they are the provider most likely to administer the medication.

RESULTS

Of the 217 ED healthcare providers invited to participate, 172 (79%) completed the survey.

Demographic Characteristics

Demographic characteristics are depicted in Table 1. Of 172 respondents, 53 (31%) were either EM residents or staff physicians, 103 (60%) were nurses, and 15 (9%) were either advanced practice providers or pharmacists. One provider did not report occupation. Overall, 96 respondents (57%) were women, and the majority of respondents had >10 years of clinical practice experience. Among nurses, respondents were more likely to be women (74%); EM residents, ED staff physicians, and ED pharmacists were more likely to be men (74%, 68%, and 86% male respondents, respectively).

Epinephrine Administration Experiences, Perceptions, and Preferences

Overall, 147 providers (87%) had either recommended, ordered, or administered epinephrine for the management of an allergic reaction or anaphylaxis in the ED. Three providers (2%) reported having a finger stick injury while using an epinephrine autoinjector; all of these respondents were nurses. When asked to estimate the amount of training time required for a provider to safely administer epinephrine, 148 respondents (88%) estimated ≤10 minutes would be adequate for training to safely use an epinephrine autoinjector compared with 94 (57%) who estimated that ≤10 minutes would be adequate for training to safely administer epinephrine with manual IM injection. Overall, 137 respondents (82%) preferred using an epinephrine autoinjector for management of an allergic reaction or anaphylaxis in the ED vs manual IM injection (Table 1).

Providers rated the autoinjector more favorably with regard to ease of use, convenience, satisfaction with weight-based dosing, risk of dosing errors, and speed of administration ($p<0.001$ for all comparisons) (Table 2). However, manual injection was rated more favorably with regard to risk of provider self-injury and patient cost ($p<0.001$ for both comparisons).

Subgroup Analysis

Some providers did not have ED experience with both methods of epinephrine administration; therefore, we performed a subgroup analysis of the 49 (28.5% of 172 total) providers who reported experience with both autoinjector and manual techniques. This subgroup was similar to the group of unilaterally experienced providers with regard to gender and years of practice (data not shown). Those with experience in both methods were more likely to be ED staff physicians (17/49 [35%] vs 16/123 others [13%], $p=0.02$). The ratings among this subgroup of providers were similar to the overall results except that no significant difference existed between ratings of satisfaction and weight-based dosing (Table 2). We also performed a subgroup analysis of the nurses; the ratings provided by the nurses were similar to the overall group except that there was no significant difference with regard to risk of self-injury.

DISCUSSION

In this survey of 172 ED healthcare providers, including ED staff physicians, nurses, advanced practice providers, residents, and pharmacists, 82% preferred the autoinjector method of IM epinephrine administration for management of allergic reactions or anaphylaxis. To our knowledge, this is the first study to assess provider preferences with regard to methods of IM administration of epinephrine. ED providers rated the autoinjector method more favorably with regard to amount of time required for training, ease of use, convenience, satisfaction with weight-based dosing, risk of dosing errors, and speed of administration. However, manual injection was rated more favorably with regard to risk of provider self-injury and patient cost.

Importantly, the epinephrine autoinjector was rated much more favorably compared with manual injection for risk of dosing errors. The perceived increase in risk of dosing errors with manual injection may be due to the risks of unfamiliarity with the appropriate dose or route, miscalculation of the dose, and miscommunication between the ordering provider and the nurse administering the medication, as has been suggested previously.[10] Although anaphylaxis is more commonly managed in the ED than in other clinical settings,[2,3] it is not a common occurrence. A study by Gaeta et al[20] showed that allergic concerns made up about 1% of ED visits, and only about 1% of these were coded as anaphylaxis. These findings

Table 1. Comparison by occupation of responders to survey on use of autoinjector vs. manual injection of epinephrine

Characteristic	Occupations, no. (%)					All (n=172)[a]	*P* value[b]
	ED nurse (n=103)	ED PA/ NP (n=7)	EM resident (n=20)	EM staff physician (n=33)	ED pharmacist (n=8)		
Gender (n= 167)							<0.001
Female	76 (74)	3 (50)	5 (26)	10 (32)	1 (14)	96 (57)	
Male	27 (26)	3 (50)	14 (74)	21 (68)	6 (86)	71 (43)	
Years in practice							<0.001
0-3	0	2 (29)	17 (85)	3 (9)	2 (25)	24 (14)	
4-9	26 (25)	4 (57)	3 (15)	11 (33)	5 (63)	49 (28)	
10-20	41 (40)	1 (14)	0	10 (30)	0	52 (30)	
>20	36 (35)	0	0	9 (27)	1 (13)	47 (27)	
Epinephrine recommended, ordered, or administered in ED (n=169)	88 (87)	6 (86)	17 (85)	31 (97)	4 (50)	147 (87)	0.02
Epinephrine formulation used (n=147)[c]							
Autoinjector	71 (81)	3 (50)	17 (100)	21 (68)	4 (100)	116 (79)	0.02
Manual IM injection	36 (41)	1 (17)	3 (18)	21 (68)	1 (25)	62 (42)	0.004
Subcutaneous injection	53 (60)	1 (17)	0	18 (58)	1 (25)	74 (50)	<0.001
IV bolus	24 (27)	3 (50)	3 (18)	11 (35)	0	41 (28)	0.35
IV infusion	17 (19)	0	4 (24)	10 (32)	3 (75)	34 (23)	0.06
Injured using epinephrine autoinjector (n=168)							0.79
No	97 (97)	6 (100)	20 (100)	33 (100)	8 (100)	165 (98)	
Finger stick injury	3 (3)	0	0	0	0	3 (2)	
Other injury	0	0	0	0	0	0	
Injured during manual IM injection (n=168)							NA
No	101 (100)	5 (100)	20 (100)	33 (100)	8 (100)	168 (100)	
Finger stick injury	0	0	0	0	0	0	
Other injury	0	0	0	0	0	0	
Training time for epinephrine autoinjector, min (n=169)							0.66
<5	43 (43)	4 (57)	6 (30)	12 (36)	2 (29)	67 (40)	
5-10	45 (45)	3 (43)	11 (55)	16 (48)	5 (71)	81 (48)	
10-20	10 (10)	0	3 (15)	3 (9)	0	16 (9)	
20-30	2 (2)	0	0	2 (6)	0	4 (2)	
>30	1 (1)	0	0	0	0	1 (1)	
Training time for manual IM injection, min (n=166)							<0.001
<5	23 (23)	1 (14)	0	4 (12)	1 (14)	30 (18)	
5-10	45 (46)	3 (43)	4 (20)	9 (27)	3 (43)	64 (39)	
10-20	25 (26)	3 (43)	9 (45)	9 (27)	3 (43)	49 (30)	

ED, emergency department; *EM,* emergency medicine; *IM,* intramuscular; *IV,* intravenous; *NA,* not applicable; *NP*, nurse practitioner; *PA,* physician assistant.

[a] One respondent did not report occupation.

[b] *P* values for comparisons of features by occupation were obtained with Kruskal-Wallis or Fisher exact tests.

[c] Respondent could select more than 1 choice.

Table 1. Continued.

Characteristic	Occupations, no. (%)					All (n=172)[a]	*P* Value[b]
	ED Nurse (n=103)	ED PA/ NP (n=7)	EM Resident (n=20)	EM Staff Physician (n=33)	ED Pharmacist (n=8)		
20-30	5 (5)	0	4 (20)	4 (20)	0	17 (10)	
>30	0	0	3 (15)	3 (15)	0	6 (4)	
Overall preference (n=168)							<0.001
Highly prefer autoinjector	72 (73)	2 (29)	17 (85)	14 (42)	4 (50)	109 (65)	
Somewhat prefer autoinjector	13 (13)	2 (29)	3 (15)	6 (18)	3 (38)	28 (17)	
No preference	7 (7)	2 (29)	0	6 (18)	1 (13)	16 (10)	
Somewhat prefer manual IM injection	6 (6)	0	0	6 (18)	0	12 (7)	
Highly prefer manual IM injection	1 (1)	1 (14)	0	1 (3)	0	3 (2)	

ED, emergency department; *EM,* emergency medicine; *IM,* intramuscular; *IV,* intravenous; *NA,* not applicable; *NP,* nurse practitioner; *PA,* physician assistant.

[a] One respondent did not report occupation.

[b] *P* values for comparisons of features by occupation were obtained with Kruskal-Wallis or Fisher exact tests.

[c] Respondent could select more than 1 choice.

likely underestimate the frequency of anaphylaxis in the ED due to underdiagnosis. More recent data indicate that ED visits for anaphylaxis are increasing.[21] However, this may be due, at least in part, to increased recognition rather than a true increase in incidence; nevertheless, anaphylaxis continues to be a relatively infrequent emergency in the ED. Its infrequency can lead to unfamiliarity with epinephrine dosing for the ordering provider and the nurse administering the medication and to subsequent increased risk of dosing errors and adverse effects.

Interestingly, although epinephrine autoinjectors are available in only two different doses (0.15 and 0.30 mg), the providers in our study overall rated autoinjectors more favorably with regard to weight-based dosing, whereas the providers who had experience with both methods of IM epinephrine administration rated them similarly. This favorable rating of autoinjectors suggests that providers considered the autoinjector doses, although inexact for weight-based dosing, to be adequate for the majority of patients.

Nevertheless, autoinjectors may not be the best mode of administration for very young patients. In patients weighing <15 kg, autoinjector use could potentially result in overdose, particularly in patients weighing <10 kg. Thus, although the adverse effects of an autoinjector epinephrine dose of 0.15 mg in patients weighing <15 kg are unlikely to be dangerous at the plasma levels achieved,[22] manual injection may be preferred in this patient population.[23] Likewise, in patients weighing >30 kg, the autoinjector may result in underdosing of epinephrine. However, manual injection may delay administration because of the time needed to calculate the dose and administer the medication. Finally, studies have found that the autoinjector needle length may be inadequate in a substantial number of children and adults, particularly those with a higher body mass index.[24,25] This inadequate needle length could result in subcutaneous injection rather than IM delivery. Subcutaneous injection has been shown to result in lower peak plasma concentrations than IM administration.[26,27] Conversely, a long needle in children weighing <15 kg may place them at risk of epinephrine being administered into bone.[28]

Although autoinjectors were rated favorably in many respects, overall the providers identified an increased risk of self-injury with the autoinjector. Interestingly, although three nurses reported self-injury with the epinephrine autoinjector, when the nursing responses were analyzed as a subgroup, there was no significant difference in the rating of risk of self-injury. This may be due to the fact that, by the time of the survey, nurses had received additional training to prevent finger stick injuries and therefore did not perceive an increased risk of self-injury. Nonetheless, autoinjector-related finger stick injury has been well documented in the literature and can result in delay in administration.[13,14] Fortunately, death or long-term morbidity have not been reported as related to inadvertent finger self-injection.[29,30] Furthermore, recent reports have documented patient lacerations and embedded needles secondary to autoinjectors.[12] However, the true incidence of these injuries is unknown and may be mitigated by proper limb immobilization before administration.

Providers also correctly identified that autoinjectors are more expensive than manual injection. As we previously published,[11] the average wholesale cost of the autoinjectors used in the present study was approximately U.S. $75.00 compared with U.S.$ 3.00 for the 1:1,000 vial of epinephrine. However, more recently, the cost of autoinjectors has increased substantially. Currently, EpiPens are only

Table 2. Ratings of epinephrine autoinjector and manual intramuscular injection by 172 survey respondents[a].

Parameter (no. of respondents)[a]	Epinephrine autoinjector,[b] mean (SD); median (IQR)	Manual IM injection,[b] mean (SD); median (IQR)	*P* value[c]
Ease of use (161:150)	85.5 (16.4); 90 (80-97)	49.6 (24.7); 50 (29-67)	<0.001
Convenience (162:155)	88.7 (15.0); 94.5 (85-100)	38.2 (26.3); 33 (17-50)	<0.001
Satisfaction with weight-based dosing (152:148)	68.3 (23.5); 69.5 (50-90)	56.7 (25.8); 50 (45-77)	<0.001
Risk of dosing errors (155:152)	20.1 (19.8); 15 (4-27)	67.8 (22.0); 72 (52-83)	<0.001
Cost to patient (133:129)	58.2 (15.9); 50 (50-70)	40.6 (16.9); 50 (27-50)	<0.001
Speed of administration (161:154)	84.1 (16.6); 90 (76-97)	45.7 (23.3); 50 (28-61)	<0.001
Risk of self-injury (155:154)	52.6 (24.8); 58 (30-73)	38.4 (22.4); 39 (20-50)	<0.001
Subset of 49 respondents[d]			
Ease of use (46:44)	87.8 (18.2); 95.5 (85-99)	53.8 (28.9); 50.5 (27-75)	<0.001
Convenience (45:45)	92.5 (10.7); 96 (91-100)	38.3 (29.7); 30 (15-60)	<0.001
Satisfaction with weight-based dosing (47:45)	65.7 (27.2); 60 (50-97)	59.9 (30.7); 65 (40-88)	0.47
Risk of dosing errors (45:45)	19.7 (20.3); 14 (3-26)	71.4 (25.6); 75 (60-94)	<0.001
Cost to patient (41:39)	63.0 (17.5); 61 (50-77)	38.5 (16.9); 50 (25-50)	<0.001
Speed of administration (46:46)	86.2 (16.7); 90.5 (80-98)	44.6 (25.6); 36.5 (25-66)	<0.001
Risk of self-injury (47:47)	57.7 (25.3); 60 (30-79)	36.0 (20.6); 34 (20-50)	<0.001
Subset of 103 ED nurses			
Ease of use (95:90)	87.9 (16.2); 94 (84-99)	50.9 (25.8); 50 (29-67)	<0.001
Convenience (94:92)	89.9 (16.1); 96 (87-100)	39.1 (28.1); 34 (18.5-50)	<0.001
Satisfaction with weight-based dosing (89:87)	70.1 (24.4); 74 (50-94)	54.7 (26.3); 50 (41-75)	<0.001
Risk of dosing errors (92:90)	18.0 (18.7); 11.5 (2.5-26)	68.1 (23.7); 75 (50-86)	<0.001
Cost to patient (73:71)	57.1 (13.8); 50 (50-70)	43.2 (12.6); 50 (36-50)	<0.001
Speed of administration (96:92)	88.0 (14.6); 92 (83.5-98)	46.6 (25.0); 50 (28.5-67.5)	<0.001
Risk of self-injury (91:90)	49.8 (25.0); 50 (26-70)	44.0 (21.7); 50 (26-60)	0.14

ED, emergency department; *IM*, intramuscular; *SD,* standard deviation; *IQR,* interquartile range.
[a] The first number represents the number of respondents who rated the parameter for the epinephrine autoinjector and the second number represents the number of respondents who rated the parameter for manual injection.
[b] Higher scores indicate increased ease of use, increased convenience, greater satisfaction with weight-based dosing, increased risk of dosing errors, greater cost to patient, higher speed of administration, and higher risk of self-injury scores.
[c] *P* values obtained from Wilcoxon signed rank tests for paired data.
[d] Subset of 49 respondents with epinephrine autoinjector and IM manual injection of epinephrine experience in the ED.

available in packages of two and have an average wholesale price for the 0.15-mg or 0.3-mg dose of U.S. $730.33, while the average wholesale cost of the 1-mL 1:1,000 vial of epinephrine is U.S. $15.00.[31] The generic epinephrine autoinjector, Adrenaclick, is sold individually and has an average wholesale price of U.S. $103.50 or as a two-pack for U.S. $206.98.[31] This cost is substantial and may be a barrier for use of autoinjectors in some EDs. Prefilled epinephrine syringes have been suggested as a potential low-cost alternative to epinephrine autoinjectors and have been shown to be stable and sterile three months after preparation.[32] Few data exist on the current availability of autoinjectors in EDs or other healthcare settings. One study reported that only one of seven hospitals that responded to a survey reported having epinephrine autoinjectors available in their hospital crash carts.[9] Furthermore, this cost must be weighed against the potential cost of complications related to delay in epinephrine administration or to epinephrine overdose.

LIMITATIONS

The present study is limited because only 28% of the respondents had actual ED experience with both epinephrine autoinjectors and manual IM injection of epinephrine. Yet, the perceptions and preferences of the respondents overall were consistent with the respondents who had experience with both methods. Only the EpiPen and EpiPenJr were introduced in our ED, and therefore, perceptions and preferences may have been different if a different brand of autoinjector had been chosen. In addition, although we had an excellent response rate of 79%, the survey may have non-respondent bias because providers most interested in epinephrine administration may have been more likely to respond. Furthermore, there was

an approximately 2.5-year period between the introduction of epinephrine autoinjectors and the time of the survey, which could result in recall bias. However, during this time, there was a gradual increase in use of the autoinjectors, and because epinephrine administration for an allergic reaction or anaphylaxis is relatively infrequent, this allowed time for providers to have an opportunity to use the autoinjector. In addition, although autoinjectors were available, providers could continue to use the manual method if they preferred. Finally, the survey was conducted at a single tertiary care ED, and providers in other clinical environments may have different practice patterns, perceptions, and preferences. Thus, larger, multicenter studies should be undertaken to further characterize the risks, benefits, and perceptions of use of autoinjectors vs manually administered epinephrine.

CONCLUSION

Of ED provider respondents, 82% preferred the autoinjector method of IM epinephrine administration over manual dosing and administration for management of allergic reactions or anaphylaxis. Ultimately, risks and benefits of the two options for IM epinephrine administration must be considered on the basis of the individual patient. Epinephrine autoinjectors, though more costly, provide a rapid and reliable way to administer a life-saving medication in a high-stress situation.[33,34] Thus, autoinjector use may reduce barriers to epinephrine administration for anaphylaxis management in the ED and should be considered to improve patient care.

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Hours and Miles: Patient and Health System Implications of Transfer for Psychiatric Bed Capacity

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Introduction: An increasing number of behavioral health (BH) patients are presenting to the emergency department (ED) while BH resources continue to decline. This situation may lead to more external transfers to find care.

Methods: This is a retrospective cohort study of consecutive patients presenting to a tertiary care academic ED from February 1, 2013, through January 31, 2014. Patients were identified through electronic health record documentation of psychiatric consultation during ED evaluation. We reviewed electronic health records for demographic characteristics, diagnoses, payer source, ED length of stay, ED disposition, arrival method, and distance traveled to an external facility for inpatient admission. Univariable and multivariable associations with transfer to an external facility in comparison with patients admitted internally were evaluated with logistic regression models and summarized with odds ratios (OR).

Results: We identified 2,585 BH visits, of which 1,083 (41.9%) resulted in discharge. A total of 1,502 patient visits required inpatient psychiatric admission, and of these cases, 177 patients (11.8%; 95% CI = [10.2-13.5]) required transfer to an external facility. The median ED length of stay for transferred patients was 13.9 hours (interquartile range [IQR], 9.3-20.2 hours; range, 3.0-243.0 hours). The median distance for transport was 83 miles (IQR, 42-111 miles; range, 42-237 miles). In multivariable analysis, patients with suicidal or homicidal ideation had increased risk of transfer (odds ratio [OR] [95% CI], 1.93 [1.22-3.06]; P=0.005). Children younger than 18 years (OR [95% CI], 2.34 [1.60-3.40]; P<0.001) and adults older than 65 years (OR [95% CI], 3.46 [1.93-6.19]; P<0.001) were more likely to require transfer and travel farther to access care.

Conclusion: Patients requiring external transfer for inpatient psychiatric care were found to have prolonged ED lengths of stay. Patients with suicidal and homicidal ideation as well as children and adults older than 65 years are more likely to require transfer. [West J Emerg Med. 2016;17(6)783-90.]

INTRODUCTION

The population of patients in need of mental health care continues to grow despite increasing limitations in resources available for these patients.[1-5] Behavioral health (BH) patients

presenting to the emergency department (ED) who require transfer to other facilities, children and adults older than 65 years, and those with a history of violence or cognitive disorder are more likely to have prolonged ED length of stay (LOS) while a facility with capacity to care for them is identified.[6-8] Long LOS strains ED resources and places the patient at increased risk of harm by prolonging the stay in a facility that may be inadequately equipped to prevent patient self-harm and other adverse events, including placing staff safety at risk.[9-11]

The necessity for patient transfer to an external psychiatric facility results in prolonged ED LOS.[3,7] Although prolonged lengths of stay for BH patients have been well documented,[3,6-8] little is known about the subsequent effects on the patients themselves. Specifically, the distance that patients must be transported to be admitted has not been studied. The objectives of this study were to characterize the ED patients who require external transport to psychiatric facilities and to track the distances they must travel due to insufficient local psychiatric inpatient capacity.

METHODS

Study Design and Setting

This was a retrospective cohort study of consecutive patients who presented to the ED of the Mayo Clinic Hospital - Rochester, Saint Marys Campus from February 1, 2013, through January 31, 2014. The hospital has a tertiary care academic ED with 73,000 annual patient visits and includes a dedicated psychiatric hospital consisting of 73 psychiatric beds divided among a child and adolescent unit (18 beds), an acute adult unit (25 beds), an adult mood disorders unit (16 beds), and a medical psychiatry and geriatric psychiatry unit (14 beds). The city of Rochester, Minnesota, also has the Community Behavioral Health Hospital, which has 16 beds for adult patients.

The Mayo Clinic Institutional Review Board reviewed and accepted the study protocol before study initiation. The reporting of study results follows the reporting guidelines of Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).[12]

Selection of Participants

We identified all ED BH patients through documentation of a psychiatric consult during ED evaluation in their electronic health record. They were eligible for inclusion when they provided research authorization in accordance with Minnesota law.

Data Collection and Outcome Measures

The electronic health record was reviewed for data that were retrospectively collected, including patient demographic characteristics (e.g., age), diagnosis, payer source, ED LOS, ED disposition, arrival method, and distance traveled to an external facility for inpatient disposition. All patient data could be electronically extracted using the electronic health record in use (PulseCheck version 5.4; Optum) and did not require manual chart review. We characterized patients as *transferred* if they were discharged to a nonlocal external facility. Those who required admission and were hospitalized at the affiliated hospital were characterized as *admitted*. We subsequently calculated the distance to transfer sites on the basis of the number of miles reported on Google Maps.

Statistical Analysis

We summarized continuous features with median, interquartile range (IQR), and absolute range; categorical features were summarized with frequency count and percentage. Comparisons of patients who received a psychiatric consultation and were discharged from the ED with patients who received a psychiatric consultation and were admitted for psychiatric care were evaluated with Wilcoxon rank sum and χ^2 tests. We evaluated the differences in distance to the external facility between age groups with Wilcoxon rank sum tests. Univariable and multivariable associations with transfer to an external facility were evaluated with logistic regression models and summarized with odds ratios (ORs) and 95% confidence intervals (CIs). We conducted multivariable associations to determine if the significant associations observed on univariable analysis remained after multivariable adjustment. All variables of interest were used in both univariable and multivariable analyses. Univariable associations with transfer to an external facility were subsequently evaluated for the adult and pediatric cohorts separately. We performed statistical analyses with version 9.3 of the SAS software package (SAS Institute Inc). All tests were two-sided, and *P* values less than 0.05 were considered statistically significant.

RESULTS

During the study period, we identified 2,585 ED patient visits involving an ED consultation by psychiatry services. Multiple patients presented to the ED on more than one occasion. Of the 2,585 ED visits, there were 1,981 distinct patients seen in the ED. Of the ED visits, 1,083 (41.9%) were patients evaluated and discharged from the ED and 1,502 (58.1%) were patients evaluated and determined to require inpatient psychiatric care. In the second group, 1,325 patients (83.9%) were admitted to the affiliated hospital, 65 (4.3%) were transferred to the local community behavioral health hospital, and 177 patients (11.8%; 95% CI = [10.2-13.5]) required transfer to a nonlocal external facility (Table 1).

The characteristics of admitted patients were similar to the dismissed cohort (Table 1). The median age of BH patients was in the early third decade. More than one-half (54.0%) of the patients were female. Most patients arrived to the ED by personal transport. The cohorts differed in payer source, as well as diagnosis. Admitted patients also had a significantly longer LOS than the non-admitted patients.

The median distance required for transfer to outside facilities was 83 miles (IQR, 42-111; range, 41-280 miles) (Figure). Fifty patient transports (28.2%; 95% CI = [21.9-

35.6]) were within 50 miles, 63 (35.6%; 95% CI = [28.9-43.2]) were transferred between 50 and 100 miles, and 46 (26.0%; 95% CI = [19.8-33.2]) were transferred between 100 and 200 miles. Children and patients older than 65 years also required longer transport distances. The median distance to the external facility for patients younger than 18 years (102 [IQR, 83-141; range, 72-262] miles) was significantly greater than for patients aged 18 to 65 years (60 [IQR, 42-85; range, 41-280] miles; $P<0.001$). The distance for patients older than 65 years (83 [IQR, 59.5-144.5; range, 42-226] miles) also was significantly greater than for patients aged 18 to 65 years ($P=0.04$).

The median ED LOS for patients transferred to an external psychiatric facility was 13.9 hours (IQR, 9.3-20.2; range, 3.0-243.0 hours). Patients who did not require transfer and were admitted to inpatient psychiatric services in house had significantly shorter stays (4.4 [IQR, 3.4-6.7; range, 0.3-76.0] hours; $P<0.001$).

The characteristics of patients who were admitted to our hospital vs those who required transfer to an external facility for admission are summarized in Table 2, with the results of the univariable and multivariable models to predict transfer to an external facility. The multivariable analysis indicated that patients with suicidal or homicidal ideation had increased risk of requiring transport to an external facility (OR [95% CI], 1.93 [1.22-3.06]; $P=0.005$). Patient age was also significantly associated with increased risk of patient transfer. Children younger than 18 years were more likely to require transfer than patients aged 18 to 65 years (OR [95% CI], 2.34 [1.60-3.40]; $P<0.001$). In addition, adults older than 65 years were more likely to require transfer to an external facility (OR [95% CI], 3.46 [1.93-6.19]; $P<0.001$). Lastly, patients with noncommercial medical insurance were more likely to be transferred to an external facility, independent of patient age (Medicare or Medicaid, OR [95% CI], 1.54 [1.04-2.27], $P=0.03$; self-pay/other, OR [95% CI], 2.08 [1.30-3.32], $P=0.002$).

We also analyzed associations with transfer to an external facility vs admission to our hospital in the subsets of adult and pediatric cohorts. In these univariable models, adults with a diagnosis of suicidal or homicidal ideation were still found to be more likely to be transferred to an external facility (OR [95% CI], 2.17 [1.23-3.81]; $P=0.007$); however, there was no longer a significant association in the pediatric population (OR [95% CI], 1.18 [0.56-2.51]; $P=0.67$) (Table 3).

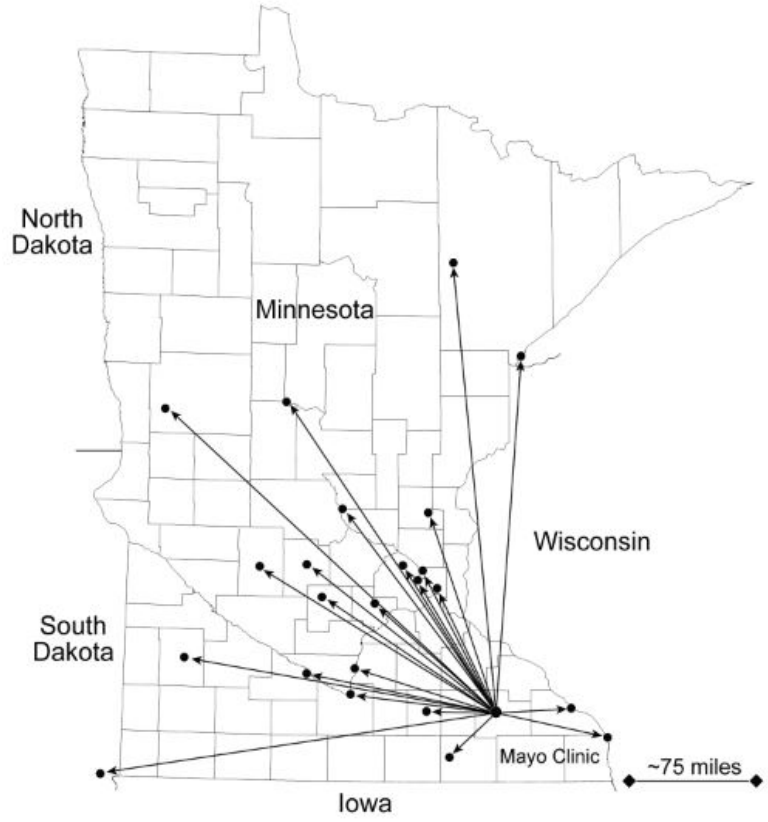

Figure. Locations for patients requiring transfer to an external facility for inpatient psychiatric care. Median transport distance was 83 miles; the longest distance was 280 miles.

Table 1. Summary of patient characteristics collected for behavioral health visits to the emergency department.

Characteristic[a]	All ED BH patient visits (n=2,585)	Patient visits resulting in discharge (n=1,083)	Patient visits resulting in psychiatric admission (n=1,502)	*P* value
Age, median (IQR; range), y	31 (20-47; 4-93)	30 (20-46; 4-93)	32 (20-48; 5-90)	0.07
Age, y				
<18	510 (20)	212 (20)	298 (20)	0.96
18-65	1,941 (75)	816 (75)	1,125 (75)	
>65	134 (5)	55 (5)	79 (5)	
Gender				
Female	1,392 (54)	585 (54)	807 (54)	0.88
Male	1,193 (46)	498 (46)	695 (46)	
Mode of arrival	(n=2,579)[b]		(n=1,497)[b]	
Personal transport	1,761 (68)	728 (67)	1,033 (69)	0.51
EMS	494 (19)	209 (19)	285 (19)	
Law enforcement	324 (13)	145 (13)	179 (12)	
Payment type				
Commercial	945 (37)	357 (33)	588 (39)	<0.001
Medicare or Medicaid	1,132 (44)	461 (43)	671 (45)	
Other/self-pay	508 (20)	265 (24)	243 (16)	
Diagnosis				
Mood disorder	629 (24)	246 (23)	383 (26)	<0.001
Suicidal or homicidal ideation	848 (33)	219 (20)	629 (42)	
Altered thought processes	243 (9)	93 (9)	150 (10)	
All others	865 (33)	525 (48)	340 (23)	
Transfer to external facility	177 (7)	0	177 (12)	
LOS, median, h	4.4	3.8	4.8	<0.001
LOS, range (IQR), h	0.2-243.0 (3.1-7.2)	0.2-74.6 (2.7-5.8)	0.3-243.0 (3.5-8.9)	

BH, behavioral health; *ED*, emergency department; *EMS*, emergency medical services; *IQR*, interquartile range; *LOS*, length of stay.
[a] Values are presented as number (percentage) of patients unless specified otherwise.
[b] Sample size for characteristics with missing data.

DISCUSSION

Nearly 12% of BH patients required transport to an external psychiatric facility. Other investigators evaluating ED LOS for psychiatric patients have reported significantly higher rates of external transfer (37%-46%) for patients presenting with a mental health concern.[7,13] Similar to other studies, our analysis found that BH patients requiring transport to an external psychiatric facility have prolonged LOS compared with those discharged or admitted locally.[14,15] In our study, this difference was approximately three times longer (4.4 vs 13.9 hours). Chang et al[14] demonstrated a median LOS approximately 2.5 times longer (2.5 vs 6.3 hours). Although most of the protracted LOS instances were measured in hours, some were measured in days (longest period, >10 days).

Our study reinforces some of the data previously published on factors affecting ED LOS. Nevertheless, this is the first study, to our knowledge, to characterize the patient experience—including distances that ED patients are transported to access inpatient psychiatric care—when local care is unavailable.

We found that certain patients had a greater predisposition for external transfer for inpatient psychiatric hospitalization than other patients, and transportation distances were considerable for patients requiring this transfer. Adults older than 65 years, children, patients with suicidal or homicidal ideation, and patients with noncommercial medical insurance were more likely to require transport to an external facility. In addition, when external transport was required, the older adults and the children were transported farther distances to access inpatient psychiatric care. Although the median travel distance was 83 miles, 10% of transports spanned more than 200 miles. This may be due in part to the location of our facility, which has largely rural surrounding communities. The closest location from our facility for inpatient psychiatric care

Table 2. Univariable and multivariable associations of behavioral-health patient characteristics with transfer to external facility.

			Univariable		Multivariable	
Characteristic[a]	No transfer (n=1,325)	Transfer (n=177)	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Age, y						
<18	244 (18)	54 (31)	2.20 (1.54-3.14)	<0.001	2.34 (1.60-3.40)	<0.001
18-65	1,022 (77)	103 (58)	1.0 (reference)		1.0 (reference)	
>65	59 (5)	20 (11)	3.36 (1.95-5.81)	<0.001	3.46 (1.93-6.19)	<0.001
Gender						
Female	709 (54)	98 (55)	1.0 (reference)		1.0 (reference)	
Male	616 (46)	79 (45)	0.93 (0.68-1.27)	0.64	0.97 (0.70-1.34)	0.84
Mode of arrival						
Personal transport	907 (69)	126 (71)	1.0 (reference)		1.0 (reference)	
EMS	252 (19)	33 (19)	0.94 (0.63-1.42)	0.78	0.94 (0.61-1.44)	0.77
Law enforcement	161 (12)	18 (10)	0.81 (0.48-1.36)	0.41	0.78 (0.45-1.33)	0.35
Payment type						
Commercial	534 (40)	54 (31)	1.0 (reference)		1.0 (reference)	
Medicare or Medicaid	584 (44)	87 (49)	1.47 (1.03-2.11)	0.04	1.54 (1.04-2.27)	0.03
Other/self-pay	207 (16)	36 (20)	1.72 (1.10-2.70)	0.02	2.08 (1.30-3.32)	0.002
Diagnosis						
Mood disorder	340 (26)	43 (24)	1.41 (0.86-2.32)	0.18	1.57 (0.93-2.63)	0.09
Suicidal/homicidal ideation	540 (41)	89 (50)	1.84 (1.18-2.87)	0.008	1.93 (1.22-3.06)	0.005
Altered thought processes	133 (10)	17 (10)	1.42 (0.75-2.69)	0.28	1.44 (0.75-2.77)	0.27
All others	312 (24)	28 (16)	1.0 (reference)		1.0 (reference)	

EMS, emergency medical services; *OR*, odds ratio.
[a] Values are presented as number (percentage) of patients unless specified otherwise.

is 41 miles away. This problem, however, is not unique to our institution. Between 1990 and 2008, the number of hospital or residential mental health organizations decreased by 812, with a loss of 86,515 beds.[15] As closures of psychiatric facilities throughout the country continue, many hospitals likely face similar, if not longer, distances to the next inpatient psychiatric facility. These distant hospitalizations can place substantial burdens on patients and their family members.

Patient age was strongly associated with increased risk of need for external transfer. Children were more likely to require transfer. This need may be due to the overall lack of pediatric inpatient psychiatric beds available in the region. Minnesota has approximately seven adult inpatient psychiatric beds for every pediatric bed.[16] National data indicate that adults and adolescents have a similar prevalence of mental illness, and in a recent report, adolescents had a higher rate of serious mental illness than adults (8.0% vs 5.8%).[17] Children requiring psychiatric admission have the added stress of prolonged ambulance transport to an unknown facility and may have to travel without parental supervision. Parents are faced with the challenge of arranging their own transportation to visit their child and coordinating leave from their employer and care for other dependents. Although adult psychiatric care facilities have declined over the years, pediatric treatment centers have not experienced a similar trend and in fact have increased in number nationally—so, too, have the number of specialists certified in child and adolescent mental health care.[18] While this is a positive trend, resources will need to continue to grow in order to meet the growing needs of the population.

Adults older than 65 years are also more likely to require transfer to an external facility than younger adults. In our institution, a limited number of geriatric psychiatric beds are available. In addition, a limited number of medical psychiatric beds are available to care for the higher rate of comorbid medical conditions in this population. Estimates report that more than 20% of geriatric patients have mental disorders, and as the U.S. population continues to age, this number is expected to double over the next 30 years.[19] Cromwell and Maier[19] demonstrated that these medical psychiatric units and geriatric psychiatric units require the most staff hours per patient per day compared with general adult units, psychiatric intensive care units, and dual psychiatric and substance-abuse units.[20] The burgeoning geriatric population and the increased requisite psychiatric resources likely will pose challenges for inpatient placement and may continue to increase the transfer rate for these patients.

Table 3. Univariable associations of characteristics with transfer to external facility for adult and pediatric patients.

	Adult patients (n=1,204)				Pediatric patients (n=298)			
Characteristic[a]	No transfer (n=1,081)	Transfer (n=123)	OR (95% CI)	*P* value	No transfer (n=244)	Transfer (n=54)	OR (95% CI)	*P* value
Age, y					NA	NA	NA	
18-65	1,022 (95)	103 (84)	1.0 (reference)					
>65	59 (5)	20 (16)	3.36 (1.95-5.81)	<0.001				
Gender								
Female	564 (52)	67 (54)	1.0 (reference)		145 (59)	31 (57)	1.0 (reference)	
Male	517 (48)	56 (46)	0.91 (0.63-1.33)	0.63	99 (41)	23 (43)	1.09 (0.60-1.97)	0.78
Mode of arrival[b]								
Personal transport	726 (67)	82 (67)	1.0 (reference)		181 (74)	44 (81)	1.0 (reference)	
EMS	225 (21)	28 (23)	1.10 (0.70-1.74)	0.68	27 (11)	5 (9)	0.76 (0.28-2.09)	0.60
Law enforcement	126 (12)	13 (11)	0.91 (0.49-1.69)	0.77	35 (14)	5 (9)	0.59 (0.22-1.59)	0.29
Payment type								
Commercial	392 (36)	26 (21)	1.0 (reference)		142 (58)	28 (52)	1.0 (reference)	
Medicare or Medicaid	510 (47)	69 (56)	2.04 (1.28-3.26)	0.003	74 (30)	18 (33)	1.23 (0.64-2.38)	0.53
Other/self-pay	179 (17)	28 (23)	2.36 (1.34-4.14)	0.003	28 (11)	8 (15)	1.45 (0.60-3.51)	0.41
Diagnosis								
Mood disorder	283 (26)	32 (26)	1.75 (0.95-3.23)	0.07	57 (23)	11 (20)	0.95 (0.38-2.37)	0.91
Suicidal or homicidal ideation	407 (38)	57 (46)	2.17 (1.23-3.81)	0.007	133 (55)	32 (59)	1.18 (0.56-2.51)	0.67
Altered thought processes[c]	128 (12)	17 (14)	2.06 (1.02-4.16)	0.045	54 (22)	11 (20)	1.0 (reference)	
All others	263 (24)	17 (14)	1.0 (reference)					
Length of stay, median (IQR; range), h[d]	4.4 (3.4-6.4; 0.3-76.0)	12.8 (8.6-18.2; 3.3-140.1)	1.47 (1.34-1.61)	<0.001	4.6 (3.2-15.7; 2.0-75.1)	15.9 (11.0-25.9; 3.0-243.0)	1.18 (1.09-1.27)	<0.001

EMS, emergency medical services; *IQR,* interquartile range; *NA,* not applicable; *OR*, odds ratio.

[a] Values are presented as number (percentage) of patients unless specified otherwise.

[b] For adult patients, n=1,200; for pediatric patients, n=297.

[c] All other diagnoses were combined with this category for the analysis of pediatric patients.

[d] OR represents a 4-h increase in length of stay.

Adult patients who received a diagnosis including suicidal or homicidal ideation were almost twice as likely to be transferred to another facility. This finding was not seen in the pediatric population. This may be due to the increased resources such as video-monitored rooms and additional staffing needed to care for potentially violent adult patients.

Finally, an association was found between transfer to an external facility and a noncommercial payer source. The reasons for this finding are not clear, because the payer source is not considered in the process of identifying either outside facilities for transfer or patients for admission to our psychiatric hospital. Thus, lack of commercial insurance may correlate with other factors not accounted for in our model. Further studies are needed to more clearly understand this association.

This study is limited by being isolated to a single tertiary care setting with a relatively large internal psychiatric inpatient capacity. Hospitals in a larger urban setting may experience different trends in the association between increased LOS and patient transfers. In addition, this study is limited in that data were extracted electronically rather than by manual individual chart review. Hence, the study is limited by what data could be extracted electronically from the health record.

CONCLUSION

Inadequate local and regional psychiatric hospital capacity results in significantly prolonged ED LOS and puts many patients at risk for transfer outside their local community for care. Patients with suicidal and homicidal ideation, patients older than 65 years, and children are at significantly increased risk for requiring transfer to an external facility for inpatient psychiatric care. Delays in transfers to distant facilities for inpatient psychiatric care strain the ED system, and the transfers place additional stress on patients and their families. A thorough evaluation of the BH system is needed to better address patient needs for inpatient psychiatric care.

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Impact of Prior Therapeutic Opioid Use by Emergency Department Providers on Opioid Prescribing Decisions

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Introduction: Our study sought to examine the opioid analgesic (OA) prescribing decisions of emergency department (ED) providers who have themselves used OA therapeutically and those who have not. A second objective was to determine if OA prescribing decisions would differ based on the patient's relationship to the provider.

Methods: We distributed an electronic survey to a random sample of ED providers at participating centers in a nationwide research consortium. Question topics included provider attitudes about OA prescribing, prior personal therapeutic use of OAs (indications, dosing, and disposal of leftover medication), and hypothetical analgesic-prescribing decisions for their patients, family members, and themselves for different painful conditions.

Results: The total survey population was 957 individuals; 515 responded to the survey, a 54% response rate. Prior personal therapeutic OA use was reported in 63% (95% CI = [58-68]). A majority of these providers (82%; 95% CI = [77-87]) took fewer than half the number of pills prescribed. Regarding provider attitudes towards OA prescribing, 66% (95% CI = [61-71]) agreed that OA could lead to addiction even with short-term use. When providers were asked if they would prescribe OA to a patient with 10/10 pain from an ankle sprain, 21% (95% CI = [17-25]) would for an adult patient, 13% (95% CI = [10-16]) would for an adult family member, and 6% (95% CI = [4-8]) indicated they themselves would take an opioid for the same pain. When the scenario involved an ankle fracture, 86% (95% CI = [83-89]) would prescribe OA for an adult patient, 75% (95% CI = [71-79]) for an adult family member, and 52% (95% CI = [47-57]) would themselves take OA. Providers who have personally used OA to treat their pain were found to make similar prescribing decisions compared to those who had not.

Conclusion: No consistent differences in prescribing decisions were found between ED providers based on their prior therapeutic use of OA. When making OA prescribing decisions, ED providers report that they are less likely to prescribe opioids to their family members, or themselves, than to an ED patient with the same painful condition. [West J Emerg Med. 2016;17(6)791-7.]

INTRODUCTION

According to the 2011 National Hospital Ambulatory Medical Care Survey (NHAMCS), pain-related complaints accounted for five of the top 10 principal reasons patients sought care in the emergency department (ED).[1] Consequently, ED providers are high-volume prescribers of nonprescription analgesics, such as acetaminophen, non-steroidal anti-inflammatory drugs, and of opioid analgesics (OA). Examination of NHAMCS data between 2001-2010 showed an increase from 20.8% to 31% in OA prescribing during ED visits, while the rate of prescriptions for non-opioid analgesics over the same period was unchanged.[2] Prescribing rates for OA by different specialties between 2007-2012 noted a downward trend by emergency medicine prescribers.[3] Despite this trend, the absolute number of patients receiving an OA prescription remains high, with emergency physicians providing 12.5 million OA prescriptions in 2012.[3] However, the number of pills per prescription is low and the opioid formulation chosen is almost exclusively short acting.[4]

Over the past decade, there has been widespread recognition of the adverse effects and risks associated with OA. Even when prescribed for their intended therapeutic benefit, a concerning percentage of patients will develop an opioid use disorder and others will overdose and suffer from consequential respiratory depression. Although ED providers are not primarily responsible for the current epidemic of opioid-related addiction and overdose, all prescribers have been encouraged to examine and rationalize their prescribing decisions.[5]

Prior research shows that decisions to prescribe opioid medications are highly individualized; different providers will make different decisions based on the same information.[6] Hence, a better understanding of factors underlying prescriber variability may help identify strategies that promote meaningful modification of their prescribing practices. One factor that could affect prescribing decisions, and that has not yet been examined in the literature, is a provider's personal history of taking OA therapeutically to treat his or her own pain.

Our study sought to examine the OA prescribing decisions of ED providers who have used OA therapeutically compared to those who have not. A second objective was to study the reported prescribing decisions to patients compared to family members with the same painful conditions. We hypothesized that providers who themselves used OA would be less likely to prescribe to their patients and that providers would be less likely to prescribe to family members than to patients.

METHODS

Study Design and Setting

This was a multi-center, cross-sectional, web-based survey of 957 ED providers at seven participating centers. The study was conducted between August 2014 and October 2014. Eligible providers included attending physicians, emergency medicine resident physicians, and advanced practice providers (nurse practitioner or physician assistant) who work in the ED. There were no exclusion criteria. Potential respondents were invited to complete a web-based questionnaire via email.

Selection of Participants

We used the Prescribing Opioids Safely in the Emergency Department (POSED) Research Consortium to conduct the study.[4] The consortium is comprised of 30 primarily academic medical centers located in 20 states, spanning all four regions of the country, with over two million annual ED visits. A random cluster sample of seven centers was selected from among the 30 total POSED centers. All of the selected centers in the sample are affiliated with an emergency medicine residency program.

All subjects who participated in the study provided informed consent. Respondents completed the survey anonymously. The study protocol was reviewed and approved by the coordinating center's institutional review board.

Survey Content and Administration

We developed the study questionnaire in accordance with methods outlined by Burns et al.[7] The initial questionnaire was written by the investigators and then iteratively developed through feedback solicited from expert colleagues as well as a biostatistician for purposes of item generation and improving structure. Question topics included prior personal therapeutic use of OAs (indications, dosing, and disposal methods of leftover medication), and the type of pain medication providers would prescribe or recommend to their patients, friends, family members, and themselves for two common, painful conditions (ankle sprain and ankle fracture). Additional questions addressed attitudes towards OA prescribing and demographic information. The survey instrument was pilot tested using emergency providers with a similar demographic to the potential respondents to improve question clarity and assist with item reduction. Formal psychometric testing of the questionnaire was not performed.

The survey questionnaire was hosted online and administered using FluidSurveys (http://www.fluidsurveys.com). We identified points of contact (POCs) for each participating center to coordinate distribution of email announcements and to determine the total number of eligible providers at each center. An email announcing the study was sent to potential respondents at each center by the POC, followed several days later by a second email containing a link to the questionnaire. Three reminder emails were sent over the subsequent month to encourage participation. In addition, we offered a nominal incentive to survey respondents in the form of a raffle sweepstakes for a gift card. The raffle database was independently administered from the main study database with no link between the two.

Data Analysis

The survey collected information on respondents' attitudes and hypothetical prescribing decisions using a

five-point Likert scale. To facilitate analysis in the presence of sparse tables and zero-cells, we collapsed the Likert scale responses into two likelihood groups: Likely (respondents who indicated they were likely or very likely to prescribe) and Unlikely/Neutral (respondents who indicated that they were neutral, unlikely or very unlikely to prescribe). Respondents were also classified into groups who would prescribe an opioid (alone or in combination with other pain medications) and who would not prescribe opioids at all. Data regarding prescribing decisions for different types of patients were stratified using a question about whether respondents would rather over-prescribe and risk misuse of OA or rather under-prescribe and risk under-treating pain. Although the data were not complete for every respondent, we used all available data for each analysis. Any missing data were handled using pairwise elimination. We used a simple adjustment to the sampling weights to account for overall survey non-response. All analyses were completed in SAS 9.3 (Cary, NC) using the specialized survey procedures to account for the cluster sampling design. These procedures account for the clustering within the centers by adjusting the chi-square statistic to properly reflect the loss in precision that comes from the increased homogeneity in the observations within a center.

RESULTS

Characteristics of Study Subjects

There were 957 eligible ED providers total from the seven selected centers; 515 responded to the survey invitation for an overall response rate of 54%. Twenty-four respondents did not consent to participate in the study, and 48 responses were excluded for insufficient data, leaving 443 responses included for analysis. Demographic data are presented in Table 1. Data were not available regarding the demographics of non-respondents. There was no indication of bias due to variations in response patterns between respondents.

Table 1. Number and percentage of respondents with different demographic characteristics and prior therapeutic opioid analgesic use.

Characteristic	Number (%)
Male (n = 412)	220 (53)
Role in ED (n = 419)	
Attending	207 (49)
Resident	170 (41)
Advanced practice provider	42 (10)
Years working in ED (n = 417)	
< 1 year	52 (13)
> 1 - < 5 years	164 (39)
> 5 - < 10 years	53 (13)
> 10 - < 20 years	85 (20)
> 20 years	63 (15)
Location of ED* (n = 420)	
Rural	8 (2)
Suburban	24 (6)
Urban	410 (98)
ED practice setting* (n = 420)	
Academic	409 (97)
Community	71 (17)
VA/military	16 (4)
Prior therapeutic OA use (n=420)	265 (63)

ED, emergency department; *OA,* opioid analgesic
*Cumulative responses exceed 100%; respondents were asked to identify all types of ED practice settings in which they worked.

Personal Therapeutic Use of OA

Sixty-three percent (95% CI = [58-68]) of respondents reported prior personal therapeutic OA use. A majority of these providers (82%; 95% CI = [77-87]) took fewer than half the number of tablets prescribed.

OA Prescribing Decisions by Patient Type

The figure summarizes the frequencies respondents would prescribe or recommend an OA for different types of patients with an ankle sprain or ankle fracture. Among all respondents, 21% (95% CI = [17-25]) indicated they would prescribe an opioid to an adult patient with an ankle sprain reporting 10/10 pain, while 6% (95% CI = [4-8]) indicated they themselves would take an opioid for the same pain. Similarly, 86% (95% CI = [83-89]) indicated they would prescribe an opioid to an adult patient with an ankle fracture reporting 10/10 pain, while 52% (95% CI = [47-57]) indicated they themselves would take an opioid for the same pain. Thirteen percent (95% CI = [10-16]) would prescribe an OA to an adult family member with an ankle sprain and 75% (95% CI = [71-79]) would do the same for an adult family member with an ankle fracture. Rates were lower for a teenage family member, with 4% (95% CI = [2-6]) prescribing OA for an ankle sprain and 42% (95% CI = [37-47]) for an ankle fracture.

Attitudes Towards OA Prescribing

When asked about their attitudes towards OA prescribing, 92% (95% CI = [89-95]) of respondents agreed it is important for ED providers to consider the public health effects of prescribing OA. In addition, 76% (95% CI = [72-80]) agreed that ED prescriptions are a source of OA that are used non-medically or diverted. Sixty-six percent (95% CI = [61-71]) agreed that OA could lead to addiction even with short-term use. Finally, 43% (95% CI = [38-48]) indicated they would rather over-treat patients in pain with OA to avoid under-treating a single patient with significant pain, while 57% (95% CI = [52-62]) indicated they would rather under-treat patients in pain with limited or no OA to avoid causing addiction, dependence, or overdose in a single patient.

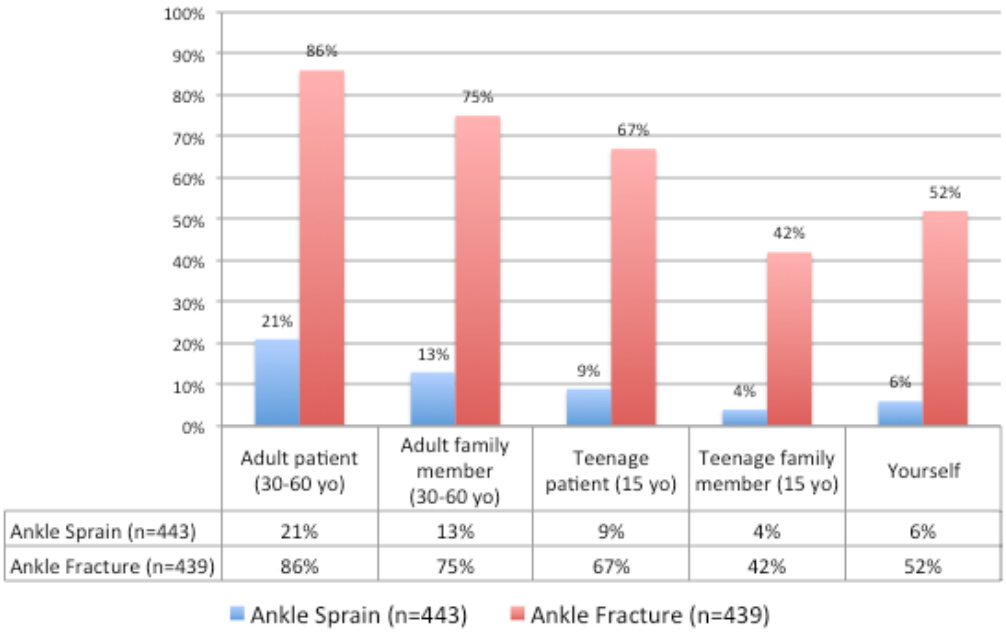

Figure. Frequency of opioid analgesic prescription by patient type for ankle sprain and fracture.

Table 2. Percentage of respondents who would prescribe an opioid analgesic (OA) to a patient complaining of 10/10 pain from an ankle sprain by history of personal therapeutic OA use.

Ankle sprain: patient type	Overall % [95% CI] n=443	Personal OA yes % [95% CI] n=265	Personal OA no % [95% CI] n=157
Adult patient (30-60 years)	21 [17-25]	24 [19-29]	16 [10-22]
Adult family member	13 [10-16]	15 [11-19]	11 [6-16]
Teenage patient (15 years)	9 [6-12]	10 [6-14]	5 [2-8]
Teenage family member	4 [2-6]	5 [2-8]	2 [0-4]
Yourself	6 [4-8]	7 [4-10]	4 [1-7]

CI, confidence interval

Table 3. Percentage of respondents who would prescribe an opioid analgesic (OA) to a patient complaining of 10/10 pain from an ankle fracture, by history of personal therapeutic OA use.

Ankle fracture: patient type	Overall % [95% CI] n=439	Personal OA use % [95% CI] n=265	No personal OA use % [95% CI] n=157
Adult patient (30-60 years)	86 [83-89]	89 [85-93]	85 [79-91]
Adult family member	75 [71-79]	78 [73-83]	72 [65-79]
Teenage patient (15 years)	67 [63-71]	73 [68-78]	59 [51-67]
Teenage family member	42 [37-47]	48 [42-54]	35 [28-42]
Yourself	52 [47-57]	60 [54-66]	41 [33-49]

CI, confidence interval

Comparison of OA Prescribing Decisions Among Providers

Table 2 summarizes the number of respondents who would prescribe OA to a patient complaining of 10/10 pain from an ankle sprain comparing those respondents who have a history of personal therapeutic OA use and those who do not. Table 3 is a similar comparison of respondents except the patient has 10/10 pain from an ankle fracture instead of an ankle sprain.

Table 4 summarizes the number of respondents who would prescribe OA to a patient complaining of 10/10 pain from an ankle sprain comparing providers who indicated they would rather over-treat with OA to avoid under-treating a patient in pain to providers who would rather under-treat with OA to avoid opioid misuse. Table 5 is a similar comparison of respondents except the patient is complaining of 10/10 pain from an ankle fracture.

Table 4. Percentage of respondents who would prescribe an opioid analgesic to a patient complaining of 10/10 pain from an ankle sprain, by whether they would rather over-treat or under-treat pain using opioids.

Ankle sprain: patient type	Overall % [95% CI] n=443	Over-treat pain % [95% CI] n=178	Under-treat pain % [95% CI] n=233
Adult patient (30-60 years)	21 [17-25]	32 [25-39]	12 [8-16]
Adult family member	13 [10-16]	23 [17-29]	8 [5-11]
Teenage patient (15 years)	9 [6-12]	13 [8-18]	4 [1-7]
Teenage family member	4 [2-6]	7 [3-11]	2 [0-4]
Yourself	6 [4-8]	12 [7-17]	2 [0-4]

CI, confidence interval

Table 5. Percentage of respondents who would prescribe an opioid to a patient complaining of 10/10 pain from an ankle fracture by, whether they would rather over-treat or under-treat pain using opioids.

Ankle fracture: patient type	Overall % [95% CI] n=439	Over-treat pain % [95% CI] n=178	Under-treat pain % [95% CI] n=233
Adult patient (30-60 years)	86 [83-89]	88 [83-93]	88 [84-92]
Adult family member	75 [71-79]	80 [74-86]	73 [67-79]
Teenage patient (15 years)	67 [63-71]	74 [68-80]	64 [58-70]
Teenage family member	42 [37-47]	53 [46-60]	35 [29-41]
Yourself	52 [47-57]	61 [54-68]	45 [39-51]

CI, confidence interval

DISCUSSION

One objective of this study was to assess whether prior therapeutic OA use was associated with a clinician's current OA prescribing decisions. The majority of ED providers in this study reported prior personal therapeutic OA use and the vast majority of these providers took fewer than half the number of tablets prescribed. Tables 2 and 3 show that more respondents who had personally taken opioids indicated they would prescribe OA compared to those who had not. However, it is important to note that the confidence intervals overlap for eight of the 10 comparisons, which prohibits drawing a general conclusion of a difference based on prior OA use. The absence of an observed difference could mean that providers are truly not influenced by their own experience using OA therapeutically when making prescribing decisions. It is also possible the influence of prior OA use on prescribing decisions is more nuanced than could be detected based on our questionnaire. We did not ask providers whether they had a favorable or negative experience with the OA they had used; providers with favorable experiences may be more likely to prescribe OA while those with negative experiences may be less likely to prescribe. The personal experiences using OA therapeutically may influence provider beliefs about the safety, efficacy, and risk-versus-benefit relationship of these drugs. Lastly, it is also possible that the sample size was simply not large enough to show a true difference.

A second objective of this survey was to determine if OA prescribing would differ based on the patient's relationship to the prescriber. The figure illustrates a consistent trend found among respondents; when treating the same pain, more ED providers indicated they would prescribe an OA to one of their patients more frequently than to a family member (adult or teenage) or to themselves. This is demonstrated by a three-fold relative difference in prescribing an OA for a patient with an ankle sprain compared to self-use for the same indication (21%; 95% CI = [17-25] vs. 6%; 95% CI = [4-8]). These data suggest that ED providers may treat themselves and their family members differently than how they treat their patients.

Reasons for this observed difference in practice can only be speculated. Presumably there is no intrinsic difference in the risk-versus-benefit profile for OA use in a given individual based solely on whether that person is related to a provider. Inferred from our data is that ED providers might be more cautious prescribing OA to family members or themselves out of concerns about harms or lack of benefit over other types of pain medications. Our finding that the majority of respondents were concerned that even short-term use of opioids can trigger addiction supports this inference.

Other reasons for differential prescribing by population might include the pressure to meet patient expectations or maintain high patient-satisfaction scores. It has been suggested that the priority placed on achieving high patient satisfaction scores could carry unintended consequences of driving inappropriate OA prescribing.[8] Evidence to address this issue thus far is mixed. One study of patients with painful conditions at a single ED found a significant association between patient satisfaction and reduction in their level of pain.[9] Another retrospective study found no association between Press Ganey satisfaction scores and receipt of OA while in the ED.[10] There are no conclusive data yet to define whether provider satisfaction scores drive OA prescribing decisions. In our experience, certain

clinicians likely prescribe more OA than is typically required in order to avoid suboptimal analgesia in a few or to avoid the need for unscheduled follow up for pain.

It is notable that OA were consistently more frequently prescribed by providers when treating ankle fracture compared to ankle sprain (Figure). The clinical scenarios presented in the survey questionnaire described a patient with 10/10 pain with either an ankle fracture or ankle sprain. Despite the similar pain score, there were large differences in prescribing decisions between fracture and sprain, when in reality the pain experienced by patients with these diagnoses may be very similar. This difference may reflect providers' bias towards fracture being considered an intrinsically more painful condition and a prioritization of this assessment over the reported pain scores.

Tables 2-5 reveal that there were larger differences in the frequencies of OA prescribing for patients with an ankle sprain than with an ankle fracture. Table 2 shows that 21% of respondents would prescribe an opioid to an adult patient with an ankle sprain, while Table 3 shows 86% of respondents would prescribe an opioid to an adult patient with an ankle fracture. This result suggests that most ED providers agree ankle fracture is an appropriate indication to treat using OA. Table 4 offers evidence of increased variability of OA use between ED providers for the "softer" indication of ankle sprain showing a clear pattern of providers who would rather over-treat pain prescribing OA more often than those who would rather under-treat pain. Table 5 shows less variability of OA prescribing for ankle fracture based on the difference in attitude towards prescribing. If this attitudinal disparity towards prescribing OA can produce such a difference between providers, it begs the larger question about deciding what "appropriate prescribing" of OA truly means.

The majority of ED providers surveyed believe they are important sources of opioids used non-medically, that even short-term OA use risks addiction, and that ED prescribing decisions should be made with consideration of public health implications. One possible explanation for these views may have to do with the types of patients and situations commonly encountered in the ED. ED providers prescribe analgesics for large numbers of patients with painful conditions, the majority of whom have acute, generally self-limited pain. In addition, a substantial number of patients with intermittent and chronic pain syndromes seek care in the ED.[11] ED providers must be facile with properly targeting the use of safe and effective analgesics for outpatient use following discharge from the ED. This task is complicated by the lack of an ongoing provider-patient relationship with most patients. Furthermore, this lack of an ongoing relationship, and the ED's "open door" nature, make the ED vulnerable to individuals intent on obtaining opioids for aberrant uses. Prior literature confirms EDs as locations targeted by these individuals. One statewide study showed that 88% of ED providers reported seeing at least one provider-shopping patient per week.[12-15] It seems reasonable to think ED providers who are concerned about public health and the contribution of their prescribing to the opioid epidemic prescribe less in the same situations than those without such concerns. While our data could not be used to directly assess any such associations, future investigations designed to test this possibility would likely provide valuable information.

Finally, it is widely postulated that teenagers are at a higher risk for developing opioid use disorder than adults; recent evidence suggests that use of OA before 12th grade is associated with future opioid use disorder.[16] It is therefore interesting that ED providers in our study would prescribe opioids less frequently to teenage patients compared to adult patients, and even more judiciously to teenage family members compared to adult family members. This may reflect a different risk-benefit profile for adult and teenage populations. Of note is that respondents more frequently opted not to prescribe opioids for teenage family members compared to their teenage patients for ankle sprain. This likely again reflects a differential risk-benefit analysis in family versus patients.

LIMITATIONS

We did not collect direct measurements of behaviors, so we do not know how the study population would actually perform in real-world situations. Formal psychometric analysis of the questionnaire was not performed and respondents may interpret some questions differently due to potentially unclear or misunderstood language. This survey may be confounded by social desirability bias; respondents may have unknowingly over-reported what they consider more socially desirable behaviors and under-reported what they interpreted as less desirable behaviors. In addition, the results pertaining to personal therapeutic use of OA may also be affected by recall bias on the part of respondents. The generalizability of the results may be affected by the overall response rate and the preponderance of academic medical centers. There is also potential for selection bias insofar as only providers from centers participating in the POSED consortium comprised the study population. However, we took several steps in our analysis to mitigate what might be considered a low response rate in order to maximize the representativeness of our results. Our analyses properly adjusted for cluster. Standard analytical methods require an underlying simple random sample design; our complex design was chosen based on ease of implementation and reduction in cost. A simple random sample would have required a list of participating physicians and would have been much more difficult to implement in real life. A less rigorous approach (e.g., sending a survey to every provider in the network) would have provided a more biased estimate and the representativeness of the convenience sample would have been impossible to determine. Detailed demographic information regarding the entire population across all the centers is unknown; non-response bias could also confound the results. Lastly, while the results do not show statistical differences in prescribing decisions, we do think the results are of clinical importance. The results suggest providers' personal experiences with OA can influence

prescribing decisions. Moreover, the differences in prescribing decisions for patients compared to family members suggests that providers are prescribing OA to patients despite having concerns about drug-related risks to which they would not want to expose their family members. We find this telling of strong factors favoring OA prescribing among ED providers that have yet to be fully elucidated.

CONCLUSION

No consistent differences in prescribing decisions were found between ED providers based on their prior therapeutic use of OA**.** Providers were more likely to prescribe OA for severe pain due to ankle fracture compared to ankle sprain. When making OA prescribing decisions, ED providers report that they are less likely to prescribe opioids to their family members, or themselves, than to an ED patient with the same painful condition.

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Opioid Dependent Malingerer with Self-Induced Sepsis

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A 21-year-old woman was admitted to the emergency department (ED) with severe sepsis. Both the mechanism of infection and organisms discovered were unusual. [West J Emerg Med. 2016;17(6)798-800.]

INTRODUCTION

Physicians learn to identify and treat disease through pattern recognition. But what if the traditional patterns are violated, and the resulting diseases are unknown? How is a bizarre clinical finding rationalized? We present a case in which a societal epidemic, patient subterfuge and microbiologic mystery all intersected to provide a truly unique case report.

There have been few reports of unusual organism bacteremia in intravenous (IV) drug users, and none that we could find in the emergency medicine (EM) literature. A 2016 comprehensive review from *Postgraduate Medical Journal* (from the *BMJ*) of infective endocarditis (IE) lists common culprits as *Staphylococcus aureus*, *Candida albicans* and *Pseudomonas* species, among others, and alludes to saliva contamination among addicts.[1] A 2012 review in the microbiology/ infectious disease (ID) literature lists multiple unusual organisms causing IE,[2] and a 2016 case report in the ID literature describes a case of persistent *Bacillus cereus* and *Flavimonas bacteremia.*[3] However, none of these reports identify the organisms found in our patient's blood. Even though blood culture results return after a patient is admitted from the emergency department (ED), emergency physicians frequently treat IV drug users with malingering behavior, and ferret out unusual causes for life-threatening presentations such as sepsis.

Prescription opioid abuse has risen to epidemic proportions globally. Over the past 2.5 decades, prescriptions for oral narcotics have close to tripled or quadrupled.[4] The United States is no exception; in 2014, 47,055 individuals in this country died from drug overdose with 18,893 of those related to prescription narcotics alone.[5] This staggering number represents a 3.4 fold increase since 2000.[5] In 2008, ED visits for non-medical use of prescribed or over-the- counter medications equaled that of visits related to illicit drugs.[6] The increase in overdoses from opioid pain medications has risen in conjunction with the increase in narcotic prescriptions.[7]

These opioid analgesics can be taken in many forms; traditionally, the pills are taken by mouth but they can also be crushed and snorted or dissolved and injected intravenously ("mainlining") or subcutaneously ("skin popping").

CASE REPORT

A 21-year-old woman was transported to the ED via ambulance with a complaint of one week of fever, shortness of breath and generalized weakness. She also had a cough productive of green sputum, chest tightness, and redness to both arms at sites of previous peripheral IV insertions and her current midline catheter (peripheral long line to the axillary vein) in her left arm.

She provided a medical history of pulmonary alveolar proteinosis and asthma, and, per chart review, had a history of pseudoseizures, anxiety, and borderline personality. She had been hospitalized multiple times for pulmonary infections, most recently at another hospital twice in the previous week for similar symptoms. She was treated there for both cellulitis and pneumonia and was discharged home on IV daptomycin. She later received a phone call from the other hospital that IV aztreonam would be prescribed in response to a new positive blood culture. She did not recall the names of the bacteria. She self-administered aztreonam and daptomycin just prior to ED arrival. The patient stated that the other hospital inserted a peripheral IV near her left thumb that was removed when her surrounding skin turned red and drained pus. She reported

frequent infections, citing cellulitis from multiple small insults, such as IV placements. She also reported anaphylaxis to many antibiotics.

On arrival, her vital signs were blood pressure 99/61 mm/Hg, heart rate 160 beats per minute, respiratory rate 22 respirations per minute, oxygen saturation 100% on 4 liters nasal cannula (NC, chronic home O_2), and oral temperature 39.5º C. Physical exam showed moderate respiratory distress with the patient only able to speak in short sentences. She was tachycardic without audible murmur, had diffuse rhonchi in all lung fields, and flushed, warm skin. There was redness to her right antecubital fossa at the prior IV insertion site, the dorsum of her left hand, the previous PICC site in her left arm, and also her left antecubital fossa with tenderness over her current home midline IV. In fact, all her current and former upper extremity IV sites appeared red. However, there was no purulent drainage, induration, or areas of fluctuance.

In the ED, the patient received IV fluids and antipyretics. Electrocardiogram revealed sinus tachycardia. Chest radiograph demonstrated hazy bilateral mid and lower lung opacities with low lung volumes with possible subsegmental atelectasis, although consolidation could not be excluded. Serum chemistries measured Na^+ 128 mmol/L (normal 135-145 mmol/L), K^+ 2.8 mmol/L (normal 3.4 -5.0 mmol/L), HCO_3^- 17 mmol/L (normal 20-29 mmol/L) , lactate 0.8 mmol/L, and Mg^{++} 1.3 mg/dL (normal 1.8-2.5mg/dL) and PO_4^- < 1.0 mg/dL (normal 2.5-4.5mg/dL). Complete blood count demonstrated: white blood cell count 2.7x 10^3/uL with a normal differential.

The patient was admitted to the internal medicine service on a telemetry bed with a working diagnosis of sepsis from a pulmonary source. As an inpatient, the medicine team obtained her previous medical records. The blood cultures from the other hospital grew *Cronobacter sakazakii* (formerly *Enterobacter sakazakii*) and *Candida parapsilosis*. The current admission blood cultures also grew *C. parapsilosis* as well as *Staphylococcus saccharolyticus*, and the patient was administered micafungin. The patient attempted to block access to other hospital records and only acquiesced if specific documents were not requested (e.g. discharge summary) because they were "wrong." The ED case manager was notified by the case manager from the patient's insurance company that the patient was abusive toward staff and left against medical advice (AMA) if she did not receive IV narcotics. She refused lab draws and some antibiotics on the basis of "anaphylaxis" unless she also received IV diphenhydramine and threatened to sign out AMA from the hospital. Her history of pseudoseizures was ultimately confirmed, including resolution of one episode of "convulsions" with IV normal saline. She also maintained that she required continuous NC O_2, and yet did not desaturate when it was discontinued without her knowledge.

She was transitioned to oral fluconazole and levofloxacin as recommended by the ID consultant. However, the patient refused levofloxacin due to reported anaphylaxis, and she was treated with ciprofloxacin.

Due to her history of line infections, the patient was placed on a 1:1 sitter for suspected line manipulation. The morning of discharge on hospital day 4, the patient was discovered with a syringe filled with partially dissolved hydromorphone that was hidden under her blankets. The sitter reported that the patient had been taking her oral pain medication underneath her blanket and, thus, had not been observed swallowing the pills. The organisms discovered in this patient's blood, *C. parapsilosis, C. sakazakii*, and *S. saccharolyticus*, have been found in food and on human skin, and in hospital environs. It is likely that the patient was injecting her oral pain medications IV after dissolving them in her mouth, and contaminated her paraphernalia with organisms from her bedding, food, and saliva.
She was discharged to home on two weeks of oral ciprofloxacin and fluconazole.

DISCUSSION

This patient was so debilitated by her substance abuse disorder that she went to extreme measures to potentiate the effects of her oral narcotics by injecting them. The patient caused substantial self-harm and developed recurrent sepsis from pathogens typically found in the mouth, skin and environment. This explained the infection of all her former and current IV lines.

Cronobacter sakazakii is a gram negative bacterium that typically does not cause significant infection in adults, but can cause fatal meningitis infections in neonates and young children with underdeveloped immune systems.[8] This organism is also found in some foods, especially plants, and oral contamination during IV drug use is the likely source of this bacteremia.[9]

Candida parapsilosis is a lesser known fungal pathogen in the Candida genus that is commonly found on human skin and was previously unknown as a source of severe infections.[6] However, it actually can cause significant fungemia and is reported to be the second leading cause of fungemia [10,11] behind *C. albicans* in certain populations. [9,12]

Staphylococcus saccharolyticus is an anaerobic, coagulase negative pathogen found as native skin flora.[13] It has been rarely reported to cause nosocomial cases of bacteremia and infectious endocarditis.[14]

CONCLUSION

The lesson to the astute clinician is to look beyond the usual patterns of disease when faced with atypical presentations. Given the patient's pseudoseizures, multiple hospitalizations, unusual blood culture results, abusive and obstructive behavior, and deceitful information, it was prudent to investigate her previous records for malingering

behavior. Further, the inpatient team astutely assigned a sitter for the patient, who ultimately exposed the root cause of her otherwise puzzling multi-organism bacteremia and sepsis.

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Rapid Diagnosis of Rhabdomyolysis with Point-of-Care Ultrasound

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It is important to rapidly diagnosis and treat rhabdomyolysis in order to decrease morbidity and mortality. To date there are no reports in the emergency medicine literature on the use of point-of-care ultrasound in the diagnosis of rhabdomyolysis. This unique case describes how ultrasound was used in the emergency department (ED) to quickly diagnose and treat rhabdomyolysis prior to confirmation with an elevated serum creatine kinase. When coupled with a high index of suspicion, ultrasound can be one of the most portable, readily available, low cost, and minimally invasive techniques for making a rapid diagnosis of rhabdomyolysis in the ED. [West J Emerg Med. 2016;17(6)801-4.]

INTRODUCTION

Rhabdomyolysis is the breakdown of skeletal muscle that can rapidly progress to acute renal failure or death. It is important to make a rapid diagnosis and initiate treatment for rhabdomyolysis in order to decrease morbidity and mortality. To date there are no reports in the emergency medicine literature on the use of point- of-care ultrasound in the diagnosis of rhabdomyolysis. This unique case describes a patient who presented to the emergency department (ED) with localized musculoskeletal pain. Using ultrasound, the patient was quickly diagnosed and treated for rhabdomyolysis prior to confirmation with an elevated serum creatine phosphokinase (CPK). When coupled with a high index of suspicion, ultrasound can be one of the most portable, readily available, low-cost, and minimally invasive techniques for making a rapid diagnosis of rhabdomyolysis in the ED.

CASE REPORT

A 24-year-old male presented to the ED with a two-day history of bilateral arm pain. The pain was constant, located primarily to the biceps region of his upper arms. His pain began shortly after weight lifting. Past medical history included bipolar disorder and polysubstance abuse, including recent use of cocaine, marijuana, and a synthetic marijuana known as "spice."

On arrival to the ED the patient had a temperature of 97.9 F, blood pressure of 167/88, heart rate of 122, and respirations of 16 per minute. Physical findings included bilateral biceps swelling and fullness with diffuse tenderness to the musculature. There was no external evidence of trauma. The patient's upper extremities were neurovascularly intact with no evidence of paresthesias, weakness, or pallor. He was noted to display paranoid behavior without features of acute psychosis.

A point-of-care musculoskeletal ultrasound was performed by the emergency physician to evaluate for a possible muscle or biceps-tendon tear. The sonogram showed areas of both increased and decreased echogenicity of the biceps muscle, as well as disorganized muscle fibers with surroundings areas of fluid (Figure 1, Video 1). There was preservation of the muscle boundary and the biceps tendon was intact. A presumptive diagnosis of rhabdomyolysis was made pending laboratory testing and the patient was started on intravenous (IV) fluids.

The patient's lab work in the ED was notable for a creatine phosphokinase (CPK) of 83,000 U/L. AST/ALT were 813/169 IU/L respectively, total bilirubin of 1.5 mg/dl, and bicarbonate of 16 mEq/L. Urine results included amber color and "large" hemoglobin with 3-5 red blood cells per high powered field. A complete blood count, complete metabolic profile, and urinalysis were otherwise unremarkable. A urine drug screen was positive

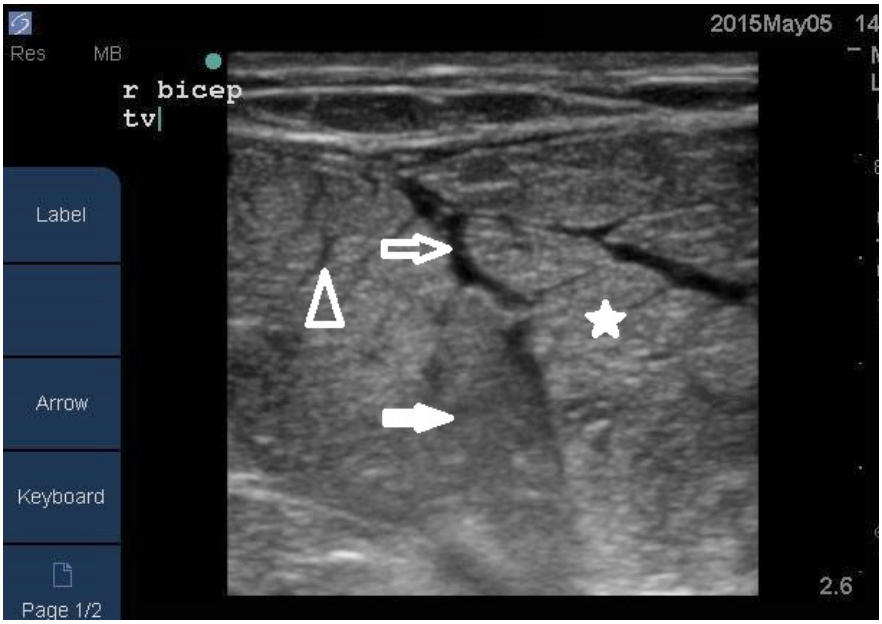

Figure 1. Transverse image of rhabdomyolysis of the right biceps muscles using a linear array transducer. Areas of increased and decreased echogenicity are seen, as well as disorganized muscle fibers within surroundings areas of fluid. The arrowhead is pointing towards the disorganized muscle fibers. The open arrow is pointing to areas of fluid. The closed arrow is pointing to areas of decreased echogenicity. The star is indicating the areas of hyperechogenicity.

for marijuana.

The patient was hospitalized and treated with aggressive IV fluids. His CPK peaked at 124,000 and subsequently improved daily thereafter. His liver enzymes improved as well. A hepatitis panel led to a new diagnosis of hepatitis C, though liver enzyme elevation was thought to be primarily related to his acute rhabdomyolysis. Renal function remained normal throughout his stay. His hospital course was complicated by paranoia, psychosis, and aggression toward hospital staff. He was subsequently placed under an involuntary psychiatric hold and required security intervention and sedation. He was transferred to the local mental health facility on hospital day five for further psychiatric care after his rhabdomyolysis resolved.

DISCUSSION

Rhabdomyolysis is a syndrome of skeletal injury that can rapidly progress to acute renal failure or even death.[1,2] It is imperative that it be diagnosed and treated appropriately to reduce the lasting effects of the disease.[1] Rhabdomyolysis results from a myriad of conditions including trauma, illicit drugs, medications, infection, excessive exercise, immobilization and psychiatric condition.[2] The symptoms of rhabdomyolysis are as variable as the causes: from a patient with a traumatic crush injury, who has pigmented urine and renal failure, to one with no significant history of trauma who may simply present with fatigue, nausea, fever or muscle weakness.[1,2] For these reasons, diagnosing rhabdomyolysis cannot be based on history and physical alone and generally requires a serum CPK that is greater than five times the normal limit, without evidence of brain or cardiac injury.[3]

Once a diagnosis of rhabdomyolysis is suspected, additional workup is needed. An electrocardiogram should be performed to screen for conduction abnormalities caused by hyperkalemia including: peaked T waves, prolonged PR interval and a widened QRS complex.[2] A metabolic panel should be performed to assess renal function, calcium, potassium and phosphorous levels.[1] CBC and coagulation studies should be done to monitor for evidence of DIC.[1]

Imaging may be required in patients who present with localized pain. Ultrasound and magnetic resonance imaging (MRI) can both be used to determine the extent of muscular damage that exists. On ultrasound normal skeletal muscle has a relatively hypoechoic echotexture with clearly demarcated linear hyperechoic strands of fibroadipose septa[4] (Figure 2). In rhabdomyolysis the findings are variable but may include hyperechoic areas of muscle,[5,6] which is likely due to hypercontractile muscle fibers in the acute phase of muscle injury,[4] hypoechoic areas of muscle,[4,7] which is believed to be caused by edema and inflammation of the muscle,[4,7] increased muscle thickness, and fluid within the surrounding the muscles.[4] Areas of locally disorganized fascicular architecture[8] may also be appreciated but generally the muscle boundary itself remains intact unless an associated tear is present.[8] The area of locally disorganized fasicular architecture is thought to represent necrosis of the muscle.[4,7]

Abscesses and hematomas may also appear anechoic and hypoechoic and should be considered on the differential diagnosis.[5] However, on examination neither of these conditions correlates with the clinical picture. With both an abscess and hematoma one would expect a localized fluid collection on

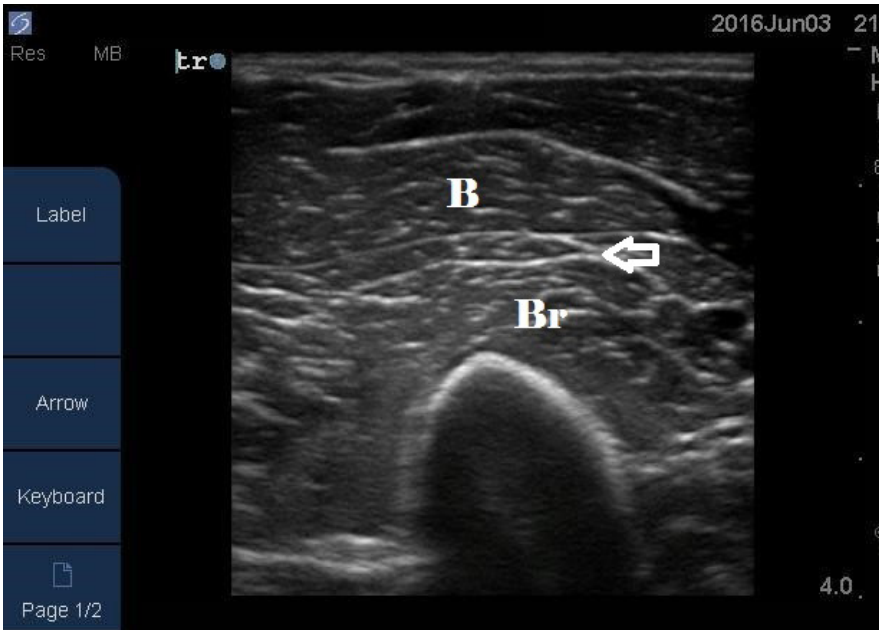

Figure 2. Transverse image of a normal left biceps muscle (B) and brachialis muscle (Br) using a linear array transducer. Normal skeletal muscle has a relatively hypoechoic echotexture with clearly demarcated linear hyperechoic strands of fibroadipose septa (arrow).

ultrasound in conjunction with physical exam findings of infection and trauma respectively. Additionally, there would not be a significantly elevated serum CPK or increase in creatinine level associated with these diagnoses.

Clinicians performing soft tissue ultrasound should be familiar with the sonographic changes associated with other common musculoskeletal pathologies such as muscle tears, strains, and contusions in order to avoid diagnostic error. Complete muscle tears are associated with avulsion and retraction of the injured muscle segment along with an adjacent anechoic or hypoechoic hematoma.[9] Partial tears, strains, and contusions have focal hypoechoic areas within the muscle fibers themselves, representing localized edema and hemorrhagic changes that have disrupted the normal fibroadipose pattern.[9] Unlike in rhabdomyolysis, the sonographic findings seen with tears, strain injuries, and contusions are limited to a focal area of injury and are not diffusely present throughout the involved muscle. MRI is excellent at demonstrating rhabdomyolysis with T2-weighted MRI images of rhabdomyolysis generally show increased signal intensity.[8] Unfortunately performing an MRI is associated with greater cost and long testing times. In addition, MRI is not readily available in most EDs.

The initial treatment of rhabdomyolysis involves early and aggressive IV fluid resuscitation.[2] The patient should be admitted and monitored for life-threatening complications such as acute renal failure and hyperkalemia.

In this case, the patient presented with bilateral upper extremity pain and swelling and the ultrasound was used to narrow the differential of possible musculoskeletal pathologies. A presumptive diagnosis of rhabdomyolysis was made and later confirmed by serum CPK levels. If a patient has sonographic findings suggestive of rhabdomyolysis, treatment can be initiated immediately while laboratory testing is still in progress. The increasing availability of point-of-care ultrasound in most EDs makes it an ideal imaging modality for the initial evaluation of the patient in whom rhabdomyolysis is considered.

LIMITATION

There are no follow-up ultrasounds available to show this patient's return to normal muscles.

Video. This ultrasound video is of the patient's left bicep muscle. It shows disorganized muscle fibers with surrounding areas of anechoic fluid. The biceps muscle displays areas of both increased and decreased echogenicity. There is preservation of the muscle boundaries within the echogenic fascial planes.

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E-cigarette Blast Injury: Complex Facial Fractures and Pneumocephalus

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Electronic cigarettes (also known as e-cigarettes or e-cigs) are becoming a popular method of recreational nicotine use over recent years. The growth of new brands and devices has been outpacing the FDA's ability to regulate them. As a result, some of these devices fail without warning, most likely from malfunction of the lithium-ion batteries that are in close proximity to volatile compounds within the device. Failures have occurred during both use and storage of the devices or their components. The subsequent injuries from several of these events, including full thickness burns requiring grafting and blast injuries, have been observed at Arrowhead Regional Medical Center, a regional trauma and burn center in southern California. One severe case resulted in several maxillofacial fractures, blurred vision, and pneumocephalus after a device failed catastrophically during use. The patient required close monitoring with serial imaging by neurosurgery in the intensive care unit and multiple procedures by oral maxillofacial surgery to reconstruct his facial bones and soft tissue. Ultimately, the patient recovered with minimal permanent damage, but the potential for further injury or even death was apparent. Cases such as this one are becoming more frequent. It is important to increase awareness of this growing problem for both medical professionals and the general public in order to curb this concerning new trend. [West J Emerg Med. 2016;17(6)805-7.]

INTRODUCTION

The Federal Emergency Management Agency (FEMA) reported in 2014 that there were over 2.5 million e-cigarette users in the United States, and since then that number has grown substantially.[1] The introduction of electronic cigarettes (ECs) and the rapid growth in both use and manufacturing of such products in recent years has prompted the need for more research, regulation, and awareness about the potential hazards of these devices and their contents. These devices use a battery-powered heating filament to aerosolize volatile compounds, such as propylene glycol or glycerin, nicotine, and flavoring compounds.

Patients are presenting to emergency departments (EDs) with not just thermal but also severe blast injuries that have occurred during both the use and storage of ECs. To date, only limited studies exist on the safety of the inhaled substances, second-hand exposure, and the devices themselves. At least 18 cases of EC explosions have presented to Arrowhead Regional Medical Center (ARMC) in Colton, California, a regional trauma and burn center serving San Bernardino and several surrounding counties. Injuries range from mild first and second degree superficial burns to complex craniofacial fractures requiring intensive medical and surgical care. Here we present a case of explosive failure of an EC resulting in severe maxillofacial and skull fractures leading to pneumocephalus.

CASE REPORT

A 59-year-old male with history of leukemia, hyperlipidemia, chronic back pain and baseline right hearing loss was airlifted to ARMC for trauma evaluation following the explosion of an e-cigarette while "vaping." The patient had received the device two days prior after purchasing it online and reportedly made no modifications.

On arrival to the ED, the patient was alert, oriented, and calm with an initial Glasgow Coma Scale of 15. He complained of epistaxis, facial pain, blurry vision in his right eye, and decreased hearing in the left ear. His physical exam was significant for palpebral edema and ecchymosis of the right eye, maxillary tenderness and gross blood in the oropharynx without brisk bleeding, and a circular avulsion injury to the philtrum (Figure 1). In addition, he was covered with soot on his lips, right hand and the right side of his face. Computed tomography (CT) showed fractures of the petrous, ethmoid, cribriform plate, nasal choanae, nasal septum and right medial orbital wall as well as pneumocephalus (Figure 2). He also sustained a right periorbital contusion. A nearly completely avulsed philtrum communicated intraorally and through the nasal mucosa bilaterally with exposure of nasal septal cartilage.

Oral and maxillofacial surgery (OMFS) performed reduction and splinting of the nasal fractures and repair of the philtrum and nasal floor defects. The patient was admitted to the surgical intensive care unit for close monitoring of neurologic function. Neurosurgery recommended a repeat CT head to re-evaluate pneumocephalus the following day, and it was found to have increased in size. The patient was continued on supplemental oxygen via non-rebreather mask to aid in resorption of pneumocephalus, which has been demonstrated as effective management in patients with pneumocephalus following craniotomy.[2] A repeat CT head two days later showed that the pneumocephalus had improved. Ophthalmological evaluation of the right eye blurriness and periorbital contusion did not reveal any significant eye injury and daily artificial tears were recommended. The patient reported clinical improvement of blurry vision and diminished hearing in the left ear prior to his discharge. He had no change in neurologic function and was discharged home on hospital day three with instructions to follow up with neurosurgery within two weeks and with OMFS within one week.

The patient followed up with OMFS one week after the incident, at which time the nasal splints and lip sutures were removed without complication (Figure 1). At a one-month follow-up visit with the ARMC neurosurgery department, a repeat CT of the brain demonstrated the complete resolution of the pneumocephalus (Figure 2) and his facial injuries were well healed with minimal residual scarring. He had no neurological deficits at that time. The only potential complication was persistent yellow-green nasal discharge, possibly indicative of a sinus infection.

DISCUSSION

It is currently thought that EC explosions are caused by the proximity of the heating element to an improperly insulated lithium ion battery and its exposure to volatile liquids. Reported cases of possible EC failures are consistent with lithium ion battery failures observed in other devices. The proposed mechanism of failure has been well documented.[1] The failure is potentially more frequent and more harmful in ECs, due to their configuration and proximity to users' faces. This high rate of failure may be caused primarily by design flaws or manufacturing defects and exacerbated by user device modification, or even due to common storage situations. In this case, the patient was using the device, but other cases have been noted of spontaneous failure during storage and transport. Cases of documented blast injury have demonstrated directionality toward the upper and posterior oral cavity and palate causing fractures, burns, lacerations and dental injuries, including avulsion and fracturing of the teeth.[3,4] These injuries have the potential to be permanently disfiguring and disabling with serious neurologic sequelae.

Management of injuries sustained from EC explosions should be approached from the standpoint of addressing both

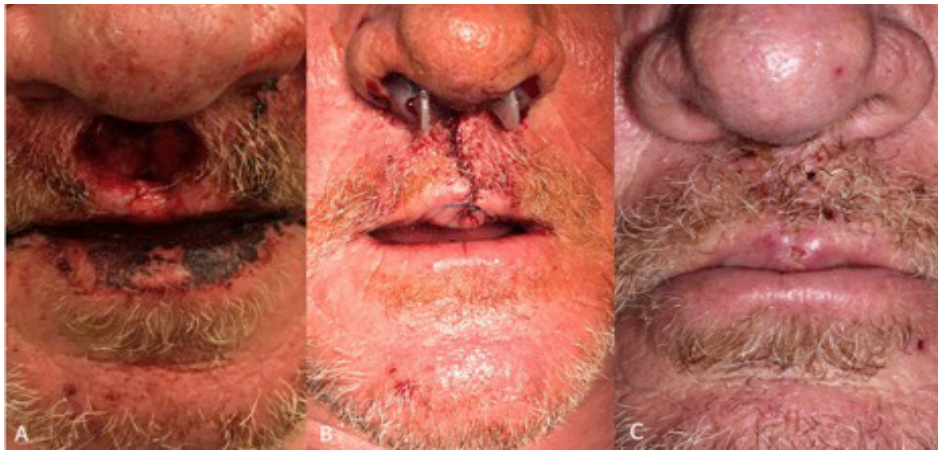

Figure 1. A. excisional blast injury to philtrum. **B.** Philtrum and nares after surgical repair and packing by oral maxillofacial surgery. **C.** Well healed wound at follow-up visit.

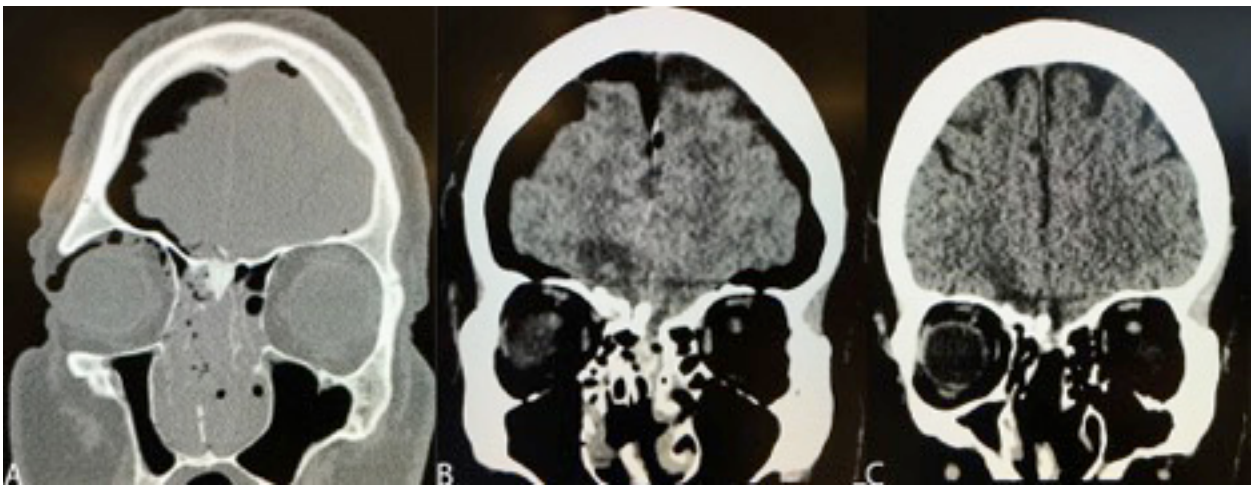

Figure 2. A. Maxillofacial computed tomography from outside facility demonstrating ethmoid, nasal, and cribriform fractures with pneumocephalus, with **B.** progression over the initial 24 hours following injury, and **C.** resolution of pneumocephalus at one month.

thermal and chemical burns, as well as concussive blast injuries. Patient clothing should be removed as there may be residual nicotine or other chemicals present. There should be a high suspicion for occult, possibly severe maxillofacial and cranial injuries. Providers should also consider pulmonary irritation from inhalants and potential overdoses of nicotine or other substances in any patient exposed to open cartridges; there is potential for acute lung injury in these cases.[5]

CONCLUSION

The cases observed at ARMC over the last several months are only a small portion of potential problems in an entirely new field of the consumer market, but are likely to present daily in EDs across the country. The EC products market is booming in America. With their growing popularity, these products are being produced and distributed at a rate that exceeds the FDA's current ability to monitor, test, and regulate them. They are sold widely on the Internet, making them more difficult to track. These devices are also modifiable beyond the manufacturer's recommendations. This is particularly dangerous as these modifiable parts include a heating element in close proximity to lithium ion batteries, which have highly exothermic and potentially explosive consequences under certain circumstances. Compatibility issues between brands and replacement parts may also lead to device failures, which can cause catastrophic injuries.

The alarming severity and increasing frequency of catastrophic failures warrants further investigation into the safety of ECs. Whether failure is caused by the device as a whole, the battery, or any of its other components, the injuries that have resulted are well out of reasonable tolerances. Even if most or all of the accidents are due to user modification or improper storage, there needs to be further safety mechanisms in place. In the meantime, focus should be on increasing public awareness along with hospital and ED provider education across the country to treat the victims.

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Large Posterior Communicating Artery Aneurysm: Initial Presentation with Reproducible Facial Pain Without Cranial Nerve Deficit

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Unruptured posterior communicating artery (PCOM) aneurysms can be difficult to diagnose and, when large (≥ 7mm), represent a substantial risk to the patient. While most unruptured PCOM aneurysms are asymptomatic, when symptoms do occur, clinical manifestations typically include severe headache (HA), visual acuity loss, and cranial nerve deficit. This case report describes an atypical initial presentation of a large unruptured PCOM aneurysm with symptoms mimicking trigeminal neuralgia, without other associated cranial nerve palsies or neurologic deficits. The patient returned to the emergency department four days later with a HA, trigeminal neuralgia, and a new cranial nerve III palsy. After appropriate imaging, she was found to have a large PCOM aneurysm, which was treated with surgical clipping with significant improvement in patient's symptoms. [West J Emerg Med. 2016;17(6)808-10.]

INTRODUCTION

Intracranial aneurysms are estimated to have a prevalence of 3.2% in the United States. Patients have a mean age at diagnosis of 50 years.[1] Unruptured aneurysms are often asymptomatic and may be discovered as incidental findings. When intracranial aneurysms rupture they result in subarachnoid hemorrhage (SAH) and/or subdural hemorrhage (SDH), with fatality rates of 40%. Of patients who survive rupture of an intracranial aneurysm, 66% suffer from permanent symptoms, most with neurological deficits.[2,3] Recent evidence has suggested posterior communicating artery (PCOM) aneurysms may have a higher rate of rupture than anterior circulation aneurysms, with a five-year risk of rupture of 14.5% for aneurysms 7-12mm. Thus, identifying these aneurysms before they rupture is key to improving patient outcomes.[4] Symptoms suggestive of PCOM aneurysms vary, but most sources agree that the presence of ocular motor nerve palsy and severe SAH-like headache are the most common.[5,6]

We present the case of a patient who initially presented to the emergency department (ED) with unilateral, reproducible facial pain consistent with trigeminal neuralgia (with migraine in the differential) and was treated as such with some relief of her symptoms. It was not until her second visit to the ED that she exhibited the neurological deficit of cranial nerve III (CN III) commonly associated with large PCOM aneurysm.

CASE REPORT

A 42-year-old woman presented to the ED with two weeks of right-sided headaches similar to her previous headaches. Past medical history was remarkable for headaches that usually resolved spontaneously, but this one had not. In addition, she also noted right-sided facial pain and sensitivity. The facial pain was reproducible and originated behind her right ear, with radiation across the face. The patient denied any facial droop or weakness. She also denied any changes in visual acuity, but did complain of a foreign body sensation in her eye.

The patient's initial vital signs were a blood pressure of 144/79, pulse 72, respirations 17, temperature 99.7˚F, and SpO2 100% (room air). On physical exam, the patient exhibited no physical distress. Her neurologic exam was unremarkable with cranial nerves, strength, and gait tested and noted to be intact. An ocular exam, including intraocular

pressure testing and fluorescein evaluation, was also noted to be negative for pathology. She was treated with metoclopramide and ketorolac for her migraine while in the ED, with some relief of symptoms. Because her symptoms also appeared consistent with trigeminal neuralgia, she was discharged with a trial of carbamazepine.

The patient returned to the ED four days later with a chief complaint of right eye pain and pressure with associated blurred vision. The patient's sister also noted that the patient's eyelid appeared "droopy." The patient also complained of some numbness to her right side. Physical exam was remarkable for a new marked ptosis of the right eyelid and miosis of the right pupil. The rest of the physical exam was unremarkable. Based on these new physical findings, an emergent computed tomography angiography (CTA) of the head and neck was performed. The imaging revealed 7mm by 4mm bilobed posterior directed PCOM saccular aneurysm, which is demonstrated in the figure.

Once imaging was completed, an emergent neurosurgery consult was obtained. The patient was maintained on strict blood pressure control (systolic blood pressure less than 140), and transferred to the neurosurgery intensive care unit until the she could be taken to the operating room. In the operating room a right pterional craniotomy was performed followed by clipping of the right posterior communicating artery. The patient also received dexamethasone on the day of the surgery and post-operative day one.

The patient progressed remarkably well after her surgical procedure. She had immediate relief of her facial pain and significant improvement of her CN III palsy and was discharged home three days post-operation. At her outpatient follow-up appointment two weeks post-operation she reported complete resolution of her headaches and had completely normal extra-ocular movements and only mild ptosis on exam.

DISCUSSION

This case helps illustrate why patients presenting with a headache and cranial nerve irritation may require advanced imaging for a mass. The differential of facial pain is broad and contains treatable conditions with high morbidity and/or mortality such as intracranial aneurysms, masses, bleeds or acute angle closure glaucoma, in addition to the more benign diagnoses of primary headache or trigeminal neuralgia. While facial pain without neurological deficits is a rare presentation of a large PCOM aneurysm, full neurologic and ocular exams should be considered in patients presenting with facial pain, with the possibility of neuroimaging based on clinical findings. As seen in this case, such patients can present with associated headache as well as prior history of headaches. With headaches being a common chief complaint, comprising 4.5% of all ED visits in U.S., and the overwhelming majority of them being benign primary headaches, vigilance for the possibility of more serious secondary headaches is difficult to maintain but important.[7]

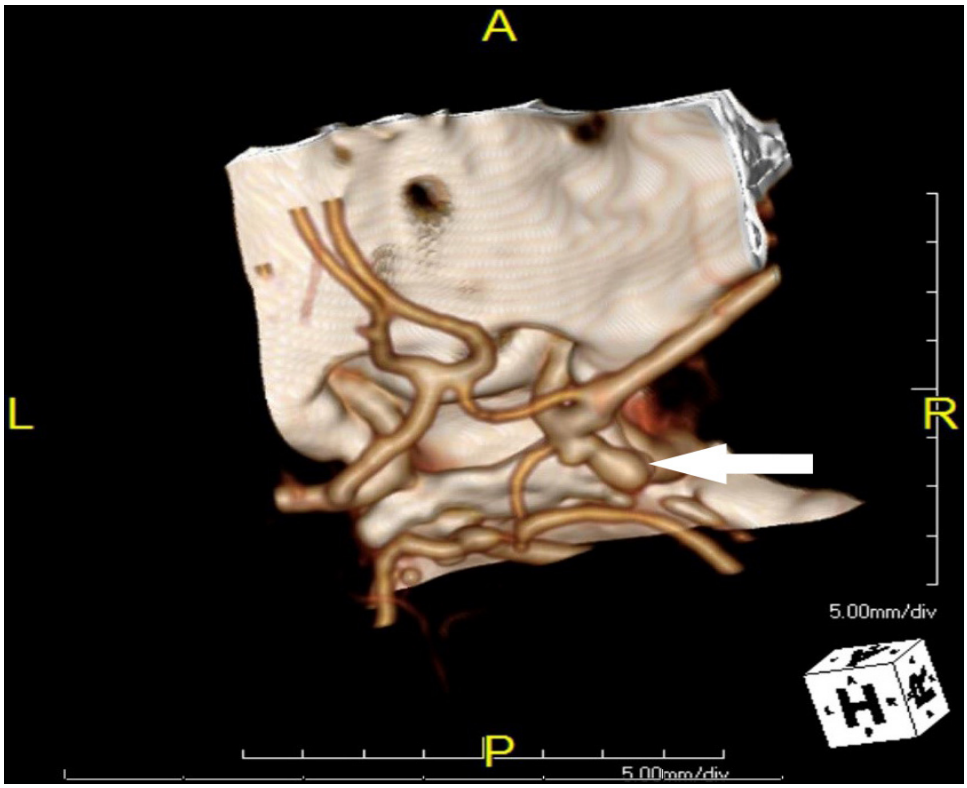

Figure. Three-dimensional contrast enhanced computed tomography reconstruction showing bilobed right posterior communicating artery aneurysm.

All patients presenting to the ED with facial pain, especially if it is new in onset or different from previous episodes, should have a thorough physical exam including complete neurological and ophthalmological exam, with specific focus on cranial nerve deficits and intraocular pressures. Any abnormalities on this exam should prompt the provider to strongly consider further investigation with neuroimaging, as they are potentially caused by a life-threatening intracranial process such as a large PCOM aneurysm. In this case, a detailed neurologic exam was performed, but irritation of the trigeminal nerve was attributed to a peripheral cause instead of a central cause. In this patient's case, it appears that her trigeminal neuralgia was caused by a central irritation due to the compression by the bilobed aneurysm. This is likely why her pain (and CN III deficit) resolved after surgery. If neuroimaging is not pursued during the patient's ED visit (as it was not in this patient's first visit due to lack of perceived central neurological deficits), it is imperative that strict ED return precautions be given. These should include neurological deficits such as vision or eye movement deterioration as well as worsening of the patient's pain. As in this case, such return precautions can lead to timely reevaluation of the patient, where changes in physical exam can be identified and further workup performed.

Upon identification of large (≥ 7mm) or clinically symptomatic intracranial aneurysms, emergent neurosurgical consultation is indicated, as interventions such as surgical clipping are associated with improved clinical outcomes and cost effectiveness.[8]

This case illustrates the importance of considering posterior circulation aneurysms in patients with new headaches or changing symptoms specifically involving new pain of the face or eyes. Thorough neurological and ophthalmological examination including cranial nerve function and bilateral IOPs should be performed on these patients when they present to the ED. Good follow-up instructions and return precautions, including development of cranial nerve palsies, is important so the patient knows what symptoms to monitor for and when to return for reevaluation. Early surgical clipping of large and/or symptomatic aneurysms can improve patient quality of life and mortality.

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Spermatic Cord Anesthesia Block: An Old Technique Re-imaged

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Spermatic cord anesthesia block (SCAB) is a useful technique for providing anesthesia to males with scrotal pain. This technique has been described and published in the urology and anesthesia literature for more than 40 years. Initially described as a blind injection, anesthesia of the spermatic cord provides pain control to the scrotal contents. The technique can easily be performed under ultrasound guidance by emergency physicians and should be considered a useful option when seeking to provide pain relief to male patients with scrotal pain. [West J Emerg Med. 2016;17(6)811-13.]

CASE REPORT

A 37-year-old male presented to the emergency department (ED) with a one-week history of left-sided scrotal pain. He denied previous trauma, associated fever, abdominal pain, hematuria, or any past genitourinary-related medical history. He was previously evaluated for a similar complaint five days earlier at an outside institution. At that time, his physical exam was unremarkable and he was treated for presumed epididymitis with oral antibiotics. However, his symptoms had not improved with this treatment. Upon arrival to our ED, his abdomen was soft with no guarding or palpable mass. He was a circumcised male with normal external genitalia without notable abnormality to the penis or scrotum. His testicles were bilaterally descended in normal anatomic position and there was no inguinal lymphadenopathy or evidence of scrotal cellulitis. His cremasteric reflex was intact. He was however, tender to palpation along the left testicle/epididymis. A radiology department ultrasound was performed, which showed mildly increased vascular flow to the left testes. His pain had not improved and he was subsequently offered a spermatic cord anesthesia block (SCAB) for pain management.

DISCUSSION

The SCAB technique has been described multiple times previously in the literature.[1,2] As early as 1960, Earle published an article in the *American Journal of Surgery* discussing local anesthesia options for inguinal herniorrhaphy, which described the technique without naming it as such.[3] The spermatic cord (SC) is a distinct structure in males containing the vas deferens, which exits the abdomen and extends from the deep inguinal ring down to each testicle. The cord is covered by the tunica vaginalis, an extension of the peritoneum. Along with the vas deferens, contained within the SC are the testicular and cremasteric arteries, lymphatic vessels, the pampiniform plexus of veins, and two key nerves – the genital branch of the genitofemoral nerve and the ilioinguinal nerve. The ilioinguinal nerve arises off the 12th thoracic and first lumbar nerve. The genitofemoral nerve arises off the first and second lumbar nerves.[2] Combined, these nerves provide enervation to the cremasteric muscles and sensation to the intrascrotal contents.[2] A correctly performed SCAB provides anesthesia to the scrotal contents without providing scrotal skin anesthesia.[10]

Most previously published case series describe a blind technique whereby the SC is identified by manual palpation.[10] A needle is inserted to deliver anesthetic medication based on tactile location of the cord. The landmark for this procedure is classically described as being a point 1 cm below and 1 cm medial to the pubic tubercle.[4] The technique as described by Kaye et al was proposed to facilitate vasovasotomy, hydrocelectomy, spermatocelectomy, and orchiectomy[4] and has been generally viewed as a successful technique.[2] Both Kaye and Cassady describe a technique involving three needle passes at slightly different angles to the SC with total deposition of 12-15ml of local anesthetic.[2,4] Subsequent articles have commented on the difficulty in palpating and identifying the pubic tubercle,[9] especially in patients with protuberant abdomens or large pannus

folds. These case reports and studies involving SCAB have primarily been published in the urology and anesthesia literature.

The SCAB technique has been proposed as a cost-savings option to facilitate various surgical procedures including outpatient orchiectomy[5] and vasectomy reversal.[6] It has also been proposed for treatment of SC torsion prior to manual reduction.[7,8] Kiesling et al report a case series of 15/16 successful detorsions following SCAB.[8] Some reported advantages to this technique include the lack of need for general anesthesia and its attendant potential complications.[4] Additionally, patients require less post-operative pain control as the block serves as its own anesthetic resulting in an overall cost savings for the technique compared with general anesthesia.[5] Reported complications of the blind injection technique include vascular injury to the testicular artery[6] or possible intra-arterial injection and/or damage to the deferent ducts.[9] As the availability of ultrasound (US) for emergency physicians continues to increase, SCAB under ultrasound (US) guidance is a simple technique that can provide immediate anesthesia for patients with testicular and scrotal pain.

The SC block performed on our patient was achieved with a multifrequency linear L8-3 probe on our ZONARE Z1 Ultra ultrasound machine. The technique involved first identifying the spermatic cord and cremasteric artery. The probe was positioned between the pubic tubercle and the anterior superior iliac spine on the affected side (Figure 1). Once the SC was identified (Figure 2), 5ml of 1% xylocaine and 5 ml of 0.5% bupivacaine were combined in a single syringe with a #21 gauge 1.5-inch needle. The skin site was prepared and draped and the SC was palpated. The SC location was confirmed by bedside US in both the longitudinal and transverse planes. Under direct US visualization, the needle was positioned in the SC, avoiding the vascular structures (Figure 3). Approximately 8 cc's of the anesthetic solution was injected in and directly around the SC (Figure 4). The patient reported nearly immediate symptomatic relief without bleeding at the injection site. The patient was monitored for pain

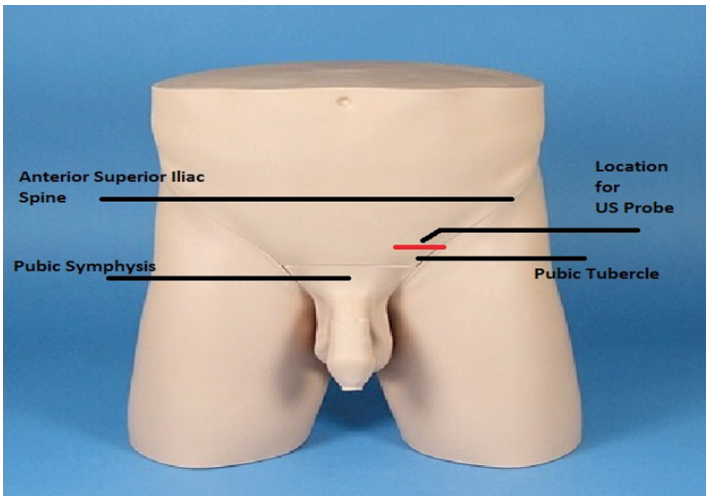

Figure 1. Initial positioning of the ultrasound (US) probe to locate the spermatic cord.

relief and was ready for discharge within 15 minutes of nerve block completion. A subsequent follow-up phone call confirmed that our patient did not have any delayed complications nor did he experience a recurrence of his pain.

We present the technique of SCAB under ultrasound guidance. This technique has been described for more than 40 years and has been shown to be an effective adjunct for addressing pain in patients with testicular and/or scrotal complaints. The first step in the management of testicular pain without acute surgical findings remains conservative in nature. Consideration should include the use of scrotal elevation, NSAIDS, and cold compresses. Additionally, US-guided SCAB is a simple effective adjunct. As US availability in the ED is readily accessible, this technique is easily and safely performed by emergency physicians and should be considered a viable option for treating testicular pain in the ED.

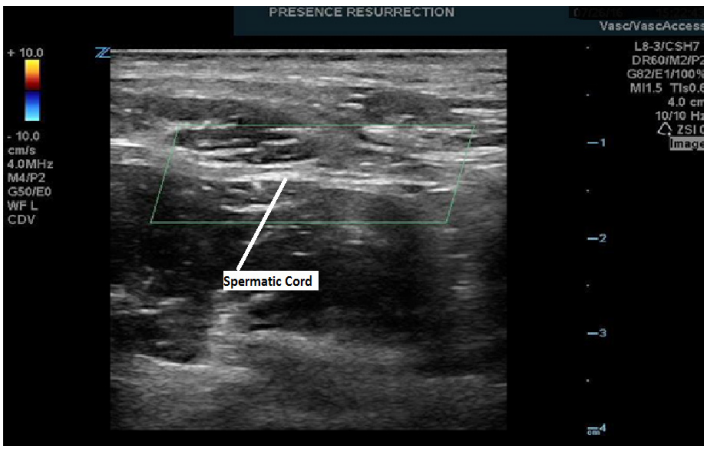

Figure 2. Transverse view of the spermatic cord.

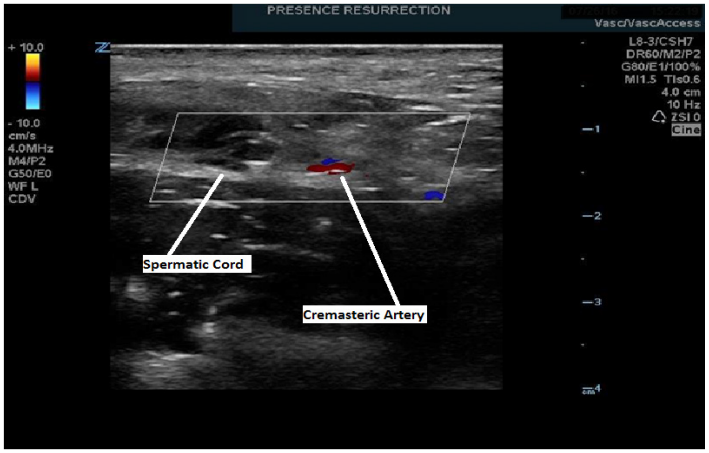

Figure 3. Identification of adjacent vascular structure. Transverse view showing the spermatic cord and adjacent cremasteric artery.

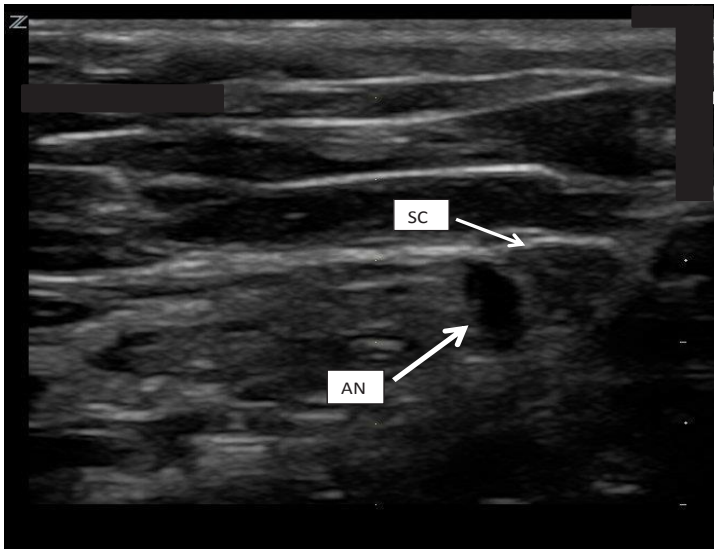

Figure 4. Coronal view. Sonographic anatomy of the spermatic cord (SC) and anesthesia (AN) solution deposited adjacent to the cord.

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Ultrasound Detection of Patellar Fracture and Evaluation of the Knee Extensor Mechanism in the Emergency Department

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Traumatic injuries to the knee are common in emergency medicine. Bedside ultrasound (US) has benefits in the rapid initial detection of injuries to the patella. In addition, US can also quickly detect injuries to the entire knee extensor mechanism, including the quadriceps tendon and inferior patellar ligament, which may be difficult to diagnose with plain radiographs. While magnetic resonance imaging remains the gold standard for diagnostic evaluation of the knee extensor mechanism, this can be difficult to obtain from the emergency department. Clinicians caring for patients with orthopedic injuries of the knee would benefit from incorporating bedside musculoskeletal US into their clinical skills set. [West J Emerg Med. 2016;17(6)814-16.]

A 39-year-old male was brought into the emergency department (ED) after a washing machine fell onto his right knee. On physical examination, the patient had severe tenderness to palpation over the right knee. There was a significant amount of soft tissue swelling around the knee, a palpable joint effusion, and active right knee extension was markedly decreased. A bedside ultrasound (US) was performed using a 10-MHz linear transducer (FUJIFILM SonoSite Ultrasound) and showed severe cortical disruption of the patella, with associated hematoma on long-axis view (figure, video). The quadriceps tendon and patellar ligament, both critical structures for active knee extension, were found to be intact. A comminuted patellar fracture was confirmed on plain radiography, and intact quadriceps tendon and patellar ligament (also termed patellar tendon, but referred in this article as ligament) noted intra-operatively.

Previous literature describes the use of bedside musculoskeletal ultrasound (MSK US) to detect fractures. MSK US can be used for the diagnosis of long bone fractures, as well as to identify those fractures that may be difficult to identify on plain radiography. These include fractures of the sternum, ribs, scaphoid and metacarpals (and patella).[1-3] MSK US is also very helpful in the evaluation for fracture in austere locations, or in practice environments with limited resources.[4] Furthermore, MSK US can be particularly helpful in evaluating injuries to the entire extensor mechanism of the knee, especially when severe pain limits the physical examination.[5,6 7,8] US can potentially shorten the time to diagnosis and appropriate treatment of significant knee injuries, when compared with traditional methods.[9]

The high-frequency linear transducer is used for this MSK US application. A fracture is identified when there is a disruption in the normal continuous bright (hyperechoic) interface between the bone and soft tissue. Identification of a hypoechoic (dark) collection, suggestive of a hematoma, can also guide the clinician to the site of cortical disruption.[10] In acute knee trauma, MSK US has been shown to have increased sensitivity, 94% versus 84%, over plain radiography in the diagnosis of fractures.[5]

To further assess the knee extensor mechanism using US, the probe is positioned in the long-axis configuration, cephalad to the superior pole of the patella and directly over the quadriceps tendon. It is then moved sequentially caudal over the patella down to the patellar ligament, allowing detailed assessment of these structures (see video).[11]

This case demonstrates the utility of bedside MSK US in the timely evaluation and management of patella fracture, and in assessment for associated knee ligamentous and tendon injuries. While magnetic resonance imaging has traditionally been the reference imaging standard for knee tendon and ligament injuries, US also has a high sensitivity for the diagnosis of these injuries.[12] Therefore, MSK US is an increasingly important diagnostic modality for all healthcare providers who initially care for patients with acute knee injuries.

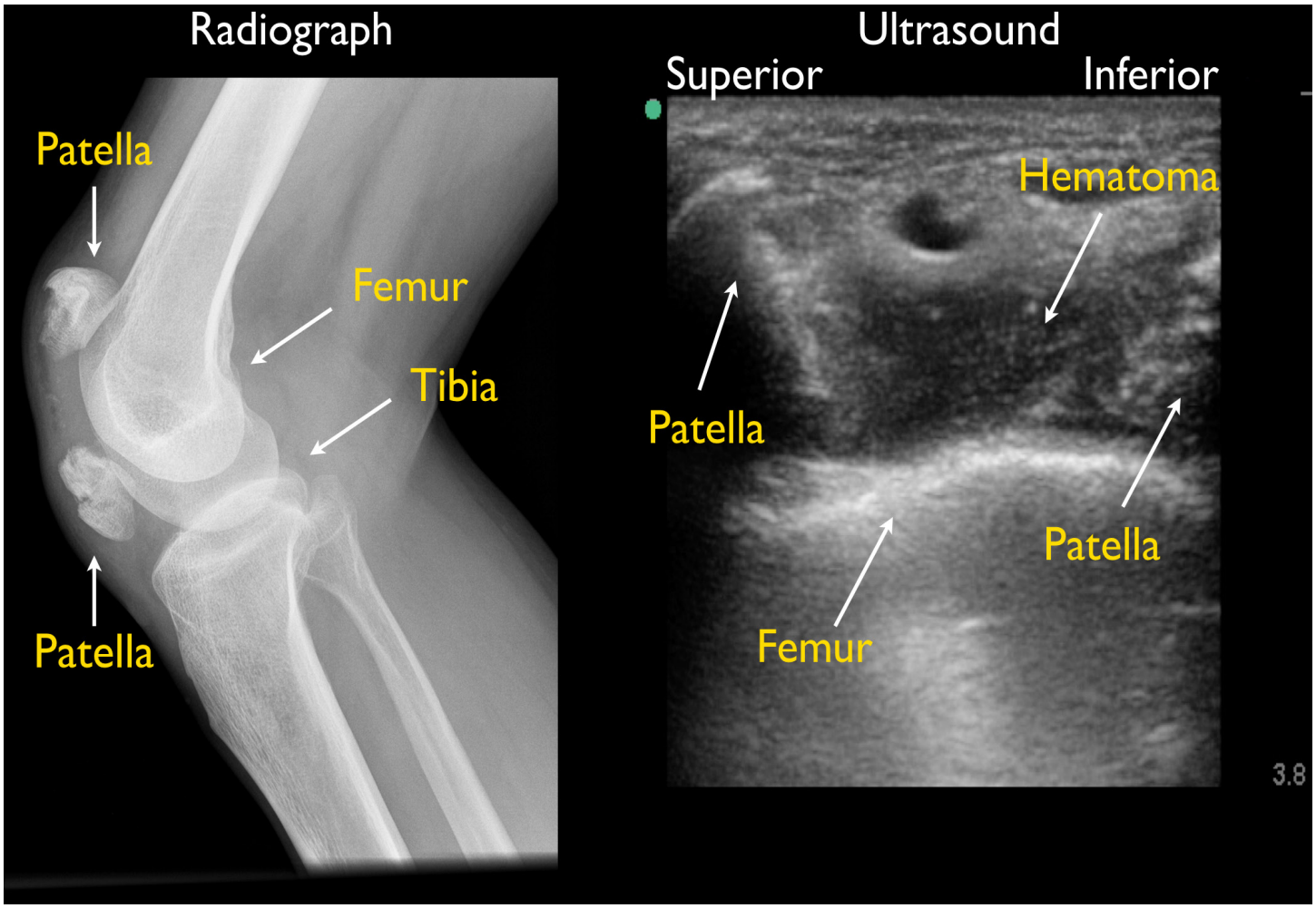

Figure. Patient's knee radiograph and ultrasound.

Video. Ultrasound diagnosis of patellar fracture and evaluation of the extensor tendon mechanism of the knee. Insall-Salvati calculation of the relative distances of the patella and patellar ligament and the normal alignment of these structures is referenced in the video.[13]

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Point-of-Care Ultrasound to Locate Retained Intravenous Drug Needle in the Femoral Artery

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We describe the use of point-of-care ultrasound to localize a retained intravenous drug needle, and subsequent surgical removal without computed tomography. [West J Emerg Med. 2016;17(6)817-8.]

CASE

A 33-year-old male presented to the emergency department (ED) with left groin pain. Six days prior, a needle had broken off in his groin while injecting intravenous (IV) drugs. On exam, he had track marks in his left groin, but no evidence of infection. The neurovascular exam of his left lower extremity was normal.

The patient had a point-of-care ultrasound (POCUS) initially, and subsequently a plain film of his left groin.

The POCUS of his left groin demonstrated a linear foreign body oriented horizontally through his superficial femoral artery and deep femoral artery, just distal to the bifurcation. (Video 1, Figure 1)

A plain radiograph confirmed these findings (Figure 2).

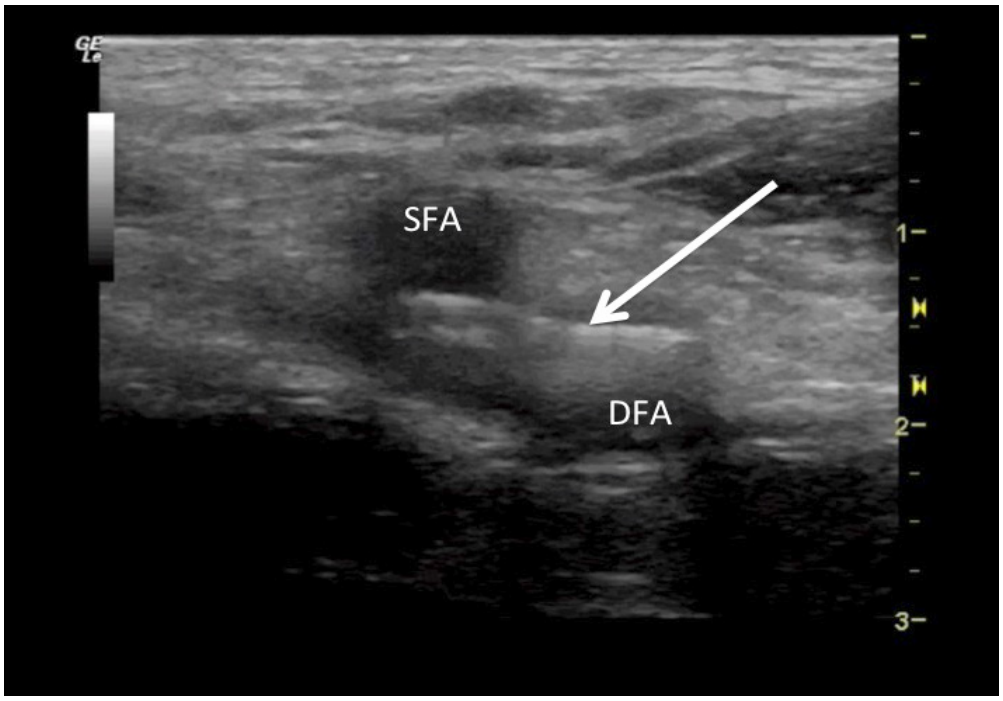

Figure 1. Linear foreign body (arrow) within the femoral artery just distal to the bifurcation of the superficial femoral artery (SFA) and the deep femoral artery (DFA), consistent with retained needle, as seen on point-of-care ultrasound.

The patient was taken from the ED to the operating room (OR) with no additional imaging. In the OR, the surgical team confirmed the presence of the foreign body with fluoroscopy, then dissected down to the femoral artery. Using the anatomic landmarks described in the POCUS, the surgery team localized and removed the needle. The patient was discharged later that morning.

DISCUSSION

Needle loss is not a rare occurrence for IV drug abusers.[1,2] When dislodgement occurs in the vasculature, grave complications can ensue, as the needle has the potential to embolize to the right heart or lungs. Prompt extraction is therefore necessary.[3,4] Surgical extraction typically requires a pre-procedural computed tomography (CT) to localize the object.[5,6] While effective, CTs are costly, expose the patient to considerably high doses of radiation, and lengthen the time to definitive treatment. Ultrasound is a well established method of locating radiolucent foreign bodies,[7,8] with comparable efficacy in the detection of radiopaque foreign bodies in soft tissue when compared to CT.[9,10] In cases of smaller wooden splinters, it has been found to be superior to CT.[11] In this case, we described the use of POCUS to localize a retained IV drug needle that was then surgically removed without complication, emphasizing the value of POCUS as a timely, cost-saving, radiation-sparing technology.

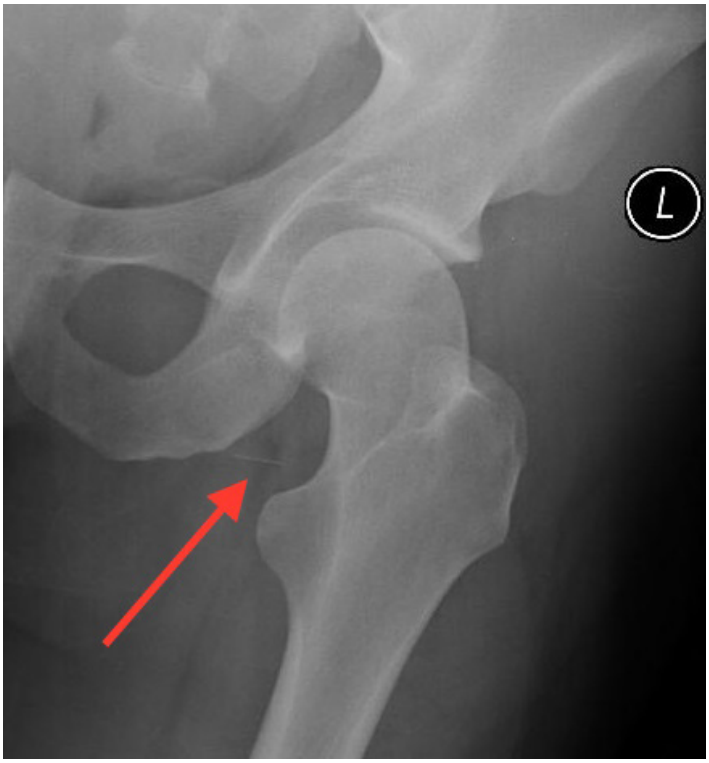

Figure 2. Linear foreign body (arrow) in the groin as seen on plain radiograph.

Video 1. Video of point-of-care ultrasound demonstrating the linear foreign body, consistent with retained needle, oriented horizontally just distal to the bifurcation of the superficial femoral artery (SFA) and the deep femoral artery (DFA).

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Role of Ultrasound in the Identification of Longitudinal Axis in Soft-Tissue Foreign Body Extraction

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Identification and retrieval of soft-tissue foreign bodies (STFB) poses significant challenges in the emergency department. Prior studies have demonstrated the utility of ultrasound (US) in identification and retrieval of STFBs, including radiolucent objects such as wood. We present a case of STFB extraction that uses US to identify the longitudinal axis of the object. With the longitudinal axis identified, the foreign body can be excised by making an incision where the foreign body is closest to the skin. The importance of this technique as it pertains to minimizing surrounding tissue destruction and discomfort for patients has not been previously reported. [West J Emerg Med. 2016;17(6)819-21.]

INTRODUCTION

Soft-tissue foreign bodies (SFTB) are of important clinical significance in the emergency setting given the risk for significant inflammation, infection, impaired or prolonged wound healing and pain or discomfort for the patient.[1] Physical exam, wound exploration and conventional radiography are ineffective means to identify or retrieve retained foreign bodies.[2] In the emergency department (ED) setting, ultrasound (US) is a readily available tool that has been shown to be highly effective at identification of STFBs. In cadaveric and animal tissue studies, US has shown to have higher specificity and sensitivity than conventional imaging modalities such as plain film radiography in identification of STFBs.[3]

We present a case of a patient who was found to have a radiolucent wooden STFB that was detected and safely removed with the assistance of bedside US. Our retrieval technique emphasizes the importance of minimizing surrounding tissue destruction by using US to help identify the longitudinal axis of the foreign body.

CASE REPORT

A 22-year-old woman with no significant past medical history presented to the ED with hip pain after hitting an old wooden table while walking by. The patient reported she felt something "go in" but was unable to retrieve the foreign body herself. She described the pain as dull, 3/10 in severity, non-radiating, and worse with ambulation. The patient's vital signs on arrival were as follows: temperature 37.4°C; blood pressure 118/68 mmHg; heart rate 68 beats per minute; respiratory rate 14 breaths per minute; oxygen saturation 99% on room air. Physical exam of the hip revealed a 3mm puncture wound in the anterior-lateral thigh, approximately 10cm distal to the anterior-superior iliac spine. There was noted to be 1cm diameter of surrounding erythema; however, there was no fluctuance or induration that was appreciated. No foreign body was palpated on exam. No pain was elicited on passive extension of the hip or knee.

A plain film radiograph showed no evidence of retained foreign body. However, given clinical suspicion for a radiolucent retained foreign body, bedside US was done, which confirmed the presence of a foreign body in the anterior thigh (Figure 1). The USprobe was placed in an orientation that allowed for direct visualization of the longitudinal axis of the foreign body. Using sterile technique at the bedside, a new tract was created using a scalpel and the foreign body was removed using forceps with traction applied along the longitudinal axis.

DISCUSSION

Ultrasound has long been accepted to be a superior

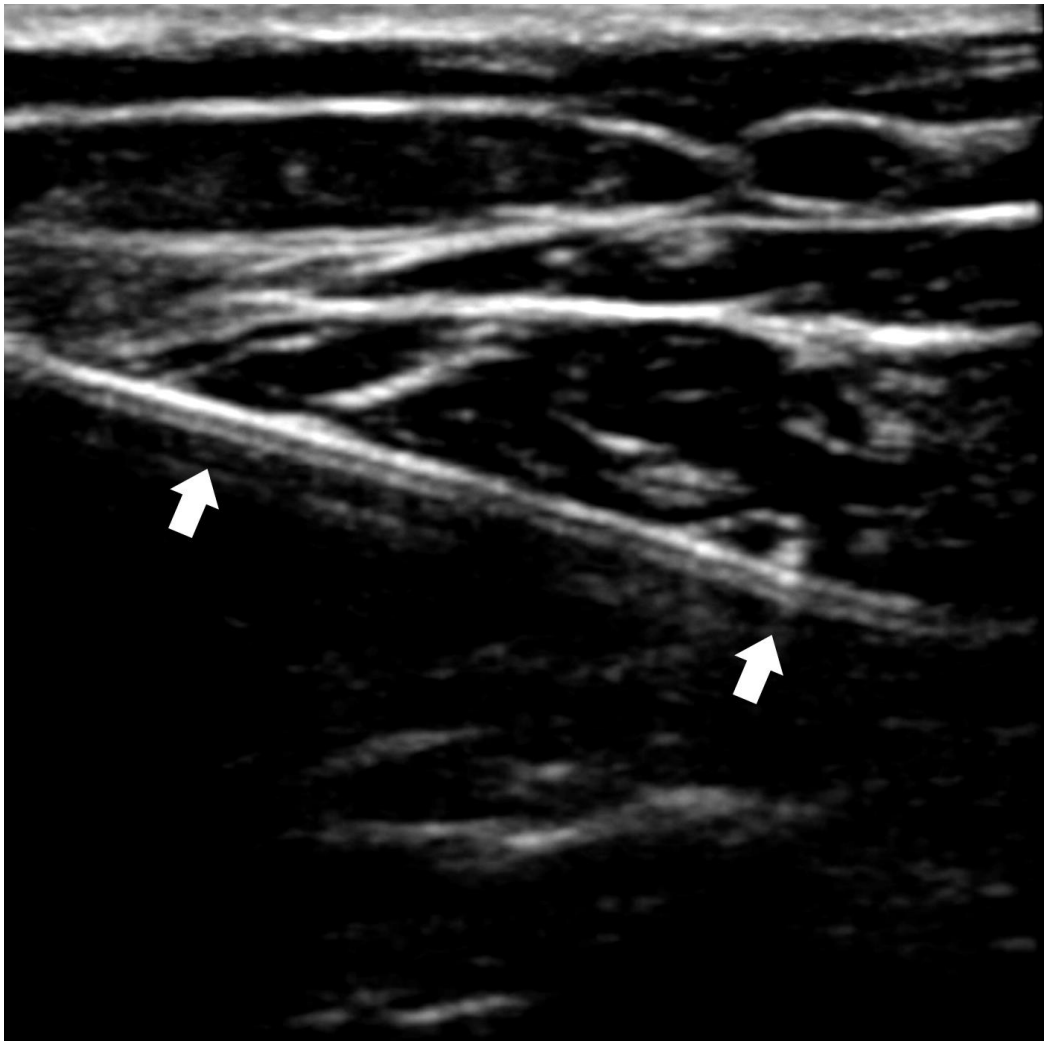

Figure 1. Ultrasound image of soft tissue foreign body (arrows) in longitudinal axis.

imaging modality in comparison to conventional radiography in the detection of radiolucent STFBs. In one retrospective study of 200 patients Anderson et al. showed that conventional radiographic studies identified wood foreign bodies only 15% of the time.[4] Bray et al demonstrated that US has a sensitivity of 94% and specificity of 99% in the identification of STFBs.3 More recent studies, including a meta-analysis conducted by Davis et al showed that US has moderate sensitivity of 72% but still high specificity of 92% in the detection of STFBs.[5] In addition, US can accurately measure the size of a lodged foreign body within ± 1 mm.[3] Deeper foreign bodies can be retrieved with the aid of continuous US guidance. Bradley showed an 88% success rate in US-guided percutaneous removal of STFBs.[6]

The ability of ultrasound to accurately assess the length (longitudinal axis), width (transverse axis) and depth of the STFB offers significant advantage when it comes to removing the object.[7] In particular, the ability of US to delineate the longitudinal axis of an object is critical because it decreases the amount of tissue dissection needed and reduces discomfort for the patient (Figure 2). As in the case of this particular patient, once the longitudinal axis is identified on US, an incision can be made at the site where the foreign body is closest to the skin.[8] The foreign body is then grasped with forceps and traction is applied in parallel along the long axis of the foreign body. This allows for the object to easily slide along its long axis out of the soft tissue without causing unnecessary pain or tissue destruction.

It is possible to attempt to retrieve the foreign body by extending the incision from the entry wound.[9] However, this poses certain risks and complications. On occasion, foreign bodies have been shown to migrate from the initial site of entry and can result in significant morbidity and mortality.[10] In the event this occurs, it makes retrieval through the entry wound unfavorable due to the need for extensive dissection and further devitalization of surrounding soft-tissue structures. Instead, by locating the longitudinal axis of the STFB, the clinician is able to create a new tract that facilitates easy removal.

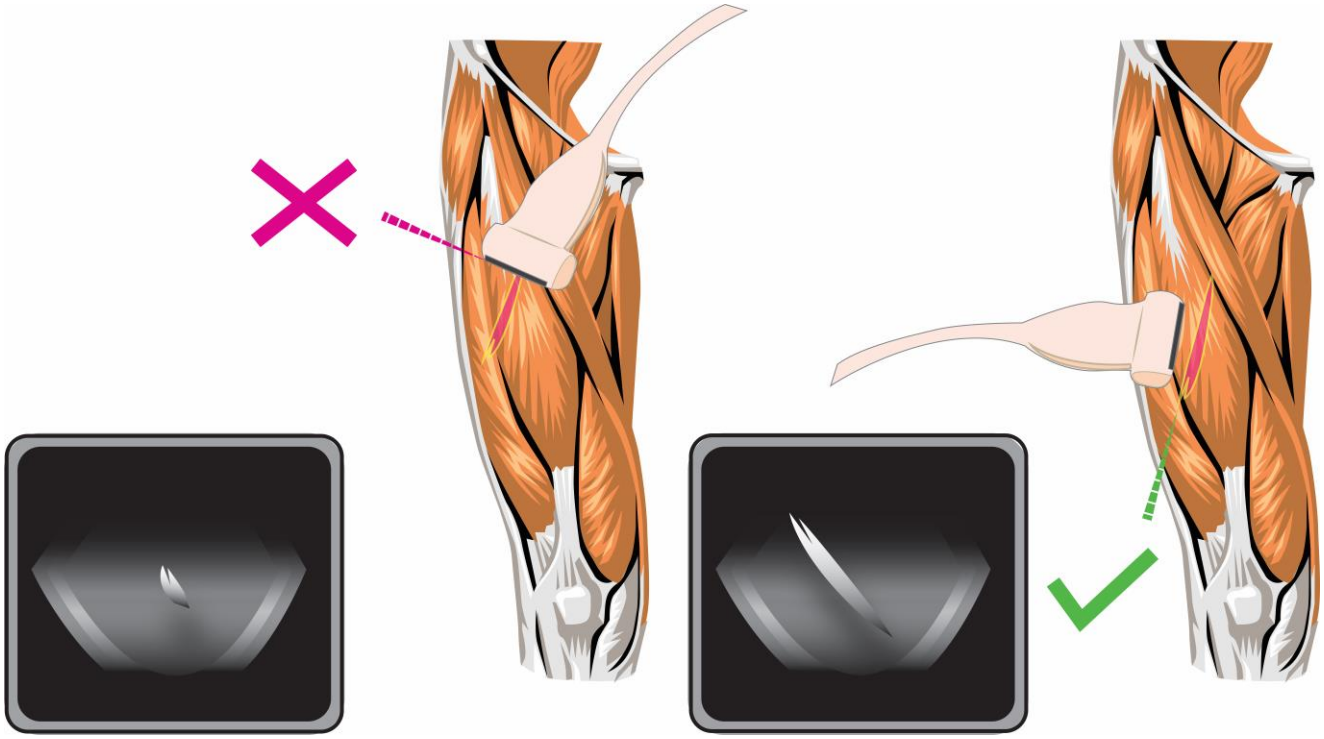

Figure 2. Approach to using ultrasound to aid with excision of soft-tissue foreign body. Left: Foreign body in transverse axis (incorrect approach). Right: Foreign body in longitudinal axis (correct approach).

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Point-of-Care Sonographic Findings in Acute Upper Airway Edema

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We describe a case where a patient presented with acute angiotensin-converting enzyme inhibitor (ACE-I) induced angioedema without signs or symptoms of upper airway edema beyond lip swelling. Point-of-care ultrasound (POCUS) was used as an initial diagnostic test and identified left-sided subglottic upper airway edema that was immediately confirmed with indirect fiberoptic laryngoscopy. ACE-I induced angioedema and the historical use of ultrasound in evaluation of the upper airway is briefly discussed. To our knowledge, POCUS has not been used to identify acute upper airway edema in the emergency setting. Further investigation is needed to determine if POCUS is a sensitive and specific-enough tool for the identification and evaluation of acute upper airway edema. [West J Emerg Med. 2016;17(6)822-6.]

INTRODUCTION

Angiotensin-converting enzyme inhibitor (ACE-I) induced angioedema is a known side effect of ACE inhibitors. This class of medication causes non-immunoglobulin E mediated angioedema that is precipitated by bradykinin release. This type of angioedema is usually gradual in onset without rash and can involve various parts of the body. Its incidence is estimated to be 0.3-0.68%. Although the numbers appear small, due to the large number of patients taking these medications it is a common cause of angioedema. Symptoms may develop within hours of starting the medication or may take years to develop and typically involves the face, lips, tongue, and may involve the gastrointestinal mucosa.[1]

Patient presentations can be dramatic with significant facial swelling, voice changes, and critical airway compromise that requires immediate airway intervention. However, presentations can also be mild with subtle findings that do not clearly indicate the need for airway intervention. During these presentations it may not be readily apparent which patients require immediate intervention for rapid progression of airway edema, which can be monitored for airway compromise, and which can be safely discharged home. The current tools to evaluate the upper airway beyond physical exam include direct and indirect laryngoscopy, which involves equipment that may not be readily available in all settings, time for sedation and anesthesia, and patient discomfort.

CASE REPORT

A 70-year-old female presented to the emergency department (ED) with shortness of breath and left upper and lower lip swelling. The night prior to presentation, the patient felt well without any complaints or issues. She woke up with a feeling of fullness in her lip, but denied visible swelling. Over the next two hours she had onset of left-sided lip swelling. The patient denied other facial swelling or feeling of difficulty swallowing. She also denied chest pain, abdominal pain, nausea, vomiting, fevers, and chills. She had never had similar symptoms previously.

Her past medical history included hypertension and one of her home medications was Lisinopril. Her uvula was resected many years ago due to sleep apnea, but she had no other relevant surgical, social or family history. Vital signs at presentation were temperature 36.7˚ C, blood pressure 128/80, heart rate 66, respiratory rate 18, and pulse oximetry was 100% on room air. On exam, left-sided edema and fullness to the upper and lower lip was present

without tongue swelling. Her uvula was resected, but there was no posterior oropharyngeal swelling, stridor or muffled voice. The remainder of the exam was unremarkable, including no tachycardia, adventitious breath sounds, abdominal tenderness, rash or lower extremity edema. Further testing included labs and a chest radiograph, which were unremarkable.

A bedside, point-of-care ultrasound (POCUS) was performed with the intention to evaluate the subglottic regions near the vocal cords for signs of airway edema. Images were acquired while using a Zonare ultrasound machine and a high frequency, linear transducer (10-15 MHz) in the soft-tissue exam setting. The patient was seated and was instructed to place herself in a sniffing position. Starting in the submandibular region and ending at the base of the anterior neck, serial transverse videos clips were obtained. Specific focus centered on the region above and below the thyroid cartilage. The vocal cords were identified and confirmed by patient phonation (Figure 1). Mild vocal cord asymmetry was noted with fullness on the left side as the transducer was slid cephalad to the level of the arytenoids (Figure 2). Significant asymmetry was noted at the region just cephalad to the vocal cords on the left side at the level of the false vocal cords. The subglottic region on the left appeared larger, more echogenic, with a distinct centrally demarcated mass that was not present on the patient's right side (Figure 3). This was suspected to represent subglottic edema on the left side at the level of the false vocal cords. This was immediately confirmed by indirect fiberoptic laryngoscopy. Figure 4 demonstrates the relative anatomical location of each captured image at the level of the vocal cords, arytenoids, and false vocal cords. Video 1 is a narrated video demonstrating relevant anatomy, appearance on ultrasound, and identification of pathology.

Nasopharyngeal laryngoscopy (NPL) was performed approximately one hour after arrival to assess for vocal cord involvement. The NPL scope showed left-sided false vocal cord, true vocal cord and epiglottic swelling as well as edema of surrounding tissues. Her vocal cords were fully mobile without right-sided swelling. She was treated with

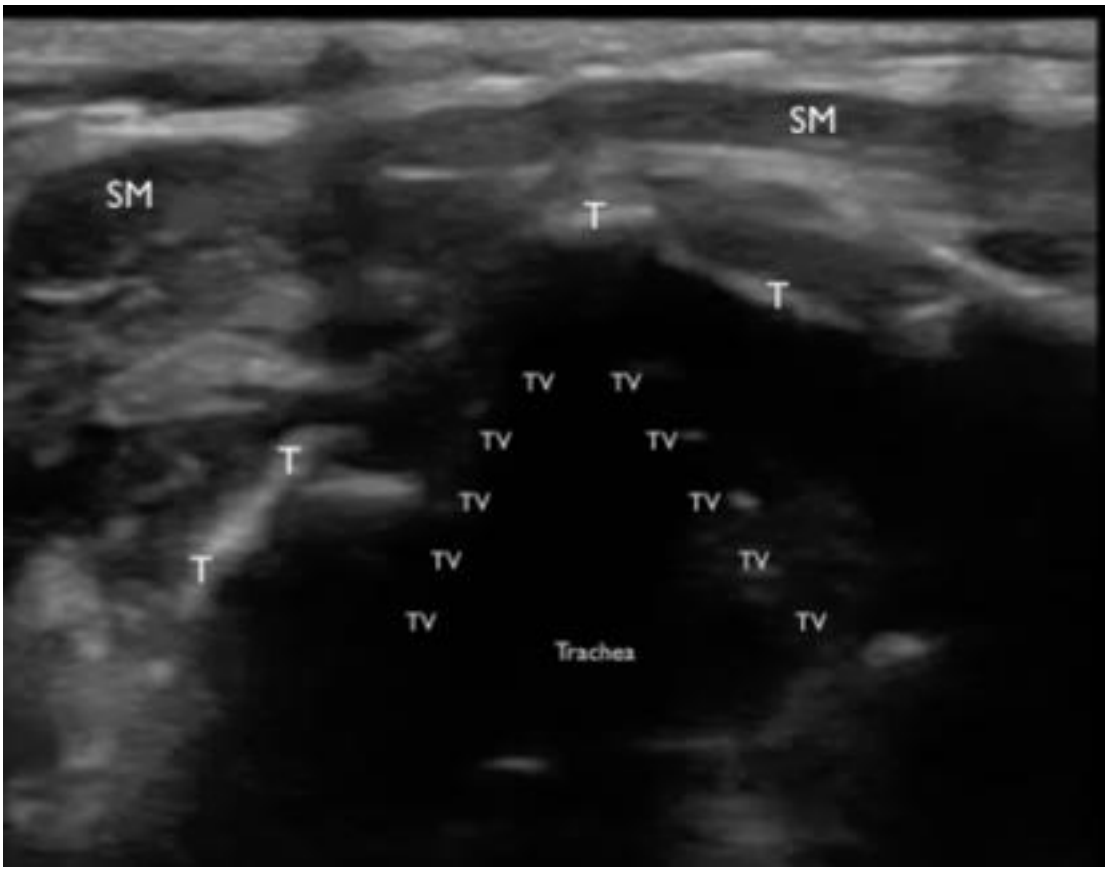

Figure 1. A transverse still image of the upper airway using the high frequency, linear transducer at the level of the true vocal cords (TV). Sternocleidomastoid muscles (SM) are seen anterior in the image. The true vocal cords appear as a linear structure that moves with phonations and is generally hypoechoic compared to the false vocal cords. The thyroid cartilage (T) appears hyperechoic in the image and provides a good acoustic window to visualize the vocal cords.

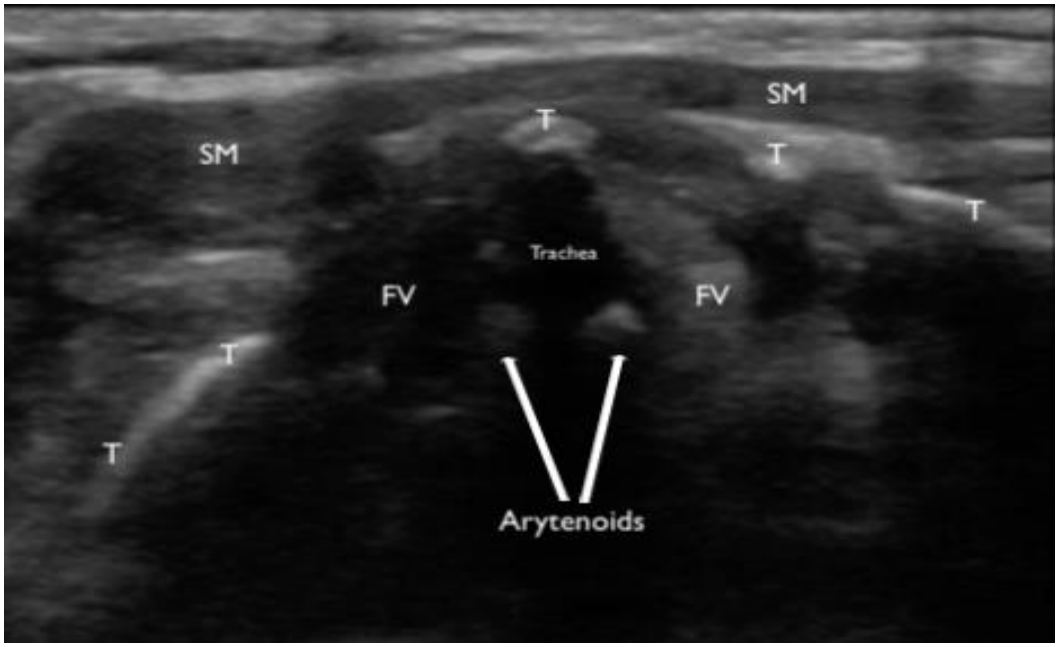

Figure 2. A transverse still image of the upper airway taken with a high frequency, linear transducer at the level of the arytenoid cartilage. Sternocleidomastoid muscle (SM) and thyroid cartilage (T) are re-demonstrated. The false vocal cords (FV) are visualized with noted asymmetry, edema on the patient's left side (right side of the image).

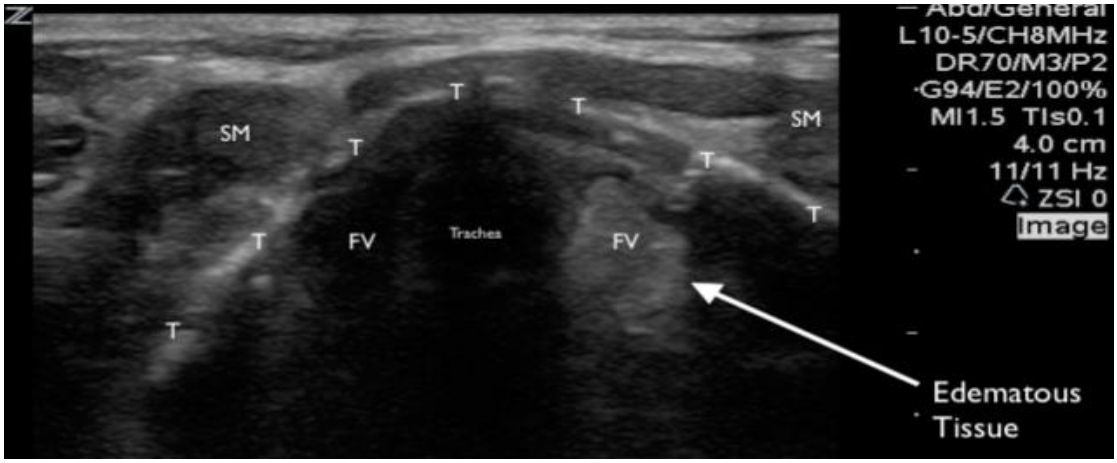

Figure 3. A transverse still image of the upper airway using the high frequency, linear transducer at the level just cephalad of the vocal cords and arytenoids. Asymmetry is identified with a hyperechoic fullness of the left side of the airway (right side of the image). This was immediately confirmed as subglottic edema at the level just cephalad of the vocal cords by indirect fiberoptic laryngoscopy.

diphenhydramine, famotidine and dexamethasone in the ED. For airway monitoring, the patient was admitted to the intensive care unit (ICU) for observation without immediate intubation.

DISCUSSION

Ultrasound has been used for over two decades in the evaluation of the vocal cords and the upper airway.[2,3] As a comfortable, non-invasive test ultrasound has been used to evaluate for vocal cord paralysis and lesions in both pediatric and adult patients.[4-6] Ultrasound has also been used to evaluate for postextubation laryngeal edema. Measuring the air column width (ACW) during endotracheal tube balloon deflation has been found to be effective in ruling out mild to moderate laryngeal edema and similar to the cuff leak test.[7-9] Vocal cord examinations use high-frequency transducers (8-15MHz) and typically have

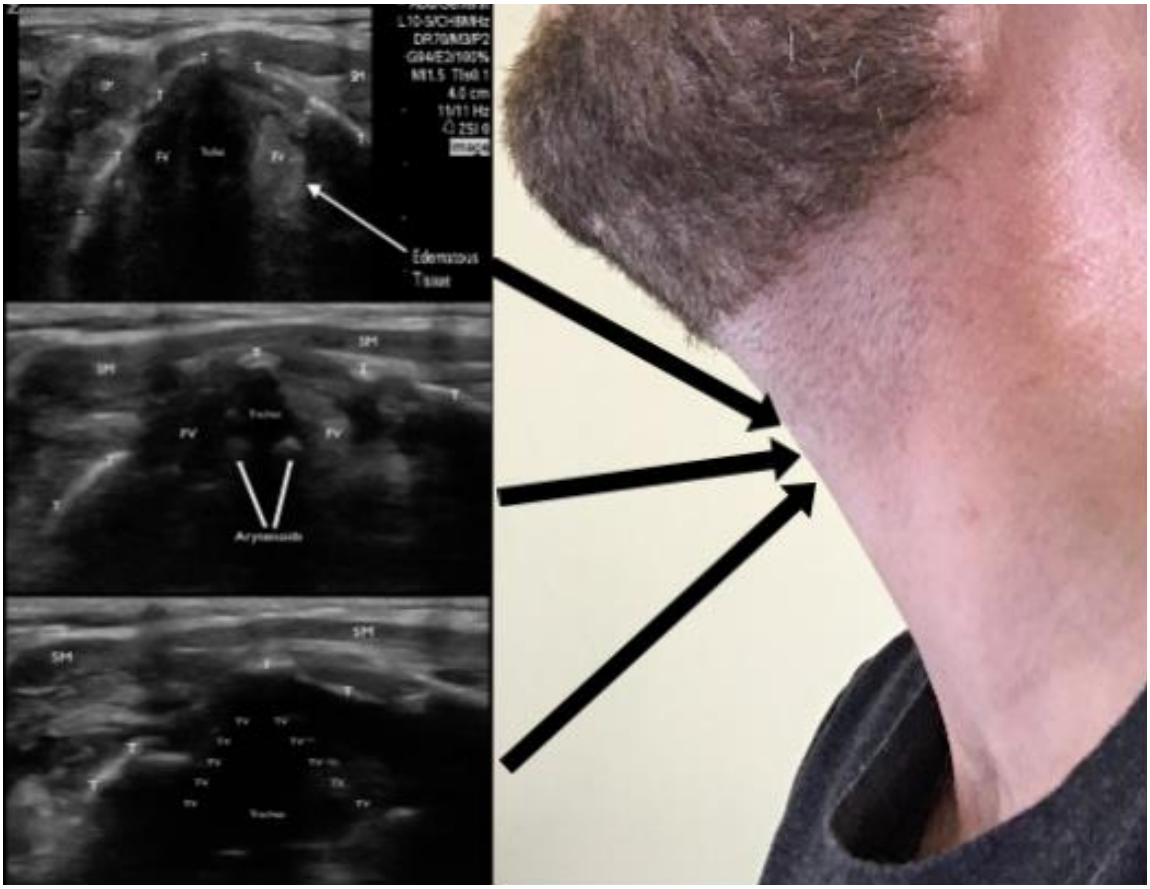

Figure 4. The previous three figures shown at their relative anatomic location. The transducer is held in the transverse plane with the indicator to the patient's right side.

patients in a supine position with the neck slightly extended. Extension of the neck may increase the spaces between tracheal cartilage and broaden the acoustic window. Alternatively, patients may sit upright and be in the "sniffing position" with the head extended and neck slightly flexed. The patient should breathe spontaneously. External identification of the thyroid cartilage by physical exam should guide placement of the ultrasound transducer in the transverse plane at the level of the thyroid cartilage. The transducer is then slid superiorly and inferiorly in the transverse plane until the vocal cords are clearly identified. Evaluation of the vocal cords should occur with phonation by the patient using the "long E" for best visualization.[10] This region, along with the regions above and below the vocal cords from the submandibular region to the base of the neck, should be interrogated for asymmetry.

In this case, the patient was observed for 24 hours in the ICU. Approximately 12 hours after initial presentation her swelling was mildly improved. She was treated supportively with scheduled diphenhydramine, solumedrol, and famotidine. Repeated ultrasound or fiberoptic laryngoscopy was not performed. The next morning the patient's swelling had significantly improved and she was diagnosed with angioedema secondary to ACE inhibitors. She was discharged with instructions to stop Lisinopril as well as to complete a four-day course of prednisone and famotidine. After follow up with her primary care physician, no adverse events were reported. During hospitalization she noted that for approximately one week, she had been taking a different color Lisinopril than she was previously taking.

To our knowledge, POCUS has not been used to identify acute upper airway edema in the emergency setting. POCUS is fast, non-invasive and readily available in most EDs in the United States. POCUS accurately identified airway edema in this patient that did not have obvious symptoms or signs on history or physical exam. Color flow was not used in this case, but might be an adjunct in the evaluation of edematous tissue. Further investigation is needed to determine if POCUS is a sufficiently sensitive and specific tool for the identification and evaluation of acute upper airway edema.

Video. A narrated video explaining the relevant anatomy, appearance on ultrasound, and identification of pathology.

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Point-of-Care Ultrasound to Diagnose a Simple Ranula

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In the following vignette we demonstrate the use of point-of-care ultrasound to diagnose a simple ranula. [West J Emerg Med. 2016;17(6)827-8.]

CASE

An 11-year-old previously healthy girl presented to the emergency department (ED) with three weeks of a rapidly progressive swelling underneath her tongue, causing difficulty in talking and eating. Physical examination revealed a 4.5 X 3 cm sublingual mass arising from the base of the tongue, around the midline (Figure 1). The mass was soft, movable and non-tender. The contents had a bluish hue, which was covered with normal appearing mucosa. A point-of-care ultrasound (POCUS) revealed a well-circumscribed homogenous cystic mass, separated from the muscular fibers of the tongue, without extravasation towards the neck (Figure 2) and without intra-cystic flow. A diagnosis of simple ranula was made.

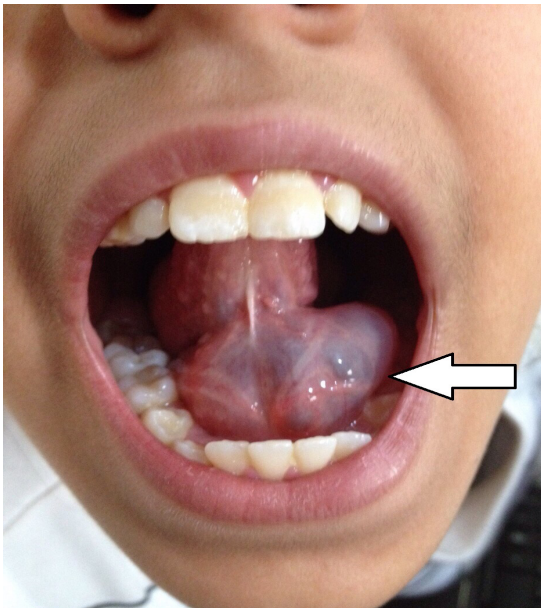

Figure 1. The sublingual mass, a simple ranula, seen on physical exam of a pediatric patient.

DISCUSSION

A ranula is a pseudocyst that is formed after oral trauma or inflammation, causing extravasation of mucous from the sublingual salivary gland or from the main salivary duct. A simple ranula is restricted to the oral cavity floor. A plunging ranula extravasates through the mylohyoid muscle, towards the cervical structures in the submandibular space.[1] The differential diagnosis includes dermoid and epidermoid cysts as well as rarer conditions.[2] Ultrasonography is a useful imaging method for the sublingual space, particularly for simple ranulas, as it is unaffected by dental amalgam and can locate the lesion.[3] Furthermore, ultrasonography has been suggested as a key component in the management of floor-of-the-mouth masses in children.[4] The now-accepted treatment of simple ranulas in pediatric patients consists of a six-month period of observation before considering other treatments.[1] In this case, a POCUS was consistent with the clinical diagnosis, reassured the parents and prevented an additional medical visit as the entire management took place in the ED. The follow-up visit at the otorhinolaryngology clinic was scheduled for a few months later; by that time the ranula had completely resolved.

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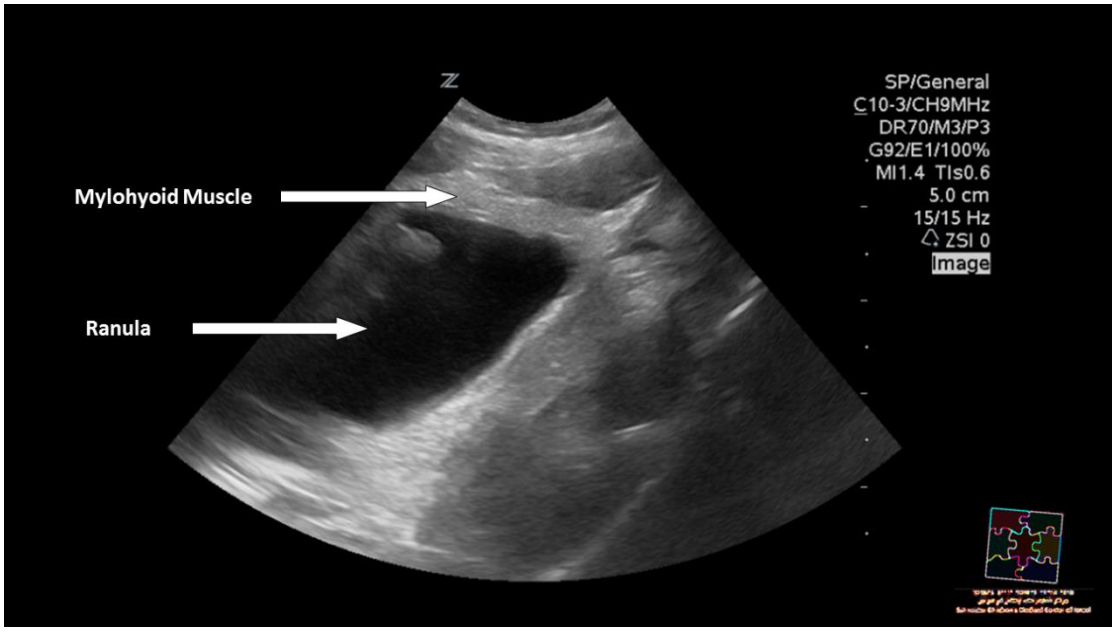

Figure 2. The ultrasonographic image, demonstrating the isolated ranula without extravasation through the mylohyoid muscle.

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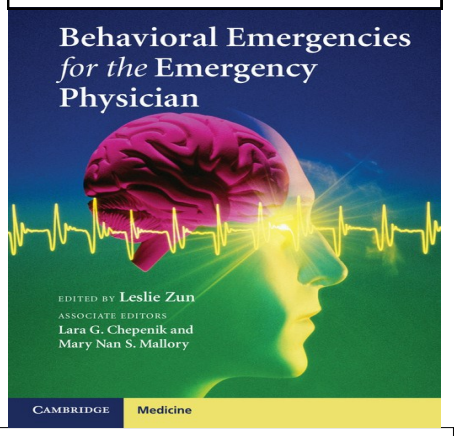

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