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Western Journal of Emergency Medicine:

Integrating Emergency Care with Population Health

Indexed in **MEDLINE**

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The San Bernardino, California, Terror Attack: Two Emergency Departments' Response

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On December 2, 2015, a terror attack in the city of San Bernardino, California killed 14 Americans and injured 22 in the deadliest attack on U.S. soil since September 11, 2001. Although emergency personnel and law enforcement officials frequently deal with multi-casualty incidents (MCIs), what occurred that day required an unprecedented response. Most of the severely injured victims were transported to either Loma Linda University Medical Center (LLUMC) or Arrowhead Regional Medical Center (ARMC). These two hospitals operate two designated trauma centers in the region and played crucial roles during the massive response that followed this attack. In an effort to shed a light on our response to others, we provide an account of how these two teaching hospitals prepared for and coordinated the medical care of these victims.

In general, both centers were able to quickly mobilize large number of staff and resources. Prior disaster drills proved to be invaluable. Both centers witnessed excellent teamwork and coordination involving first responders, law enforcement, administration, and medical personnel from multiple specialty services. Those of us working that day felt safe and protected. Although we did identify areas we could have improved upon, including patchy communication and crowd-control, they were minor in nature and did not affect patient care.

MCIs pose major challenges to emergency departments and trauma centers across the country. Responding to such incidents requires an ever-evolving approach as no two incidents will present exactly alike. It is our hope that this article will foster discussion and lead to improvements in management of future MCIs. [West J Emerg Med. 2016;17(1):1–7.]

INTRODUCTION

On December 2, 2015, terrorists attacked the Inland Regional Center (IRC) in San Bernardino, California, killing 14 Americans and injuring 22 in the deadliest attack on U.S. soil since September 11, 2001. The city of San Bernardino is situated approximately 60 miles east of Los Angeles and has a population of 215,000 and a median income of $38,385.[1] Many of its citizens rely on the resources provided by entities such as the IRC, where the shooting occurred. The IRC is a not-for-profit organization that provides services for over 31,000 people with developmental disabilities and their families, including children,[2] and employs nearly 600 people.

The shootings began at approximately 11:00 AM when two terrorists entered a conference hall at the IRC and started shooting. The initial available information was limited and it was unknown to the hospital providers whether the incident represented workplace violence or a terrorist attack. The mode and appearance of the attack, however, was concerning for terrorism. When patients were being treated and transported to the emergency department (ED) by first responders, the shooters had not been apprehended.

Although emergency personnel are familiar with multi-casualty incidents (MCIs), as well as violent acts, the shootings that occurred that day were unprecedented. Since the attack, reports of the heroism of the victims have been well documented in the lay press. In the coming months our medical community will undoubtedly review our system's response to the attack in depth, including the key roles our community hospitals provided. We applaud the professionalism and valor of the responders in the field and grieve the loss of those who died on site. We wanted the opportunity to do more. However, in an effort to provide timely information to other emergency physicians who may be preparing for such an event, we are providing an account of how two separate teaching hospital EDs responded to the attack.

Loma Linda University Medical Center and Children's Hospital Response

Loma Linda University Medical Center and Children's Hospital (LLUMC&CH) is a Seventh-day Adventist institution located in Loma Linda, CA, approximately three miles from where the incident occurred. An academic center with 714 beds, it is the only Level I trauma center for adults and children in San Bernardino County and serves the Inland Empire (San Bernardino and Riverside counties). The ED has 38 adult beds, 18 pediatric beds, and four Express Care beds and sees more than 70,000 patients per year.

Activation

LLUMC ED personnel first became aware of the incident when a firefighter, dispatched to the scene, alerted our Mobile Intensive Care Nurse (MICN) directly through a phone call. No "official" notification through our county "Comm Center" or the emergency medical communications network (ReddiNet) had yet been received at the time of this initial call. The County Comm Center was contacted for verification, but none was yet available. On-scene responders estimated that there were at least 20 severely injured patients.

The charge nurse was notified and nursing administration began the emergency response, activating our disaster plan based on the initial call. We established an incident command center in the nursing administration office, which is located away from the ED. The ED was full at the time of the attack and all admitted patients were quickly sent upstairs as per our normal disaster plan. We relocated the remaining patients away from the six adult resuscitation rooms. We also cleared and readied an additional five beds in the pediatric ED to receive critical patients. The pediatric and adult EDs are separate spaces but physically attached making mutual support fluid. Disaster supply carts were brought to the outside triage area located in the adjacent parking lot, staff were assigned specific duties, and handheld phones were distributed to key personnel. A wireless computer set up outside allowed for order entry to the electronic medical record.

The ED attending physician was also aware and with the anticipated number of victims, she contacted the trauma surgeon on call. Additional trauma surgeons were placed on standby and the trauma medical director contacted the operating room (OR) manager who worked to clear rooms for victims. Five ORs were made immediately available with assurances others would become available in short order. There was no resistance to holding planned elective surgeries and ORs were kept on standby for about four hours. This process allowed our patients immediate OR access once it was determined they needed surgery. ED physician leadership was paged to respond to the ED.

Hospital security established a corridor outside the ED and all vehicular traffic was diverted from the area. Access to the ED, as well as other portals of entry to the hospital, was controlled. A small number of non-shooting related patients and one person looking for a family member involved in the shooting were allowed through the corridor to access the ED after being checked by security. A sizeable number of local law enforcement and fire personnel soon arrived, providing a needed additional security and response capability. They also successfully addressed the bomb threat our hospital received later that afternoon. Media were maintained outside the safety corridor and quickly established themselves on the street side opposite the ED entrance. Approximately four media trucks were visible from the entrance of the ER, although more were likely on campus at different locations.

Our disaster plan includes setting up a triage tent outside the ED, including basic supplies. This was completed in less than 20 minutes from the initial activation. Registration personnel prepared patient labels and charts so that incoming patients could be quickly registered, necessary for placing orders and charting, as well as for tracking. Patients already in the waiting room were moved to any available ED beds out of the resuscitation area as well as into an Express Care associated with the ED, and later into the triage tent.

With the activation of the disaster plan, the Department of Environmental Health and Safety, which oversees disaster planning for the medical center and university, was notified. A representative was sent to the ED command center, along with hospital administration, security, public information, information technology, and communications.

Response

At the time of the activation, the ED was staffed with two attending physicians on the adult side and one on the pediatrics

side. With the paging of the ED physician leadership, four additional attendings arrived to the ED a short time after the activation. Serendipitously, an emergency medicine (EM) resident education conference was in progress on campus at the time of the attack. An attending physician in the lecture hall had been alerted to the shootings by a CNN "breaking news" text alert and two attendings were already making their way to the ED to investigate when official word was received through the disaster communication system. Physicians at conference were notified and prior to the first patient arriving to the ED, 26 EM residents, three pediatric emergency medicine (PEM) fellows, seven EM attendings, and five PEM attendings arrived in the ED to assist with the response.

Two emergency physicians were assigned to the triage area, along with nursing and ancillary staff. As it was known that the IRC provides services for children, there was concern that there might be pediatric victims as well as adults. Five resuscitation beds in the Peds ED were ready for pediatric or adult patients. A total of 11 resuscitation beds were initially available. Each resuscitation bed was manned with an ED attending and senior EM resident prepared to receive a patient. Two procedure nurses, one nurse for documentation, an ED tech, and a respiratory therapist (RT) were also assigned to each resuscitation bed. Additional physicians were placed on standby in an area out of the resuscitation zone.

The chief of trauma surgery also responded to the ED with another three attending surgeons, approximately five trauma residents, and a trauma nurse practitioner. Three additional surgery attendings, who had been called in, also arrived to the ED giving us immediate access to seven attending surgeons. ED trauma care at our facility is collaborative, and the EM and surgery teams integrated into respective roles smoothly. Patients were placed alternately in the adult and pediatric EDs so that resources would be more evenly distributed. The trauma surgeons determined the order in which they would attend the patients. The on-call surgeon was the last to be assigned, allowing him to be available for other patients not involved in the incident. We had initially notified Comm Center that we would be able to take 10 "immediate" patients, and with the response that was available felt we could treat up to 50 additional patients.

Additional nursing personnel quickly arrived in the ED as well. In addition to implementing our official staffing processes for disasters response, many nurses aware of the attack from other sources came to the ED to assist with the care of patients. Approximately 50 nurses and techs were available. Respiratory therapy successfully mobilized extra personnel so that each resuscitation bed was set up with an RT and ventilator. Another RT was available for providing care to the other patients in the ED. Radiology staffed two auxiliary computed tomography (CT) scanners, and x-ray stood ready with the portable machine. The director of the blood bank responded to the ED with our "Code Black" blood products (O negative and positive blood, cryoprecipitate, FFP, platelets) and two "runners" to obtain more blood products as required. We had been informed that our blood supplier was within the incident area and would not be available to us. The blood inventory was assessed and seemed ample, with 60 units of PRBC immediately available. However without knowing how many victims might need transfusion, contingency plans were made. Our affiliated and other local hospitals were contacted, in case additional blood would be necessary, and transport was placed on standby. The directors of the laboratory and pharmacy, along with a pharmacist, were also available in the ED for immediate access to those services. A pharmacist is regularly physically present in our ED and ensured we had what was needed to respond to the patients' needs.

At the time of the attack approximately 15 patients were in the waiting room. No announcement was initially made to the waiting room regarding the shooting and the waiting patients were moved to other areas. Care to the other patients in the ED was continued by the physician's assistant and nurse practitioner already working in the ED. ED attendings and residents not assigned to the resuscitation teams also continued to see the other patients. During the response period, multiple other critically ill patients were managed, including a patient with acute stroke, a patient in respiratory failure who required immediate intubation, and a patient with an acute arterial occlusion of the upper extremity. A Level B trauma activation for a motor vehicle accident with multiple serious injuries was already en route to our facility prior to the shooting notification and was successfully stabilized in the ED before admission. We used the time between the arrival of the fourth and fifth shooting victims to see the less acute patients in the triage tent, some of whom were able to be discharged directly from there, albeit without the usual discharge paperwork.

Patient Timeline

The first patient arrived at 11:44 with an anterior chest gunshot wound. The patient was alert but tachypneic. Bedside ultrasound was negative for a pericardial effusion, but concerning for decreased lung sliding. A chest tube was placed in the ED. Although initially hemodynamically stable, during the ED course the patient became hypotensive, underwent multiple transfusions, and was taken emergently to the OR by the trauma team.

Patient number two presented at 11:48 with a laceration to the chest, as well as multiple wounds to the face, arm, and leg. The patient remained alert in the ED, and was hemodynamically stable. A focused assessment with sonography for trauma (FAST) scan was negative, and multiple plain radiographs of chest and extremities showed no fractures, but multiple metallic fragments. The patient continued to have bleeding from leg wounds, concerning for vessel injury. CT angiography showed a possible venous injury and the patient was taken to the OR for exploration and washout.

The third patient arrived at approximately 11:50 in critical

condition with multiple gunshot wounds including wounds to the chest, hypotension, and altered mental status. FAST scan was positive for bilateral pneumothoraces. Multiple metallic fragments and rib fractures were seen on plain radiographs. We placed a chest tube and the patient was transfused packed red cells, but persistent hypotension resulted in the patient going directly to the OR for further evaluation.

The fourth patient arrived five minutes later, approximately 11:55, with multiple gunshot wounds to the pelvis and leg. One of these wounds with copious bleeding was sutured in the ED for hemostasis. Radiographs showed multiple pelvic fractures. FAST was positive for blood in the bladder. The patient was given tranexamic acid and underwent massive transfusion protocol for hypotension and was taken immediately to the operating room.

The fifth patient arrived sometime after the initial influx of patients. Before the patient arrived, it was noted that several news helicopters were overhead with high resolution cameras focused on the ED parking lot, in addition to the press stationed at the street opposite the ED entrance. A line of nursing staff used sheets to create a visual barrier while the patient was transported from the ambulance to the ED. This act of compassion was recognized and appreciated by the patient and family. Fortunately the patient's injuries were not immediately life threatening and the patient was admitted to the trauma service rather than the OR.

Discussion of Loma Linda University Medical Center and Children's Hospital Response

This incident underscored the importance of disaster training. With a disaster drill recently conducted in our hospital, the initial set up of the ED with equipment, communications, triage, and security occurred seamlessly. ED providers were familiar with the process and their duties. Having the infrastructure in place served to organize and focus the response.

Assigning treatment teams (triage, resuscitation, existing ED patients) also worked well. With this "zone" perspective, we were able to provide care to the victims as well as to our current ED patients and keep the department running.

Having blood bank immediately available was invaluable. Three of our patients required multiple transfusions, one of whom received multiple blood products.

The presence of the surgery attendings and immediate access to the ORs was crucial. While the patients received stabilizing measures in the ED, since it was unknown exactly how many patients would be received, ED procedures were minimized and were performed in the OR. This allowed our resuscitation teams to prepare for the arrival of additional patients.

Communication between the key personnel and the hospital incident command worked reasonably well. Access to several handheld phones was key, but having pre-assigned numbers for the various positions, or pocket cards to write in each individual's extension would have been helpful. A major issue, however, was the communication challenges with the on-site command and first responders. We received limited information regarding patient injuries prior to the patients' arrival, which made the planning for care more difficult. Also, there was confusion regarding the number of patients we were receiving. Most of the confusion was related to "unofficial" calls from the scene. Believing that three additional patients were on their way, we held surgeons and operating rooms for extra time before learning that no more patients were being transported. It should be noted that the information received from Reddinet was accurate. From a more personal perspective, incident information from the site was limited, and ED staff was receiving multiple messages from friends and family, even from as far away as Afghanistan. Throughout the hospital, employees were trying to get accurate details. Knowledge that the shooters were still at large only added to the concerns. At one point, it was rumored that two shootings that occurred during the same time frame at other local venues were related to the incident at the IRC. So many hospital employees were attempting to live stream newscasts that our IT department recognized it might slow down hospital communication services. For a short period of time, Internet access was restricted to hospital and emergency operations only. Employees were advised to centralize their access to news, or were able to continue the use of their telecommunications networks.

Safety and crowd control was another concern. The ED was inundated with essential and nonessential personnel offering assistance. This could have impacted efficiency and posed a potential security threat. Staging of additional personnel in an area near but outside the ED is a better option. This would provide access to personnel when needed but would also allow verification of each individual and accountability for who is on site. This is especially important should a second simultaneous incident occur. For example, during our response to the multiple shooting victims our institution received a bomb threat. Because explosive devices had been found at the IRC it was felt to be a credible threat. Notification of staff, patients, and families in the hospital was discussed in the incident command, and it was felt that all should be notified. Our ED executive director informed patients in the waiting room and gave them the option of leaving. Only one patient chose to leave. Senior administrative personnel went to each inpatient unit and informed the charge nurse, who was asked to inform staff, patients and family. Physicians received information about the bomb threat through our communication system about 20 minutes after the initial threat was received. Additionally, an email and text/page was sent to all personnel. Knowing who is in the department and who has already left is crucial for both security and accountability.

Similarly, there should be an established location for family assistance. We had family members calling and

arriving to the ED trying to locate potential victims. We were able to divert these calls to our social workers, but this was done ad hoc. There is a plan for family assistance in our disaster plan, but because the hospital was so close to the incident site, this portion of the plan and not been initiated prior to their arrival.

This response, while focused in the ED, was successful only because of the willingness of all of our hospital partners to fully participate in necessary activities to decompress the ED, expedite patient flow, and provide the best care possible to all our patients. Collaboration led to a successful response to a heinous attack.

Arrowhead Regional Medical Center's Hospital Response

Arrowhead Regional Medical Center (ARMC) is a 456-bed university-affiliated teaching hospital operated by the County of San Bernardino. The hospital is located in Colton, California, which is approximately five miles from the scene of the terrorist attack that occurred on December 2, 2015. It is the only American College of Surgeons (ACS) verified level II trauma center in the region. Additionally, it operates a regional burn center, a primary stroke center, a behavioral health center, and a tertiary referral center providing more than 40 specialty care services. ARMC also supports multiple training programs including a four-year EM residency with 33 residents. ARMC's ED is one of the busiest in the state, handling more than 116,000 patient visits each year.

Activation

On December 2, 2015, ARMC was notified that we had an active shooter scenario in the nearby city of San Bernardino. This notification came to us directly from the city of Colton police department to the ED charge nurse on duty around 11:10 AM, even before the incident was officially posted on the regional emergency broadcast system called ReddiNet at 11:17 AM. Reports were that this was a multi-casualty incident and we were to expect around 12 gunshot wound (GSW) victims. Three ED attending physicians were already on duty that morning; one of them is additionally trained as a tactical medicine SWAT team member. Because we were able to immediately mobilize additional ED attending physicians and residents who were already on the hospital campus attending a weekly lecture, he decided to respond to the scene of shooting along with SWAT team members.

Response

Immediately, we fully staffed our eight trauma beds. Each bed had anesthesia, EM, and trauma surgery personnel. In addition, we converted four of our medical beds into lower acuity trauma beds, bringing our total to 12 available trauma beds. We had three trauma nurses in house that morning, but three additional nurses responded to the call for extra help. The charge nurse also sent five ED nurses into the trauma resuscitation area. An ED tech was placed at each bed.

All together, we had available five EM attending physicians, 20 EM residents, and several physician assistants (PA-C) in the ED. This workforce was divided into receiving and assisting with newly arriving shooting victims and continuing care of existing ED patients. In addition, we had four attending trauma surgeons and eight general surgery residents respond. Overall, we had enough staff to assign at least one attending (either trauma surgeon or EM attending) and two residents to each trauma bay. We had four attending anesthesiologists present, enough to assign two trauma bays to each anesthesiologist. Hospital administration including the medical director and the chief of surgery also responded to the ED.

We assigned two nurses to each trauma bay, preferably using the combination of one trauma nurse paired with an ED nurse. We also notified the RTs to prepare all available vents to be mobilized (we had the ability to place over 30 victims on vents if the need occurred) along with preparation for additional intubation trays and supplies. Additional RTs also responded so that one RT could be assigned to each trauma team.

Beyond our ED, eight operating rooms were placed on standby. All elective non-emergent surgeries were held. Two CT scanners were made available for immediate use and all but emergent CT studies were put on hold. Three X-ray techs were placed in the hallways outside the trauma bays for portable studies. Furthermore, the blood bank, sterile processing, laboratory and pharmacy were also put on alert.

In addition to mobilizing staff and resources in preparation, we asked for assistance from several inpatient services and bed control in order to free up as many ED beds as possible. Particularly, the internal medicine service and pediatric service responded quickly by completing admitting processes for several patients pending admission in the ED. Bed control and hospital administration assigned inpatient beds quickly and facilitated these patients' movement out of the ED even before the first victim arrived. All patients already in the waiting room or in the ED rooms were seen and evaluated in a usual manner by a separate ED crew. No one was sent home without proper medical evaluation. All discharged patients were provided with usual instructions and follow up. However, during our lockdown period, efforts were made to redirect new, stable patients to other hospitals after confirming that they had the capacity and the capability to treat them. No outside tent was used as we were able to clear a large number of ED beds quickly.

Many ED staff not on duty voluntarily called the charge nurse or the charge physician and offered to report. In addition, many on campus but not necessarily on duty either physically reported to the ED or called in, offering assistance in any way possible. In total, we had more than 70 additional staff members from various services physically show up to the ED. Most of them were re-directed to a separate area where they were asked to wait for further instructions.

Because our hospital runs disaster drills regularly and we had just completed one within the past month, most of the staff members in the hospital were familiar with their roles and the processes involved in a large-scale disaster.

During the event, we were notified that there might have been shootings at the nearby Patton State Hospital. This report came in directly from one of the SWAT members working in the first shooting scene via a text message to the ED physician in charge. Patton State Hospital is a forensic psychiatric hospital located within the County of San Bernardino. It operates 1,527 beds and typically houses those incompetent to stand trial or found not guilty of a crime by reason of insanity. This immediately raised our concern that possibly a coordinated attack was being carried out on multiple psychiatric/medical/public health facilities operated by government entities. We also received reports that the shooters might have been San Bernardino county employees. At this point, ARMC went on lockdown; no persons were allowed in or out. SWAT members deployed from multiple surrounding cities took posts outside the hospital with snipers on the rooftops. Armed police officers from multiple cities and precincts (including those Colton city police officers already stationed at ARMC) took posts within the hospital. Each ambulance approaching the ED was stopped by law enforcement at the road block outside of the hospital, and occupants in each ambulance were checked by SWAT before being allowed to pull up to the ambulance bay. We were asked to be aware of any persons in the area not wearing hospital badges. At times, none of us knew for sure the identities of the patients we were receiving, but we were assured by the law enforcement that all our patients were pre-screened at the scene before being loaded onto the ambulances.

Patient Timeline

At the end of the event, 14 shooting victims were pronounced dead at the scene and were not transported. We at ARMC received six injured patients: five were transported via EMS and one was driven in by a police officer. In total, 21 patients were transported via EMS to local hospitals: five to ARMC, five to LLUMC, two to Community hospital of San Bernardino, two to Kaiser Hospital Fontana, two to Kaiser Hospital Ontario, two were flown to Riverside County Medical Center, two to San Antonio Community Hospital, and one to St. Bernadine's Medical Center. In all, 22 patients were evaluated and treated, and all survived their injuries. Of the six patients that were brought to ARMC, one went directly to the OR, one was discharged home from the ED, and the rest were admitted to either ICU's or trauma floor units with various injuries. Overall, there were no inpatient fatalities.

Discussion of Arrowhead Regional Medical Center's Response

A week after the event, a debriefing was held; participants included hospital administration, trauma surgeons, anesthesiology and ED attending physicians, along with ED charge and trauma nurses. Overall consensus was that our response was well-organized, well-run, and well-staffed. We were incredibly proud of the teamwork that was displayed and amazed by everyone's willingness to step up and help out in such a challenging situation. However, we identified several issues regarding security/safety, communication, and crowd control that we thought could be improved upon.

First, there was a concern that when everyone in the trauma bay was fully gowned and masked, there was no way to identify the person's role. There should be additional tags or banners with labels (such as "team captain," "airway doctor," "trauma nurses," etc.) to help identify each team member. Anyone without a proper label should be questioned, as there was always a concern of breach of security, where a shooter might unknowingly be allowed access into the ED and cause more casualties or that a shooter could actually be one of the patients. Related to this topic of security, we discussed whether all patients should have been completely undressed at the ambulance bay to check for any hidden weapons or explosive devices before they were allowed inside of the hospital. For this particular incident, every patient was searched beforehand by the law enforcement officials. However, for future scenarios, this should not be assumed and we should consider a more standard way for law enforcement, paramedics, and receiving hospitals to communicate that patients have already been searched and cleared as a potential threat.

Communication was identified as another area that needed improvement. Initial information we received was limited and sometimes inaccurate. We could not verify the exact number of patients we would be receiving, nor the severity of their injuries. Each patient en route was called into the base station, but the information we received was patchy in terms of their acuity, stability, and types of injuries. Additionally, the first notification came directly from the field and not through the regional emergency communication network, making it difficult for us to confirm its legitimacy.

Finally, crowd control was a major challenge. We estimated that close to 70 people were in the ED/trauma area at one time or another, and it became difficult to identify who was essential and who was not. Non-essential staff members were directed to wait in the cafeteria located one floor below, but more and more people continued to present themselves to the ED throughout the day and in some way hindered security and efficient operation.

CONCLUSION

MCIs are unique events that bring forth a bevy of challenges to EDs and trauma centers across the country. They test the technical abilities of providers, stretch the resources of

multiple hospitals, and rely heavily upon the communication skills at each level of patient care. Responding to such incidents requires an ever-evolving approach, as no two incidents will ever present exactly alike.

While MCIs traditionally are taught and practiced through scenarios involving natural disasters or accidental trauma, it is undeniable that we are currently in an era where it is crucial to prepare ourselves for MCIs of a different nature, namely the active shooter.

In 2015 alone the U.S. experienced the following mass shootings: nine deaths at Emanuel African Methodist Episcopal Church in Charleston South Carolina on June 18; five deaths at a Navy support center in Chattanooga, Tennessee on July 16; nine deaths at Umpqua Community College in Roseburg, Oregon, on October 1; three deaths at a Planned Parenthood clinic in Colorado Springs, Colorado, on November 29; 14 deaths in San Bernardino on December 2.

It is our hope that this article will foster discussion that leads to improvement in our management of MCIs while shedding light on what it was like to manage a live incident while dealing with the possibility of an on-site hospital threat.

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Lethal Means Counseling for Parents of Youth Seeking Emergency Care for Suicidality

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Introduction: A youth's emergency department (ED) visit for suicidal behaviors or ideation provides an opportunity to counsel families about securing medications and firearms (i.e., lethal means counseling).

Methods: In this quality improvement project drawing on the Counseling on Access to Lethal Means (CALM) model, we trained 16 psychiatric emergency clinicians to provide lethal means counseling with parents of patients under age 18 receiving care for suicidality and discharged home from a large children's hospital. Through chart reviews and follow-up interviews of parents who received the counseling, we examined what parents recalled, their reactions to the counseling session, and actions taken after discharge.

Results: Between March and July 2014, staff counseled 209 of the 236 (89%) parents of eligible patients. We conducted follow-up interviews with 114 parents, or 55% of those receiving the intervention; 48% of those eligible. Parents had favorable impressions of the counseling and good recall of the main messages. Among the parents contacted at follow up, 76% reported all medications in the home were locked as compared to fewer than 10% at the time of the visit. All who had indicated there were guns in the home at the time of the visit reported at follow up that all were currently locked, compared to 67% reporting this at the time of the visit.

Conclusion: Though a small project in just one hospital, our findings demonstrate the feasibility of adding a counseling protocol to the discharge process within a pediatric psychiatric emergency service. Our positive findings suggest that further study, including a randomized control trial in more facilities, is warranted. [West J Emerg Med. 2016;17(1):8–14.]

INTRODUCTION

Suicide is the second leading cause of death in the United States for youth ages 12-17 years with mortality rates of 4.8 per 100,000 nationally in 2013 and a morbidity rate, as measured by emergency department (ED) visits for intentional self-harm, of 342.3 per 100,000.[1] Youth (ages 12-17) suicide attempts seen in emergency facilities are most often associated with poisoning, at a rate in 2013 of 151.5 per 100,000[2] while nearly half of completed suicides in this age group are associated with firearms.[3]

One approach to addressing the risk of youth suicide is counseling families to reduce access to lethal means of self-harm (i.e., lethal means counseling).[4] Studies of lethal means counseling have demonstrated the potential effectiveness of this approach,[5-7] including one study that found parents made changes in storage of medications and guns after the counseling.[8] However, surveys of ED personnel and retrospective chart reviews indicate that many do not routinely engage in lethal means counseling with suicidal patients, suggesting that the dissemination and implementation of this intervention warrants more concerted attention.[9,10]

Our team evaluated a protocol aimed at improving the quality of lethal means counseling for parents of pediatric patients being discharged from the Children's Hospital Colorado ED after a psychiatric assessment that addressed concerns about suicidal ideation or behavior. This counseling delivered by ED personnel was designed to: a) educate parents about common risks for suicide; b) urge parents to lock all medications in a lock box or other secure location; and c) encourage parents to store firearms away from the home or lock them securely during the mental health crisis period.[11]

METHODS

Setting

The Psychiatric Emergency Service (PES) at Children's Hospital Colorado provides round-the-clock access to specialty behavioral health providers (physicians and social workers) for pediatric patients coming for emergency care who are in behavioral health crisis. During the five-month project period (March 1, 2014 to July 31, 2014), the PES served over 1,405 children and adolescents.

The Intervention

Our approach, modeled on the work of Kreusi[8] and Johnson, et al.,[6] included a 1.5 hour online training for discharge counselors to support the delivery of a counseling session with families prior to discharge from PES and distribution of brochures and free lock boxes to these families. The online training, developed by Barber and Frank,[12] featured situations specific to adolescents seen in an ED, and guided counselors on how to ask and counsel families about safe storage of medications and firearms. The brochures (adapted from the Center to Prevent Youth Violence "Suicide-Proof" program) were in English and Spanish and included local resources for mental health services, medication disposal, and firearm storage. Families were offered free lock boxes ($59 value) suitable for storing medications. The adults accompanying the patients were informed that we would call them within several weeks to help us assess and improve our counseling procedures. They were not explicitly told that the call was to evaluate their compliance with recommendations.

The five-minute counseling session addressed the fact that access by the youth to medications and firearms was particularly dangerous and that parents should secure these items, at least during the child's crisis. They were given suggestions on how to talk to the adolescent about suicidal feelings and were urged to temporarily remove guns from the home and lock medications where the teen could not access them.

All 14 behavioral health clinicians and two physicians who do discharge planning completed the training and implemented the intervention. The protocol also called for clinicians to complete a flow sheet through the electronic medical record, with drop-down menus prompting specific responses about the encounter. This included indications of the presence of unlocked medications and/or guns in the home, language preference, and whether brochures and lock boxes were given to the parent at discharge. The lethal means counseling was incorporated as part of the usual discharge process and did not disrupt normal patient flow.

We obtained approvals for this quality improvement project from the Children's Hospital Colorado Organizational Research Risk and Quality Improvement Review Panel.

Patient Population

PES clinicians counseled the accompanying adult (parent or guardian) of patients seen in the PES. Eligible patients were 12 to 17 years of age, endorsed suicidal ideation or had attempted suicide, and were being discharged home.

Measures

We extracted information from the patients' medical records and planned follow-up calls with the adults who accompanied the patient to the PES within two to three weeks post-discharge, confirming with them their phone numbers prior to discharge.

Medical Record Data

Our data abstraction from medical records included a chart review to ascertain if all eligible patients seen during the time period were offered the intervention. We also extracted data from a patient flow sheet completed by the counselors to examine information recorded by providers about the presence of medications and guns in the home, how they were stored, whether the counseling was done (including provision of a brochure in English or Spanish), whether the family made any plans to change storage practices, and whether they accepted a lock box (with notation of the reason for refusals). The flow sheet also included contact information to enable follow-up interviews with the accompanying adults.

Parent Interview

We trained three interviewers to conduct follow-up interviews using a computer-assisted survey via Survey Monkey. The protocol called for up to five calls to reach an adult family member who had received the lethal means counseling with the goal of completing the interview soon after being seen in the PES. For Spanish speakers, interviewers worked through the hospital translation service.

The telephone interview included a series of mostly close-ended questions about the parent's recall of the storage status of medications and firearms in the home both at the time of the PES visit and the time of the interview, whether they recalled receiving discharge counseling, the most important messages they recalled, and their views about the counseling. All close-ended responses were recorded automatically in Survey Monkey requiring no further coding. We started with an open-ended question: "What was the most important thing you remember the counselor saying to you about medications in your home?" then continued with close-ended yes/no items that included: "Counselors talk about different things with different families based on their needs. Did your counselor talk about any of these things with you: a) Locking up prescription medications; b) Locking up all medications; c) Getting rid of old or expired medications." To understand parent responses to the counseling, we asked a series of yes/no questions: "How did you feel about the way the counselor talked to you about the medications in your home--was it respectful of your family's needs? "Were they clear about what they were recommending?" "Did they give you enough time to ask all your questions without you feeling rushed?" We had parallel questions specific to discussion of gun storage.

Analyses

We compiled data in Microsoft Excel and conducted descriptive analyses of the rates of counseling among eligible families, details of the counseling process, and parent recall and assessment of the counseling. We computed chi-square or Fischer's exact test statistics to assess differences between families counseled vs. not counseled and those interviewed vs. not interviewed.

RESULTS

Implementation of the Counseling

Of the 236 eligible families, 209 (89%) received the counseling intervention. Families counseled vs. not counseled did not vary significantly based on sex or age of the patient nor on whether the visit occurred during the day or night or on a weekday vs. weekend.

Clinician flow sheets indicated that they had discussed medication storage with 205 of the 209 (98%) counseled families. They discussed gun storage with 50 of the 52 (96%) of the families recorded as having guns in the home or 24% of 209 counseled families. Of the 236 eligible families, 79% accepted a free lock box and 86% were given brochures.

Parent Participation in Interviews

Our interviewers were able to contact 55% (n=114) of the parents who accompanied a patient to the ED and whose records indicated they had received the counseling (see Figure). Among these, 104 interviews were conducted in English and 10 in Spanish. Seven were reached but refused to participate, and we could not make contact with 23 because of invalid phone numbers, missing names or numbers. Sixty-five parents did not answer repeated calls. We were not able to reach all within the planned 2-3 week period post-discharge but were able to complete all but five interviews within 90 days of the visit and all within 105 days.

To assess potential biases among our interview respondents, we compared the characteristics of the 114 counseled families who completed interviews with the 95 who received counseling but did not complete an interview. As shown in Table 1, parents who completed an interview did not differ significantly from those not interviewed on age, sex of patient, language preference, day of the week, time period of their visit, reported guns or medications at home, and acceptance of a lock box during the ED visit.

Parent Response to Counseling and Materials

During the follow-up telephone interviews, 83 parents stated that they received the brochure, 13 indicated they did not receive it, and 18 could not recall. Among the 83 who reported receiving the brochure, 64 considered it "somewhat" or "very" helpful. However, 13 indicated they "didn't know" or "didn't read" it. Four reported it was not helpful and two did not respond.

Almost all (n=106) of those interviewed at follow up recalled the clinician talking about medication storage and indicated that the counselor was respectful of their family's needs, clear about what they were recommending, and gave them enough time to ask questions. However, when asked if the counselor had discussed getting rid of old or expired medications, 51 said "yes," 38 said "no" and 25 could not remember or didn't respond.

We also asked respondents "What was the most important

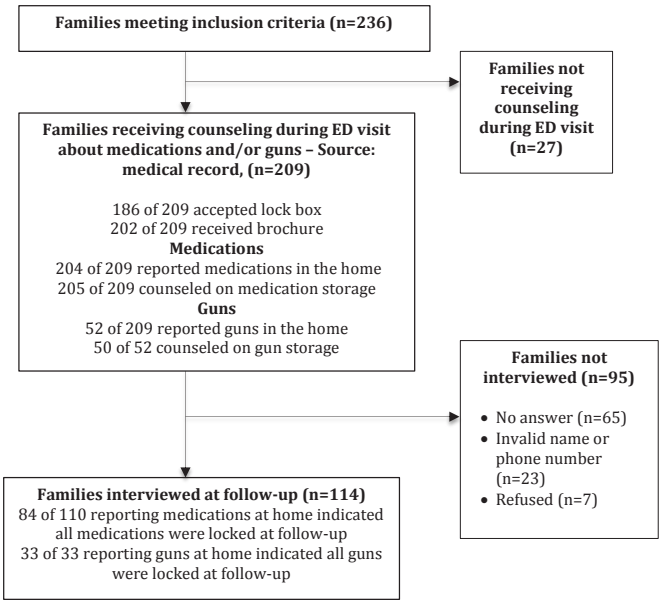

Figure. Receipt of counseling, participation in follow-up interviews, and family reports of storage behaviors.
ED, emergency department

Table 1. Characteristics of families with completed follow-up interview (n=114) vs. no interview (n=95) based on data from medical record.

Characteristics (derived from medical record)	Interviewed (n=114)[B] n (%)	Not interviewed (n=95)[B] n (%)
Sex of patient (p=0.71)		
Female	82 (72%)	66 (69%)
Age of patient (p=0.17)		
<15	60 (53%)	59 (62%)
15+	54 (47%)	36 (38%)
Language preference (p=0.75)		
English	100 (88%)	80 (84%)
Spanish	13 (11%)	12 (13%)
Time of arrival to ED[A] (p=0.8)		
Daytime (7AM–6:59PM)	68 (60%)	59 (62%)
Nighttime (7PM–6:59AM)	36 (32%)	30 (32%)
Day of arrival to ED[A] (p=0.10)		
Weekday	90 (79%)	69 (73%)
Weekend	14 (12%)	20 (21%)
Reported guns at home at time of ED visit (p=0.14)	33 (29%)	19 (20%)
Reported medications at home at time of ED visit (p=0.38)	110 (96%)	94 (99%)
Accepted a lock box during visit (p=0.28)	99 (87%)	87 (92%)

ED, emergency department
[A]Based on time of triage recorded in medical record.
[B]Missing data for some variable for 16 patients.

thing you remember the counselor saying to you about storing medications in your home?" More than 70 parents stated that they remembered being encouraged to lock up medications and/or to "keep them out of the reach of children" or in a "safe spot" such as in a locked room. Seven respondents indicated remembering that they should store all medications locked, while four mentioned over-the-counter medications and several focused on prescriptions. Five participants indicated they had been told to store knives in the lock box and two mentioned that they were also told to store cleaning supplies and chemicals in the lock box, though neither recommendation was intended as part of the intervention.

Thirty-three interviewed parents had indicated to the counselor at the time of their visit that they had guns in their homes, as recorded on the flow sheets. Among these, 26 (79%) recalled the counselor discussing with them how to store their guns. Most who remembered the discussion felt this part of the counseling was respectful of their family's needs, was clear, and that the counselor allowed enough time for questions. Nineteen reported that the counselor had discussed temporarily storing guns out of the home, 26 indicated the counselor discussed storing guns in a locked cabinet or gun box, and 12 said the counselor talked about using trigger locks.

When asked what was the most important thing the counselor said about guns, 16 individuals said it was about locking the guns, with six also noting it should be kept unloaded as well and/or with ammunition stored separately. One gave a more generic answer (e.g., "not to have them within a child's reach"). Eight specifically cited the discussion related to storing the firearm away from home during the mental health crisis.

Parent Behaviors

Almost all (n=109) respondents who participated in the follow-up telephone interviews recalled having been offered a lock box for storing medications; 98 accepted it. Among those not taking the lock box, six indicated they already had one or locked their medications in a safe. Others gave varied reasons, ranging from not wanting to take one that might be needed by others less able to afford purchasing their own to being concerned that taking the lock box out of the hospital would have made their child self-conscious, while one stated that "[his/her child] will break into anything."

At the time of the visit, flow sheet data indicated that 110 of the 114 parents later reached for follow-up interviews had reported to the counselor that they had medications in the home and 10 of these told the counselor that all of those medications were locked. When asked at the time of the follow-up interview about the current status of any unlocked medications in the home, 84 of 114 (76%, p=0.0016) reported that all medications in the home were locked (Table 2).

Counselors asked parents at the time of the visit about the presence of guns, with 52 families indicating they had guns in the

Table 2. Comparison of medication and gun storage behavior reported by parents at time of visit and in follow-up interview among those completing a follow-up interview (n=114).

	At the time of ED visit n (%)[A]	At the time of follow-up n (%)[B]	Statistical test of change over time period
Medication storage among families indicating they had medications in the home at visit (n=110, 96%)			
All locked[C]	10 (9%)	84 (76%)	p=0.0016[E]
Gun storage at time of ED visit among families indicating they had guns in the home at visit (n=33, 29%)			
All locked[D]	22 (67%)	33 (100%)	p=0.0004[F]

ED, emergency department
[A]From flow sheet data recorded by counselor on day of visit.
[B]From follow-up interview.
[C]At the visit, we recorded 9 (8%) reporting some were locked; 89 (81%) reporting none were locked, and 2 (2%) responses were missing or reported "not sure". At follow-up the question only asked if there were "any unlocked medications at home today". Data missing for one family.
[D]At the visit, we recorded no families reporting some guns were locked, 9 (27%) reporting that none were locked and 2 (6%) indicating they were unsure of whether guns were locked or not. At follow-up, the question asked if there were "unlocked guns at home today".
[E]Chi Square test.
[F]Fisher's Exact test.

home. Thirty-three of these 52 families participated in the follow-up interview (Table 2). Among these, 22 (67%) reported to the counselor at the time of the visit that their guns were all locked. At the time of the follow-up interview, all 33 parents (100%) reported that all of their guns currently were locked (p=0.0004).

DISCUSSION

Most parents of children who met our eligibility criteria for counseling received lethal means counseling, demonstrating the feasibility of delivering the protocol in a pediatric emergency care setting. The vast majority of families were receptive to the discharge counseling and to receiving a free lock box during the visit. They described the discussions as being clear and respectful of their needs.

That parents showed good recall of key counseling messages at follow up, reported a high degree of acceptance of the intervention, and indicated substantial changes in storage practices is very encouraging and suggests the counseling was effective.

Though recall of key messages was strong overall, some remembered different messages than intended by the protocol (e.g., getting them out of the reach of children vs. locking them). Also, though the majority of families remembered being counseled about safe medication storage, the message regarding safe medication disposal was not consistently recalled. However, our quality improvement data does not allow us to determine if this reflects differences in how some clinicians may have delivered the intended messages or recall issues among the parents we interviewed. In some cases, more than one adult participated in the ED encounter while our interview was conducted with just one adult. It could be that different adults provided information to the clinician and to the interviewer, for example, reflecting variation in understanding of how guns or medications are stored in the home.

After the start of the project, the mental health team developed a checklist to remind clinicians of major points to include in their counseling. Larger-scale projects could examine in more detail if improvements are needed in the training protocol for clinicians; for example, giving stronger emphasis to consistency in providing the guidance to families, suggesting specific out-of-home gun storage locations to families; and using staff meetings to reinforce the importance of specific recommendations for storage and sharing ideas among personnel on how best to deliver those recommendations. Also, more developmental research to understand which messages are most persuasive with what types of patients could help guide this process.

As a group, self-reported storage practices changed substantially from the time of the visit to the ED and the time of the follow-up phone interview. These behavior changes are highly encouraging and suggest that giving adults a concrete way to effectuate safe storage (e.g., lock boxes) was helpful.

There are a number of cautions in considering the implications of our findings. First, this project took place in just one tertiary care facility with a relatively small number of clinicians and parents. Quality improvement projects like this one are designed to address service enhancement in a specific facility and are not intended to develop generalizable knowledge. This will require carefully designed research, ideally a randomized trial. Second, this facility has a 24/7 child and adolescent psychiatric emergency service, something that exists in a very small number of facilities. We cannot determine if our training and implementation model would have the same level of effectiveness in an ED

with more limited access to behavioral health professionals specializing in the care of children. Third, the project design relied on self-report regarding counseling delivery and changes in storage practices. It is possible that, due to a social desirability concerns, some parents reported that they had locked up their medications and/or locked firearms or stored them away from home when in fact they had not. To mitigate social desirability influences, we made a point to ask behavior change questions at the start of the interview before questions about the counseling encounter itself. We cannot be sure this alleviated the potential problem. Finally, we completed follow-up interviews with just 55% of the recipients of the intervention, raising the risk of non-responders having had a different experience with this counseling. However, the fact that participants and non-participants did not differ on key variables is reassuring.

Provision of the free lock boxes was enabled by grant funding from a foundation. The feasibility of providing free or reduced-cost lock boxes will depend upon the ability of a given provider to identify a stable funding source for lock box purchase. Future research should seek to determine if providing free or low-cost lock boxes are a cost effective and critical part of the intervention.

In this intervention, we debated whether to counsel families to lock all medications or only the most lethal. It is unknown if it is advisable to counsel parents to lock only the more toxic drugs and leave small quantities of low-toxicity medications unlocked in case the child is inclined to substitute and attempt suicide with another method. The drawback is that such a shift in protocol would require more training, more complicated messaging to families, and potentially reduced compliance by parents because of the more complex task involved. Future research should examine this further.

A review of studies that examined repetition of self-harm found that on average 5-11% of people treated for an index suicide attempt go on to die by suicide,[13] a far higher suicide rate than in the general population. Access to a firearm in particular is a risk factor for completed suicide.[14-16] It is encouraging that among the nine suicidal youth whose families received the intervention and had had unlocked guns at home at the time of their ED visit, none reported unlocked guns at follow up. One outcome that was not explicitly assessed was whether parents took steps to store firearms away from home after the PES visit. This should be assessed in future work.

Expansion of the intervention may also be warranted. The protocol evaluated here was delivered only to adults accompanying patients who were being discharged home from the ED after evaluation by the PES team. We did not examine how counseling is done with the families of youth transferred to inpatient care prior to discharge and cannot generalize to facilities where care is delivered by providers without mental health credentials. We also did not differentiate responses among families whose child presented with suicidal ideation vs. an attempt to determine if response to the intervention differed. This will be important to examine in future research. The interval between the ED visit and an adolescent's return home from inpatient care presents another potential opportunity for families to change their medication and firearm storage and is worthy of more careful investigation.

While more research is warranted, addressing lethal means counseling as a part of routine emergency care is increasingly being advocated as a critical element of provider training and practice.[17] This project suggests that lethal means counseling for parents of suicidal youth is feasible to incorporate into emergency care in a way that is acceptable to them and results in positive behavior change.

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Emergency Physicians as Good Samaritans: Survey of Frequency, Locations, Supplies and Medications

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Introduction: Little is known about the frequency and locations in which emergency physicians (EPs) are bystanders to an accident or emergency; equally uncertain is which contents of an "emergency kit" may be useful during such events. The aim of this study was to describe the frequency and locations of Good Samaritan acts by EPs and also determine which emergency kit supplies and medications were most commonly used by Good Samaritans.

Methods: We conducted an electronic survey among a convenience sample of EPs in Colorado.

Results: Respondents reported a median frequency of 2.0 Good Samaritan acts per five years of practice, with the most common locations being sports and entertainment events (25%), road traffic accidents (21%), and wilderness settings (19%). Of those who had acted as Good Samaritans, 86% reported that at least one supply would have been useful during the most recent event, and 66% reported at least one medication would have been useful. The most useful supplies were gloves (54%), dressings (34%), and a stethoscope (20%), while the most useful medications were oxygen (19%), intravenous fluids (17%), and epinephrine (14%).

Conclusion: The majority of EPs can expect to provide Good Samaritan care during their careers and would be better prepared by carrying a kit with common supplies and medications where they are most likely to use them. [West J Emerg Med. 2016;17(1):15–17.]

INTRODUCTION

Off-duty emergency physicians (EPs) may be called upon to provide care as bystanders to accidents and emergencies outside of the hospital.[1] The EP, with a unique skill set for rapid assessment and stabilization, is often the most qualified bystander to act as a "Good Samaritan," named for the biblical parable of a Samaritan who aided an injured traveler on the roadside.[2] Moreover, medical ethicists cite a moral imperative to provide such care when it is safe to do so.[3,4]

Anecdotes of EPs providing care outside of their official roles can be heard from the break room to popular emergency medicine podcasts. With the exception of Good Samaritan events on airplanes and in schools, little is known about how often or in which locations these events occur.[3,5,6]

Anticipating that most EPs will be bystanders to an emergency in their lifetime, several organizations worldwide have recommended carrying an emergency kit.[7,8] Recommendations for kit contents are largely based on consensus or expert opinion, focusing on airway protection and hemorrhage control.[1,9] An inventory of commonly used supplies and medications has yet to be established. This study aims to do the following:

1. Describe the (a) frequency and (b) locations of out-of-hospital emergencies in which EPs are called upon to provide Good Samaritan care.
2. Determine which supplies and medications are most frequently useful to EPs during Good Samaritan acts.

METHODS

We emailed a link to an electronic survey to a convenience sample of board-certified and board-eligible EPs and pediatric EPs at five emergency departments along the Front Range of Colorado in April 2015. After obtaining written consent, the respondents were asked a total of eight multiple choice and fill-in-the-blank questions. Comments and anecdotes were welcomed at the end of the survey.

Survey responses were aggregated in Microsoft Excel (v.14.5.5, Redmond, WA) and analyzed with simple descriptive statistics. The survey was approved by the Colorado Multiple Institutional Review Board.

RESULTS

A total of 90 responses were returned from the 167 invitations sent (response rate: 54%). During their careers as EPs, 78% (n=70) reported having provided Good Samaritan care. The median reported number of Good Samaritan acts was 2.0 events per five years in practice (IQR 0.5 to 4.2). Several outliers reporting very high numbers of Good Samaritan acts were noted (Figure 1).

The locations of Good Samaritan events are reported in Figure 2. Sports and entertainment events were most common (24.9%, n=144), followed closely by road traffic accidents (21.3%, n=123), and wilderness settings (19.4%, n=109).

Of the 70 respondents who reported previous experience as Good Samaritans, 86% (n=60) reported that at least one emergency kit supply would have been useful during their most recent Good Samaritan event, and 66% (n=46) reported that at least one medication would have been useful. The utility of supplies and medications is reported in Figures 3 and 4, respectively.

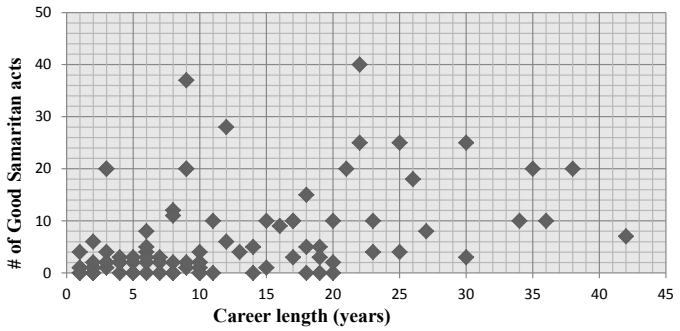

Figure 1. Reported career Good Samaritan acts.

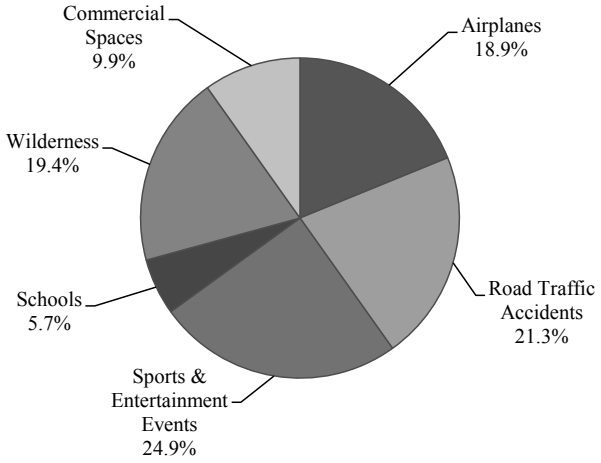

Figure 2. Locations of Good Samaritan events.

DISCUSSION

The vast majority of surveyed EPs have performed Good Samaritan acts during their careers. Many of the respondents reported that at least one supply and one medication would have been useful. The high frequency of Good Samaritan acts and the reported utility of supplies and medications support the idea that EPs should be prepared in the event that they are bystanders to an accident or emergency.

One strategy to improve preparedness would be to carry a kit with commonly used supplies and medications while in the locations where Good Samaritan events most frequently occur. In this way, keeping an emergency kit in one's car—which is often within reach of the EP at the scene of road traffic accidents or sports and entertainment events—would maximize access to useful supplies and medications in times of need.

LIMITATIONS

This survey was limited by its retrospective nature.

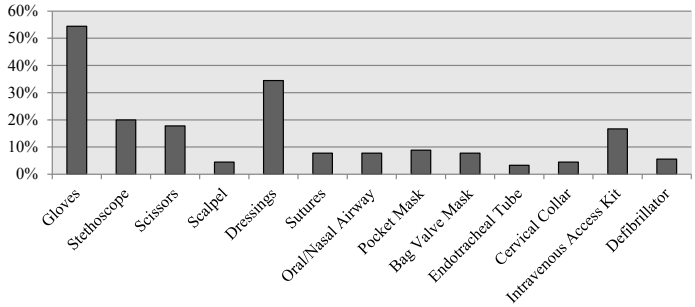

Figure 3. Supplies considered useful (by survey respondents).

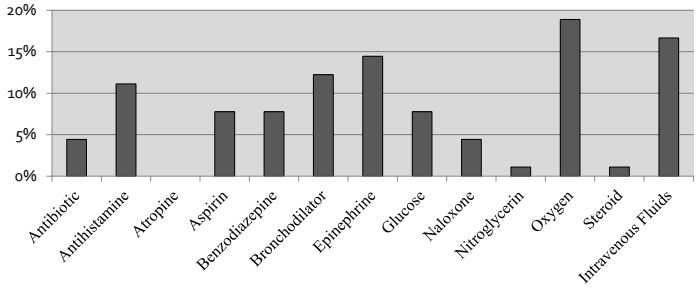

Figure 4. Medications considered useful (by survey respondents) in the event of Good Samaritan intervention.

The reported frequency, locations, and utility of supplies and medications were all dependent on the EPs' ability to recall events. Also, respondents eager to share their Good Samaritan experiences may have been more likely to complete the survey than those who did not have any experience. Validity outside of the state of Colorado would also need to be further assessed, especially regarding locations of Good Samaritan events.

In analyzing several of the extreme outliers, comments left at the end of the survey suggest that these respondents included events that were outside of the scope of Good Samaritan acts defined in the survey (e.g., suturing a laceration of a family member at home). This likely over-reports the median frequency of Good Samaritan acts.

Although commonly desired supplies and medications should influence the composition of an emergency kit, there are other factors that must be considered. Supplies geared toward airway protection (i.e., airway adjuncts, pocket masks) and bleeding control (i.e., tourniquets) may be infrequently used but have significant life-saving utility in certain circumstances. Cost, perishability, and environmental-specific factors should also influence emergency kit composition.

CONCLUSION

The prepared emergency physician can expect to provide Good Samaritan care multiple times during a career. Many physicians report utility of supplies and medications during these events. Keeping this in mind, EPs may benefit from carrying a kit containing commonly used supplies and medications in situations where they are most likely to be called upon as Good Samaritans.

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Access to In-Network Emergency Physicians and Emergency Departments Within Federally Qualified Health Plans in 2015

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Introduction: Under regulations established by the Affordable Care Act, insurance plans must meet minimum standards in order to be sold through the federal Marketplace. These standards to become a qualified health plan (QHP) include maintaining a provider network sufficient to assure access to services. However, the complexity of emergency physician (EP) employment practices – in which the EPs frequently serve as independent contractors of emergency departments, independently establish insurance contracts, etc… – and regulations governing insurance repayment may hinder the application of network adequacy standards to emergency medicine. As such, we hypothesized the existence of QHPs without in-network access to EPs. The objective is to identify whether there are QHPs without in-network access to EPs using information available through the federal Marketplace and publicly available provider directories.

Results: In a national sample of Marketplace plans, we found that one in five provider networks lacks identifiable in-network EPs. QHPs lacking EPs spanned nearly half (44%) of the 34 states using the federal Marketplace.

Conclusion: Our data suggest that the present regulatory framework governing network adequacy is not generalizable to emergency care, representing a missed opportunity to protect patient access to in-network physicians. These findings and the current regulations governing insurance payment to EPs dis-incentivize the creation of adequate physician networks, incentivize the practice of balance billing, and shift the cost burden to patients. [West J Emerg Med. 2016;17(1):18–21.]

INTRODUCTION

The Emergency Medical Treatment and Active Labor Act (EMTALA), passed in 1986, guaranteed access to emergency medical care.[1] However, it did not guarantee that health insurers would pay for that care. As a result, patients seeking care from emergency departments (EDs) outside of their insurance networks commonly faced higher out-of-pocket charges (cost-sharing) in the form of co-insurance and co-payments than from EDs in their insurance networks. The Affordable Care Act (ACA) attempted to eliminate that practice and standardize those out-of-pocket costs by prohibiting insurance companies from imposing higher cost-sharing at out-of-network EDs than what is required at in-network EDs.[2] Recently, however, the issue of high-cost emergency care and "surprise medical bills" have re-emerged as a result of "balance billing," where patients are billed by

out-of-network emergency physicians (EPs) at in-network facilities.[3] The outcry against this practice has prompted states to evaluate means to improve consumer protections, including bans on balance billing.

One potential protection already in place is the federal regulation of qualified health plans (QHPs). The ACA granted the U.S. Department of Health and Human Services (HHS) authority to establish federal network adequacy standards for plans certified for sale through the Health Insurance Marketplace. Those QHPs must "maintain a network that is sufficient in number and type of providers… to assure that all services will be accessible without unreasonable delay."[4] Thereafter, network adequacy is enforced under a "reasonable access" standard that provides leniency for the structure of insurers' provider networks.[5]

Although the HHS network adequacy standards are generalizable to all medical specialties, their applicability to emergency medicine is unclear given the unique regulatory space the field occupies. The template submitted by carriers to HHS for QHP certification requests the number of providers in particular specialties but does not include emergency medicine among them.[6] Additionally, despite the submission of that information prior to QHP certification, a recent study using provider directory information found an alarming number of QHPs offered in 2015 lacked access to in-network physicians for multiple specialties.[7] In light of this finding, and because network design is a potential driver of balance billing, we sought to determine how well the existing network adequacy standards protect access to in-network emergency care.

METHODS

We performed an analysis of QHP provider networks using previously published methods,[7] examining physician networks in the 34 states participating in the federal Marketplace during 2015 open enrollment. We used each plan's federally mandated public provider directory to assess access to EPs and hospitals within each QHP's network. In a previous study, provider directory findings were verified with phone calls to carriers.[7] Federal regulations require QHP issuers to make provider directories publicly available to allow consumers "to view the provider network that is specific to a given QHP."[4] As such, provider directories are expected to be an appropriate tool for assessing consumers' access to in-network care.

We conducted our search between April 11, 2015, and April 12, 2015. In the rating area (the geographic unit for Marketplace premiums) containing the most populous county within each state, we analyzed four silver plans, the most popular plans purchased by 69% of consumers;[8] these include the lowest, second-lowest, median, and highest premium plans. The second-lowest premium plan was analyzed because federal subsidies are tied to those particular plans. To conservatively account for patient travel, we applied a search radius of 50 miles relative to the primary U.S. postal service zip code pertaining to each rating area's most populous city. Our chief outcome of interest was identifying whether QHPs had in-network EPs and hospitals.

RESULTS

We analyzed a total of 136 silver QHPs. Among them, we identified 30 QHPs (22%) with provider networks completely lacking identifiable EP coverage (Figure). Uniformly, the provider directories for all 136 plans provided the functionality to search for physicians by specialty. However, 16 QHPs (11.8%) did not list emergency medicine as a searchable specialty.

Five QHPs (3.7%) lacked hospital coverage. Among them, three QHPs (2.2%) covered EPs but did not cover a hospital and two QHPs (1.5%) lacked both in-network EP and hospital coverage. Compared to previously published data regarding QHPs without access to in-network specialists, there are substantially more provider networks lacking EP coverage (22%) than for any other specialty analyzed (Table).

QHPs lacking EPs spanned 15 (44%) of the 34 states using the federal Marketplace. Importantly, information regarding whether EPs were hospital employees or independent contractors was commonly not available within the provider directories.

DISCUSSION

One in five provider networks in a national sample of Marketplace plans lacks identifiable in-network EPs. Though this does not necessarily entail a lack of access to emergency care, it represents an apparent lack of access to insured emergency care. Additionally, the wide disparity between

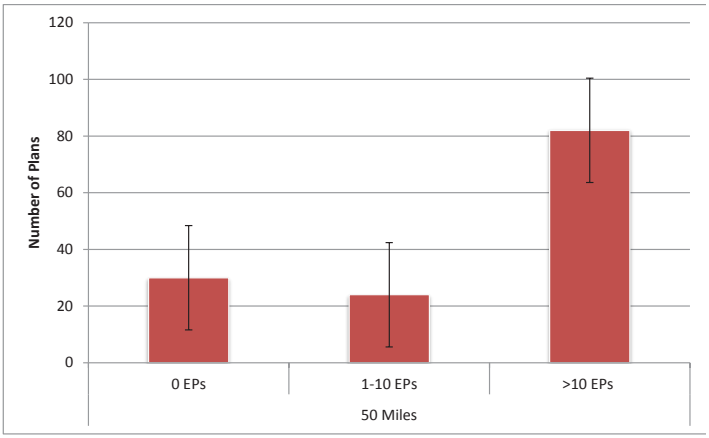

Figure. Number of Affordable Care Act plans with in-network emergency physicians by number of physicians and search radius. Sample contained 136 plans in the Silver tier on the federal Marketplace in 2015, representing the lowest, second-lowest, median, and highest premium plans in each of the 34 federal Marketplace states. Search radius was defined as 50 miles for most plans; for the 2% of plans that did not offer that radius for their provider network search tool, we used the maximum available search radius (typically 25-35 miles).
EPs, emergency physicians

Table. In-network physicians by specialty within 50 miles. Sample contained 136 plans in the Silver tier on the federal Marketplace in 2015, representing the lowest, second-lowest, median, and highest premium plans in each of the 34 federal Marketplace states. Search radius was defined as 50 miles for most plans; for the 2% of plans that did not offer that radius for their provider network search tool, we used the maximum available search radius (typically 25-35 miles). Percentages are expressed as out of 136 plans for emergency medicine and 135 plans for all other specialties due to defective provider directories.

Specialty	Number of plans with 0 specialists (%)	Number of plans with 1-2 specialists (%)	Number of plans with 3-5 specialists (%)	Number of plans with >5 specialists (%)
Cardiology	1 (0.7)	2 (1.5)	0	132 (97.8)
Dermatology	5 (3.7)	0	0	130 (96.3)
Emergency medicine	30 (22)	8 (5.9)	13 (9.6)	85 (62.5)
Endocrinology	11 (8.0)	0	3 (2.2)	121 (89.6)
Neurology	1 (0.7)	1 (0.7)	0	133 (98.5)
OB/GYN	2 (1.5)	0	0	133 (98.5)
Oncology	2 (1.5)	0	7 (5.2)	126 (93.3)
Psychiatry	6 (4.4)	1 (0.7)	2 (1.5)	126 (93.3)
Pulmonology	1 (0.7)	2 (1.5)	6 (4.4)	117 (86.7)
Rheumatology	9 (6.7)	5 (3.7)	0	121 (89.6)

OB/GYN, obstetrics and gynecology

access to in-network hospitals and in-network EPs suggests the potential for balance billing.

While many patients may assume that when they go to the ED at an in-network hospital they will be treated by hospital employees, that is most commonly not the case. Only 21.2% of EPs are hospital employees.[9] The majority of EPs are employed by physician groups, which negotiate their own insurance contracts and staff EDs with independent contractors. A 2014 analysis found that within the network for one of the largest insurance carriers in Texas, more than half of the hospitals were not staffed with any in-network EPs.[10] Our data suggest such a scenario is common, creating widespread potential for balance billing. Just how frequently the practice occurs is unclear, but only one-fourth of states currently have some form of consumer protection against bills from out-of-network providers.[11]

In an attempt to ensure that QHPs do not pay unreasonably low amounts to out-of-network EPs, the ACA specified a minimum reimbursement threshold for emergency care provided out-of-network.[12] Carriers must pay out-of-network providers the greatest of the plan's median payment amount for in-network providers, a payment based on the usual methods the plan uses to determine payments for other out-of-network services, or the amount that Medicare would pay for those services. However, EPs report that these payment thresholds are insufficient to cover the cost of emergency care.[13] As such, EPs are incentivized to balance bill, and patients subsequently carry a greater cost burden.

LIMITATIONS

This study disproportionately analyzes lower-cost plans. However, network-adequacy standards are uniform and do not differ by premium pricing. Additionally, our results may be due to issues with the transparency of provider directories themselves. The template submitted to HHS for QHP certification does not contain the full breadth of information available in the provider directories. For 2015 QHPs, HHS required an "up-to-date provider directory where the consumer can view the provider network that is specific to a given QHP."[4] Emergency medicine is not specifically identified in the QHP certification submission; however, the provider directories are required to be "complete." As such, our data may be due to a lack of provider directory transparency.

However, 21% of plans in our sample list 1-5 in-network EPs, suggesting that at least these plans identify EPs; there is clearly no blanket policy excluding EPs from directory inclusion. Instead, this suggests that our results are driven by network inadequacy rather than directory structure. Furthermore, although there have been problems with provider directories, the predominant issue has been an over-reporting of in-network providers. Thus, under the presumption that carriers were compliant in publishing an up-to-date directory of the provider network, the in-network physicians should be identifiable by any specialty. Even a perceived lack of access to a specialty could disrupt the market, and consumers should be empowered to make informed market choices. In the interest of transparency, HHS' final letter to 2015 issuers indicated that provider directories should "include location, contact information, specialty, and medical group, any institutional affiliations for each provider, and whether the provider is accepting new patients."[4] We did not find this to be common practice. HHS has imposed more stringent regulations on provider directories for QHPs offered in 2016 to ensure greater accuracy.[14,15]

CONCLUSION

Our findings suggest that there is an unfulfilled

opportunity to apply network adequacy standards to emergency medicine and ensure sufficient access to in-network emergency care. Without requiring QHPs to submit in-network EPs as part of the network adequacy template, it is impossible to provide oversight for adequate in-network access to emergency care. In the absence of that enforcement, insurance companies are incentivized to pay the minimum repayments outlined by the ACA to out-of-network providers, and EPs are consequently incentivized to balance bill their patients. As states seek to ban balance billing, in the absence of meaningful network adequacy or payment reform, EDs will be hard pressed to recuperate the costs of providing emergency care.

Ultimately, the most effective way to protect affordable patient access to emergency care may be to enact "Any Emergency Physician" regulations requiring that QHPs effectively view all EPs as "in network" and negotiate reasonable reimbursements rather than attempting to enforce, determine, and regulate the sufficient number of physicians needed to provide adequate in-network access to emergency care.

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Association of Insurance Status with Severity and Management in ED Patients with Asthma Exacerbation

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Introduction: Previous studies have demonstrated an association of low socioeconomic status with frequent asthma exacerbations. However, there have been no recent multicenter efforts to examine the relationship of insurance status – a proxy for socioeconomic status – with asthma severity and management in adults. The objective is to investigate chronic and acute asthma management disparities by insurance status among adults requiring emergency department (ED) treatment in the United States.

Methods: We conducted a multicenter chart review study (48 EDs in 23 U.S. states) on ED patients, aged 18-54 years, with acute asthma between 2011 and 2012. Each site underwent training (lecture, practice charts, certification) before reviewing randomly selected charts. We categorized patients into three groups based on their primary health insurance: private, public, and no insurance. Outcome measures were chronic asthma severity (as measured by ≥2 ED visits in one-year period) and management prior to the index ED visit, acute asthma management in the ED, and prescription at ED discharge.

Results: The analytic cohort comprised 1,928 ED patients with acute asthma. Among these, 33% had private insurance, 40% had public insurance, and 27% had no insurance. Compared to patients with private insurance, those with public insurance or no insurance were more likely to have ≥2 ED visits during the preceding year (35%, 49%, and 45%, respectively; p<0.001). Despite the higher chronic severity, those with no insurance were less likely to have guideline-recommended chronic asthma care – i.e., lower use of inhaled corticosteroids (ICS [41%, 41%, and 29%; p<0.001]) and asthma specialist care (9%, 10%, and 4%; p<0.001). By contrast, there were no significant differences in acute asthma management in the ED – e.g., use of systemic corticosteroids (75%, 79%, and 78%; p=0.08) or initiation of ICS at ED discharge (12%, 12%, and 14%; p=0.57) – by insurance status.

Conclusion: In this multicenter observational study of ED patients with acute asthma, we found significant discrepancies in chronic asthma severity and management by insurance status. By contrast, there were no differences in acute asthma management among the insurance groups. [West J Emerg Med. 2016;17(1):22–27.]

INTRODUCTION

Asthma prevalence remains at historically high levels, affecting 26 million Americans in 2011.[1] Asthma exacerbations were responsible for approximately two million emergency department (ED) visits in 2012.[2] ED visits for asthma exacerbation suggest a failure of prevention-oriented

care since most asthma exacerbations are preventable with high-quality longitudinal management.[3,4] The morbidity burden is uneven in patients presenting to the ED with asthma exacerbation – the population at high risk. In a previous multicenter study of ED patients with asthma exacerbation during 1997-1998,[5] we found that uninsured adults received suboptimal chronic asthma care (e.g., lower inhaled corticosteroid [ICS] use) and had higher chronic asthma severity (e.g., frequent ED visits). Despite a substantial ongoing burden of asthma-related ED visits, there have been no recent efforts to examine chronic and acute asthma management disparities by insurance status in this population. To address the knowledge gap, using data from a multicenter observational study of ED patients with asthma exacerbation, we investigated whether chronic asthma severity, guideline-recommended chronic asthma care, and acute asthma management differ by insurance status.

METHODS

This is a secondary analysis of data from a multicenter chart review study that characterized adult ED patients with asthma exacerbation, as part of the Multicenter Airway Research Collaboration (MARC).[6] The study setting, methods of measurement, and collected variables have been reported previously.[7-13] Briefly, we recruited EDs by inviting sites that had participated in the earlier MARC study that evaluated ED patients with asthma exacerbation during 1996 to 2001.[5,14,15] A total of 48 EDs across 23 U.S. states completed the current study.

Using the ICD-9-CM code 493.xx,[16] each site identified all visits with a primary ED or hospital discharge diagnosis of asthma during a 12-month period, from January 1, 2011, to December 31, 2012 (i.e., sites had 24-month window from which to select the 12-month study period) among patients aged 18 to 54 years with a history of physician-diagnosed asthma. Onsite chart abstractors reviewed medical records (ED, inpatient, primary care physician, and/or specialist records) of 40 patients who were randomly selected by the EMNet Coordinating Center at Massachusetts General Hospital. In the case of repeat visits, we only included the first randomly sampled ED visit. This approach was also used in other MARC studies.[17,18] Two hospitals each examined an additional 40 randomly selected patients to obtain a total of 2,000 patients.

Data abstraction was performed with a standardized form and included patients' demographics, primary insurance type, estimated household income, chronic asthma factors, current asthma medications, specialty care status, details of the current asthma exacerbation, asthma management in ED or at discharge, and disposition. We estimated household income using home ZIP codes.[19] Specialty care was defined as outpatient asthma care by an allergist/immunologist, pulmonologist, or other physician specifically focusing on asthma care (e.g., a general internist who is director of the local asthma center). All abstracters were trained with a one-hour online lecture, followed by the completion of two practice medical records, which were evaluated with a "criterion standard." If a reviewer's accuracy was <80% per medical record, the reviewer was retrained.

The outcome measures were 1) chronic asthma severity (as measured by ≥2 ED visits in a one-year period);[7,20] 2) guideline-recommended chronic asthma care (i.e., use of ICS and evaluation by an asthma specialist) prior to the index ED visit;[3,4] and 3) acute asthma management (i.e., use of systemic corticosteroid in the ED and initiation of ICS at ED discharge). Frequency of ED visits with acute asthma during the preceding one year from the index ED visit was measured by reviewing the medical records (not only ED records but also inpatient, primary care physician, and/or specialist records) for each patient. Specialty care was defined as outpatient asthma care by an allergy/immunologist, pulmonologist, or other physician focusing on asthma care (e.g., a general internist who is director of the local asthma center).

For the purpose of this analysis, we classified patients into three groups based on their primary insurance status: private insurance, public insurance (e.g., Medicaid, Medicare), and no insurance.[5,14,15] To examine the association of insurance status with each outcome, we constructed logistic regression models adjusting for age, sex, race/ethnicity, estimated household income, and history of hospitalization and intubation for asthma exacerbation. We used the generalized estimating equations to account for patient clustering within EDs. All analyses were performed with SAS 9.4 (SAS Institute, Cary, NC). The institutional review board of each participating hospital approved the study.

RESULTS

Of 2,000 ED patients with asthma exacerbation, 1,928 patients (96%) had data on insurance status and were included in the analysis. The analytic and non-analytic cohorts were similar in their age, sex, chronic asthma factors and management, ED asthma management, and disposition (Appendix 1). Among the analytic cohort, 632 patients (33%) had private insurance, 775 (40%) had public insurance, and 521 (27%) had no insurance. Patient demographics differed across the groups (Table 1). For example, compared to patients with private insurance, those with no insurance were more likely to be male, non-Hispanic black and smoker, and less likely to have a primary care physician (all $p<0.001$).

Likewise, chronic asthma factors and management differed across the groups. Compared to patients with private insurance, those with public insurance or no insurance were more likely to have a marker of chronic asthma severity (i.e., ≥2 ED visits in a one-year period) (35%, 49%, and 45%, respectively; $p<0.001$; Table 1). Despite their higher chronic severity, those with no insurance were less likely to have received guideline-recommended chronic asthma care before the ED visit – i.e., lower use of ICS (41%, 41%, and 29%;

Table 1. Patient characteristics and emergency department course, according to primary insurance status.

Patient characteristics	Private insurance (n=632; 33%)	Public insurance (n=775; 40%)	No insurance (n=521; 27%)	P value
Demographics				
Age (y), median (IQR)	34 (25-45)	35 (25-45)	33 (25-45)	0.38
18-29	249 (39)	267 (34)	203 (39)	
30-39	145 (23)	207 (27)	129 (25)	
40-54	238 (38)	301 (39)	189 (36)	
Male sex	230 (36)	267 (35)	285 (55)	<0.001
Body mass index, median (IQR)*	31 (26-37)	31 (26-38)	28 (24-34)	<0.001
Race/ethnicity†				<0.001
Non-Hispanic white	170 (27)	107 (14)	99 (19)	
Non-Hispanic black	297 (47)	414 (53)	291 (56)	
Hispanics	103 (16)	184 (24)	88 (17)	
Other	30 (5)	20 (3)	8 (2)	
Median household income estimated from ZIP code, median (IQR)	$39,327 ($28,337-$57,004)	$32,733 ($25,967-$45,137)	$34,167 ($25,991-$46,377)	<0.001
Having primary care physician	450 (71)	506 (65)	189 (36)	<0.001
Active smoker	160 (25)	265 (34)	203 (39)	<0.001
Chronic asthma factors				
Ever hospitalized for asthma	202 (32)	314 (41)	151 (29)	<0.001
Ever intubated for asthma	70 (11)	123 (16)	47 (9)	0.01
ED visit for asthma in past 12 months	219 (35)	381 (49)	235 (45)	<0.001
Hospitalization for asthma in past 12 months	74 (12)	150 (19)	63 (12)	<0.001
Chronic asthma care				
Current use of oral corticosteroids	86 (14)	100 (13)	53 (10)	0.17
Current use of ICS	259 (41)	315 (41)	153 (29)	<0.001
Current use of long-acting β-agonist	168 (27)	213 (27)	87 (17)	<0.001
Current use of leukotriene modifiers	82 (13)	102 (13)	31 (6)	<0.001
Seen by asthma specialist in past 12 months	55 (9)	78 (10)	21 (4)	<0.001
ED presentations				
Duration of symptoms				
≤3 hours prior to ED arrival	53 (8)	78 (10)	54 (10)	0.40
Vital signs				
Initial respiratory rate (breaths/min), median (IQR)	20 (18-22)	20 (18-22)	20 (18-22)	0.04
Initial oxygen saturation (%), median (IQR)	98 (96-99)	98 (96-99)	97 (95-99)	0.01
Initial PEF (L/min), median (IQR)‡	240 (160-320)	230 (170-300)	235 (175-300)	0.81
Concomitant medical disorders§	94 (15)	119 (15)	51 (10)	0.01
ED treatment				
Inhaled β-agonists	626 (99)	769 (99)	516 (99)	0.92
Inhaled anticholinergics	434 (69)	571 (74)	380 (73)	0.09
Systemic corticosteroids	471 (75)	613 (79)	406 (78)	0.08
Intravenous magnesium	53 (8)	81 (10)	42 (8)	0.25
Mechanical ventilation	12 (2)	8 (1)	7 (1)	0.38

IQR, interquartile ratio; *ICS,* inhaled corticosteroids; *ED,* emergency department, *PEF,* peak expiratory flow

*Analyzed for 1,179 patients with body mass index available.

†Percentages are not equal to 100 because of missing data.

‡Analyzed for 805 patients with initial PEF available.

§Defined by pneumonia, congestive heart failure, pneumothorax, arrhythmia, sinusitis, and otitis media.

Table 1. Patient characteristics and emergency department course, according to primary insurance status.

Patient characteristics	Private insurance (n=632; 33%)	Public insurance (n=775; 40%)	No insurance (n=521; 27%)	P value
ED disposition				<0.001
Sent home	525 (83)	488 (76)	457 (88)	
Hospitalized	97 (15)	172 (22)	55 (11)	
Other (e.g., left against medical advice)	10 (2)	15 (2)	9 (2)	
ED length of stay (min), median (IQR)	183 (123-283)	188 (120-301)	175 (117-287)	0.52
Prescribed medications at ED discharge				
Prescribed oral corticosteroids¶	365 (70)	448 (76)	341 (75)	0.01
Newly prescribed ICS‖	38 (12)	46 (12)	47 (14)	0.57

ED, emergency department; *IQR,* interquartile ratio; *ICS,* inhaled corticosteroids
¶Analyzed for discharged patients (n=1,570).
‖Analyzed for discharged patients who did not report recent use of inhaled corticosteroids (n=1,042).

p<0.001) and lower utilization of asthma specialist care (9%, 10%, and 4%; p<0.001). However, the proportion of patients who had received these two chronic asthma management measures was low across the groups.

By contrast, there were no clinically important differences in ED presentation or statistically significant differences in acute asthma management by insurance status (Table 1). However, even with the higher chronic asthma severity of patients with public insurance or no insurance, the proportion of patients newly prescribed ICS at ED discharge did not differ across the groups (12%, 12%, and 14%; p=0.57). In multivariable models adjusting for potential confounding factors and patient clustering, these results did not change materially (Table 2).

DISCUSSION

In this multicenter study of ED adult patients with asthma exacerbation, we found significant discrepancies in chronic asthma severity and management by insurance status. Specifically, compared to patients with private insurance, those with public insurance or no insurance had a higher risk of frequent ED visits (≥2 visits during the preceding year). Yet, even with the higher chronic asthma severity, those with no insurance were less likely to have received guideline-recommended chronic asthma care. By contrast, ED asthma treatment did not differ across the insurance groups. However, at ED discharge, patients with public insurance or no insurance were, despite their much higher chronic severity, equally likely to be newly prescribed ICS.

Our findings were disappointingly similar to those of our previous multicenter study of 1,019 adult ED patients with asthma exacerbation in the late 1990s.[5] With the use of a similar design and setting, the previous study found that uninsured patients received suboptimal longitudinal care prior to their ED visits, despite their higher chronic severity. These observations paralleled another multicenter study of 965 children presenting to the ED with asthma exacerbation in the same period.[15] Additionally, in the community setting, studies have reported that patients with public insurance had fewer prescriptions of ICS,[21] difficulties with scheduling outpatient care,[22] and higher rates of ED visits for asthma exacerbation.[23,24] To our knowledge, our multicenter study is the largest study to have investigated chronic and acute asthma management disparities by insurance status among ED patients. Our data corroborate these findings and extend them by demonstrating persistent disparity not only in the use of ICS but also in utilization of specialist care.

The reasons for the disproportionate healthcare-related disparity is likely multifactorial. Potential explanations include differences in patient demographics (e.g., race/ethnicity) and socioeconomic status (e.g., income). However, our inferences did not change even after adjusting for these factors. Alternatively, insurance status may be an identifiable surrogate marker for many patient and health system factors – e.g., patient's health beliefs, self-management knowledge, and access to preventive care.[25]

LIMITATIONS

This study has several potential limitations. First, we relied on chart review for data collection; therefore, error in data measurement is possible. For example, our methods of assigning insurance status may have led to misclassification. However, the use of medical records is likely to be more accurate than patient self-report.[26] Additionally, although we did not measure interrater agreement in this study, we used a previously-applied standardized data collection system with uniform definitions and rigorous training, which achieved a high inter-observer agreement (*k* coefficients, 0.6-1.0) in our recent study.[27] Second, as with any observational studies, the observed associations do not necessarily prove causality and might be confounded by unmeasured factors (e.g., access to ambulatory care, inter-hospital practice variations). However, we addressed this concern, at least partially, by accounting for clustering. Lastly, the EDs that composed this study were

Table 2. Unadjusted and multivariable-adjusted associations of insurance status with study outcomes.

	Private insurance		Public insurance		No insurance	
Outcomes and models	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
ED visit for asthma in past 12 months						
Unadjusted model*	reference	-	1.79 (1.40-2.27)	<0.001	1.48 (1.13-1.94)	0.004
Adjusted model†	reference	-	1.64 (1.29-2.10)	<0.001	1.55 (1.17-2.05)	0.002
Current use of ICS						
Unadjusted model*	reference	-	0.97 (0.75-1.24)	0.79	0.58 (0.42-0.81)	0.001
Adjusted model†	reference	-	0.85 (0.67-1.08)	0.19	0.63 (0.45-0.86)	0.004
Evaluation by asthma specialist in past 12 months						
Unadjusted model*	reference	-	0.97 (0.68-1.38)	0.86	0.43 (0.28-0.65)	<0.001
Adjusted model†	reference	-	0.93 (0.64-1.36)	0.70	0.52 (0.32-0.84)	0.008
Use of systemic corticosteroids in the ED						
Unadjusted model*	reference	-	1.38 (1.10-1.74)	0.006	1.19 (0.94-1.51)	0.14
Adjusted model†	reference	-	1.25 (0.98-1.60)	0.07	1.27 (0.98-1.64)	0.07
Newly prescribed ICS at ED discharge‡						
Unadjusted model*	reference	-	0.74 (0.50-1.10)	0.14	0.86 (0.54-1.38)	0.54
Adjusted model†	reference	-	0.73 (0.49-1.07)	0.10	0.91 (0.57-1.46)	0.70

OR, odds ratio; *CI,* confidence interval; *ED,* emergency department; *ICS,* inhaled corticosteroids
*Unadjusted logistic regression model using the generalized estimating equations to account for patient clustering within EDs.
†Multivariable logistic regression model using the generalized estimating equations to account for patient clustering within EDs, with adjusting for age, sex, race/ethnicity, estimated household income, and history of hospitalization and intubation for asthma exacerbation.
‡Analyzed for discharged patients who did not report recent use of inhaled corticosteroids (n=1,042).

mainly urban, academic centers. This study setting resulted in a high proportion of patients with public insurance or no insurance as well as urban-dwelling minorities. However, our observations might not be generalized to rural, community EDs where asthma morbidity is also high.[28]

CONCLUSION

In this large multicenter study of 1,928 ED patients with asthma exacerbation, we found an ongoing disparity in disease burden and management by insurance status. Compared to patients with private insurance, those with public insurance or no insurance had a greater risk of frequent ED visits. However, those with no insurance had less utilization of asthma controller medications and asthma specialist care. Although acute asthma treatment in the ED did not differ by insurance, patients with public insurance or no insurance were no more likely to be newly prescribed ICS at ED discharge despite their higher chronic severity. Additionally, we found that only a small subset of patients received guideline-recommended prevention-oriented asthma care regardless of their insurance. Therefore, it is unlikely that expanding insurance coverage through the Affordable Care Act alone can fully address the observed disparities in this high-risk population. Our data should encourage policymakers and clinicians to improve access to asthma specialists and promote greater implementation of the evidenced-based asthma guidelines.[3,4]

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Randomized Controlled Trial of Electronic Care Plan Alerts and Resource Utilization by High Frequency Emergency Department Users with Opioid Use Disorder

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Introduction: There is a paucity of literature supporting the use of electronic alerts for patients with high frequency emergency department (ED) use. We sought to measure changes in opioid prescribing and administration practices, total charges and other resource utilization using electronic alerts to notify providers of an opioid-use care plan for high frequency ED patients.

Methods: This was a randomized, non-blinded, two-group parallel design study of patients who had 1) opioid use disorder and 2) high frequency ED use. Three affiliated hospitals with identical electronic health records participated. Patients were randomized into "Care Plan" versus "Usual Care groups". Between the years before and after randomization, we compared as primary outcomes the following: 1) opioids (morphine mg equivalents) prescribed to patients upon discharge and administered to ED and inpatients; 2) total medical charges, and the numbers of; 3) ED visits, 4) ED visits with advanced radiologic imaging (computed tomography [CT] or magnetic resonance imaging [MRI]) studies, and 5) inpatient admissions.

Results: A total of 40 patients were enrolled. For ED and inpatients in the "Usual Care" group, the proportion of morphine mg equivalents received in the post-period compared with the pre-period was 15.7%, while in the "Care Plan" group the proportion received in the post-period compared with the pre-period was 4.5% (ratio=0.29, 95% CI [0.07-1.12]; p=0.07). For discharged patients in the "Usual Care" group, the proportion of morphine mg equivalents prescribed in the post-period compared with the pre-period was 25.7% while in the "Care Plan" group, the proportion prescribed in the post-period compared to the pre-period was 2.9%. The "Care Plan" group showed an 89% greater proportional change over the periods compared with the "Usual Care" group (ratio=0.11, 95% CI [0.01-0.092]; p=0.04). Care plans did not change the total charges, or, the numbers of ED visits, ED visits with CT or MRI or inpatient admissions.

Conclusion: Electronic care plans were associated with an incremental decrease in opioids (in morphine mg equivalents) prescribed to patients with opioid use disorder and high frequency ED use. [West J Emerg Med. 2016;17(1):28–34.]

INTRODUCTION

Attendees at the 2011 Academic Emergency Medicine Consensus Conference prioritized electronic alerts and patient-specific care plans as interventions that potentially enhance the delivery of evidence-based and guideline-concordant care.[1] The common purpose of these proposed interventions is to optimize communication between different providers working varying schedules.[2] There is a paucity of literature supporting the use of electronic alerts for patients with high frequency emergency department (ED) use, which we define as four or more ED visits in the preceding 12 months.[3,4] Based on our review of the recent peer-reviewed literature, we found only a few current, prospective studies that have examined the benefits of electronic alerts in this population.[5,6]

Previous studies broadly address the general population of high frequency ED users; however, given the burgeoning problem of opioid misuse and addiction in our community and across the country, we decided to focus our study on the subgroup of high frequency ED users with opioid use disorder.[7] The latter term combines opioid abuse and dependence criteria into a single diagnosis according to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) published by the American Psychiatric Association in 2013.[8] We believed that a randomized, controlled study to evaluate the effectiveness of electronic alert care plans was needed to demonstrate the benefits of this intervention. Our goal was to evaluate how "pushed" electronic alerts might impact the growing epidemic of prescription opioid misuse in this country.

We designed the electronic alerts in order to "push" care plan recommendations to providers as prominently visible "pop-up" screens when accessing the patients' electronic health records. Without the electronic alerts, the provider must "pull" the information from various software applications, paper records and direct communication with primary care physicians. Accordingly, we hypothesized that use of "pushed" electronic alert care plans would help standardize care 24/7 and reduce opioid usage and other resource utilization. The primary goals were to assess the behavior of providers in terms of prescribing and administering opioids to ED and inpatients and to measure anticipated reductions in healthcare costs.

METHODS

Study Design

This was a randomized, non-blinded, two-group parallel design study of high frequency ED users with opioid use disorder. The researchers collecting the outcome data and the statisticians performing the analysis were blinded to the allocation. This research study received expedited approval by the investigational review board at Baystate Healthand a waiver of consent was granted since the electronic alerts presented minimal risk of harm to subjects and were implemented as standard ED practice. Our risk management department determined that signed consent for care upon presentation to the ED provided consent for participation in the electronic alerts program. Patients for whom care plans were implemented were informed of their care plans during visits to the EDs and primary care practices. The primary providers in these settings were responsible for this communication and patients could not opt out. The study was not registered at ClinicalTrials.gov since the intervention targeted provider behavior and does not involve drugs, surgical procedures, devices, behavioral treatments, educational programs, dietary interventions or quality improvement interventions.

The High Frequency User Task Force at Baystate Health System was established as a multi-disciplinary initiative to coordinate the care and create electronic alerts for patients who frequently use emergency services. The efforts of the group were primarily targeted towards individuals with opioid use disorder.[9-11] The health system comprises Baystate Medical Center, an academic medical center with 114,000 annuals ED visits and two affiliated community hospitals, Mary Lane Hospital and Franklin Medical Center, with 16,000 and 27,000 annual ED visits respectively. The three institutions are located in the Pioneer Valley of western Massachusetts within a distance of no more than 40 miles from each other. The task force meets monthly and includes physicians from primary care, hospital and emergency medicine, as well as representatives from hospital-based services including case management, social services, risk management and nursing. Additional members included community partners such as Health Care for the Homeless, the Behavioral Health Network Crisis Team (community-based psychiatric outreach program) and the Springfield Coalition for Opioid Overdose Prevention (Division of the City of Springfield Department of Health and Human Services).

To minimize bias in the selection of eligible patients, we used electronic tracking of adults (age 18 and older) with four or more ED visits in the previous 12 months to the Baystate Health System to identify candidates for care plans (Figure 1–Study flow diagram). We identified candidates by review of a monthly list of patients using our Shared Medical Systems Corp. (SMS®) patient registration system, which stores patient demographic and visit data and serves as a master index for patient identification. Patients with opioid use disorder were identified by query of our SMS® patient accounting system, a hospital financial management software program that includes diagnosis, procedure and service codes for billing and collection. Patients with "Accidental poisoning by analgesics, antipyretics and antirheumatics" physician billing e-codes E850.0 (heroin), E850.1 (methadone) and E850.2 (opiates) in this accounting database were considered to meet criteria for opioid-use disorder. We used a unique patient account number to link the patient registration and accounting databases in order to create a list of eligible patients who met both criteria. In addition, potentially eligible patients with four or more ED visits in the preceding

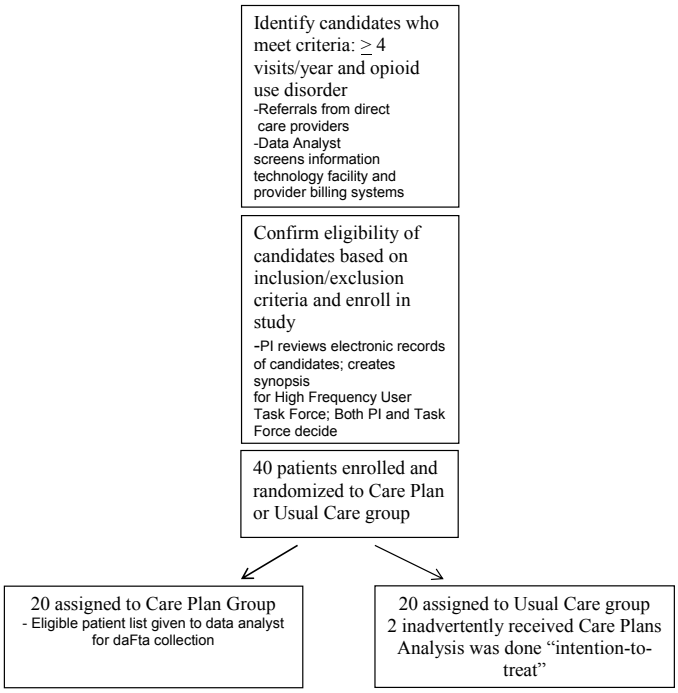

Figure. Study flow diagram.
PI, principal investigator

12 months were referred to the High Frequency User Task Force by direct care providers (practicing emergency, internal or hospital medicine in our institution) who had a strong suspicion of opioid use disorder.

Patients met criteria for study based on additional supportive evidence from the following: 1) inpatient and outpatient electronic health records (Cerner FirstNet ®) including the Problem Lists e.g. for the presence of an "opiate contract" or diagnoses of "opioid dependence" or "abuse," and, 2) the State Prescription Drug Monitoring Program. The following were criteria for exclusion: 1) significant cardiac, renal, hepatic, endocrine, metabolic, neurologic or other systemic disease (significant disease was defined as one, which, in the opinion of the principal investigator may influence the results of the study); 2) patient receiving hospice, end-of-life or comfort care only. For proposed candidates, the High Frequency User Task Force members assessed the reasons for the ED visits, reviewed the previously listed data and proposed interventions. Task force members collaborated with primary care physicians to review plans, provided input and were responsible for final determination of eligibility for the study.

Eligible patients were randomized to one of two groups ("Care Plan" group and "Usual Care" group) in a 1:1 ratio using a concealed block randomization list with a blocking factor of four. For patients randomized to the "Care Plan group," a care plan was developed by the proposing member, reviewed by the Task Force and presented by information technology programming as an alert in the electronic health record at Baystate Health (see Appendix A for care plan template). Patients allocated to "Usual Care" group did not have a care plan or other triggers or alerts instituted. The electronic alerts appeared automatically upon initial access of the electronic health record by all ED and inpatient providers and nurses at the three affiliated hospitals.

The list of enrolled patients along with their study specific ID number, group allocation, and electronic alert implementation date were collected and managed using REDCap electronic data capture tools hosted at Tufts University.[12] One year after enrollment, the data analyst accessed the REDCap database and collected all data for both groups before and after the intervention. We compared baseline characteristics between groups including the following: 1) age; 2) gender; 3) race; 4) presence of a primary care physician; 5) chief complaint upon presentation to the ED; 6) diagnoses documented in the past medical history; 7) presence of insurance coverage.

Between the 12-month period before and 12-month period after the implementation date, we compared changes in the following primary measures: 1) opioid medications (converted to morphine mg equivalents) prescribed to patients upon discharge, and administered to ED and inpatients. As secondary outcomes, we compared changes in: 2) total charges defined as all medical charges from all payers related to all visits to Baystate Health hospitals, 3) number of ED visits, 4) number of ED visits with advanced radiographic imaging (CT or MRI) studies; and 5) number of inpatient admissions. We included as outcomes advanced imaging and inpatient admissions since these are significant drivers of cost and typically are under the direct control of emergency providers. For example, advanced diagnostic imaging performed in the ED is reimbursed at a significant premium compared with identical outpatient exams.[13] Moreover, hospital admission is widely considered to be the single most costly decision made by emergency providers.[14]

Data Analysis

We conducted univariable comparisons at baseline between study groups using Fisher's exact test for categorical variables and the Wilcoxon rank-sum test for continuous variables. To estimate change in outcomes over the two periods, a "difference-in-differences" approach was used. Repeated measures multivariable models were developed using generalized estimating equation methods with robust standard errors to account for the within-subject correlation.[15] These models included terms for study group and period (i.e., pre vs. post), as well as a group-by-period interaction term to assess the difference in group means, across study periods. A significant p-value for this interaction term would indicate that the study means differed in their magnitude of change. We adjusted all regression models for any baseline factor that achieved a significance level of $p<0.15$ in the baseline comparison.

Morphine mg equivalents and total charges were log-transformed prior to multivariable analyses to account for the substantial skew in the distributions and the positive

correlation between the mean and variance. Estimates for these variables were back-transformed and the ratio of their geometric means are reported with 95% confidence intervals. We analyzed and reported all other variables as a difference in adjusted means with 95% confidence intervals. The results presented are based on intention-to-treat analyses.

Sample size was estimated using the approach described by Frison and Pocock for a repeated measures analysis.[16] A total sample size of 40 (20 patients per study group) would provide at least 80% power to detect a large effect size (Cohen's d=0.90) for a continuous outcome (e.g., charges or morphine mg equivalents) for a two-sided test of significance at a critical level of 5%. This estimate assumes two time points (pre vs. post) and a conservative correlation among repeated measures of the outcome of 0.50. We conducted all analyses in Stata (version 13.1, StataCorp, College Station, TX).

RESULTS

A total of 40 patients were enrolled between August, 20, 2012, and May, 29,2013. Twenty were randomized into the "Care Plan" group and 20 were randomized to the "Usual Care" group. The care plans were reviewed every six months but none required revision during the study. We excluded no eligible patients as candidates because of the following: 1) significant cardiac, renal, hepatic, endocrine, metabolic, neurologic or other systemic disease which, in the opinion of the principal investigator, would influence the results, or 2) hospice, end-of-life or comfort care only. Tables 1 and 2 list baseline patient characteristics and none of the differences were statistically significant. The only baseline covariate that met criteria for inclusion in the multivariable models was a presenting complaint of "Headache" as reported in the ED.

Table 3 shows the comparison of study groups on baseline primary and secondary measures. The results demonstrate that the groups did not demonstrate statistically significant differences at baseline as a result of the randomization process. Two individuals assigned to the "Usual Care" group inadvertently received care plans as electronic alerts. A re-analysis of the data based on "protocol-received" assignment did not alter the intention-to-treat results as presented in any meaningful way.

Table 4 shows the geometric means and proportional change for morphine mg equivalents administered to ED and inpatients, prescribed to discharged patients, as well as charges, by study group. Both study groups revealed reductions in ED and inpatient, and discharged patient opioid utilization over the study period. For ED and inpatients in the "Usual Care" group, the proportion of morphine mg equivalents received in the post-period compared with the pre-period was 15.7%, while in the "Care Plan" group the proportion received in the post-period compared with the pre-period was 4.5% (ratio=0.29, 95% CI [0.07-1.12]; p=0.07). For discharged patients in the "Usual Care" group, the proportion of morphine mg equivalents prescribed in the post-period compared with the pre-period was 25.7%. In the "Care Plan" group, the proportion prescribed in the post-period compared to the pre-period was 2.9%. The "Care Plan" group showed an 89% greater proportional change in morphine mg equivalents prescribed over the periods compared with the "Usual Care" group (ratio=0.11, 95% CI [0.01-0.092]; p=0.04).

Charges for both groups were reduced approximately 50% in the post-period compared to the pre-period, specifically 51.7% in the "Usual Care" group and 47.4% in the "Care Plan" group. Thus, the ratio of the proportional changes was 0.92; (95% CI [0.31-2.7]; p=0.88). Care plans did not alter the number of ED visits, the number of ED visits with CT or MRI studies or the number of inpatient admissions (Table 5).

DISCUSSION

Prescription drugs and opioids specifically have taken center stage in what has become an epidemic of abuse.[17] In 2010, an estimated seven million individuals engaged in non-medical use of prescription drugs in the United States each year.[18] Moreover, annual deaths from prescription drug overdose have exceeded those from overdose from conventional street drugs as well as traffic accidents since 2002.[19] To date, the efforts of policy-makers, medical providers and investigators to design and implement interventions have not been successful in reversing these trends.

With reference to the goal of studying ongoing efforts to combat opioid use disorder, our results suggest that electronic alerts prompted providers to reduce the amount of opioids prescribed to patients upon discharge from the ED and inpatient wards. In absolute terms, the incremental reduction in the "Care Plan" group was a geometric mean of -38.6 morphine mg equivalents (-85.7 versus -47.1); in context; this is equivalent to 7.8 five mg tablets of hydrocodone per patient over the course of one year.

Assuming that our results are replicable, this reduction may be significant from a clinical and public health point of view, when accounting for the multitude of patients who could benefit from electronic alerts for opioid use disorder. There were 136.3 million ED visits in the U.S. in 2011.[20] Based on a community-based study from Oregon, authors estimated that at least 0.7% of ED visits were related to opioid use disorder in general.[2] Specific to the non-medical use of prescription opioids, the 2011 Drug Abuse Warning Network (DAWN - Substance Abuse and Mental Health Administration) estimates that 348,000 ED visits were related to this problem.[21] If successfully used for all of these visits, electronic alerts could-by extrapolation-conceivably eliminate the prescription of the equivalent of over 2.7 million five mg tablets of hydrocodone per year.[19]

Moreover, opioid administration decreased incrementally in absolute terms (not the geometric mean reported in Table 4) by a mean of 25.1 morphine mg equivalents (-314.8mg versus -289.7mg) with the use of electronic care plans. This change was not statistically significant; however, the analysis suggests that a larger sample size could have resulted in a statistically

Table 1. Demographic characteristics of study groups.

	Usual care group (N=20)		Care plan group (N=20)		
Baseline characteristics	%	(n)	%	(n)	p
Male	35.0	(7)	60.0	(12)	0.21
Race					
Caucasian	50.0	(10)	60.0	(12)	0.83
African-American	30.0	(6)	25.0	(5)	
Hispanic	20.0	(4)	15.0	(3)	
Age, mean (sd)	47.9	(11.5)	44.7	(10.5)	0.37

Table 2. Baseline clinical characteristics of study groups.

	No care plan (N=20)		Care plan (N=20)		
Baseline characteristics	%	(n)	%	(n)	P
Primary care physician	95.0	(19)	95.0	(19)	1.0
Chief complaint					
Back pain	60.0	(12)	45.0	(9)	0.53
Headache	50.0	(10)	20.0	(4)	0.10
Abdominal pain	95.0	(19)	85.0	(17)	0.60
Chest pain	55.0	(11)	45.0	(9)	0.75
Chronic medical condition					
IV drug use	10.0	(2)	25.0	(5)	0.41
Diabetes	30.0	(6)	50.0	(10)	0.33
Renal failure	10.0	(2)	10.0	(2)	1.00
Coronary artery disease	20.0	(4)	15.0	(3)	1.00
Gastrointestinal disorder	45.0	(9)	65.0	(13)	0.34
HIV	0.0	(0)	5.0	(1)	1.00
Cocaine	20.0	(4)	20.0	(4)	1.00
Alcohol	30.0	(6)	35.0	(7)	1.00
Anxiety	75.0	(15)	65.0	(13)	0.73
Depression	70.0	(14)	85.0	(17)	0.45
PTSD	25.0	(5)	20.0	(4)	1.00
Psychosis	25.0	(5)	50.0	(10)	0.19
Insurance coverage	50.0	(10)	45	(9)	1.00

IV, intravenous; *HIV,* human immunodeficiency virus; *PTSD,* post-traumatic stress disorder

significant reduction in the amount of opioids administered. It should be noted that incremental reductions in both opioid administration and prescribing patterns occurred in both study groups after the implementation of electronic alerts. While this could be explained by a "carry-over" effect from the "Care Plan" group, it is more likely explained by a national trend towards decreased opioid use.

We were not able to demonstrate a statistically significant reduction in total charges or in any of the remaining measures of utilization. The difference in the geometric mean in total charges between groups was -$9,128. It should be noted that with the exception of ED visits, our outcomes point toward a favorable trend towards a reduction in resource utilization as a result of the introduction of "pushed" electronic alerts.

Mandelberg et al. discovered that, even without specific interventions, fully 62% of high frequency ED users in one year ceased to fall into that category the following year.[22] Other investigators have likewise concluded that high frequency ED users as a group are subject to a high attrition rate from year to year.[23] This natural pattern of high frequency ED use is patient-specific, often related to social factors and, in many cases, beyond the influence and control of our current systems of medical care. Pre-post trials are therefore subject to significant bias due to the natural ebb and flow of ED use. Accordingly, it is critical that interventions designed to manage this population are tested in a randomized controlled fashion. While high frequency ED use and interventions to address the problem have been identified as areas of research focus for many years, few rigorous comparative trials have appeared in the medical literature.[24-28]

Two previous studies have addressed the use of information technology to create individualized care plans for high frequency users. Both of these were pre-post trials without control groups; moreover, the trials studied a broad range of patients and were not limited to subjects at high risk of opioid use disorder. Based in hospital medicine, Mercer et al. demonstrated reductions in hospital admissions and inpatient direct costs.[5] The second by Stokes-Buzzelli et al. was an ED trial that identified reductions in charges, laboratory tests ordered and the number of ED visits after introduction of electronic care plans.[6] The reductions in utilization and costs demonstrated by these authors are noteworthy, but must be considered in the context of the study design. In contrast, our randomized controlled study did not find changes in total charges, ED visits or hospitalizations. The differing conclusions suggest that a randomized controlled study with a sample size larger than our current study may be required to definitively answer the questions.

LIMITATIONS

Our study was limited to three affiliated hospitals within Baystate Health System located within a 40-mile radius of each other. We cannot exclude the possibility that patients sought care for pain-related conditions at other institutions in western Massachusetts In order to avoid "exporting" the problem to other institutions, the electronic alerts need to be adopted across a broad geographic region. The national attention on opioid use disorder and efforts by the FDA and the states to provide educational programs to limit opioid use may have impacted the numbers. In fact, both groups showed decreases in morphine mg equivalents prescribed and administered to ED and inpatients–making it more difficult to demonstrate an effect.

Table 3. Baseline comparison of primary and secondary measures per patient for the year prior to study entry.

	Usual care group (N=20)		Care plan group (N=20)		
Utilization measure per patient	*median*	*(range)*	*median*	*(range)*	P
Morphine mg equivalents					
Administered to ED/inpatients	540.7	(27.5, 1529.3)	551.2	(0.0, 5008.3)	0.45
Prescribed to discharged patients	100.0	(0.0, 757.5)	285.0	(0.0, 976.5)	0.32
Charges	$34,905	($0, $191,174)	$42,035	($2,200, $250,184)	0.59
Number of ED visits	17.5	(4, 50)	20.5	(4, 62)	0.68
Number of ED visits with CT/MRIs	5	(0, 31)	8.5	(1, 51)	0.61
Number of admissions	2	(0, 22)	2	(0, 17)	0.35

ED, emergency department; *CT,* computed tomograph; *MRI,* magnetic resonance imaging

Table 4. Proportional change in selected outcomes per patient by study group.

	Usual care group			Care plan group				
Utilization measure per patient	Pre	Post	Post/pre (%)	Pre	Post	Post/pre (%)	Ratio (95%CI)	p
Morphine mg equivalents								
Administered to ED/inpatients	343.7	54.0	15.7	329.8	15.0	4.5	0.29 (0.07, 1.12)	0.07
Prescribed to discharged patients	63.4	16.3	25.7	88.2	2.5	2.9	0.11 (0.01, 0.92)	0.04
Charges ($)	27,465	14,201	51.7	42,605	20,213	47.4	0.92 (0.31, 2.7)	0.88

ED, emergency department

Table 5. Comparison of change in utilization measures per patient over time by study group.

	Usual care group (N=20)		Care plan group (N=20)		
Utilization measure per patient	*mean*	*(95% CI)*	*mean*	*(95% CI)*	P
Number of ED visits	-12.8	(-19.8, -5.8)	-10.7	(-17.5, -4.0)	0.68
Number of ED visits with CT/MRI	-5.8	(-9.1, -2.5)	-5.7	(-10.0, -1.4)	0.98
Number of admissions	-1.3	(-2.8, 0.2)	-2.6	(-5.0, -0.2)	0.46

ED, emergency department; *CT,* computed tomography; *MRI,* magnetic resonance imaging

This should be considered to be a pilot study given the small sample size; the study has sufficient power to detect only large effects (i.e., large differences between the study groups in the change over time relative to the variability of the change) of the electronic alerts. Despite the limited power, it should be noted that, regardless of level of significance, the "Care Plan" group showed greater change in the hypothesized direction compared with the "Usual Care" group (except for number of ED visits). We suggest that a larger study will generate more precise estimates of effect.

CONCLUSION

In an effort to combat the epidemic of opioid misuse, we implemented an intervention that was designed to influence provider prescribing practices. Our results indicate that the "pushed" electronic alerts are associated with a reduction in the dosages of morphine mg equivalent opioids prescribed to high frequency ED users patients with suspected opioid use disorder. The study did not reveal a statistically significant decrease in opioids administered during ED visits and inpatient admissions. Total charges and the numbers of total ED visits, ED visits with advanced imaging (CT or MRI) and inpatient admissions were also not reduced. "Pushed" electronic alert care plans show promise as a method of curbing the prescription of opioids, although we were unable to demonstrate an impact on other utilization measures.

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Frequency of Fractures Identified on Post-Reduction Radiographs after Shoulder Dislocation

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Introduction: Most emergency physicians routinely obtain shoulder radiographs before and after shoulder dislocations. However, currently there is limited literature demonstrating how frequently new fractures are identified on post-reduction radiographs. The primary objective of this study was to determine the frequency of new, clinically significant fractures identified on post-reduction radiographs with a secondary outcome assessing total new fractures identified.

Methods: We conducted a retrospective chart review using appropriate International Classification of Diseases, 9th Revision (ICD-9) codes to identify all potential shoulder dislocations that were reduced in a single, urban, academic emergency department (ED) over a five-year period. We excluded cases that required operative reduction, had associated proximal humeral head or shaft fractures, or were missing one or more shoulder radiograph reports. All charts were abstracted separately by two study investigators with disagreements settled by consensus among three investigators. Images from indeterminate cases were reviewed by a radiology attending physician with musculoskeletal expertise. The primary outcome was the percentage of new, clinically significant fractures defined as those altering acute ED management. Secondary outcomes included percentage of new fractures of any type.

Results: We identified 185 total patients meeting our study criteria. There were no new, clinically significant fractures on post-reduction radiographs. There were 13 (7.0%; 95% CI [3.3%-10.7%]) total new fractures identified, all of which were without clinical significance for acute ED management.

Conclusion: Post-reduction radiographs do not appear to identify any new, clinically significant fractures. Practitioners should re-consider the use of routine post-reduction radiographs in the ED setting for shoulder dislocations. [West J Emerg Med. 2016;17(1):35–38.]

INTRODUCTION

Shoulder dislocations are a common emergency department (ED) presentation, affecting 1.7% of the population.[1,2] Dislocations occur due to a variety of both traumatic and atraumatic causes ranging from falling onto an outstretched arm to reaching over to pick up a telephone. Shoulder dislocations often recur, especially in young adults, so it is not unusual for a patient to present repeatedly to the ED for this problem.[1]

Most emergency physicians (EP) routinely obtain shoulder radiographs before and after shoulder dislocations to assess for persistent dislocations and fractures. Prior studies

have demonstrated that EPs are able to detect reductions clinically with excellent accuracy.[3-5] Additionally, the identification of new fractures on post-reduction imaging has been suggested to be low in prior studies, though most are limited by small sample sizes.[4-8] As a result, it has been suggested that the post-reduction radiograph may not be necessary in the ED environment.[8]

Decreasing the number of radiographs obtained would save time, reduce radiation exposure, and lower health care costs. With increased focus on cost containment, throughput times, and radiation exposure, there is a need to re-evaluate our current approach to many traditional procedures in the ED. The objective of this study was to determine the frequency of new, clinically significant fractures identified on post-reduction radiographs.

METHODS

This study was conducted in an urban, tertiary care, ED associated with an emergency medicine residency program, with an annual ED census of 120,000 patients. We conducted a retrospective chart review of all cases of shoulder dislocation seen in the ED between November 2010 (the first available electronic medical record) and March 2015. A search of all International Classification of Diseases, 9th Revision (ICD-9) discharge codes relevant to shoulder dislocation was performed to generate the initial patient list. The inclusion criteria required an evaluation in the ED for shoulder dislocation, complete medical record, and both pre- and post-reduction images. We excluded cases with missing images or those requiring operative reduction. Patients with pre-reduction fractures not described above (i.e. Hill-Sachs, Bankart, or greater tuberosity fracture) were included in this study.

Each chart was reviewed independently by two study investigators and entered into a data collection form. All disagreements were settled by consensus among three investigators. Age, sex, past medical history, reduction technique, pre-reduction radiograph findings, and post-reduction radiograph findings were all extracted and subsequently entered into the study database. Any new fractures or indeterminate cases were reviewed by an attending radiologist with musculoskeletal expertise who was blinded to the case data.

The primary outcome was the percentage of new, clinically significant fractures on post-reduction radiographs. Clinical significance was defined as a new fracture not classified as a Hill-Sachs, Bankart, or greater tuberosity fracture. Clinically significant fractures included, but were not limited to, humeral neck and shaft fractures. The decision to exclude Hill-Sachs, Bankart, and greater tuberosity fractures from the primary outcome was based upon prior evidence suggesting that these fracture types are well known to be caused by the initial dislocation mechanism and may be present in as many as two-thirds of shoulder dislocations, but are often only identified on specific orthopedic views and advanced imaging not typically performed in the ED.[9,10] This definition was in conjunction with prior studies that had also excluded these fracture types from the "clinically significant" category.[3] Moreover, these fracture types rarely affect acute ED patient management. Although identification of these fractures may increase the risk of recurrent dislocation due to joint instability, all patients were given an urgent follow-up appointment in orthopedic clinic, so it was not anticipated to alter the acute treatment or follow-up plan. The secondary outcome assessed the percentage of newly identified fractures of any type.

We calculated a sample size of 180 subjects based upon a 90% power with a two-tailed alpha=0.05 to detect a maximum new fracture rate of 3%. We performed all of the statistical analyses included in this study using Statistical Package for the Social Sciences (Version 21.0. Armonk, NY). Descriptive statistics, including population estimates at a 95% level of confidence were generated for percentage of new clinically significant fractures and percentage of total new fractures.

This study was conducted with adherence to the Statement for Reporting Studies of Diagnostic Accuracy (STARD) criteria.[11] The local institutional review board approved this study.

RESULTS

During the study period, we identified 296 patients with an ICD-9 code suggesting shoulder dislocation. Of these cases, full chart review identified 185 patients meeting the study criteria. We excluded 111 patients after initial chart review for the following reasons: 70 patients had isolated acromioclavicular joint separation or an already reduced shoulder dislocation prior to arrival; 21 patients had missing or inadequate imaging; eight patients were reduced in the operating room; six left the ED prior to having their shoulder reduced; and six records were duplicates of the same patient encounter (Figure 1).

Of the remaining 185 patients, the average age was 39 years (range: 16 to 85 years) and 80% were male. Ninety patients (48.6%) had a history of prior dislocation of the same shoulder joint. One hundred thirty-five patients (73.0%) had the reduction technique(s) described. Of these patients, 74 (54.8%) were reduced with the Kocher technique, 53 (39.2%) were reduced with traction/counter-traction, 24 (17.8%) were reduced with scapular manipulation, 14 (10.4%) were reduced with the FARES technique, eight (5.9%) were reduced with the Milch technique, five (3.7%) were reduced with the Cunningham technique, and three (2.2%) were reduced with the Stimson technique. Thirty patients (22.2%) were reduced using multiple of the aforementioned techniques.

There were no new, clinically significant fractures. There were 13 (7.0%; 95% CI [3.3%-10.7%]) total new fractures identified. Of these new fractures, 12 (6.5%) were Hill-Sachs deformities and four (2.2%) were Bankart fractures. All patients with fractures identified on post-reduction radiograph

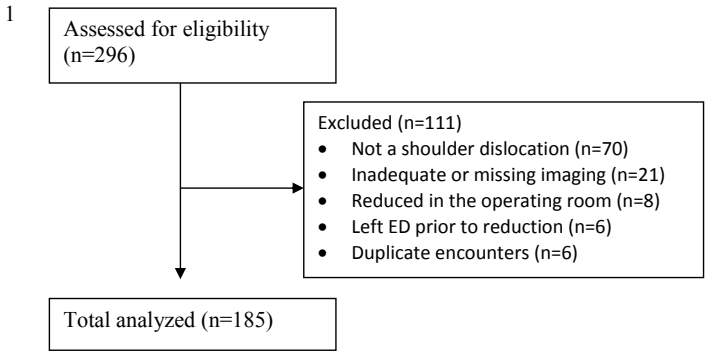

Figure 1. STROBE flow diagram.

received urgent orthopedic surgery follow up and none underwent surgical intervention.

DISCUSSION

Many physicians routinely obtain shoulder radiographs before and after reduction of shoulder dislocations. However, there is questionable yield with such practice. Given increasing pressure to reduce costs, radiation exposure, and turnaround times, this is an area that may significantly benefit from reduced imaging.

Prior studies have assessed similar aspects in an attempt to reduce the number of pre- and post-reduction radiographs obtained. The first publication was a retrospective analysis of 69 total dislocations identifying no clinically significant post-reduction fractures.[6] Hendey and Kinlaw[3] performed a subsequent retrospective analysis in 1996 demonstrating no clinically significant new fractures among 175 patients, while both Shuster[4] and Hendey[5] prospectively assessed this with smaller groups in 1999 demonstrating no clinically significant fractures in two separate studies of 45 and 98 patients, respectively. Finally, Hendey[7] and Kahn[8] both noted similar results in 2006 as secondary outcomes in two separate studies of 30 and 40 patients, respectively.

Our study was the largest analysis to date, consisting of 185 patients from a different patient population than most prior studies. Our patient population was urban, predominately uninsured, and of an older age group than prior studies. Additionally, we assessed this with more recent radiographic technology, which may allow for improved sensitivity compared with that of 20 years prior. We identified no new clinically significant fractures in our patient population, further strengthening existing data identifying the low utility of post-reduction radiographs for shoulder dislocations. Although there were 13 new fractures identified on the post-reduction radiograph, the majority were Hill-Sachs and Bankart fractures, which are well known to be caused by the initial dislocation and often not visible on the initial pre-reduction films.[9,10] Identification of these fractures may increase the risk of recurrent dislocation due to joint instability. However, as all patients were given an urgent follow-up appointment in orthopedic clinic, it did not alter the acute ED treatment or follow up. Additionally, there is no set cutoff with regard to Hill-Sachs or Bankart deformities that triggers operative management, and most operative decisions are made in conjunction with the patient age, physical examination, and response to conservative treatment.[9] Screening for Hill-Sachs or Bankart lesions post-reduction may be performed as an outpatient to improve ED flow.

Some physicians may not feel comfortable confirming shoulder reduction on physical examination alone. However, prior research has demonstrated that physical examination is reliable for confirming reduction.[3-5] Moreover, a recent study of 73 patients demonstrated that ultrasound could reliably confirm both dislocation and reduction with 100% accuracy.[12] Nonetheless, in cases where the physician is unsure of the reduction, post-reduction radiographs should be obtained.

LIMITATIONS

One limitation of this study was the use of a retrospective design. Consequently, the decision to obtain imaging was dependent upon the clinical judgment of the involved providers, which may have led to a selection bias. However, only 21 patients (7.1%) identified by the study protocol did not have adequate pre-reduction and post-reduction imaging. Additionally, by using a chart review technique and searching by ICD-9 codes, it is possible that some cases may have been missed. However, given the breadth of ICD-9 codes used, it is unlikely to have been a significant proportion of cases and there is no reason to suggest that the missed patients would be substantially different than the included cases. Further, reduction techniques were not documented for some patients. However, as the primary outcome was the number of clinically significant fractures, this information was not critical to the study. Finally, many pre-reduction radiographs were missing either a lateral or scapular Y-view, which may have caused the initial fracture to be missed. If this occurred, it would have decreased the rate of new fractures, which would serve to strengthen our current conclusion.

CONCLUSION

Post-reduction radiographs do not appear to identify any new clinically significant fractures. Practitioners should re-consider the use of routine post-reduction radiographs in the ED setting for shoulder dislocations.

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Identifying Frequent Users of an Urban Emergency Medical Service Using Descriptive Statistics and Regression Analyses

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This retrospective cohort study provides a descriptive analysis of a population that frequently uses an urban emergency medical service (EMS) and identifies factors that contribute to use among all frequent users. For purposes of this study we divided frequent users into the following groups: low-frequent users (4 EMS transports in 2012), medium-frequent users (5 to 6 EMS transports in 2012), high-frequent users (7 to 10 EMS transports in 2012) and super-frequent users (11 or more EMS transports in 2012). Overall, we identified 539 individuals as frequent users.

For all groups of EMS frequent users (i.e. low, medium, high and super) one or more hospital admissions, receiving a referral for follow-up care upon discharge, and having no insurance were found to be statistically significant with frequent EMS use ($P<0.05$). Within the diagnostic categories, 41.61% of super-frequent users had a diagnosis of "primarily substance abuse/misuse" and among low-frequent users a majority, 53.33%, were identified as having a "reoccurring (medical) diagnosis." Lastly, relative risk ratios for the highest group of users, super-frequent users, were 3.34 (95% CI [1.90-5.87]) for obtaining at least one referral for follow-up care, 13.67 (95% CI [5.60-33.34]) for having four or more hospital admissions and 5.95 (95% CI [1.80-19.63]) for having a diagnoses of primarily substance abuse/misuse.

Findings from this study demonstrate that among low- and medium-frequent users a majority of patients are using EMS for reoccurring medical conditions. This could potentially be avoided with better care management. In addition, this study adds to the current literature that illustrates a strong correlation between substance abuse/misuse and high/super-frequent EMS use. For the subgroup analysis among individuals 65 years of age and older, we did not find any of the independent variables included in our model to be statistically significant with frequent EMS use. [West J Emerg Med. 2016;17(1):39–45.]

INTRODUCTION

There have been several attempts to define the term emergency medical services (EMS) "frequent users" in regards to both frequency and reasons for use. Many studies have defined them as individuals with anywhere between three to nine emergency department (ED) visits in a year.[1] The Rhode Island State Department of Health defines frequent EMS users as having needed four or more 911 ambulance transports in one calendar year. Squire et. al[2] and Rucker et. al[3] found that a greater proportion of individuals frequently transported by ambulance were individuals 65 years or older and Medicare recipients. The most common complaints during transports included chest pain, abdominal pain, and shortness of breath.[4-6]

Recently, there has been a growing focus on reducing the number of frequent users as a means of decreasing healthcare costs. The United States Government Accountability Office estimated that a single ground ambulance transport cost from

$224 to $2,204 in 2010.[7] In that same year the Centers for Medicare & Medicaid Services (CMS), the largest single payer for ambulance transports, spent $5.2 billion to cover EMS-related fees and services.[7] In an attempt to control spending on EMS, especially unreimbursed transport, many cities, states and communities have designed and implemented EMS diversion programs to provide appropriate and cost-effective alternatives for patients with non-emergent and chronic issues. Dunford et al[8] found that diverting chronic alcoholics with high EMS and ED utilization to non-ED treatment services reduced EMS transports by 50% and resulted in a $5,662 decrease in total monthly EMS charges for those accepting treatment, as well as reducing the "revolving door" effect between jail and frequent ED visits. In Baltimore, Maryland, Rinke et al[9] showed that improved case management for 10 frequent EMS users decreased each individual's EMS transports by 32% on average, resulting in an estimated net savings of $14,461.

Providence, Rhode Island, has the state's highest volume of 911-dispatched EMS calls, the majority of which are handled by the city's fire department. In 2009, Providence Fire responded to 43,000 calls, most of them medical.[10] Overall, the department consists of six rescue companies with engine response and transport of a significant number of adult patients to two major hospitals in the city. Both are nonprofit teaching hospitals affiliated with Warren Alpert Medical School of Brown University. The larger of the two hospitals consist of 719 beds and serves as the Level I trauma center for southeastern New England.

Study Objectives

Although many EMS caregivers can anecdotally identify frequent users of their services, there are few attempts in the literature to systematically examine frequent users' common features and reasons for use. This knowledge may assist healthcare leaders in developing and implementing appropriate interventions to control EMS overuse and contain healthcare costs in the face of constricting municipal budgets. Our objective was to clearly define and describe characteristics of frequent EMS users in order to provide suggestions for efficient and cost-effective interventions that address the healthcare needs of this vulnerable population.

METHODS

Study Sample

We defined frequent users using the Rhode Island State Department of Health's criteria. The criteria are based on previous literature reporting ED overuse and was reported in the Special Senate Commission to Study Rhode Island Emergency Department Room Diversion in February 2012. Adults with four or more 911-dispatched EMS transports to the ED in 2012 were identified from EMS records (station logs and compiled run reports) provided by Providence Fire. Each identified patient was matched to hospital ED discharge data found within the ED electronic health record (EHR). In order to focus on only individuals with four or more 911 EMS transports, other ED visits resulting from the following transport types were removed: internal (2), car (2), police transported (177), transfer (1), walk-in (2344), unknown (442).

Extracting Medical Records

With approval from the local institutional review board we electronically extracted the following data from the hospital EHR for all patients identified as frequent users of EMS: date of birth, gender, diagnosis, arrival method, outcome (discharged or admitted), arrival time, departure time, referral for follow-up care, payer name and payer description.

Cleaning/Preparing Data

We created a de-identified database with patient names replaced with unique identifiers, and dates of birth converted to ages. Ten variables were created for the study: (1) age, (2) gender, (3) total number of ED visits, (4) total number of EMS transports, (5) diagnostic category, (6) insurance status, (7) referral for follow-up care (yes or no), (8) time of EMS transport, (9) number of inpatient admissions, and (10) average length of ED stay in minutes. We created six diagnostic categories for the study:

1. Primarily mental health (MH)
2. Primarily substance abuse (SA)
3. Multiple medical
4. Multiple medical with MH/SA
5. Reoccurring diagnosis
6. Reoccurring diagnosis with SA/MH

For purposes of this study we obtained all discharge data used from ED discharges. Patients categorized under "primarily mental health" or "primarily substance abuse" had discharge diagnosis terms related to MH and SA (Table 1) appear at least 50% of the time for all EMS transports. Cases identified as "multiple medical" had no one diagnostic term show up 50% or more times. And those categorized under "reoccurring diagnosis" had the same or similar diagnostic term show up 50% or more times for all EMS transports. Lastly, patients categorized as "multiple medical with substance abuse/mental health" or "reoccurring diagnosis with substance abuse/mental health" followed the same guidelines as previously mentioned but included more than one SA or MH diagnosis. In situations where the reoccurring diagnosis and a SA or MH diagnosis appear both 50% of the time and an equal number of times, the patient was categorized as "reoccurring diagnosis with substance abuse/mental health."

Options for insurance status included Medicaid, Medicare, none and other. We could not delineate commercial insurances since it was not always clear from the discharge data provided. Therefore, we combined commercial insurances and other

Table 1. Examples of diagnoses and diagnostic categories in frequent users of emergency medical services.

Diagnostic categories	Diagnoses
Substance misuse/abuse diagnoses	alcohol (intoxication, abuse, withdrawal, dependence, overdose, gastritis), cocaine abuse, heroin, and drug abuse, ingestion, dependence – not defined
Medical diagnoses	abdominal pain, chest pain, headache, pain (i.e. back, neck, arm, hip), abscess, respiratory (asthma, allergy, shortness of breath, infection), COPD, cellulitis, congestive heart failure, cirrhosis, gastrointestinal (colitis, diarrhea, constipation), dental, seizures (epileptic, general, etc.), dizziness, fall, hyper and/ or hypoglycemia, syncope, nausea and/or vomiting, weakness, urinary tract infection
Mental health diagnoses	depression, adjustment disorder, disturbance of conduct, stress, anxiety, agitation, bipolar disorder, altered mental status

COPD, chronic obstructive pulmonary disease

non-Medicare/Medicaid insurances under the category of other. Individuals with a status of "none" had neither an insurance payer nor insurance description listed. For patients with different insurers listed across visits, the patient was classified by insurer most often under payer description.

Referral for follow-up care was coded as "Yes" or "No" and dependent on whether or not an individual was referred to a physician at least once after any EMS-transported ED visit. Time of transport was coded as "AM", "PM" or "EQUAL." Individuals with "AM" transports had a majority of transports occur between 7:00AM and 6:59PM. Individuals with "PM" transports had a majority of transports occur between 7:00PM and 6:59AM. And lastly, those categorized as "EQUAL" had an even number of AM and PM transports. We calculated total number of admissions for each patient, and based on the total, patients were assigned to one of the three categories, "0 admissions", "1 to 3 admissions" or "4 or admissions." Lastly, average length of stay was calculated for each patient but only for visits that originated from an EMS transport.

Statistical Analysis

We performed statistical analysis with Stata 12.0 (StataCorp College Station, TX).

Variables were created for gender, age, referral for follow-up care, number of admissions, diagnostic category, and number of EMS transports, insurance status, and average length of visits. The variable age was divided into the following categories: 18-24, 25-34, 35-44, 45-54, 55-64, and 65+. We divided the number of EMS transports into quartiles and defined as "low-frequent users" (4 EMS transports), "medium-frequent users" (5 to 6 EMS transports), "high-frequent users" (7 to 11 EMS transports) and "super-frequent users" (11 EMS transports or more).

Additionally, we conducted a regression analysis with indicator variables, for the outcome/dependent variable (number of EMS transports) and the independent variables. Statistical significance was set at less than alpha 0.05. Additional, analyses included a multinomial logistic regression, which provided relative risk ratios (RRR) and regression analysis for a subset of the population, individuals 65 years of age and older. Lastly, we calculated kappa statistic to test inter-rater agreement for how patients were categorized into diagnostic groups. For the kappa statistic we tested a random 10% sample of patients. Between the two raters there was 96.23% agreement and kappa equaled 0.9491.

RESULTS

We identified 539 patients and 6,425 individual discharge diagnoses as solely EMS arrivals, out of an initial pool of 643 patients and 9,616 individual discharge diagnoses of frequent users. The number of EMS transports per frequent-user patient ranged from four to 270 in one year. There were more males in all groups of frequent users and the greatest disproportion was found among super-frequent users (68.5% male vs. 31.5% female). Patient ages ranged from 18 to 98 years. In the medium-, high-, and super-frequent user groups the age range most frequently represented was 45-54 years. The most frequent age range in the low=frequent user group was individuals 65 years and older (Table 2).

Thirty percent of all frequent users in this study were most often transported for reasons related to substance abuse and/ or misuse, with the majority being alcohol related. Twenty-eight percent fell into the "reoccurring diagnosis" group (same or similar medical condition). Finally, 21% made up the "multiple medical" group.

Among low-frequent users the most common diagnostic category was "reoccurring diagnosis" with no substance abuse/misuse or mental health. A substantial number of low-frequent users received no referral for follow-up care upon discharge (72.38%), and a majority had one to three hospital admissions over the course of a year. Having four or more hospital admissions, a diagnostic category of "primarily substance abuse/misuse," no insurance status, at least one referral for follow-up care upon discharge, and being 65 years of age and older were all associated with an increased relative risk of EMS transport for these low-frequent users.

The super-frequent user category had a higher frequency of four or more admissions, a higher percentage of individuals with primarily substance abuse/misuse diagnoses (41.61%) and a higher frequency of being referred for follow-up care. Individuals identified as super-frequent users had high RRR pertaining to diagnostic category, hospital admissions and referral for follow-up care. The RRR for those with no hospital admissions relative to those with four or more admissions was 13.67 (95% CI [5.60-33.34]) among super-frequent users compared to medium-frequent users, holding

Table 2. Demographic and clinical characteristics for frequent users with varying degrees of EMS utilization in 2012.

Characteristic	Low FrU	Medium FrU	High FrU	Super FrU
Gender				
Male	50.48% (53)	50.99% (77)	54.48% (73)	68.46% (102)
Female	49.52% (52)	49.01% (74)	45.52% (61)	31.54% (47)
Age				
18-24	5.71% (6)	5.30% (8)	2.24% (3)	3.36% (5)
25-34	10.48% (11)	10.60% (16)	8.21% (11)	8.72% (13)
35-44	19.05% (20)	14.57% (22)	17.91% (24)	19.46% (29)
45-54	25.71% (27)	24.50% (37)	33.58% (45)	38.26% (57)
55-64	10.48% (11)	23.84% (36)	20.15% (27)	22.15% (33)
65+	28.57% (30)	21.19% (32)	17.91% (24)	8.05% (12)
Patient category				
Primarily MH	6.67% (7)	9.93% (15)	6.72% (9)	4.03% (6)
Primarily SA	19.05% (20)	23.18% (35)	34.33% (46)	41.61 % (62)
Multiple medical	16.19% (17)	28.48% (43)	24.63% (33)	16.11% (24)
Multiple medical with SA/MH	4.76% (5)	7.95% (12)	9.70% (13)	18.12% (27)
Reoccurring dx	53.33% (56)	29.14% (44)	20.90% (28)	16.11% (24)
Reoccurring dx with SA/MH	0.00% (0)	1.32% (2)	3.73% (5)	4.03% (6)
Insurance status				
Medicare	49.52% (52)	48.34% (73)	41.04% (55)	44.30% (66)
Medicaid	35.24% (37)	42.38% (64)	46.27% (62)	51.01% (76)
Other	9.52% (10)	8.61% (13)	10.45% (14)	4.03% (6)
None	5.71% (6)	0.66% (1)	2.24% (3)	0.67 (1)
Referral for follow-up care (at least one?)				
Yes	27.62% (29)	34.44% (52)	41.79% (56)	51.68% (77)
No	72.38% (76)	65.56% (99)	58.21% (78)	48.32% (72)
Admissions (number of times admitted)				
0	30.48% (32)	25.17% (38)	20.15% (27)	17.45% (26)
1 to 3	56.19% (59)	50.33% (76)	38.81% (52)	36.91% (55)
4+	13.33% (14)	24.50% (37)	41.04% (55)	45.64% (68)

EMS, emergency medical services; *dx*, diagnosis; *FrU*, frequent users; *MH*, mental health; *SA*, substance abuse

other variables constant. The RRR for those with primarily mental health diagnoses relative to those with primarily substance abuse diagnoses was 5.95 (95% CI [1.80-19.63]) among super-frequent users compared to medium-frequent users holding other variables constant. Finally, the RRR for those with no referral for follow-up care relative to those with at least one referral was 3.34 (95% CI [1.90-5.87]) among super-frequent users compared to medium-frequent users, holding the other variables constant.

Additional analysis looked at use data among individuals 65 years of age and older. No patient characteristics were identified as significant in this unique group.

DISCUSSION

Frequent EMS users are a diverse group of individuals with a wide array of medical, behavioral and social challenges. We found that the largest group of super-frequent users consisted of individuals with repeated substance misuse diagnoses. This aligns with several studies[3,8,9] identifying reasons for frequent use among high ED and EMS users. Despite many challenges, a number of interventions have been implemented to target frequent users with substance abuse issues. One combination of weekly medical and psychological case management resulted in an overall 32% decrease in EMS use among a study of 10 frequent users.[9] Providing this combination of medical and psychological care may be costly due to the intensity of care and services being provided, but it has the potential to result in better healthcare and perhaps long-term savings in healthcare costs. This merits further study.

The next largest groups of frequent users we studied presented for recurrent medical conditions such as chronic obstructive pulmonary disease (COPD) and chronic abdominal pain. Some of these conditions may be better managed with improved primary care and self-management. The Cochrane Collaboration reviewed a number of studies pertaining to COPD self-management and found that with improved self-management there was a reduction in at least one hospital visit in one year.[11] Still, because of the lack of randomized controlled trials and the potential for a number of external factors to influence health outcomes Cochrane did not provide a definitive conclusion on how self-management impacts COPD outcomes. In another review investigating the outcomes of self-management and CHF, researchers found that among 857 patients, self-management care reduced "all-cause" hospital readmissions, as well as "heart failure" readmissions, and resulted in a savings of $1,300 to $7,515 per patient per year.[12]

Primary care is another important component to improving medical outcomes and has become the focus of a number of attempts to reduce EMS overuse. Community paramedicine or mobile integrated health (CP/MIH) is one model of community-based healthcare that could potentially reduce costs and transport. The model was developed to use EMTs with additional training to fill in healthcare gaps in collaboration with services such as home care, visiting nurses, or primary care access to address non-emergent conditions in a non-transport capacity.[13]

Referral for follow-up care actually increased among individuals whose intensity of EMS use increased. Although it is difficult to extract the reasons for referrals from the limited data provided, it is possible that more referrals may indicate a sicker population. The same may be true for hospital admissions. Results from our data show that high- and super-frequent users have the highest number of hospital admissions with admissions increasing with increased EMS utilization. In addition, increased hospital admissions significantly increased the risk of being a frequent user.

Men tended to make up a higher percentage of frequent users than women with the percentage growing with increasing EMS use. Men tend to have higher incidence of risky behavior (i.e. substance abuse/misuse and dangerous social/physical activities) compared to women, which may explain why men made up a larger percentage of high- and super-frequent users.[14]

The majority of frequent users were Medicare recipients. This came as a surprise since the majority of frequent users were under 65. However, it is possible that a number of individuals in our study were disabled, which would also allow them to qualify for Medicare.

Lastly, among all levels of EMS utilization, the largest number of frequent users fell between the ages of 45 and 55. The highest percentage of elderly (greater than 65 years of age) was found in the low- and medium-frequent user category. Frequent transports may be a result of the elderly being a sicker population or having a number of comorbidities.

In order to improve care for frequent users interventions may require components of both primary/preventative care and self-management education, involvement of social work and case management resources, and increased use of EMTs trained as community paramedics to provide care in the field. Future research needs to explore unique sub-populations of interest (i.e. elderly, specific reoccurring diagnoses, etc.) for potential tailored strategies to decrease EMS utilization.

LIMITATIONS

There are a number of limitations to this study. Many of the diagnoses provided in the EHR discharge data were actually symptoms rather than true medical conditions. This made it difficult to identify frequent users' true underlying medical conditions. In addition, the ED discharge diagnosis may not have been the initial reason for the patient's call or match up with the chief complaint recorded by the EMS provider. Another limitation was the fact that insurance information was often missing, unclear, or incomplete. Limited insurance data made it difficult to identify whether individuals with no insurance information truly lacked insurance or simply failed to have this information recorded. Testing several independent variables simultaneously increases the probability of obtaining a false-positive correlation and a Type I error.

Lastly, though studies show that age increases the risk of EMS transport, we did not find this effect in our study.[4] This could be a result of our small subgroup size, 98 patients. We may also have to reconsider the variables used in our model and identify other factors that more strongly influence frequent EMS use among elderly populations, such as having in-home care or lack of personal transportation.

CONCLUSION

EMS frequent users are a wide spectrum of individuals with an even greater range of underlying reasons for high EMS use. This study demonstrates that among low- and medium-frequent users a majority of patients are using EMS for reoccurring medical conditions. In addition, this study adds to the current literature that illustrates a strong correlation between substance abuse/misuse and high/super-frequent EMS use. Strategies to improve care of chronic medical conditions and direct resource utilization to theses efforts has the potential to reduce the burden of EMS use of this group and possibly improve their health.

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Point-of-Care Multi-Organ Ultrasound Improves Diagnostic Accuracy in Adults Presenting to the Emergency Department with Acute Dyspnea

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Introduction: Determining the etiology of acute dyspnea in emregency department (ED) patients is often difficult. Point-of-care ultrasound (POCUS) holds promise for improving immediate diagnostic accuracy (after history and physical), thus improving use of focused therapies. We evaluate the impact of a three-part POCUS exam, or "triple scan" (TS) – composed of abbreviated echocardiography, lung ultrasound and inferior vena cava (IVC) collapsibility assessment – on the treating physician's immediate diagnostic impression.

Methods: A convenience sample of adults presenting to our urban academic ED with acute dyspnea (Emergency Severity Index 1, 2) were prospectively enrolled when investigator sonographers were available. The method for performing components of the TS has been previously described in detail. Treating physicians rated the most likely diagnosis after history and physical but before other studies (except electrocardiogram) returned. An investigator then performed TS and disclosed the results, after which most likely diagnosis was reassessed. Final diagnosis (criterion standard) was based on medical record review by expert emergency medicine faculty blinded to TS result. We compared accuracy of pre-TS and post-TS impression (primary outcome) with McNemar's test. Test characteristics for treating physician impression were also calculated by dichotomizing acute decompensated heart failure (ADHF), chronic obstructive pulmonary disease (COPD) and pneumonia as present or absent.

Results: 57 patients were enrolled with the leading final diagnoses being ADHF (26%), COPD/asthma (30%), and pneumonia (28%). Overall accuracy of the treating physician's impression increased from 53% before TS to 77% after TS (p=0.003). The post-TS impression was 100% sensitive and 84% specific for ADHF.

Conclusion: In this small study, POCUS evaluation of the heart, lungs and IVC improved the treating physician's immediate overall diagnostic accuracy for ADHF, COPD/asthma and pneumonia and was particularly useful to immediately exclude ADHF as the cause of acute dyspnea. [West J Emerg Med. 2016;17(1):46–53.]

INTRODUCTION

Rapid and accurate diagnosis of the acutely dyspneic patient in the emergency department (ED) is both essential and challenging. Two of the most common causes, acute decompensated heart failure (ADHF) and chronic obstructive pulmonary disease (COPD), differ greatly in both their

pathophysiology and treatment, but are often difficult to distinguish clinically in the ED setting.[1-5] Numerous studies indicate that the physical exam, even with the addition of chest radiography, is often inaccurate in differentiating ADHF from COPD/asthma.[1,3-6] Moreover, results of advanced diagnostic imaging (computed tomography, consultative echocardiography) and blood tests (particularly brain naturietic peptide [BNP]) are not available during the critical first minutes. Thus, the emergency physician (EP) is often forced to initiate treatment before the etiology of the patient's respiratory distress can be clearly defined.

Point-of-care ultrasound (POCUS) is emerging as a powerful tool for rapid diagnostic evaluation of ED patients presenting with undifferentiated dyspnea. ADHF, COPD/asthma and other common causes of acute dyspnea all show characteristic findings on POCUS examination of the heart, lungs and inferior vena cava (IVC).[7-11] However, prior studies looking at the examination of each organ individually have generally reported a low specificity in differentiating ADHF from other causes of acute dyspnea.[2,12-14] There are limited data on a combined POCUS examination of the heart, lungs and IVC.[15,16] We have developed and refined a rapid multi-organ exam, dubbed "triple scan" (TS), composed of abbreviated echocardiography, lung ultrasound (US) and IVC exam, which can easily be performed by EPs at the bedside of the acutely dyspneic patient.

If the addition of the TS to the history and physical improves the accuracy of the EP's initial diagnostic impression, its routine use could greatly improve the emergency management of acutely dyspneic patients. The goal of our study was to compare the accuracy of the treating EP's diagnostic impression before and after results of the TS were available, as compared to final diagnosis.

METHODS

This was a prospective cohort study involving a convenience sample of ED patients with acute dyspnea. Patients were enrolled from December 2011 through September 2012 in the ED at Alameda Health System – Highland Hospital, an urban academic hospital with approximately 90,000 patient visits per year. During the study period there were a total of 466 patients seen in our ED who were coded as Emergency Severity Index (ESI) level 1-3 acuity presenting with the triage complaint of shortness of breath, asthma, COPD, or congestive heart failure (CHF). Of these patients, it is unknown how many met our specific vital sign inclusion criteria for enrollment.

Criteria for enrollment included age >17 years, a chief complaint of shortness of breath, need for immediate medical intervention to prevent clinical deterioration as judged by the treating physician, and signs of acute respiratory distress at triage, including at least one of the following: respiratory rate >20 breaths per minute; heart rate >100 beats per minute; pulse oximetry <94% on room air. Patients were excluded if the cause of the respiratory distress was associated with trauma or they were able to clearly tell the treating physician what was causing their dyspnea (recurrent asthma, known heart failure, etc.). A post-hoc analysis confirmed that all subjects were ESI level 1 or 2. Patients were enrolled prospectively when any of three EP investigators were available in the ED. These investigator sonologists, two US fellowship-trained attendings and one US fellow, either performed or directly supervised all TS exams. Treating physicians who provided the diagnostic impression could be senior (third- or fourth-year) emergency medicine (EM) residents or attending physicians. Study investigators could enroll patients while on attending shifts; however, in these cases the diagnostic impressions were decided by the treating resident (not the study investigator).

The study protocol was approved by the hospital's institutional review board. Written consent was obtained from all patients or their healthcare surrogates. Since US evaluations were already considered standard during resuscitations of acutely dyspneic patients, consent for enrollment was obtained after US evaluation and medical stabilization. The TS was performed and images recorded during or immediately after the initial history and physical exam. We used phased array (5-1MHz) and curvilinear (5-2MHz) transducers, at the discretion of the sonologist (SonoSite, Bothell, WA; Micromaxx™, M-Turbo™, or S-FAST™). Although the exact duration of the TS was not documented, exams were generally completed in less than two minutes.

Echocardiography

We obtained a standard parasternal long axis view and additional parasternal short, subxyphoid, and/or apical four-chamber views as needed. We assessed (a) gross left ventricular ejection fraction, categorized as either normal, poor, or hyperdynamic, estimated by visual gestalt; (b) presence or absence of pericardial effusion and, if present, signs of tamponade physiology (primarily right ventricular diastolic collapse); and (c) presence or absence of right ventricular enlargement (estimated right ventricular chamber size equal to or greater than left ventricular chamber size). This abbreviated echocardiography approach has been previously described in detail by others.[10,17]

Lung Ultrasound

A) Using only the bilateral anterior lung windows (representing four lung zones),[18] we assessed whether there was predominantly an A-line or B-line (indicating abnormal pulmonary fluid) pattern, as described by Lichtenstein.[19]

B) We also scanned the lateral chest superior to the hemidiaphragms for the presence or absence of pleural effusions, but were not evaluated for the presence of A or B lines.[18]

C) We assessed pleural sliding on 2D and M-mode as needed over the anterior lung fields to exclude pneumothorax.

Inferior Vena Cava

We obtained either a subxyphoid or right lateral view

of the IVC approximately 2cm proximal to the hepatic vein confluence and assessed for IVC collapse during inspiration. The IVC was categorized as plethoric (less than 15% collapse), flat (>90% collapse), or normal (15%-90% collapse), using gross visual estimation.

Study investigators agreed a priori on the ultrasonographic features of the three main diagnoses so that TS results were presented to the treating physician in as standardized a way as possible. ADHF was defined as the presence of B-lines in bilateral anterior lung fields, poor cardiac function, and a non-respirophasic IVC. COPD was suggested by the absence of B-lines in the anterior lung fields with normal or diminished cardiac function and either a non-respirophasic or flat IVC. Examples of sonographic findings in ADHF and COPD are shown in Figure 1. Pneumonia was diagnosed when unilateral B-lines or consolidations were noted on lung US in the setting of hyperdynamic or normal cardiac function and non-plethoric IVC.

After performing a history and physical examination but prior to the TS, and prior to return of other imaging and laboratory results, treating physicians ranked the three most-likely etiologies of the dyspnea (their "pre-TS impression") and graded their confidence in the leading diagnosis using a Likert scale (1 least confident to 5 most confident). The number one diagnosis was considered the primary impression. We chose, a priori, eight distinct diagnostic categories as the etiology for dyspnea: ADHF, COPD/asthma, pneumonia, acute respiratory distress syndrome (ARDS), pleural effusion, pericardial effusion, pneumothorax, and pulmonary embolism. The treating physicians could also specify a diagnosis other than one of these eight, which was categorized as "other." Afterwards, the TS was performed by the investigator sonologist. The images were recorded and the sonographic findings were shown to the treating physician, after which the treating physician was again asked to rank their "post-TS impression" and their confidence. The primary outcome measure was the difference in accuracy of the treating physicians' primary impressions before and after TS. Accuracy was defined as number of cases with correct primary diagnostic impression over total number of cases. We also assessed the test characteristics of treating physician impression for diagnosing ADHF, asthma/COPD and pneumonia before and after TS. We chose these three diseases because they are the most common causes of undifferentiated dyspnea in our ED.

Final diagnosis (criterion standard) was determined by medical record review by two independent senior EM attending physicians with an interest in cardiopulmonary diseases, who had not been involved in patient enrollment. These reviewers were provided with copies of the electronic medical record, including the ED chart, the admitting physician history and physical, all laboratory and radiology reports, consultative echocardiography results, pulmonary function tests, hospital discharge summary and final hospital discharge diagnosis. Only the results of the TS were redacted from the ED chart (blinding to TS result). Reviewer final diagnosis was unstructured and written on a simple data collection sheet. A third chart reviewer was available to adjudicate any disagreement on the final diagnosis, but this was not needed as the reviewers agreed in every case.

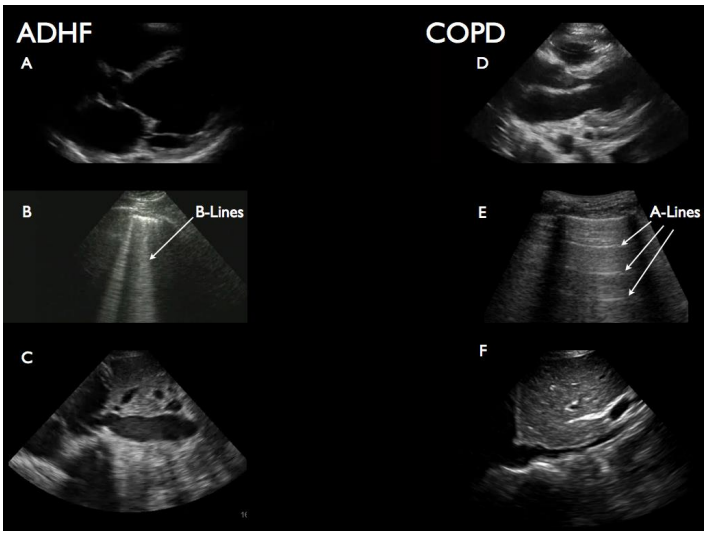

Figure 1. Typical findings on "triple scan" (TS) in acute decompensated heart failure (ADHF) and chronic obstructive pulmonary disease (COPD)/asthma. Images a-c show typical findings of ADHF: dilated left ventricle with poor mitral valve opening (a); vertical b-line artifacts in this case indicating excess lung water (b); dilated inferior vena cava (IVC [lacking respiratory variation]) (c). Images d-e show typical findings in COPD/asthma: normal left ventricle (often hyperdynamic) (d), horizontal a-line artifacts indicating hyperinflation (e) and normal IVC (f).

We estimated that the treating physician would correctly identify the primary cause of dyspnea 60% of the time. Assuming a power of 0.80, with alpha =0.05, we calculated that we would need to enroll 57 patients to show a 25% improvement in identifying the correct diagnosis after addition of the TS. We report proportions for demographic and clinical variables, means for normally distributed continuous variables (age), and median scores for diagnostic confidence on a five-point Likert scale. McNemar's test was used to compare correct and incorrect provider impressions pre- and post-TS. We compared pre-TS and post-TS provider impressions as well as diagnostic confidence scores using the Fisher's exact chi-squared test because of small numbers of observations within some cells. We considered $p<0.05$ to be statistically significant. We calculated test characteristics of provider primary impression by dichotomizing the pre-TS and post-TS impressions and final diagnoses to presence or absence of CHF, then to presence or absence of COPD/asthma and then to presence or absence of pneumonia. We report sensitivity, specificity, positive predictive value, negative predictive value, as well as positive and negative likelihood ratios with 95% CIs for each. Statistical analysis was done using Stata SE version 11 (StataCorp, College Station, TX)

RESULTS

We enrolled a total of 57 patients with acute dyspnea who met the inclusion criteria. Patient characteristics, clinical course and final diagnoses are presented in Table 1. Twenty-nine of 57 (57%) patients required non-invasive positive pressure ventilation, 48 (84%) were admitted to the hospital and six (10%) to the intensive care unit. Specific ultrasonographic findings among the cohort are listed in Table 2.

Diagnostic accuracy, our primary outcome, improved from 53% before TS to 77% after TS (p=0.003). Case level data, showing the final diagnosis in each case and comparing it to the treating physician's primary impression (diagnosis rated as most likely), before and after TS, is presented in Figure 2. The treating physician's primary impression changed after TS in 27 of 57 (47.3%) cases. In 17 of 57 (29.8%) cases, an incorrect impression (pre-TS primary impression not matching the final diagnosis) was changed to the correct diagnosis, whereas in three of 57 (5.2%) of cases the opposite occurred and the treating physician changed a correct impression to an incorrect one. Treating physician's confidence in their clinical impressions, rated on a five-point Likert scale, improved significantly after the TS (median score 3 before TS versus 5 after TS; p=0.017).

Table 3 compares the test characteristics of the treating physician's impression, before and after the TS, for diagnosis of ADHF, COPD/asthma and pneumonia. For ADHF, addition of the TS improved the point estimates for both sensitivity (73.3% to 100%) and specificity (78.6% to 95.2%) of the treating physician's impression. For asthma/COPD the specificity of the impression increased (80.0 to 93.3%), while the sensitivity decreased (76.5% to 64.7%). For pneumonia, sensitivity increased markedly (31% to 100%) while specificity decreased somewhat (90% to 83%). Because of the broad CIs around point estimates, only the improvement in sensitivity for pneumonia reached statistical significance.

Table 1. Patient characteristics, clinical course and final diagnoses in a study evaluating utility of point-of-care ultrasound. Total N=57.

	n	%
Characteristics		
Age, mean years	58.2	
Male	36	63
Noninvasive ventilation	29	57
Admitted to hospital	48	84
Admitted to ICU	6	10
Died during admission	1	1.8
Final diagnosis		
ADHF	15	26.3
Asthma/COPD	17	29.8
Pneumonia	16	28.1
Obstructive sleep apnea	3	5.2
Pulmonary embolus	2	3.5
ARDS	1	1.8
Pleural effusion	1	1.8
Interstitial lung disease	1	1.8
Psychogenic	1	1.8

ICU, intensive care unit; *ADHF,* acute decompensated heart failure; *COPD,* chronic obstructive pulmonary disease; *ARDS,* acute respiratory distress syndrome

Table 2. Ultrasonographic findings among all 57 patients.

	n	%
Ultrasonographic finding		
Hyperdynamic LV function	15	26.3
Decreased LV systolic function	18	31.6
Pericardial effusion	2	3.5
Cardiac tamponade	--	--
A-lines bilateral	22	38.5
B-lines bilateral	22	38.5
B-lines unilateral	13	22.9
Pleural effusion	3	5.3
Lack of pleural sliding	--	--
Plethoric IVC	20	35.1
Flat IVC	19	33.3

LV, left ventricular; *IVC,* inferior vena cava

DISCUSSION

In this small cohort study of ED patients presenting with acute dyspnea requiring rapid intervention, an abbreviated multi-organ POCUS examination of the heart, lungs and IVC, which we named the "Triple Scan," significantly improved physician diagnostic accuracy in determining the correct etiology of dyspnea. In particular we found that, in conjunction with history and physical exam, the TS excluded ADHF with 100% sensitivity – within just a few minutes of presentation. Two distinguishing strengths of our study are that in our cohort there was a high proportion of severe disease requiring noninvasive ventilation and hospital admission, and that our simplified TS protocol can be performed rapidly and the results incorporated into the working clinical impression within minutes of presentation, prior to chest radiograph or blood test results.

Initiating immediate, targeted therapy for ADHF, COPD, pneumonia and other causes of acute dyspnea is important; however, correctly identifying the cause of dyspnea in a clinically unstable patient can be challenging. The physical exam, even with the addition of chest radiography, is often inaccurate,[1,6] and simply starting "dual therapy" for ADHF and COPD can be harmful.[20,21] Results of laboratory studies, such as BNP, and consultative echocardiography are not available in the immediate

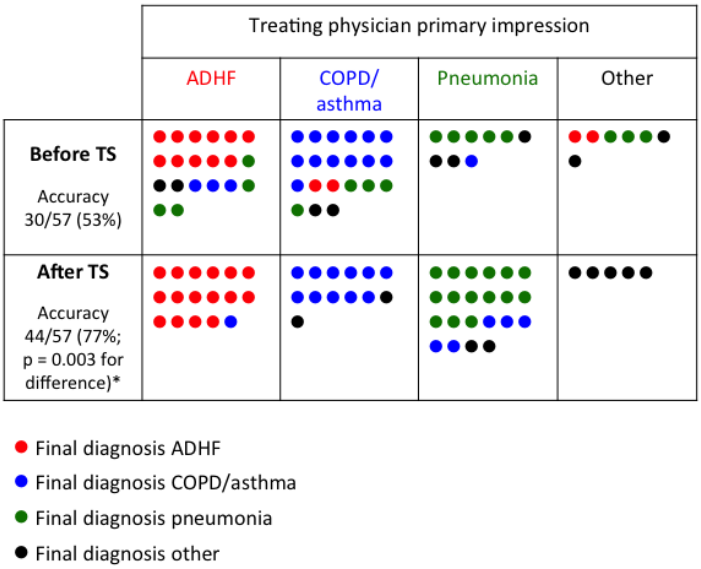

Figure 2. Case level data showing final diagnosis in each case. *ADHF,* acute decompensated heart failure; *COPD,* chronic obstructive pulmonary disease; *TS,* triple scan

Table 3. Test characteristics for treating physician primary impression, before and after "triple scan" (TS).

	Before TS		After TS	
	Value	95% CI	Value	95% CI
CHF				
Sensitivity, %	73.3	44.9-92.2	100.0	78.2-100.0
Specificity, %	78.6	63.2-89.7	95.2	83.8-99.4
LR positive	3.4	1.8-6.6	21.0	5.4-81.2
LR negative	0.3	0.1-0.8	0.0	0.0-0.5
COPD/Asthma				
Sensitivity, %	76.5	50.1-93.2	64.7	38.3-85.8
Specificity, %	80.0	64.4-90.9	93.3	77.9-99.2
LR positive	3.8	2.0-7.5	9.7	2.4-38.7
LR negative	0.3	0.1-0.7	0.4	0.2-0.7
Pneumonia				
Sensitivity, %	31.2	11.0-58.7	100.0	78.2-100
Specificity, %	90.2	76.9-97.3	82.9	67.9-92.8
LR positive	3.2	0.98-10.44	5.9	3.0-11.5
LR negative	0.76	0.54-1.08	0.0	0.0-0.5

CHF, congestive heart failure; *COPD,* chronic obstructive pulmonary disease; *LR,* likelihood ratio

setting. Furthermore, BNP can be elevated in the setting of CHF when an etiology other than ADHF actually accounts for the acute dyspnea.[22,23] A symptom-based POCUS exam that could be performed by EPs within minutes of presentation, that substantially improved diagnostic accuracy, would be a major step forward in the ED management of acute dyspnea.

Use of abbreviated POC echocardiography to evaluate dyspnea in the ED setting was first introduced by Kimura in 2001,[24] and soon after, studies were published showing that EPs can reliably and rapidly assess ejection fraction and presence of pericardial effusion.[25-27] Over the following decade studies appeared in the EM literature of POC lung US to assess for extravascular lung water (B lines, or comet tails) and hyperinflation (prominent A lines) and assessment of IVC collapsibility to gage volume status.[28,29] In addition, numerous reports have shown that POCUS can rapidly identify pneumothorax, signs of pulmonary embolus and pneumonia.[30-32]

To date, there have been five EM studies evaluating a multi-organ POCUS protocol similar to our TS – combining abbreviated echocardiography, lung US and IVC assessment – in the setting of undifferentiated dyspnea. Three studies focused strictly on diagnosis of ADHF.[2,12,16] With regard to the test performance characteristics of POCUS as a stand-alone test for ADHF, Kajimoto et al. found a sensitivity and specificity of 94% and 91%; Anderson et al. found a sensitivity of only 34% and specificity of 91%; and Russell et al. reported sensitivity and specificity of 83% and 83%. Russell et al. also found that the specificity of treating physician diagnosis for ADHF improved from 44% to 83% when POCUS was used. Two studies published in 2014, like ours, assessed the impact of multi-organ POCUS, in addition to history and physical, on the accuracy of the treating physician's initial diagnosis. In a randomized controlled trial (RCT) where patients were randomly assigned to initial assessment with and without POCUS, Pirozzi et al. found that the rate of discordance between initial and final diagnosis was 5% in the POCUS group compared to 50% in the control group.[15] Lauresen et al. performed an RCT involving a somewhat different multi-organ POCUS protocol that included proximal DVT assessment instead of IVC assessment, and allowed treating physicians to see other diagnostic test results before giving a diagnostic impression at four hours.[33] These authors found a proportion of correct presumptive diagnosis in the POCUS group of 88% compared to 63.7% in the control group, a significant difference.

Our study supports the findings of these other recent publications regarding the value of POCUS to correctly diagnose ADHF. Like Russell et al., we found that POCUS is useful in reducing false positive clinical ADHF diagnosis. In other words, while treating physicians tended to initially "overcall" ADHF, a POCUS showing no signs of ADHF forced them to consider other diagnoses, improving their diagnostic specificity for ADHF. Our study also found that POCUS increases treating physician sensitivity for ADHF, enabling them to pick up subtle ADHF cases initially misdiagnosed as COPD or other diagnoses. This is consistent with the 91% sensitivity reported by Kajimoto and with a recent meta-analysis that reported a summary sensitivity of 94% of POCUS for ADHF diagnosis.[2,34]

Yet our study went beyond just ADHF diagnosis. Similar to the studies by Pirrozi and Laursen, we found that COPD/asthma and pneumonia were roughly as common as

ADHF in our acutely dyspneic patients, and that POCUS generally improved the treating physician's ability to make these diagnoses too.[15,33] With regard to COPD/asthma, our treating physicians initially "overcalled" this diagnosis in eight cases, in which POCUS revealed unexpected ADHF in two and findings correctly indicating pneumonia in four. This underscores the notion that "all that wheezes is not asthma" and shows that there is a subgroup of patients with wheezing on exam (usually from COPD) who have concomitant pneumonia, which may be the true cause of their acute dyspnea. The improvement in COPD/asthma specificity, however, came at a cost of somewhat reduced sensitivity; we discovered that the finding of focal B-lines in patients with COPD, while sometimes a subtle sign of pneumonia, also lead to a false positive impression of pneumonia in four cases. Because of small sample size, neither the change in sensitivity or specificity reached statistical significance.

The improvement in our treating physicians' ability to diagnose pneumonia following TS is similar to the findings of Pirrozi et al.[15] This likely reflects both direct diagnosis, when sonographic findings indicating pneumonia were seen, such as focal B-lines, as well as indirect diagnosis, when absence of ADHF findings forced consideration of an alternative diagnosis. The high diagnostic accuracy for pneumonia (sensitivity 100%, specificity 83%) as compared to the hospital discharge diagnosis gold standard (which takes into account chest radiograph and often computed tomography [CT] findings) is not surprising; POCUS has been found to be highly accurate as a stand-alone test for pneumonia in children and adults and outperforms chest radiograph when compared to a CT gold standard.[31,35,36] Our findings suggest that POCUS can point clinicians toward a correct diagnosis of pneumonia early in the evaluation of the dyspneic patient, when it might otherwise be missed because the patient is initially afebrile, or wheezing, or assumed to have ADHF, or because the portable chest radiograph lacks an obvious infiltrate.

It is important to note that we accomplished these improvements in diagnostic accuracy using a highly abbreviated POCUS exam that was usually performed within minutes of arrival on patients who were frequently in extremis. As opposed to the more comprehensive and time-consuming echocardiography protocols used by other investigators,[12,16,33] the echocardiography component of our TS protocol simply focused on ejection fraction by gross visual estimation (an accepted method), presence or absence of pericardial effusion and right ventricular enlargement.[10] A single view was often adequate to assess these questions. Similarly, the lung exam consisted of assessment of only three anterior lung fields bilaterally rather than the eight zones specified in most other protocols.[12,15,33] Not only is such an abbreviated protocol feasible during initial resuscitation of the sickest dyspneic patients, but it is likely to be more generalizable to non-expert sonographers.

LIMITATIONS

Our study has numerous limitations. Convenience sampling and the small number of subjects limit the strength of our conclusions. Although we believe our abbreviated TS protocol can be performed rapidly and that scan results are reproducible, we did not measure the time required to perform the TS or measure intra-observer reliability for performing and interpreting TS. This was a pragmatic study of the impact of real-time TS on clinician diagnostic accuracy and we were not assessing accuracy of the TS result itself. The scans were performed by investigators who were attending physicians with an interest in cardiopulmonary diseases, who may have acted as bedside consultants to the treating physicians between formation of their pre-TS and post-TS impressions. Treating physicians were not blinded to the study objective. The criterion standard of final diagnosis based on chart review, though typical and well accepted in studies such as this, is always problematic.[33] Our analysis focused on the primary diagnosis (listed by the treating physician and the blinded chart reviewers as the number one / most likely cause of dyspnea), but in many cases multiple diagnoses were listed, which reflects the reality that many subjects presented with multiple disease processes, such as ADHF plus COPD or COPD plus pneumonia. Our analysis does not account well for this overlap of multiple diagnoses.

A major limitation of this study, like all studies to date of POCUS for dyspnea, is that USs were performed and interpreted by expert sonographers. This limits external validity, particularly to non-academic ED settings. The study we would like to see is a pragmatic trial involving non-expert sonographer community EPs and trainees, in which patients are randomized to initial evaluation with POCUS versus without POCUS, with USs performed by the actual treating physician, and with outcomes such as use of other diagnostic tests and ED throughput, as well as physician diagnostic accuracy.

CONCLUSION

In a cohort of patients with severe, undifferentiated dyspnea, immediate TS – in essence, an extension of the physical exam – resulted in a statistically significant improvement in treating physicians' overall diagnostic accuracy. While its primary utility appeared to be rapid diagnosis or exclusion of ADHF, the TS also seemed to markedly improve the diagnosis of pneumonia, though these findings did not reach statistical significance. Taken together with the results of other recent studies, it seems fair to conclude that multi-organ POCUS should become a routine part of the ED evaluation of acute dyspnea.

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Strain Echocardiography in Acute Cardiovascular Diseases

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Echocardiography has become a critical tool in the evaluation of patients presenting to the emergency department (ED) with acute cardiovascular diseases and undifferentiated cardiopulmonary symptoms. New technological advances allow clinicians to accurately measure left ventricular (LV) strain, a superior marker of LV systolic function compared to traditional measures such as ejection fraction, but most emergency physicians (EPs) are unfamiliar with this method of echocardiographic assessment.

This article discusses the application of LV longitudinal strain in the ED and reviews how it has been used in various disease states including acute heart failure, acute coronary syndromes (ACS) and pulmonary embolism.

It is important for EPs to understand the utility of technological and software advances in ultrasound and how new methods can build on traditional two-dimensional and Doppler techniques of standard echocardiography. The next step in competency development for EP-performed focused echocardiography is to adopt novel approaches such as strain using speckle-tracking software in the management of patients with acute cardiovascular disease. With the advent of speckle tracking, strain image acquisition and interpretation has become semi-automated making it something that could be routinely added to the sonographic evaluation of patients presenting to the ED with cardiovascular disease. Once strain imaging is adopted by skilled EPs, focused echocardiography can be expanded and more direct, phenotype-driven care may be achievable for ED patients with a variety of conditions including heart failure, ACS and shock. [West J Emerg Med. 2016;17(1):54–60.]

BACKGROUND

According to data from the Centers for Disease Control, cardiovascular disease remains the leading cause of death in the United States[1] with more than 2,200 Americans succumbing to it each day.[2] Many of the patients who ultimately die from heart disease present to the emergency department (ED) with medical issues that warrant acute intervention. While comprehensive, two-dimensional (2D) transthoracic echocardiography can provide critically important information to help guide treatment, it requires approximately 30-45 minutes to complete. The study requires a dedicated sonographer to perform and is interpreted offline by a cardiologist, which often fails to provide real-time actionable information at the point of care (POC). This time lag between performance and interpretation limits the utility of comprehensive echocardiography for the acutely ill patient where time-sensitive treatment decisions contribute directly to outcome. Thus, a more focused discerning approach to echocardiography that can be performed at the POC by adequately trained emergency physicians (EP) is often necessary.[3,4]

In 2010, the American College of EPs and the American Society of Echocardiography formed a joint committee and released a position paper entitled Focused Cardiac

Ultrasound in the Emergent Setting, establishing standards for ED-based POC echocardiography.[3] This consensus statement helped to solidify the core applications of POC echocardiography, which include the following: 1) assessment of the pericardium for pericardial effusion; 2) determination of global cardiac function; 3) evaluation of relative chamber size; 4) determination of volume status or preload; and 5) procedural guidance, specifically pericardiocentesis and insertion of a transvenous pacemaker. Components of focused echocardiography can be used in isolation for disease-specific indications such as acute heart failure (HF) or as a collective approach to conditions such as undifferentiated dyspnea or hypotension.[5,6] In this five-year period since publication of the consensus statement, significant advances have been made in the field of echocardiography that can further expand the scope of EP-performed POC studies. Foremost among these is strain imaging using speckle tracking.

STRAIN IMAGING

In the past decade, a new echocardiographic technique known as strain has been used to make more accurate assessments of the contractile state of the heart.[7] Strain echocardiography has been used in a wide range of cardiovascular conditions including HF and acute coronary syndromes (ACS). Unlike conventional techniques of determining systolic function that rely on visual assessment of wall motion and changes in volume, strain echocardiography measures actual tissue deformation within the myocardium. Conceptually, strain can be thought of as a way to determine the movement between two points as if those two points are connected by a string. The physical definition of strain is the relative change in length of a material related to its original length. Mathematically, strain (ε) is calculated by subtracting the distance between two points at the start of a movement (L_0) from the distance between them at the end of the movement (L_1), and dividing it by the starting length ($\varepsilon=\Delta L/L_0$ where $\Delta L=L_1-L_0$). Speckle tracking is a recent development in image processing that uses proprietary software to automatically determine the movements of these points, which appear sonographically as "speckles," within the myocardium over time. Tracking the movements of these speckles throughout the cardiac cycle yields positive values when the two points are moving away from one another, as in diastole, and negative values when they are moving towards one another, as in systole. Speckle tracking obviates the need for Doppler-based imaging technologies to calculate strain, which have proved to be challenging due to their angle-dependency.[8]

Strain can be measured in any of the longitudinal, circumferential or radial planes of the left ventricle (LV); however, the longitudinal orientation is likely the most useful, as impairment in this plane occurs earlier than in the other planes.[9,10] If one is measuring longitudinal systolic strain, clips of the apical four-chamber (A4C), apical two-chamber and apical three-chamber views are acquired and saved. Once the exam is completed the physician-sonographer traces the endocardial border on the standard 2D images just as one would if they were using Simpson's method to calculate the LV ejection fraction (LVEF). One tracing is made for each of the three clips during mid-systole (which is determined by the ultrasound system using a continuous electrocardiogram tracing). The software then delineates the endocardium, myocardium and epicardium and assigns speckle regions of interest within the myocardium of each segment (Figure 1). The LV is divided into 16-18 segments (depending on the ultrasound manufacturer's software) with systolic strain calculated for each segment. The segmental data can be combined to give a global evaluation of myocardial strain called global longitudinal peak systolic strain (GLS), which in healthy subjects is between -18 to -22% in the longitudinal plane (Table).[11] Once calculated, strain data can be depicted in numerous ways including the following: 1) on a simple linear graph with each segment of the LV being represented by a colored line where the x-axis is time (aortic valve closure is indicated by a green hashed vertical line) and the y-axis is strain; 2) on a curved anatomical M-mode display where each LV segment is represented on the y-axis using a different color block; and 3) using a "bullseye" map with the same red and blue color coding where the segments on the outermost ring represent basal segments, the middle ring the mid-wall segments and the innermost ring the apical segments (Figure 2). The various ways of depicting strain confer certain advantages for a given clinical scenario, such as the ease of analyzing for post-systolic shortening on the linear graph, which has been shown to be a poor prognostic marker in ischemic heart disease.[11] Strain has potential clinical applicability for a variety of conditions relevant to EPs, some of which are outlined below.

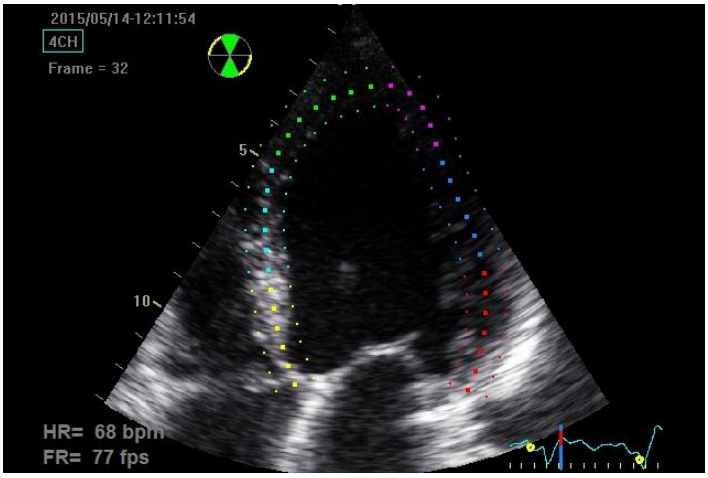

Figure 1. Apical 4-chamber image demonstrating semi-automated tracing of the endocardial border using two-dimensional speckle-tracking software. Depth is minimized excluding part of the left atrium in order to maximize frame rate.

Table. Normal left ventricular strain values.

Study	# subjects	Mean age (yrs)	Manufacturer	Technique	Mean global longitudinal strain
Marwick et al. 2009[1]	192	51+/-12	GE Vivid 7	Speckle tracking	-18.6%+/-0.1%
Nakai et al. 2009[2]	25	62+/-11	GE Vivid 7	Speckle tracking	-20.8%+/-1.8%
Manovel et al. 2010[3]	28	38+/-12	GE vs Toshiba	Speckle tracking	GE: -21.95%+/-1.8% Toshiba: -22.28%+/-2.1%
Biaggi et al. 2011[4]	47	37+/-10	GE Vivid 7	Speckle tracking (GE vs Siemans software)	GE: -21.9%+/-2.0% Toshiba: -20.9%+/-2.4%
Takigiku (JUSTICE) 2012[5]	817	36+/-18	GE vs Phillips vs Toshiba	Speckle tracking	GE: -21.3%+/-2.1% Phillips: -18.9%+/-2.5% Toshiba: -19.9%+/-2.4%
Sun et al. 2013[6]	228	44+/-15	Phillips	Speckle tracking	-20.4%+/-3.4%

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Acute Myocardial Infarction (MI)

LV strain on 2D echocardiography has been well studied in patients with ACS. For patients with ST-segment elevation MI (STEMI), LV GLS has been shown to be an important predictor of post-discharge adverse outcomes.[12] Following non-ST segment elevation MI (NSTEMI), LV GLS can also help discriminate which patients will successfully recover LV function and which patients will develop adverse LV remodeling.[13,14] Moreover, decreased GLS within 24 hours of revascularization for acute MI can reliably predict which patients are more likely to achieve a composite end-point of any of the following: all-cause mortality, hospitalization with re-infarction, HF, or stroke at six-month follow up.[15]

For the EP, strain echocardiography may offer a rapid and sensitive tool to determine which patients with NSTEMI would benefit from urgent revascularization. With the advent and implementation of increasingly sensitive troponin assays,[16] it is likely that there will be an increased proportion of ED patients with abnormal troponin values who do not require urgent revascularization. Currently, the evaluation of these patients with focused echocardiography may be able to identify an obvious wall motion abnormality; however, in the earliest phase of MI there is microvascular obstruction that does not lead to resultant wall motion abnormalities on conventional echocardiography.[17] The microvascular obstruction results in impaired function of the longitudinally-oriented subendocardial fibers of the LV prior

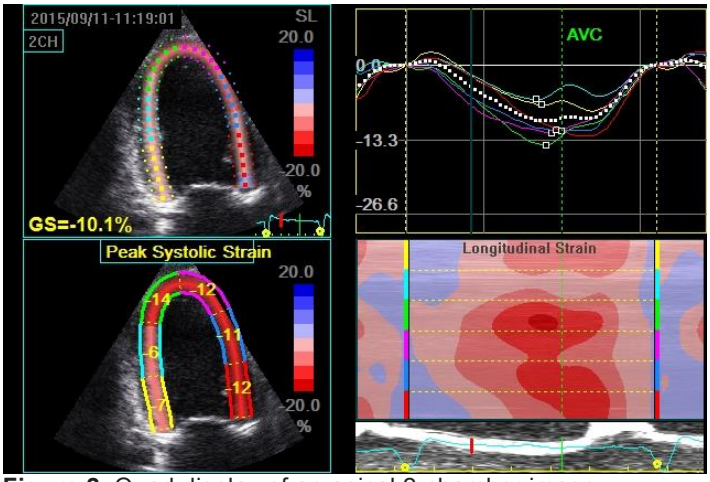

Figure 2. Quad display of an apical 2-chamber image demonstrating three different ways to depict left ventricular (LV) longitudinal strain. Images are taken from a patient with a history of heart failure with preserved ejection fraction. Top left image is a 2D depiction showing the color-coding for each LV segment and the global longitudinal strain in the 2-chamber plane (GS=-10.2%); bottom left image displays the strain for each of the 6 LV segments in the 2-chamber plane; bottom right shows the anatomical M-mode display for the 2-chamber plane with each LV segment color coded on the y-axis and the instantaneous strain being depicted using deeper red hues to represent more negative strain and deeper blue hues to represent more positive strain; top right displays strain (y-axis) plotted over time (x-axis) for each LV segment with a color-coded linear graphical display.

to the development of any overt wall motion changes (Figure 3). Thus, the addition of LV strain to the early assessment of patients with elevated troponins has the potential to identify patients who may benefit from an early and invasive management strategy. A small single center study by Dahlslett et al evaluated patients being evaluated for suspected ACS who had normal initial biomarkers.[18] They found that a GLS of -21% or better had a sensitivity of 93% to rule out coronary artery disease and was superior to standard echocardiographic parameters used in the evaluation of ischemia. As a comparison exercise echocardiography and dobutamine stress echocardiography have sensitivity ranges of 74-97% (mean 88%) and 61-95% (mean 81%). [19] If the results from this small single center study by Dahlslett can be replicated in larger multi-center trials, strain echocardiography with calculation of GLS has potential to be used in conjunction with other testing strategies in ED patients with suspected ACS.

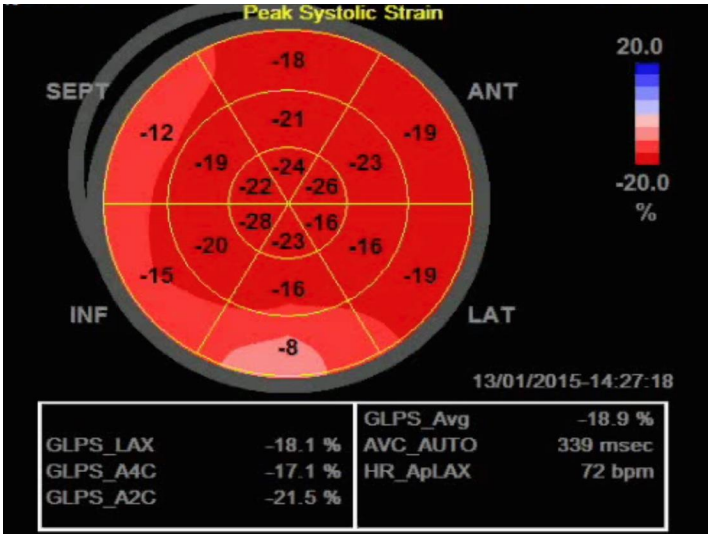

Figure 3. Bullseye map of left ventricular strain. Impaired longitudinal strain of the basal inferior wall is shown in a patient with an indeterminate troponin who would go on to develop a non-ST elevation myocardial infarction (NSTEMI).

Acute Heart Failure

The mechanics of the LV are much more complex than basic 2D imaging is able to depict. As mentioned previously, deformation of the LV occurs in three planes: longitudinal, circumferential, and radial. These vectors of motion are the result of natural myocardial fiber orientation, with subendocardial and subepicardial fibers being arranged in a longitudinal fashion, while mid-wall fibers are arranged in a circular orientation.[20] In the setting of acute HF, LV dysfunction may exist in any of the different planes, making it challenging to identify abnormalities using conventional methods. Early studies in patients with HF and preserved LVEF found impaired longitudinal strain, with values that were comparable to patients with impaired LVEF.[21] Given the microscopic anatomy of the LV, the existence of early impairment in longitudinal strain in patients with HF supports a conceptual model where cardiac dysfunction represents more than just preserved or reduced EF. Perhaps more importantly, impaired systolic strain, especially GLS has been shown to be an independent predictor of adverse outcome in patients with HF even when accounting for conventional prognosticators such as LVEF.[22-24]

Of particular importance for the ED patient with acute HF, strain is acutely sensitive to the loading conditions of the heart,[21] whereas the traditional marker of LV systolic function, LVEF, is not. The limits of LVEF as a guide to treatment during the acute phase of HF management were demonstrated in a study by Gandhi et al where they studied 38 patients who presented to the ED with acute hypertensive pulmonary edema.[25] These patients underwent echocardiography shortly after arrival, while they required respiratory support and vasoactive medications, and again one-three days after the successful treatment of the acute episode. Despite dramatic changes in their hemodynamic profiles (mean initial systolic BP 200+/-26mmHg; follow-up examination mean systolic BP 139+/-17mmHg) as well as significant improvement in dyspnea, the mean LVEF was unchanged (50+/-15% during the acute episode and 50+/-13% after treatment). Eighteen of the patients had a normal LVEF after treatment, 16 of whom also had normal LVEF during treatment.

Although traditional measurements of LV systolic function do not change appreciably during treatment of acute HF, diastolic parameters do demonstrate improvements as patients undergo treatment.[25,26] Diastolic dysfunction is an important mechanism contributing to dyspnea in patients with acute HF irrespective of systolic function.[27,28] The assessment of diastolic function requires standard 2D imaging as well as pulsed Doppler (PW) and tissue Doppler (TDI) performed from the A4C window. Strain assessment of diastolic function of the LV avoids the time-consuming process of obtaining multiple measures at various locations (LV inflow at the mitral valve leaflet tips, septal and lateral annulus of mitral valve and pulmonary veins), and instead it relies on the semi-automated software to measure the amount (strain) and rate (strain rate) of deformation of individual segments of the LV and the LV as a whole.[29]

A recent case from our ED highlights some of these important concepts. A 61-year-old female presented with two days of dyspnea, which had acutely worsened in the last several hours. Her initial blood pressure was 269/181mmHg, heart rate 105 beats per minute, respiratory rate 28 breaths per minute and pulse oximetry 89% on room air. Her lung examination revealed diffuse rates and a focused lung ultrasound showed diffuse B lines consistent with acute cardiogenic pulmonary edema. She was started on non-invasive positive pressure ventilation (NIPPV) and received multiple 2mg boluses of IV nitroglycerin, which were followed by a continuous nitroglycerin infusion. Shortly after the initiation of NIPPV a POC echocardiogram was performed

showing mild LV hypokinesis on the standard 2D images, but significantly impaired anteroseptal myocardial strain with a GLS of -7.1% (Figure 4). Approximately two hours after her initial presentation, the patient's work of breathing had significantly improved so NIPPV was discontinued. Blood pressure was 171/110mmHg at the time. Twenty-four hours after her initial presentation, repeat strain analysis was performed showing a 90% improvement in GLS (-13.5%) with dramatic reversal of anteroseptal dysfunction (Figure 5). As evidenced by this case, assessment of LV strain in acute HF has the potential to identify unique echocardiographic features that can define treatment responsiveness among different clinical phenotypes.

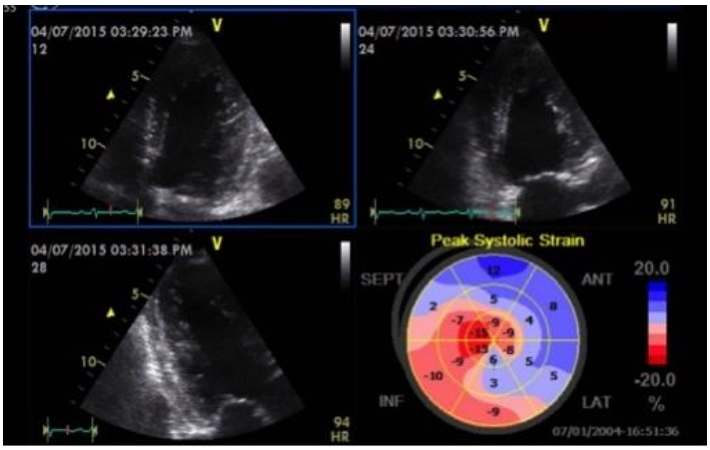

Figure 4. Baseline echocardiogram in a patient with acute hypertensive pulmonary edema.
Quad view demonstrating apical 4-chamber, 2-chamber and long axis images with a bullseye map. Global longitudinal strain is -7.1%. There is significant dyskinesis in the anteroseptal, anterior and lateral segments.

Right Ventricular Strain

One of the newer applications of strain is the assessment of the right ventricular (RV) free wall.[30] The ability to use an early, non-invasive method to assess for acute RV dysfunction in situations where submassive pulmonary embolism (PE) is suspected would enable earlier initiation of thrombolytic therapy. RV free wall strain also has the ability to rapidly risk stratify patients who have been diagnosed with PE without requiring time-consuming, technically challenging Doppler techniques. Further, the semi-quantitative assessment with speckle tracking removes much of the subjectivity associated with the determination of RV hypokinesis and the presence of McConnell's sign. A recent study showed the potential utility of strain echocardiography for this purpose, comparing measures of RV strain in 75 patients with confirmed central PE with 30 control subjects.[31] Regional and global RV free wall and septal wall strain was assessed offline using speckle-tracking software and both were significantly reduced in PE subjects compared to controls, with no difference based on presence or absence of McConnell's sign. Additional studies involving patients with acute submassive PE found the combination of mean RV free wall strain <-12%, RV EF <40% on 3D imaging, and RVSP >43mmHg to be present in 94% of those who suffered an adverse event versus 23% of patients without adverse events.[32] RV EF has not been shown to be a valid reproducible measure of RV systolic function,[33] and RVSP can be time consuming to determine and also involves using Doppler, thus making RV free wall strain a potentially easy way to calculate singular determination of RV systolic function that would be very useful to the EP caring for critically ill patients with acute PE.

LIMITATIONS

Strain analysis using speckle-tracking technology does have several limitations that need to be understood prior to the adoption of this as a part of POC echocardiography in the ED. Speckle tracking relies on the ability of the ultrasound system to track specific acoustic markers in the myocardium over time, and is thus dependent on achieving high frame rates. Increasing depth and increasing sector width (among other variables related to the transducer) will decrease the frame rate. Frame rates less than 40 frames per second (Hz), result in large frame-to-frame changes, resulting in poor tracking of acoustic speckles. One strategy we have found useful to improve the frame rate is to decrease depth in the apical windows such that the left atrium is out of the field of view. Another limitation with speckle tracking is found in patients with heart rates >120 beats per minute; as fewer data points from a single cardiac cycle are available, strain data becomes less reliable. Also, if the heart rate is dramatically different from one clip to the next (i.e. 60 beats per minute in the apical long axis and A4C views but 100 beats per minute in the apical wo-chamber) the algorithm will be unable to calculate GLS because of the differences in tracking. As a consequence of beat-to-beat variability, conditions such as atrial fibrillation and multifocal atrial tachycardia are considered a relative contraindication to strain imaging. Fortunately, in our experience, the heart rate and rhythm-related limitations occur infrequently in patients being evaluated for ACS or acute HF.

Beyond technical issues, a lack of standardization of left ventricular (LV) strain between the various ultrasound manufacturers has led to hesitancy in the adoption of strain as a routine measure of cardiac function in some echocardiography labs.[34] Much research has already been performed comparing various manufactures' strain algorithms, and leaders in the field of echocardiography have called for manufacturers to work together to standardize strain measurements across vendors.[35] Lastly, strain analysis does require equipment that is not generally found in most EDs. Many ultrasound manufacturers have equipment that offers speckle-tracking technology; however, this equipment is not typically marketed to the ED and thus many EPs are unfamiliar with it. Also, to our knowledge there is currently no manufacturer that has the ability to upgrade existing equipment by adding software to calculate strain to

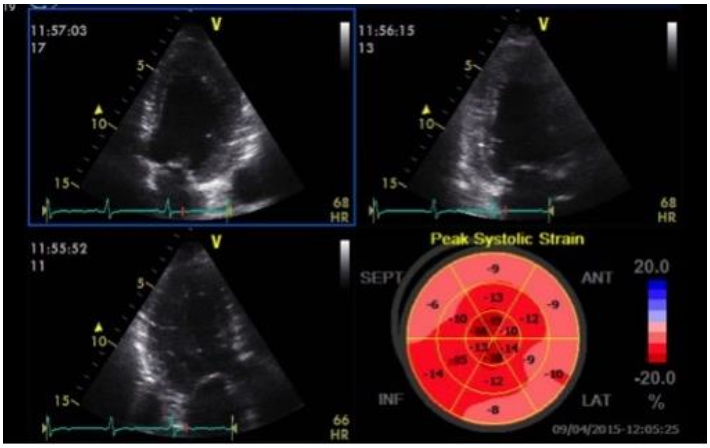

Figure 5. Follow-up echocardiogram of patient from Figure 4 24 hours after presentation. Quad view, Global longitudinal strain is now -13.5%. Anteroseptal, anterior and lateral wall dyskinesis has resolved following afterload reduction.

existing POC ultrasound platforms found in most EDs. Finally, the cost for a machine with speckle-tracking technology is, on average, slightly greater than ultrasound systems commonly used in most EDs (approximately $50,000 for a portable laptop-based system with one matrix array transducer), thus presenting a potential barrier to broad uptake.

CONCLUSION

Echocardiography in the ED has evolved from a single institution borrowing their cardiology department's equipment during off-hours to standards of training that have been endorsed by the Accreditation Council for Graduate Medical Education and adopted by all emergency medicine residencies. A core curriculum currently exists for focused echocardiography in the ED with assessment of the pericardium, LV systolic function, the right heart, preload determination, and procedural guidance. We believe that the next step in the development of the field is to adopt novel approaches such as strain echocardiography using speckle-tracking software to assist in the management of patients with HF, MI and PE. The advent of portable ultrasound systems and semi-automated software to calculate strain makes this a real possibility for ED POC echocardiography in the near-term. Once EPs gain familiarity with the speckle-tracking software, a research agenda will need to follow, with a goal of studying the utility of strain imaging at the POC. The net result will be a more individualized, image-based understanding of conditions such as ACS, acute HF, and PE with the potential to develop treatment protocols directed at echocardiographic phenotypes.

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Ultrasound Evaluation of Upper Extremity Deformity

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CASE

A 64-year-old woman presented to the emergency department after falling when she tripped on a rock while doing yard work. Physical examination revealed an open deformity of the left forearm (Figure 1). Radial pulse was palpable, sensation was intact, and she had normal range of motion of the fingers. While awaiting radiographs, bedside ultrasound was performed (Video).

Ultrasound revealed intact radius and ulna and a large linear foreign body. The wooden foreign body was removed at the bedside (Figure 2) and patient was admitted for observation and intravenous antibiotics.

DISCUSSION

Wounds containing foreign bodies are at increased risk of delayed healing and infection. Wood, in particular, is extremely inflammatory and should be removed.[1] Although radiopaque materials (metal, glass) are often visualized on plain radiography, radiolucent objects such as wood are often not.[2] Sensitivity of plain films for the detection of wooden foreign bodies is estimated as low as 15%.[3]

The accuracy and availability of sonography make it an excellent modality for evaluation of foreign bodies.[4] Sensitivity of ultrasound for the detection of foreign bodies is estimated between 50% to 100%, increasing when clinical information is available.[5,6] The linear, high-frequency transducer is best for examining the superficial soft tissues. Most foreign bodies are hyperechoic with a surrounding hypoechoic area corresponding to granulation tissue, edema, or hemorrhage.[7] Foreign body size estimation is often dependent on its orientation in relation to the ultrasound beam and can be affected by local tissue reaction.[5] Multiple tissue planes may disguise a foreign body or give the appearance of one when none is there. Air can limit the penetration of ultrasound waves or itself masquerade as a foreign body.[5]

Literature supports ultrasound's effectiveness in evaluating for fracture, and our case demonstrates the potential of emergency physician-performed ultrasound in the evaluation of all injured extremities.[8,9]

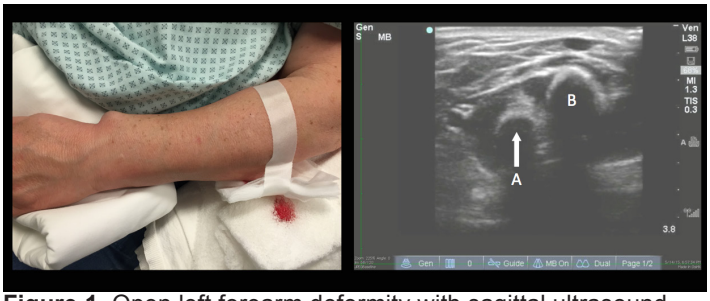

Figure 1. Open left forearm deformity with sagittal ultrasound image of the left forearm demonstrating a foreign body (A) radial to the ulna (B).

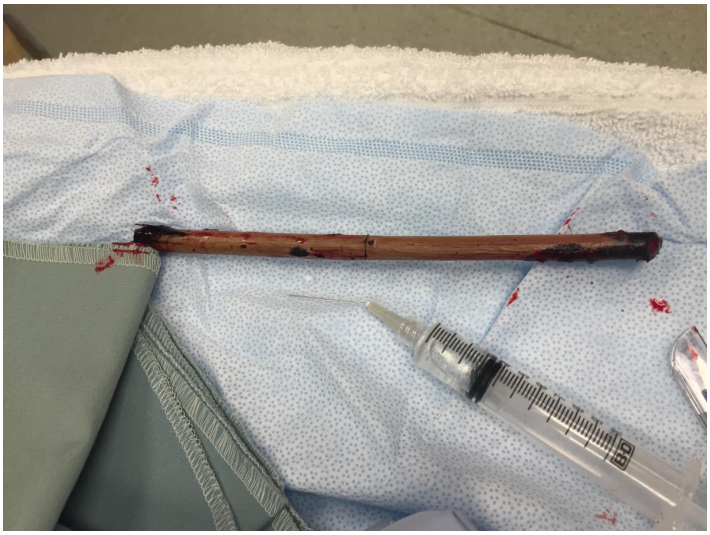

Figure 2. Wooden foreign body removed from the left forearm.

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Video. Ultrasound of the patient's left forearm performed with a linear probe in the sagittal view demonstrating an intact radius and ulna and a large linear foreign body.

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Emergency Medicine Resident Rotations Abroad: Current Status and Next Steps

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Introduction: International rotations for residents are increasingly popular, but there is a dearth of evidence to demonstrate that these rotations are safe and that residents have appropriate training and support to conduct them.

Methods: A survey was sent to all U.S. emergency medicine (EM) residencies with publicly available e-mail addresses. The survey documents and examines the training and support that emergency medicine residents are offered for international rotations and the frequency of adverse safety events.

Results: 72.5% of program director responded that their residents are participating in rotations abroad. However, only 15.4% of programs reported offering training specific to working abroad. The results point to an increased need for specific training and insurance coverage.

Conclusion: Oversight of international rotations should be improved to guarantee safety and education benefit. [West J Emerg Med. 2016;17(1):63–65.]

INTRODUCTION

International rotations for emergency medicine (EM) residents are becoming increasingly popular, but little is known about institutional support for this trend, specifically, educational supervision, safety activities, and insurance coverage related to these rotations. This research sought to determine how many EM programs in the United States were sending their residents abroad and the safety, training and insurance status of the residents, as well as any adverse events that occurred.

BACKGROUND

Over the last three decades the amount of funding for and projects in global health have significantly increased, as has awareness of global health issues within the mainstream U.S. medical system. At the same time, there has been an exponential surge in interest and involvement in international rotations among medical students and residents in the U.S.[1,2] Despite increased opportunities and funding, there is unmet demand from individuals who would like to work abroad.

By 2004, 22% of U.S. medical students had participated in an international rotation.[3] Although there are many competing demands on a trainee's time during residency, many U.S. programs allow participation in international rotations. As a specialty, EM engages in all aspects of the medical spectrum; thus, there are few clinical specialties as well suited to the global health clinical environment. Additionally, given the dynamic, high-paced, and unpredictable nature of EM, there are likely common characteristics that make global health interesting to EM providers. Several studies have shown that a significant percentage of EM residents participate in these rotations and that, at this point, there is no standardization of training for trainees who work abroad.[4,5]

METHODS

This study was given a waiver by Institutional Review Board (IRB) of the University of Washington.

We conducted an online search of the 165 U.S.-based EM residency programs during the summer of 2013. The name of the program director or assistant director and their email was obtained from the residency website. If no contact information was available, the residency was not included in the survey.

The authors created a nine-question survey that could be completed in 2-3 minutes. The study was opened on September 13, 2013, and closed on June 16, 2014.

In the fall of 2013, the survey was sent to the 134 EM programs that had publicly available email addresses. Individuals who did not complete the survey were sent a series of reminder emails requesting participation or removal from the survey. The researchers made a single phone call to those who had not completed the survey requesting their participation towards the end of the survey period. The results were permanently uncoupled from the respondent's email as per the requirement of University of Washington's IRB waiver criteria.

The first three questions identified the number of residents in the program, the length of the training program, and whether any of the residents participated in international rotations. Questions 4 and 5 inquired whether the program had dedicated global health faculty and an established international site for resident rotations. Question 6 asked if residents were given any training prior to participating in an international rotation and question 7 addressed the presence of liability coverage of the residents working abroad. Question 8 attempted to ascertain how rotation sites were assessed for safety and question 9 allowed respondents to chronicle safety events that had occurred to their residents during the preceding five years.

RESULTS

A total of 91 of 134 residency program or assistant program directors answered the survey for a response rate of 67.9%. The respondents represent 55% of all EM programs. Of the 91 responders, 66 (72.5%) responded that their residents participated in rotations abroad as part of their training program. An average 10.4% and 8.86% of residents in three- and four-year programs, respectively, were reported to have participated in a rotation longer than two weeks during the 12 months prior to the survey.

Of all respondents, only 17.6% responded that they had three or more faculty whose primary areas of academic interest is global health; 38.5% reported their program had an "established relationship (defined as frequent educational contact, one or more ongoing projects, and faculty or resident exchange) with an emergency department or training facility outside of the U.S."

An estimate of the nature of the residents' international work was given by 35 respondents. When asked to estimate the type of work performed abroad by category, results demonstrated clinical work 38%, EM development 18%, and public health work 12%. Project work that was less frequently conducted included observational and research, 9% each, and humanitarian response and disaster response, 7% each. Unfortunately and interestingly, many respondents did not complete this question.

Only 15.4% of programs reported offering any special training prior to allowing their residents to work abroad. Of the small percentage of respondents who reported conducting some training, the themes were public health skills, personal health and safety, tropical medicine and ethical considerations. Liability insurance covered the residents' work abroad at 47% of the responders' institutions, while 31% were not covered and 22% were unsure of their institutional policies.

Of the 65 responders who answered if their program sites where evaluated for safety by faculty, 29 (45%) said "yes" while 36 (55%) said "no" or were unsure. Several responders cited some other mechanism for safety evaluation including using local staff and online screening of political security. Very few security events and no deaths were reported by the respondents. Of note, 12% of responders reported major illness or political instability affecting their residents and 2% reported assault or an incident requiring evacuation. Key findings are summarized in Figure.

LIMITATIONS

This study used a publicly generated list of residency directors in order to be eligible for IRB waiver and repeated contacts. This resulted in an incomplete survey of EM residency programs; however, our data on the number of residents participating is similar to prior studies. The study relied on the memory of the respondents resulting in potential recall bias. In a few cases both the residency director and assistant residency director may have responded to the survey resulting in redundant submissions. In addition, our study over represented four-year programs. Nationally four-year residencies represent 24.6% of all EM residencies while we had 37.5% of our responses from four-year residencies.

DISCUSSION

Our study revealed both positive and negative characteristics of the current policies regarding international rotations in EM. Of greatest importance to the authors, there

Of the faculty who reported regularly sending their residents on international rotations:

- 15.6% required specialized training prior to residents departing.
- 31% know that their residents are not covered by liability insurance.
- Only 45% of the international rotation sites had been evaluated for safety by a faculty member.

Figure. Summary of results.

are a large number of residents going abroad every year and overall the level of insecurity they are experiencing from health or safety risks is low. However, pre-travel training, vetting of work sites, presence of global health faculty and ensured liability are all lower than expected. Clinical work, EM development and public health projects dominated the nature of the work, while research, humanitarian and disaster work are at surprisingly low levels.

Perhaps the most important outcome of this study is that it highlights the need for a uniform and comprehensive national education program for EM residents doing international rotations. A global health component of resident education, pre-departure safety training and use of attending physician-vetted sites to enhance resident safety and the quality of the educational experience should be considered minimum requirements for any program that allows residents to participate in rotations abroad. Pre-departure appropriate course work in working in austere environments, cultural sensitivity, tropical disease and public health should be considered. Use of mentorship should also be encouraged to maximize the resident's experience and provide additional outlets for accessing faculty.

CONCLUSION

Our survey pointed out several important issues regarding international rotations for EM. First, as with other specialties, international rotations are common and heterogeneous with regard to activities conducted and supervision. Additionally, there is a low level of pre-rotation training, insurance coverage and site safety evaluation. Finally though safety incidents are rare, several serious events including major illness, assault and injury were reported. This study highlights the need for greater supervision, training and support of EM residents conducting rotations abroad.

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Emergency Department of a Rural Hospital in Ecuador

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Introduction: There is a paucity of data studying patients and complaints presenting to emergency departments (EDs) in low- and middle-income countries. The town of Pedro Vicente Maldonado (PVM) is located in the northwestern highlands of Ecuador. Hospital PVM (HPVM) is a rural teaching hospital providing family medicine residency training. These physicians provide around-the-clock acute medical care in HPVM's ED. This study provides a first look at a functioning ED in rural Latin America by reviewing one year of ED visits to HPVM.

Methods: All ED visits between April 14, 2013, and April 13, 2014, were included and analyzed, totaling 1,239 patient visits. Data were collected from their electronic medical record and exported into a de-identified Excel® database where it was sorted and categorized. Variables included age, gender, mode of arrival, insurance type, month and day of the week of the service, chief complaint, laboratory and imaging requests, and disposition. We performed descriptive statistics, and where possible, comparisons using Student's T or chi-square, as appropriate.

Results: Of the 1239 total ED visits, 48% were males and 52% females; 93% of the visits were ambulatory, and 7% came by ambulance. Sixty-three percent of the patients had social security insurance. The top three chief complaints were abdominal pain (25.5%), fever (15.1%) and trauma (10.8%). Healthcare providers requested labs on 71.3% of patients and imaging on 43.2%. The most frequently requested imaging studies were chest radiograph (14.9%), upper extremity radiograph (9.4%), and electrocardiogram (9.0%). There was no seasonal or day-of-week variability to number of ED patients. The chief complaint of human or animal bite made it more likely the patient would be admitted, and the chief complaint of traumatic injury made it more likely the patient would be transferred.

Conclusion: Analysis of patients presenting to a rural ED in Ecuador contributes to the global study of acute care in the developing world and also provides a self-analysis identifying disease patterns of the area, training topics for residents, areas for introducing protocols, and information to help planning for rural EDs in low- and middle-income countries. [West J Emerg Med. 2016;17(1):66–72.]

INTRODUCTION

The study of global emergency medicine (EM) systems is important, and further system-development research is necessary.[1,2] Lower income countries have restricted resources including limitations in infrastructure, technology, supplies, manpower, and access to further education. The burden of disease can vary between locations, as can the "cultural, political, and social aspects of delivery of care."[3,4] A deeper understanding of acute care delivery systems and their patients is essential to providing better acute care. However, minimal

data exist from emergency departments (EDs) in Latin America, and there is no information regarding acute care in Ecuador. The information available from Latin America focuses on urban and university hospitals only, and to our knowledge there is no data on acute care in a rural setting.[5-16]

Current literature calls for the need to characterize acute care systems by nation or region and then analyze broader regional EM trends, while also calling for more research in rural areas.[17-19] There is also a call to focus on patient's chief complaint for seeking care, not the final diagnosis, as the best way to understand global acute care settings and compare between settings.[1,19]

The country of Ecuador is located in northwestern South America, lies on the Equator, and is bordered by Colombia, Peru, and the Pacific Ocean. The country has different geographical regions including the coast, tropics, highlands, and the Amazon. In 2013, the population was nearly 16 million. The under-five mortality rate was 23 per 1000, compared to the regional average of 15 and the global average of 48. There were 17 physicians per 10,000 people compared to the regional average of 21.[20] In Ecuador, 32% of the population is rural, and 42% of rural people live below the national poverty line. Twelve percent of the population lives at <$2/day, and 16% of the population is undernourished. Nearly 25% of rural Ecuadorians do not have access to an improved water source.[21]

Pedro Vicente Maldonado (PVM) is a small rural town located on the western slopes of the Andes Mountains at an altitude of 600m in northwest Ecuador, and is the catchment area for around 70,000 people living in both tropical and subtropical regions.[22] Hospital PVM is a small, 15-bed hospital that serves this area and provides secondary level healthcare services such as inpatient medical, surgical, and obstetric-gynecologic services, some intermediate intensive care unit care, full-spectrum primary care clinical services, specialist outpatient care and day procedures, and includes a functioning emergency department that is open 24 hours a day, seven days a week.[23,24]

In Ecuador only a few large urban centers have dedicated EM specialists, and most EDs are staffed by physicians with varied levels of training, most without formal EM education. Hospital Pedro Vicente Maldonado (HPVM) serves as one of two main rural teaching hospitals for providing a formal family medicine residency-training curriculum, and these physicians provide 24-hour acute medical care in HPVM's ED. This unique training program allows for improved experience, skills training, and supervision beyond the typical six-year combined medical school and rural internship undertaken by most generalists in the country.[23-26]

This study is the first descriptive analysis of a functioning ED in rural Latin America. While contributing to the global study of acute care medicine in the developing world, this study also provides an analysis of the HPVM ED that can be used to identify disease patterns of the area; define training topics for residents; identify areas for treatment guidelines and protocols; inform decisions regarding trauma education, triage strategies, and need for specialty care and more advanced technological resources while performing future ED planning; and inform local and national public health policy.

METHODS

All ED visits to HPVM over a one-year period between April 14, 2013, and April 13, 2014, were included and analyzed, totaling 1,239 patient visits. Information from each patient's visit was entered into an electronic medical record (EMR) system created by the hospital per usual ED practice. We the obtained information for purposes of this study from the EMR and abstracted the data into a de-identified and password-protected Excel® (2011) database where it was sorted and categorized.

Information obtained included age, date of service, gender, mode of arrival, insurance type (government-provided social security insurance or not), chief complaint, laboratory and imaging requests, and disposition. To keep information de-identifiable, we converted date of service into month and day-of-the-week of service. For the analysis of chief complaint, initially the 1,239 patient visits were associated with 98 different chief complaints. In an effort to categorize into useful groupings, we used a starting list of 57 chief complaints for categorization based on previous efforts by Aronsky et al in 2001.[27] We then modified these data into a more locally appropriate list of 34 complaints (Figure 1) which were then used in the analysis. Imaging requests were also further categorized from a free-text request into groupings according to imaging type and area of study. We performed descriptive statistics for all variables. Where possible, comparisons were performed using Student's T or chi-square, as appropriate. The study was determined to be exempt by the institutional review board of Maricopa Integrated Health System, and was reviewed and permitted by the Andean Health Advisory Board.

RESULTS

Between April 14, 2013, and April 13, 2014, there were a total of 1,239 ED visits for both adults and children, 48% male and 52% female; 24.6% of the patients were between age 19-30 years, and 15.3% were between 6-18yrs and 31-40 years. Nearly 7% were <1 year old (Figure 2). The average age of patients with a traumatic complaint was 31 years, and 67.9% of trauma patients were male and 32.1% were female. The average age of patients with an obstetric complaint was 25.5 years.

Mode of Arrival

Of these patient visits, 93% were ambulatory, and 7% came by ambulance. Those who came by ambulance were more likely to have a chief complaint of traumatic injury (49.4% vs. 8%, $p<0.0001$). Those who were ambulatory

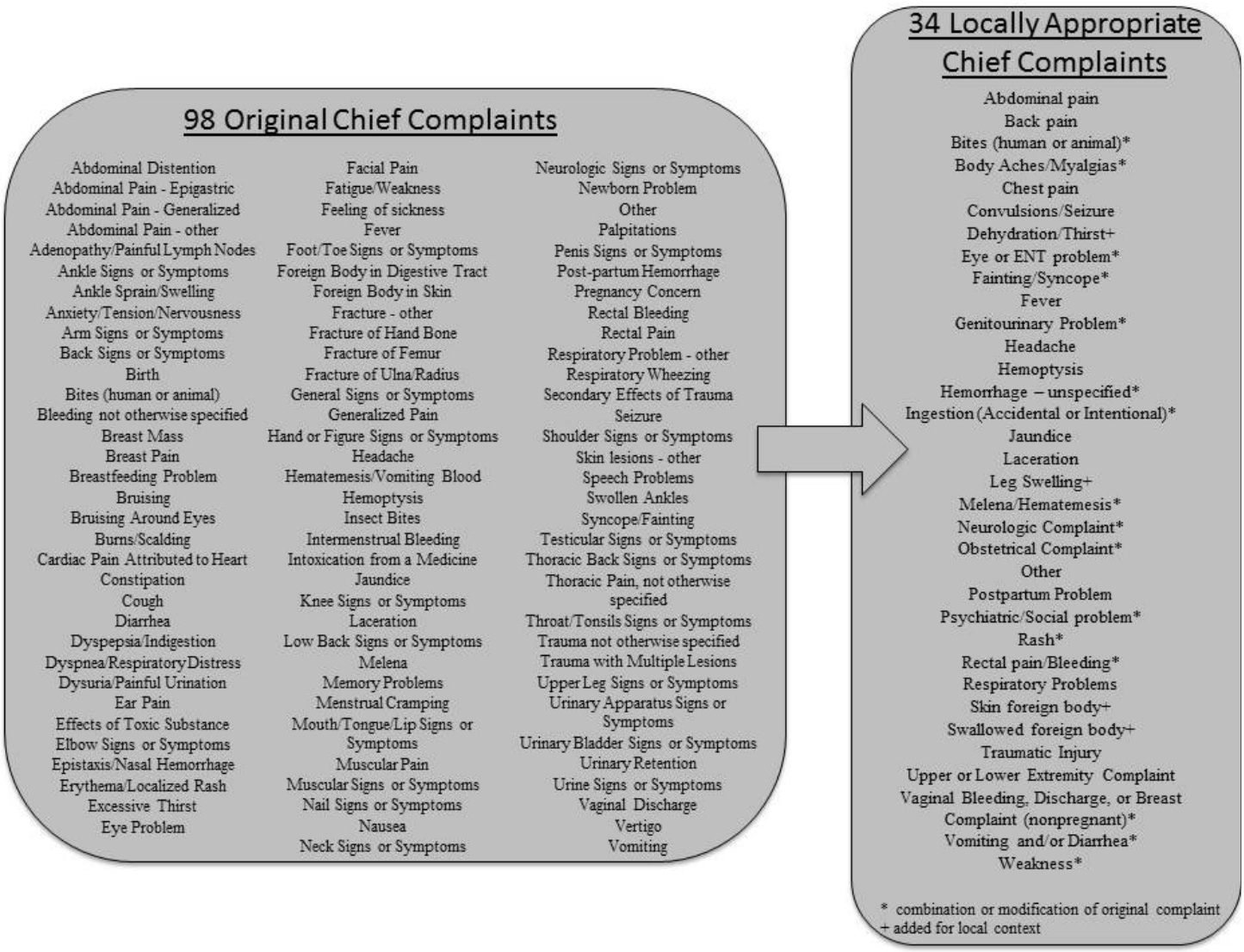

Figure 1. The development of categorization of locally appropriate chief complaints for Hospital Pedro Vicente Maldonado.

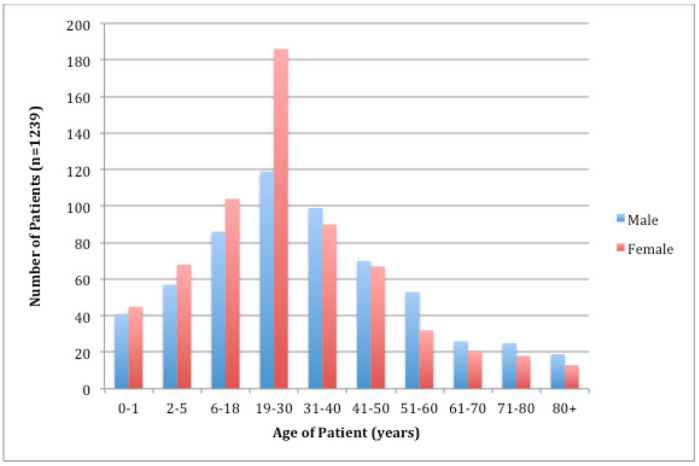

Figure 2. Age distribution of patients, by gender.

arrivals were more likely to have a chief complaint of abdominal pain (26.8% vs. 7.2%, p=0.0001), back pain (5.7% vs. 0%, p=0.049), and fever (16.1 vs. 1.2%, p=0.0005). Those who came by ambulance were more likely to be admitted (33.7% vs. 19.7%, p=0.0039) or transferred (34.9% vs. 10.8%, p<0.0001) when compared with ambulatory patients. Ambulatory patients were more likely to be discharged home (39.9% vs. 21.7%, p=0.0016) or sent to clinic (29.2% vs. 8.4%, p<0.0001).

Chief Complaint

The classification of chief complaints into their final categories is shown in Figure 1. The top three chief complaints for all-comers were abdominal pain (25.5%), fever (15.1%) and trauma (10.8%). Chief complaints were also stratified by

Table 1. Chief complaint by age, 0-5yrs.

Complaint	Total #	% of total
Fever	89	42.2%
Vomiting and/or diarrhea	38	18.0%
Respiratory problems	18	8.5%
Upper/lower extremity complaint	13	6.2%
Abdominal pain	12	5.7%
Traumatic injury	11	5.2%
Convulsions/seizures	6	2.8%
Swallowed foreign body	4	1.9%
Body aches/myalgias	3	1.4%
Eye or ENT problem	3	1.4%
Other	14	6.6%
Total	211	100.0%

ENT, ear, nose, and throat

Table 2. Chief complaint by age, 6-18yrs.

Complaint	Total #	% of total
Abdominal pain	53	27.9%
Fever	39	20.5%
Traumatic injury	22	11.6%
Upper/lower extremity complaint	22	11.6%
Obstetrical complaint	11	5.8%
Vomiting and/or diarrhea	11	5.8%
Laceration	6	3.2%
Respiratory problem	5	2.6%
Convulsion/seizure	4	2.1%
Back pain	3	1.6%
Bites (human or animal)	3	1.6%
Other	11	5.8%
Total	190	100%

children 0-5 years, adolescents 6-18 years, adults 19-59 years, and elderly 60+ years (Tables 1-4).

Insurance Status

Patient insurance type was recorded as farmer, general, retired, or "other." Farmer, general, and retired insurance types are all government-provided social security insurance (hereon grouped as "social security insurance"). Farmer's social security covers those who live in rural areas and can demonstrate that they work the land for a living and pay a very nominal monthly fee to the Ecuadorian Social Security Institute. General social security covers patients whose employers pay social security taxes. Retired social security affiliates are those who were previously in the general category but are now retired based on age. "Other" insurance is a catchment group that includes Obligatory Transit Accident Insurance (SOAT), a national plan covering medical care associated with motor vehicle accidents, police insurance, and assorted private insurance (the latter being infrequent). Unfortunately further delineation of this group is unavailable, although SOAT insurance is suspected to cover much of this.

Table 3. Chief complaint by age, 19-59yrs.

Complaint	Total #	% of total
Abdominal pain	220	31.0%
Traumatic injury	88	12.4%
Back pain	58	8.2%
Fever	49	6.9%
Upper/lower extremity complaint	48	6.8%
Obstetrical complaint	46	6.5%
Vomiting and/or diarrhea	31	4.4%
Body aches/myalgias	20	2.8%
Chest pain	20	2.8%
Hemorrhage - unspecified	16	2.3%
Respiratory problems	13	1.8%
Genitourinary problem	13	1.8%
Eye or ENT problem	12	1.7%
Laceration	11	1.6%
Headache	11	1.6%
Bites (human or animal)	10	1.4%
Other	43	6.1%
Total	709	100.0%

ENT, ear, nose, and throat

Table 4. Chief complaint by age, 60+yrs.

Complaint	Total #	% of total
Abdominal pain	31	24.0%
Respiratory problems	13	10.1%
Traumatic injury	13	10.1%
Fever	10	7.8%
Vomiting and/or diarrhea	8	6.2%
Chest pain	7	5.4%
Back pain	5	3.9%
Neurological complaint	5	3.9%
Body aches/myalgias	4	3.1%
Fatigue/syncope	4	3.1%
Genitourinary problem	4	3.1%
Other	25	19.4%
Total	129	100.0%

Of those who arrived by ambulance 65.1% had "other" insurance, compared with 35.1% of those who were ambulatory (p<0.0001). Of all total complaints, patients with social security insurance were more likely to have the chief complaint of abdominal pain (28.0% vs 21.3%, p=0.011), fever (17.3% vs 11.3%, p=0.006), headache (1.9% vs 0.2%, p=0.02), and rash (0.6% vs 0.2%, p=0.033), compared with those with "other" insurance. Patients with "other" insurance were more likely to have the chief complaint of human or animal bite (2.4% vs 0.6%, p=0.013), ingestion (accidental or intentional) (1.5% vs 0.3%, p=0.042), traumatic injury (17.8% vs 6.7%, p<0.0001), and foot/leg pain (4.3% vs 1.7%, p=0.010), compared with those with social security insurance.

Labs and Imaging

Of all patients presenting to ED, labs alone were requested on 693 (55.9%) patients. Imaging alone was requested on 344 (27.8%) patients. Both labs and imaging were requested on 190 (15.4%) patients. Eleven (0.9%) patients had neither labs nor imaging requested. Patients were more likely to have labs alone requested if they had chief complaint of fever, imaging alone requested if they had chief complaint of abdominal pain, laceration, traumatic injury, foot/leg pain, and both labs and imaging requested if they had chief complaint of respiratory problem. The most frequently requested imaging studies were chest radiograph (14.9%), radiograph of an upper extremity (9.4%), and electrocardiogram (9.0%). Other imaging available but used less frequently were radiographs of different body areas; abdominal, renal, and pelvic/genital ultrasounds; and fetal heart monitoring/non-stress tests. Of note, although a computerized tomography of the head or abdomen and pelvis may have been requested, these are not available at HPVM and patient either was transferred or did not receive this imaging.

Of all patients with a traumatic complaint, 92.5% had imaging requested but only 11.9% had labs requested. Of all patients with an obstetric complaint, 84.5% had imaging requested and 37.9% had labs requested. Of all pediatric patients <18 years, 32.0% had imaging requested and 75.5% had labs requested.

Day of Week and Seasonal Variability

The rainy season in the area of HPVM is December through May, but there was no change in number of ED visits during this time when compared with the rest of the year. There was also no statistical difference in number of visits by day of week. This is also true in a subgroup analysis of pediatric patients and in patients with obstetrical and trauma complaints.

Disposition

Of all patients presenting to the ED, 484 (39.0%) were discharged home, 256 (20.7%) were admitted to the hospital, 345 (27.8%) were sent to outpatient clinic, and 154 (12.4%) were transferred. Patients were more likely to be admitted if they had a chief complaint of human or animal bites and more likely to be transferred if they had a chief complaint of traumatic injury. Patients were less likely to be transferred if they had a chief complaint of back pain or fever.

Of those discharged to home, insurance type was not statistically different. However, of those admitted, 23.7% vs 15.4% had social security insurance (p=0.0007), and transferred patients were more likely to have "other" insurance (17.8% vs 9.2%, p<0.0001). Patient's disposition from the ED was not statistically determined by gender, day of week or month of year presentation, or requests for imaging and/or labs.

LIMITATIONS

Our data are limited in that they only include one year of data from one institution, and these data may or may not be generalizable to a larger setting within rural Ecuador, Latin America, or the greater developing world. Also, in many ways, having a "final diagnosis" or "ED impression" would be interesting and helpful when performing analysis on these patients, as this can be somewhat more tangible and familiar when comparing results with data and experiences from the developed world. Although the physicians seeing these patients listed a differential diagnosis, these lists of 4+ possibilities could not be analyzed in a useful way. Furthermore, previously published data recommended analysis based on chief complaint only and not diagnosis.[19]

Additionally, there is a lack of consensus on how to classify variables used in analyses of developing world ED systems. There is no formal universal listing of chief complaints or standard list of imaging studies that can be compared between studies,[17] so classification for this study was performed starting from available lists from the developed world and was made to be locally appropriate. We did attempt to make an inclusive list that can be replicated in further studies, but it may not be appropriate for all areas. Additionally, analysis was limited to the available variables recorded in HPVM's EMR system. A guideline for global ED data keeping and a guideline for variable analysis would be beneficial for both initiating data collection systems and for performing future comparative studies.

DISCUSSION

This is the first study looking at a rural ED in Latin America. There is therefore little available information for comparison between other sites. This study underscores the importance of EMRs, as their use in this hospital allowed a comprehensive view of an entire year's worth of patients. As HPVM accepts all patients regardless of age, gender, race, or financial status, all ED patients were included in the study. Unlike many studies having high rates of exclusions secondary to poor documentation, illegible handwriting, or research time burden associated with review of paper charting,

electronic charting for these patients was relatively efficient and nearly always complete, allowing nearly full capture of the spectrum of ED care during this time period.

This study highlights the large number of patients between age 6-40, but still underscores the need for ability to treat patients of all ages, with 7% of patients seen being <1 year old and 6% >71 years old. Similar to data from the developing world, this study shows the high number of traumatic complaints from young male patients. It also shows the high number of obstetric complaints and the need for full-spectrum OB care in this ED – not just through the first 20 weeks of pregnancy like typical EDs in the United States. Given the variety of chief complaints and high frequency of abdominal pain complaints, improving point-of-care ultrasound skills of treating physicians may increase speed and accuracy of diagnosis.

This study shows the large discrepancy between number of ambulatory and ambulance visits. Further studies in rural Ecuador regarding ambulance access, reliability, and costs would be helpful to help better understand pre-hospital transport systems and acute care in the field. There were 1,239 visits to the ED during the one-year period. Although this seems quite small when compared with a typical rural ED in the U.S, no data are available for comparison in this setting. Additionally, although time of visit was not available for analysis, anecdotally a majority of patients came to the ED in the evening and overnight hours. Further analysis of patient decisions to seek care in the ED would be helpful for catering to patient acute care needs.

Insurance status did not overall seem to affect care received in the ED. Further studies of patient's knowledge of health insurance and out-of-pocket costs will help ongoing system improvement and ED planning.

Finally this study highlights the large number of patients who are evaluated in the ED and then sent directly to clinic. An analysis of these patients may provide insight into the scope of rural outpatient care and help triage techniques for the management of chronic problems in an acute care setting. It also begins to assess the spectrum of services of a rural secondary hospital in subtropical Ecuador while also defining its limits and acknowledging circumstances requiring transfer to a higher level of care. A more detailed analysis of transferred patients would be beneficial to help determine areas for improvement of medical education curriculum and provider skill sets, define appropriate areas for allocation of limited resources, and set up transfer protocols.

CONCLUSION

This is a descriptive study analyzing an acute care system in rural Ecuador, and it provides valuable information to others attempting to set up similar rural EDs. To be clear, however, this is not a needs assessment and or a proposal of ED resident curriculum at this point. Combining an understanding of the dynamics of health, public health, and politics, along with trained clinicians, appropriate infrastructure and staff, and the help of modern technology and resources, advances can continue to be made in rural acute care in Latin America.

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Crossing Borders

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As emergency physicians, we are privileged to be in a field that crosses more boundaries than any other medical specialty. It is a calling. Our skills are portable and transferable across cultural and geographic disparities. For these reasons, many of us are drawn to sharing our knowledge and training across the globe – towards treating patients in underserved and austere environments abroad. The rapid growth of international and global health educational initiatives across our U.S. residency training programs is a direct result of those undeniable forces. Additionally, inclusion of such rotations becomes a powerful resident recruitment tool as more and more of our trainees are looking for these opportunities during their formative years.[1]

However, the survey results reported by Morris et al. in the article "Emergency Medicine Residents Abroad: Current Status and Next Steps" raise some concerns about the initial orientation, mentorship, and preparation practices of our residency programs that offer international rotations.[2] While we do have many shining examples of institutions that have "all the pieces in place," these results highlight the need for increased consistency and support practices across all emergency medicine (EM) training programs in sending our residents on global health missions.

Fortunately there are a number of resources available to guide programs in successfully implementing these types of opportunities. Many of our professional societies, including American College of Emergency Physicians,[3] Emergency Medicine Residents Association,[4] Society for Academic Emergency Medicine,[5] and the American Medical Association,[6] offer comprehensive webpages dedicated to the selection and development of global health rotations for students, residents and fellows. Additionally, many institutional EM residency programs across the country have been offering international rotations for a number of years and have developed extensive websites, protocols, and guidelines based on their experiences. But that is just the start. A number of key components must be present to provide consistency across all programs for the educational benefit and safety of our residents.

First and foremost, there should be a faculty mentor or "champion" in every EM training program for each resident and designated international rotation to coordinate and assist with logistics, planning, and educational goals. These individuals should be uniquely familiar with specific international rotation site(s), having both communicated with key contacts and traveled to the foreign clinics, hospitals, or regions at some point prior to placing residents in those environments. Thus, it is important that department mentors perform an initial site visit to the desired country for a "needs assessment" of the clinical setting(s), educational goals, safety and political stability of the country and region, and support expectations of the hosting entity. This includes identifying an appropriate "supervising physician" onsite if U.S. faculty members will not be traveling directly with trainees (an RRC mandate). The supervising physician is responsible for the educational oversight and post-rotation evaluations of the residents during the entire experience, as well as monitoring their safety and security while staying in the region.

Second, the faculty mentor and their department should establish a "Memorandum of Understanding" (MOU) with the host institution prior to the start of global health rotations. The MOU should clearly specify the roles and responsibilities of the trainees, including duty hours and off-service times. The MOU must also address the insurance coverage and limits of liability for the residents. As suggested by the previous article, up to one third of residents may be sent to locations without specified liability coverage…a very concerning statistic that should not be overlooked. Responsibility for any financial support (travel, food, housing, etc.) should also be clearly outlined in the MOU.

Third, intermittent site visits abroad should be performed by departments and/or mentors on a regular basis (i.e. every 1-2 years) to each of their global health venues. This insures consistency of educational benefits and adherence to Accreditation Council for Graduate Medical Education Core Competencies for resident participants and monitors any potential risks that can arise over time with foreign assignments.

Finally, as suggested in the previous article, establishing a formalized pre-departure training program for residents is

crucial. This curriculum could be incorporated into annual residency didactics, provided as additional training sessions, or in conjunction with Global Health Fellowship programs. Understanding culture disparities, travel safety, and regional disease prevalence and patterns are essential preparations for our residents traveling internationally.

The popularity and growth of international experiences is inevitable in our specialty. This is evidenced by the expansion of EM residency rotations and Global Health Fellowship programs. It is in our nature to share our emergency medicine expertise, practice in new environments, and experience foreign cultures. However, based on the results of this article, we have more work to do towards safely sending our residents abroad.

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Medication Overdoses at a Public Emergency Department in Santiago, Chile

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Introduction: While a nationwide poison control registry exists in Chile, reporting to the center is sporadic and happens at the discretion of the treating physician or by patients' self-report. Moreover, individual hospitals do not monitor accidental or intentional poisoning in a systematic manner. The goal of this study was to identify all cases of intentional medication overdose (MO) that occurred over two years at a large public hospital in Santiago, Chile, and examine its epidemiologic profile.

Methods: This study is a retrospective, explicit chart review conducted at Hospital Sótero del Rio from July 2008 until June 2010. We included all cases of identified intentional MO. Alcohol and recreational drugs were included only when they were ingested with other medications.

Results: We identified 1,557 cases of intentional MO and analyzed a total of 1,197 cases, corresponding to 0.51% of all emergency department (ED) presentations between July 2008 and June 2010. The median patient age was 25 years. The majority was female (67.6%). Two peaks were identified, corresponding to the spring of each year sampled. The rate of hospital admission was 22.2%. Benzodiazepines, selective serotonin reuptake inhibitors, and tricyclic antidepressants (TCA) were the causative agents most commonly found, comprising 1,044 (87.2%) of all analyzed cases. Acetaminophen was involved in 81 (6.8%) cases. More than one active substance was involved in 35% of cases. In 7.3% there was ethanol co-ingestion and in 1.0% co-ingestion of some other recreational drug (primarily cocaine). Of 1,557 cases, six (0.39%) patients died. TCA were involved in two of these deaths.

Conclusion: Similar to other developed and developing nations, intentional MO accounts for a significant number of ED presentations in Chile. Chile is unique in the region, however, in that its spectrum of intentional overdoses includes an excess burden of tricyclic antidepressant and benzodiazepine overdoses, a relatively low rate of alcohol and recreational drug co-ingestion, and a relatively low rate of acetaminophen ingestion. [West J Emerg Med. 2016;17(1):75–80.]

INTRODUCTION

A medication overdose (MO) is defined as the ingestion of a medication in an amount that exceeds recommended dosages.[1] Intentional MOs are an important problem in the

emergency department (ED) due to their potential lethality, related hospital costs, and association with mental illness. Overdose is the most common form of suicidal behavior treated in hospital, accounting for 1% of all admissions.[2-3] Knowledge of local patterns of MO is critical for emergency physicians as they attempt to quickly identify and appropriately manage life-threatening overdoses. It is also important that public health officials have the data necessary to direct policy, target interventions and appropriately allocate resources.

The incidence of suicide is increasing around the world, and Chile is no exception. Suicide rates have risen from 4.8/100,000 in 1992 to 12.7/100,000 in 2009.[4] Moreover, it is estimated that for every successful suicide there are 10 failed attempts. According to the World Health Organization (WHO), suicide by MO is a major public health problem worldwide.[5] The most common medications used in intentional MO are acetaminophen, benzodiazepines, and tricyclic antidepressants (TCA).[6]

Most of the current Chilean epidemiological data regarding intentional and accidental MO are provided by the Centro de Información de la Pontificia Universidad Católica de Chile (CITUC). CITUC was created in 1992, and has been the national poison control telephone referral center since 2009. CITUC can be accessed by both the lay public as well as by health professionals for guidance in the management of toxic ingestions and exposures via a toll-free number. According to CITUC, 49% of all calls from 1995 to 2002 were related to some type of MO.[7] MO constituted 41% of all non-intentional poisonings and 88% of all intentional poisonings in 2004; domestic and industrial pesticides and other chemicals accounted for the other causes of intentional poisonings. In 2010, an increase in MO-related calls (58.4%) was noted as compared to 49% between 1999 and 2002.[8] It has been reported from CITUC data that approximately half of the calls regarding MO involved treatment in an ED.[7,8] To date, there is no required reporting of MO events by treating physicians.

Hospital Sótero del Río (HSDR) is a public teaching hospital in Chile that serves the southeast population of metropolitan Santiago. This tertiary care hospital has 779 beds and an extremely busy ED, with over 150,000 patient visits per year. It is also the primary provider of emergency services for this diverse population, including emergency services for pediatric and obstetrical/gynecologic patients. HSDR serves both suburban and rural communities, providing care for a catchment area that includes nearly 1.5 million, or roughly 10% of the entire population of Chile.[10] Within this population, 7.1% are 65 years of age and older (compared to 9.0% nationally), and 22.9% are less than 15 years old (compared to 22.3% nationally). Females comprise 50.6% (compared to 50.5% nationally). Estimates of the poverty rate in the served area (using the WHO standard) range from 9.1% to 17.2% (compared to 14.4% nationally) and the rate of indigence from 1.6% to 4.6% (compared to 2.8% nationally). The hospital mortality rate is 3.7%, which is less than the national mean of 5.2%.[11,12]

In this study, we attempted to better characterize the spectrum of intentional MO and its true burden at one of Chile's busiest public hospitals. These data are complementary to previous studies published on MOs using the CITUC database, which captures only cases that are initiated by a phone call to the Center.

METHODS

After approval by the institutional research and ethics board, we performed an explicit chart review of patients presenting to the ED at HSDR. We conducted our chart review based on the framework suggested by Kaji et al.[9]

Search and Chart Review Methodology.

A very basic electronic database exists, which includes the following (admittedly limited) information regarding all patient visits in the HSDR ED: chief complaint, medical record number, and basic demographic data. This system is separate from the ED's paper records and electronic ordering, as well as the hospital's inpatient paper and electronic medical record. We searched the electronic database for the terms "medication intoxication," "overdose," "drug ingestion," "poisoning," "suicide" and "intent to commit suicide" in the chief complaint. This search provided several thousand patient ID numbers. All records that indicated a probable MO were selected for further examination. We reviewed hand-written ED and electronic inpatient records to determine which patients were subsequently admitted to the hospital. For this initial screening no charts were excluded based on age or any other epidemiologic patient characteristics (Figure).

These charts were then retrieved and reviewed by the authors. Abstracted data included date of visit, gender, age, origin, pulse, blood pressure, type of pharmaceutical ingested (if known), any street drugs or alcohol use, mortality, disposition, and hospital length of stay (for admitted patients). When intent was specifically documented, it was noted. Laboratory results were generally unavailable as they represent a prohibitive cost in Chile. Therefore, determination of medication type, amount, and co-ingestions was based on the history provided. As details regarding interventions were generally unavailable, patients who presented with abnormal vital signs were identified. These included a pulse below 50 or over 120 beats/min and/or a systolic blood pressure below 90 mmHg that would have likely required (and presumably received) resuscitative measures. We were not able to select patients based on respiratory rate, oxygen saturation of temperature because those vital signs were not registered in the initial triage chart. The drugs ingested were identified when possible and compared with national and international data. As data were recorded directly from charts and no data interpretation was required, we did not calculate a Kappa score.

If any component of a patient chart was illegible, missing,

or left blank, that specific data was considered missing, but the rest of the information was used for selected frequency analysis. In order to exclude accidental pediatric ingestions, we included only charts of patients eight years of age and older in the analysis.[14] We then analyzed the data using Stata 9.0; means, medians, percentages and odds ratios with 95% CI and p values were calculated and reported as appropriate.

RESULTS

We identified a total of 1,557 patient records, representing 0.51% of all ED presentations between July 2008 and June 2010. The total ED census over this period was 305,294 patient visits. This represents a mean of approximately 2.1 MO patients per each 24-hour period. Females represented 67.6%. Mean age was 28 years (SD=13), with a median of 25 years, and patient ages ranged from 8- 89 years. The frequency of MO by age is summarized in Table 1. A peak incidence of MO was observed at age 15.

Of the entire cohort, 81 patient visits had complete missing records and a further 63 left without being seen, therefore providing no information beyond the presenting complaint of MO. Of the 1,413 remaining patient visits, 216 suffered from MO of unknown pharmaceuticals or had charts that were illegible to the point that no medication(s) could be identified. Thus, for a total of 360 (23.1%) patient visits, no specific information regarding pharmaceutical class was available (Figure). The remaining 1,197 (76.8%) had one or more medications documented. Thirty-five percent of these MOs (n=545) involved more than one substance. Co-ingestion of alcohol and/or street drugs was recorded in 8.3% of cases. Four hundred and thirty patients (27.6%) were referred from primary care clinics, 169 (10.9%) presented with vital sign abnormalities that would require resuscitation and 345 (22.2%) were admitted. The proportion of ED visits resulting in admission was higher (28.6%) when they were referred from primary care services (Table 1).

When comparing main medication groups, the four most commonly identified active substances were benzodiazepines, with 547 ingestions (45.7%), followed by selective serotonin reuptake inhibitors (SSRIs) (21.3%, n=255), TCA (13.2%, n=158), and acetaminophen (6.7%, n=81). Table 2 shows the percentage of visits with abnormal vital signs that presumably required resuscitation or resulted in admission to the hospital.

Table 3 lists the top 10 active substances involved (representing 96.9% of all presenting cases of MO). Clonazepam was the most commonly ingested medication, while amitriptyline was associated with the greatest number of vital sign abnormalities on presentation. Admission rates were higher when carbamazepine and amitriptyline were involved. Acetaminophen was associated with the longest length of stay. The youngest mean age at presentation was found with acetaminophen.

We noted seasonal differences, with a higher number of ED visits for MO in the spring (31.5%, n=491) and the lowest incidence during the winter (20.2%, n=315). ($p<0.05$)

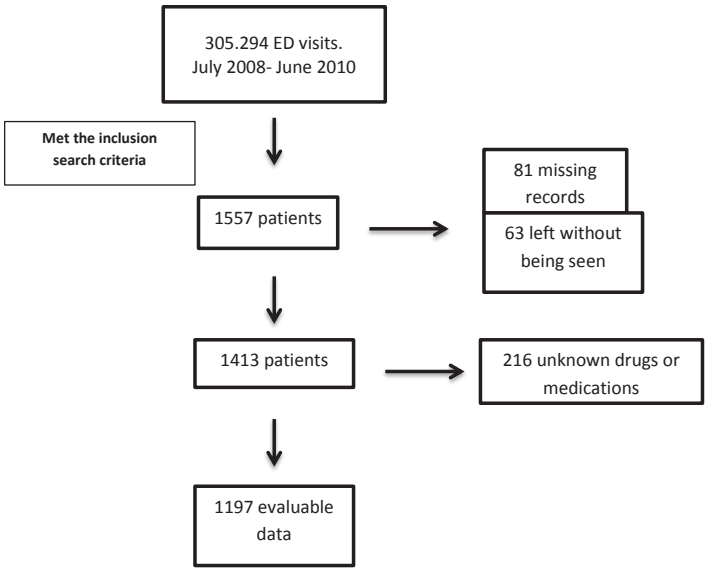

Figure. Flow diagram of the study chart review.
ED, emergency department

Six patients (0.39%) of the 1,557 died during hospital stay. No patients expired during their stay in the ED.

DISCUSSION

These results in our population in metropolitan Santiago are overall consistent with previously published studies of the Chilean population. Moreover, we present new data that provide a level of clinical detail not previously reported, including blood pressure and heart rate abnormalities as a surrogate for severity on initial presentation, admission rates, hospital length of stay, and mortality. None of these data were reported in previous studies. Our findings generally confirmed both a 10-year CITUC report from 1992-2002 and another CITUC report in 2004.[7,8] The prior CITUC studies represent a larger proportion of the country over a longer period of time. However, the database comes from self-reports by physician phone calls or from family member phone calls and may not be representative of all MO events. Ultimately, the data from our study and prior UC studies are complementary and should be used together to better understand the needs of the population they describe.

The prevalence of drug classes such as muscle relaxants and NSAIDS were noted to be the second and third most common drugs in intentional overdose in our study. This confirms previous findings in the CITUC studies. Similar to reports from other countries (including our own), we found a strong female predominance (67.5%).[16,17]

It is concerning that the peak incidence of MO in our study was 15 years of age, which is at younger than what was previously reported in the Chilean literature.[15] It is unclear whether this represents a trend of younger MO overdoses or the differences between the populations studied (nationwide call center data versus our metropolitan institution's patient population).

The results of our study diverged from those of other countries in some key ways. For example, per the American Association of Poison Control Centers, analgesics were the main cause of human exposure calls in North America.[15] In our population, we found a predominance of MO involving drugs with action on the central nervous system (benzodiazepines and antidepressants).

Table 1. Demographic characteristics of patients presenting with medication overdose to the emergency department at Hospital Sótero del Río, Santiago, Chile.

Characteristics	Category	N	Percentage (%)
Gender	Female	1,052	67.6
Age range (years)	<18	387	24.9
	18-64	1,156	74.2
	≥65	14	0.9
Arrival	Referred from PC services	430	27.6
	Direct ED presentation	1,127	72.4
Abnormal VS potentially requiring resuscitation*	Abnormal VS	169	10.9
	Normal VS	1388	89.1
Active substance identified	One active substance	652	41.9
	>1 active substance	545	35.0
	Not identified	360	23.1
Co-ingestion with alcohol	Yes	114	7.3
	No	1443	92.7
Co-ingestion with street drugs (principally cocaine)	Yes	15	1,0
	No	1542	99.0
Disposition	Home	1149	73.8
	Admitted	345	22.2
	Missing data	63	4.0
Mortality	Deaths	6	0.39

PC, primary care; *VS,* vital signs; *ED,* emergency department

In Chile, the reported prevalence of depressive symptoms was recently reported at 25.7% for women and up to 8.5% for men.[18] These numbers are markedly higher than those reported in the United States where the average prevalence is 6.7%.[18,19] There are also more cases of MO involving medications used to treat nervous system diseases in Chile than in the U.S.[15] A 2003 study found that 62% of all medications administered in Chile that year were related to the central nervous system.[20] This correlates with the incidence of MO in our study.

Most importantly, we found that the combined prevalence, morbidity, and mortality of TCA were greater than other agents. Patients who ingested TCA were more likely to present with vital signs abnormalities, and thus likely required resuscitation. Specifically, vital sign instability that would require resuscitation was seen in over 20% of cases, compared with less than 10% in patients who ingested benzodiazepines (OR 1.84, 95% CI [1.18-2.85]). TCA overdose had an associated rate of admission to the hospital over twice that of other medications. Furthermore, despite constituting less than 10% of presenting cases, the mortality in these cases represented one-third of all deaths.[2,6] The excess burden of TCA in our study may be related to its availability without a physician prescription until December 2009.

Co-ingestion with alcohol and illicit drugs, primarily cocaine, occurred less frequently in our population than reported in studies in other countries.[18,19] Furthermore, acetaminophen overdose is not as large a public health problem in Chile as it is in the U.S.[15] or the UK[22] in terms of case numbers, but the costs associated with admission and increased length of stay were noted in the present study.

In other countries, such as Brazil, hospital-based systems have been put in place to monitor not only the adverse effects of medications but also the rates of inappropriate use, including cases of MO.[23] In Chile, however, no such system is in place, and therefore, despite its limitations, our study provides the most representative epidemiological data to date. It has become apparent that further work needs to be done to ensure accurate representation of MO, including the classifications, interventions, adverse events, and outcomes. Despite shortcomings, our large sample size drawn from a hospital serving 10% of the Chilean population is likely representative of the true burden of MO and provides outcome data not previously available.

Table 2. Main medication categories and patients presenting with vital-sign instability after medication overdose to the emergency department at Hospital Sótero del Río. Chile (out of 1197 patients).

Medication group	At least one of these active substances n (%)	Vital sign abnormality requiring resuscitation OR (CI)**	p	Admission OR (CI)**	p
Benzodiazepines	547 (45.7)	0.46 (0.32-0.67)	<0.05	0.25 (0.19-0.33)	<0.05
SSRIs*	255 (21.3)	0.88 (0.57-1.35)	0.543	0.6 (0.43-0.85)	0.002
Tricyclic antidepressant	158 (13.2)	1.84 (1.18-2.85)	<0.05	2.28 (1.59-3.25)	<0.05
Acetaminophen	81 (6.77)	0.75 (0.34-1.58)	0.0421	3.39 (2.32-6.5)	<0.05

SSRIs, selective serotonin reuptake inhibitors

Table 3. Top 10 active substances identified (n=1197).

Identified substances	Patient rate (%)	Absolute number of exposures	Age average (range)	Transferred from PC (n)	Hospital admission (n)	Mean stay in days
Clonazepam	26.5	317	30.9 (11-62)	67	46	3.24
Amitriptyline	12.5	150	30 (9-68)	64	68	2.45
Alprazolam	9.7	116	32.1 (11-85)	20	16	3.38
Fluoxetine	9.4	113	24.3 (11-50)	29	24	4.26
Sertraline	8.8	105	26.8 (12-59)	31	21	2.19
Diazepam	7.4	89	30.6 (8-63)	22	11	2.82
Acetaminophen	6.7	81	16 (14-54)	30	29	5.62
Cyclobenzaprine	6.1	73	27.1 (9-50)	25	18	1.83
Carbamazepine	5.1	61	25.4 (13-55)	30	31	4.56
Zopiclone	4.7	55	31.7 (8-65)	12	5	2.75
Total*	97	1160	27.5 (11-85)	330	269	3.15

PC, primary care
*Top 10 overdoses comprised 96.6% of all cases.

Our study underscores the need for a nationwide hospital-based pharmaceutical overdose monitoring system (similar to the one in place in Brazil) that could provide this kind of data more contemporaneously without the need for time-consuming retrospective chart review. This would enable Chile's emergency practitioners to better understand the epidemiological trends in their local patient populations and stay ahead of emerging developments in prescription drug abuse. This information is also important for public health officials so that they may lead efforts to promote public safety and harm reduction.

LIMITATIONS

This study has a number of important limitations related to the medical records system at HSDR. The ability to identify subjects was dependent on the initial classification of the intake nurse or emergency practitioner in the ED. Many charts were missing, incomplete, or illegible. Patients who did not present with a known or suspected overdose were unavailable for inclusion in the study. Some cases of pharmaceutical intoxication may have been overlooked, in particular, acetaminophen, which may present without symptoms. It is impossible to know to what extent this occurred. Moreover, it is also likely that some patients with MO were misdiagnosed and therefore not included. Furthermore, these data were inherently limited to cases of intoxication leading to ED presentation. Patients not transported to the hospital, such as completed suicide or a self-limited intoxication, would not have been included. Finally, the lack of an available toxicological laboratory made laboratory confirmation impossible. In general, these factors likely led to a systematic underestimation of the true burden of MO in Chile.

This study was also hindered by the lack of completeness of the written ED record and the electronic inpatient record. The completed intervention performed on these patients was not always able to be extracted from the records and was thus not included in this study. To address this issue, we included the proxy measure of abnormal vital signs on presentation that in turn only included blood pressure and heart rate, as the rest of vital signs were not systematically recorded. This likely resulted in underestimating the number of patients requiring intervention, as a patient who has suffered MO may have normal vital signs (and thus not be captured by this measure).

CONCLUSION

It is clear that MO is a significant problem in Chile. The leading causes of intentional overdoses of patients who seek medical care in the ED include an excess burden of TCA and benzodiazepine overdoses, a relatively low rate of alcohol and recreational drug co-ingestion, and a relatively low rate of acetaminophen ingestion as compared to what has been reported in the international literature.

There remains a great need for a more robust and complete system for data collection to advance the care of patients with MO in Chile.

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Seldinger Technique for Placement of "Peripheral" Internal Jugular Line: Novel Approach for Emergent Vascular Access

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This is a case report describing the ultrasound-guided placement of a peripheral intravenous catheter into the internal jugular vein of a patient with difficult vascular access. Although this technique has been described in the past, this case is novel in that the Seldinger technique was used to place the catheter. This allows for safer placement of a longer catheter (2.25") without the need for venous dilation, which is potentially hazardous. [West J Emerg Med. 2016;17(1):81–83.]

INTRODUCTION

Peripheral intravenous (IV) access is an essential component of emergency department (ED) care. Traditionally, success rates are high.[1,2] There are, however, subsets of patients, including the morbidly obese, chronically ill, severely dehydrated, or those who use intravenous drugs, in whom peripheral venous access is difficult or impossible to obtain using conventional methods.[3] These patients represent a unique challenge to emergency and critical care physicians, and multiple alternative strategies have been described to assist in this setting. These include placement of a catheter in an external jugular (EJ) vein, blind placement into a deep (brachial) upper arm vein, ultrasound-guided placement in a peripheral vein, or placement of central venous catheter. In critically-ill patients, an intraosseous catheter or even saphenous vein cutdown may also be used.[4]

A novel technique that has been described is the placement of a standard IV catheter into the internal jugular vein under dynamic ultrasound-guidance.[4,5] Although limited data are available, there have been no reported complications secondary to the use of this technique.

At our institution, we perform ultrasound-guided placement with the AccuCath® 2.25" BC intravascular catheter (Bard Access Systems, Salt Lake City, UT) to obtain vascular access in challenging patients (Figure 1). This is an intravascular catheter that integrates a coiled tip nitinol guidewire, which minimizes the need for needle advancement.

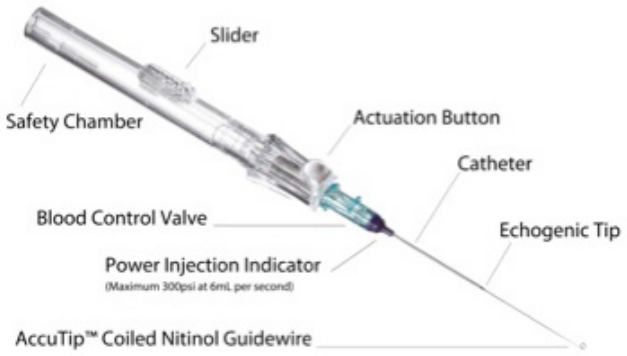

Figure 1. AccuCath® 2.25" BC catheter.

The guidewire technology aids in navigating vessel anatomy to achieve atraumatic delivery of the catheter using the Seldinger technique. Here, we describe a novel technique for obtaining vascular access through the internal jugular vein using ultrasound-guided placement of this device.

CASE REPORT

A 69-year-old female with a history of diabetes mellitus, hypertension, and end-stage renal disease presented to our ED via ambulance after becoming hypotensive during hemodialysis. She complained of mild fatigue and weakness, but had no other complaints and stated that this had happened to her previously, and that she typically improved with

intravenous (IV) hydration. She also stated that, because she has had multiple arteriovenous shunts in the upper extremities, obtaining peripheral IV access was typically not possible and that she usually required a central venous catheter. On physical examination, her blood pressure was 89/45, heart rate 92 beats per minute, respiratory rate 12 breaths per minute, temperature 37.1 degrees Celcius with a room air oxygen saturation of 98%. The patient was completely alert and oriented and in no acute distress, but appeared to be mildly fatigued. She had a right internal jugular hemodialysis catheter and scarring on the skin of her upper extremities noted in the vicinity of prior vascular access sites. The remainder of her examination was unremarkable.

Initial attempts to establish peripheral vascular access with and without ultrasound guidance were unsuccessful. However, given the patient's relatively well appearance, and the desire to avoid dilation of the left internal jugular vein (one of the patients last viable dialysis access sites), we opted to place an AccuCath® 2.25" BC catheter in this central vein under ultrasound guidance. The neck was prepped in sterile fashion and the left internal jugular vein was cannulated under dynamic ultrasound guidance using a Zonare Z.One PRO ultrasound system (Mountain View, California) (Figure 2a). The guidewire was then gently advanced into the vein (Figure 2b), and the catheter was subsequently advanced over the wire. One liter of IV normal saline was infused after which the patient's blood pressure improved. She felt much better, and was discharged home after a brief observation period in the ED.

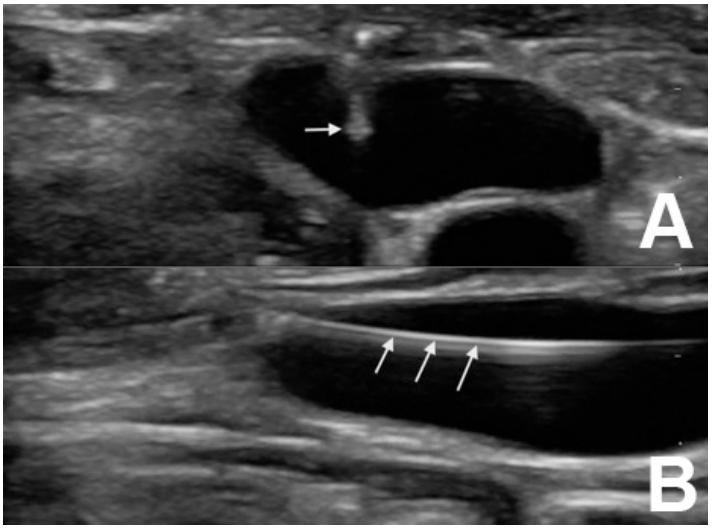

Figure 2. A) Cross-sectional view of the left internal jugular vein with needle in lumen. B) Longitudinal view of guidewire in lumen of left internal jugular vein.

DISCUSSION

Since its introduction in 1953, the Seldinger technique has been used with great success to cannulate a multitude of blood vessels, hollow viscous structures, and potential anatomical spaces. Prior to its introduction, central vascular access required the use of large bore needles through which smaller catheters were placed. This limited cannulation to larger blood vessels, and due to both the large needle and greater vessel sizes increased the risk of vessel damage and hemorrhage.[6] Seldinger's technique of placing a guide wire through the needle allowed for a catheter the same bore as the needle to be placed, enabling the placement of smaller catheters into smaller vessels, and decreasing the associated complications.[6]

The addition of ultrasound has been shown to decrease complications even further.[7] In spite of this, however, accidental arterial puncture and dilation remain problematic.[8] This is because even under ultrasound guidance, the needle can temporarily slip out of the visualized field and penetrate deeper than the operator desires.[9] Arterial puncture is generally well tolerated and can be treated conservatively in most cases. Dilation, however, can lead to significant morbidity and mortality in the form of arterial dissection, hemorrhage, and arteriovenous fistula formation.[8]

Placement of a 1.88" (48mm) angiocatheter into the internal jugular vein has been described in the literature,[4,5] and is one technique that can be used to avoid accidental arterial puncture and dilation in difficult cases. The addition of the AccuCath® 2.25" BC catheter to this method allows clinicians to benefit from the advantages of the Seldinger technique without the risks of arterial cannulation and dilation. It can be performed more quickly than central venous access via traditional methods[4] and, because the guidewire is much shorter than those typically used for central venous catheterization, the incidence of guidewire-induced cardiac dysrhythmias should be much lower.[10] The integrated guidewire technology also helps to prevent vascular trauma and posterior wall damage.[6,8] Although its use for central placement requires further study, it should be considered in difficult vascular access patients who do not require large bore or multi-lumen catheters.

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Shot in the Heart

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A 25-year-old male was brought in by ambulance to the emergency department (ED) after sustaining a gunshot wound to his chin and left shoulder. Upon arrival to the ED, his airway was intact without evidence of blood in the oropharynx. He was found to have slightly diminished breath sounds on the left side, with respirations at 34 breaths per minute, a blood pressure of 72/50mmHg, and a heart rate of 76 beats per minute with cool extremities and poor peripheral pulses. His focused abdominal sonography in trauma exam showed a foreign body within the right ventricle without a pericardial effusion (Figure 1 and Video). An upright portable chest radiograph performed immediately thereafter showed blunting of the left costophrenic angle with a bullet fragment overlying the cardiac shadow (Figure 2).

Diagnosis: Traumatic Ventricular Septal Defect

He was taken emergently to the operating room (OR) for exploration where he was found to have a ventricular septal defect (VSD), which was repaired. After a prolonged hospital stay, he was discharged to a long-term acute care facility for ventilator weaning. This patient is no longer dependent on the ventilator and is neurologically intact with a Glasgow Coma Scale of 15 and a Modified Rankin Scale of zero. He currently lives with a retained bullet fragment in his right ventricle. Traumatic VSD is a rare occurrence

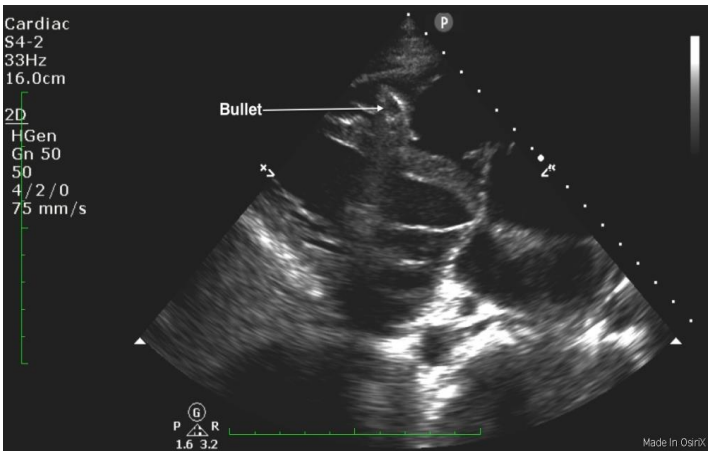

Figure 1. Parasternal long axis view demonstrating a bullet fragment within the right ventricle.

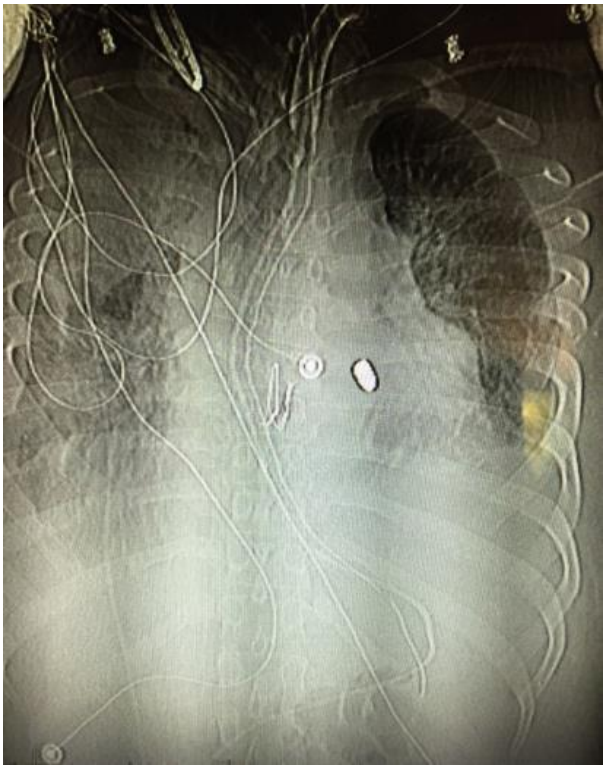

Figure 2. Anteroposteior chest x-ray demonstrating bullet fragment overlying the cardiac shadow.

in cases of penetrating cardiac injury, with an incidence of only 1% to 5%.[1] In patients who respond to resuscitation, as evidenced by systolic blood pressure >60mmHg to <100mmHg, there is evidence that they would benefit from emergency thoracotomy (ET [immediate thoracotomy performed in the OR]), as opposed to ED thoracotomy (EDT [immediate thoracotomy performed in the ED]). In these patients, survival can reach 75% to hospital discharge. Those patients who do not respond to the initial resuscitative effort have only a 25% survival rate after an EDT.[2] Ultrasonography, performed during the initial survey of a trauma patient, has promise as a diagnostic modality for a variety of foreign bodies with a sensitivity and specificity of 96.7% and 70%, respectively.[3] The chest film in the trauma bay showed a bullet fragment overlaying the cardiac shadow; however, given that only a single anteroposterior view was obtained it was difficult to ascertain the exact location of the bullet fragment. The use of ultrasound has the ability to detect intracardiac foreign bodies.

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Video. Parasternal long axis clip demonstrating a bullet fragment within the right ventricle.

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A Rare Cause of Headache

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INTRODUCTION

A 45-year-old man presented with headache for two days. He described the quality of headache as throbbing, and it was unilateral. There was no history of fever, vomiting, blurred vision, ear discharge or trauma, no relevant past medical or drug history and no family history of note. On examination, he was afebrile with pulse 76/min, regular, blood pressure of 130/80mmHg. His pupils and speech appeared normal. There were no papilledema, sensory deficit, focal neurological deficit or signs of meningeal irritation. Hyperdensity of right transverse sinus (Figure 1) and superior sagittal sinus was identified on unenhanced computed tomography (CT). Magnetic resonance venography (MRV) demonstrated lack of flow in right transverse sinus (Figure 2) and superior sagittal sinus.

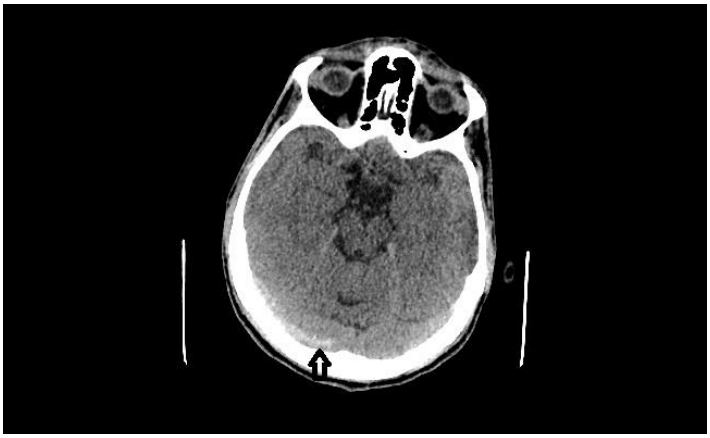

Figure 1. Computed tomography of the brain demonstrating hyperdensity in the region of right transverse sinus (arrow).

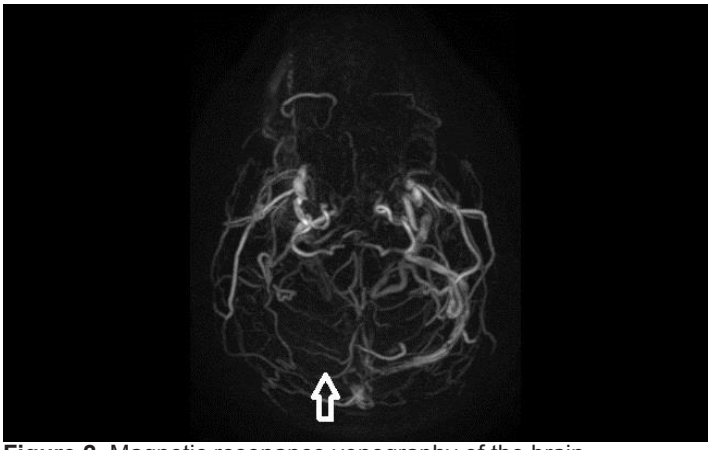

Figure 2. Magnetic resonance venography of the brain demonstrating lack of flow in right transverse sinus (arrow).

DIAGNOSIS

Cerebral venous sinus thrombosis (CVST) is a rare condition. According to the International Study on Cerebral Vein and Dural Sinus Thrombosis, the most commonly affected site is the transverse sinus, followed by superior sagittal sinus and straight sinus.[1] Predisposing risk factors may include the following: sinusitis, medications, malignancy, dehydration, prothrombotic conditions, head injury and inflammatory diseases.[2] Neuroimaging modalities of choice in CVST are CT and magnetic resonance imaging (MRI) with MRV. CT may be normal in 15-30% cases, but MRI with MRV is almost 100% diagnostic.[3]

According to the guidelines of the European Federation of Neurological Societies, the first-line treatment for CVST is antithrombolysis. Our patient was given anticoagulant therapy for six months, after which he had recovered fully.

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Tension Hydrothorax from Disseminated Endometriosis

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INTRODUCTION

We present the case of a 34-year-old woman presenting to the emergency department (ED) with dyspnea, cough, and fever. She was found to have a tension hydrothorax and was treated with ultrasound-guided thoracentesis in the ED. Subsequent inpatient evaluation showed the patient had disseminated endometriosis. Tension hydrothorax has not been previously described in the literature as a complication of this disease.

CASE REPORT

A 34-year-old Nigerian woman presented to the ED with a chief complaint of dyspnea, cough, and fever for two days. The patient also complained of epigastric pain and intermittent emesis. She denied any significant prior medical or surgical history.

Physical exam revealed a toxic-appearing female in respiratory distress. Vital signs were temperature 100.5°F; blood pressure 103/76mmHg; heart rate 126bpm; respiratory rate 32bpm; and 99% oxygen saturation on room air. She had decreased breath sounds on the right side, and exhibited right upper quadrant tenderness on palpation. The cardiovascular exam was remarkable only for the tachycardia.

A portable chest radiograph (CXR) revealed complete atelectasis of the right lung with adjacent large right pleural effusion, causing mediastinal shift to the left, consistent with tension hydrothorax (Figure 1). A computed tomography (CT) angiogram of the chest confirmed the above findings; there was no evidence of pulmonary embolism or aortic dissection (Figure 2). An ultrasound-guided thoracentesis removed 1.5L of serosanguinous fluid. The patient reported relief of chest pain and dyspnea after the thoracentesis.

The patient was admitted to the hospital and treated for presumed pneumonia and sepsis with broad spectrum antibiotics. A purified protein derivative for tuberculosis was negative. She had a chest tube placed on hospital day 2 for recurrent right pleural effusion, with return of two liters of serosanguinous fluid. Pleural fluid cultures, acid fast bacteria (AFB) and cytology were all negative.

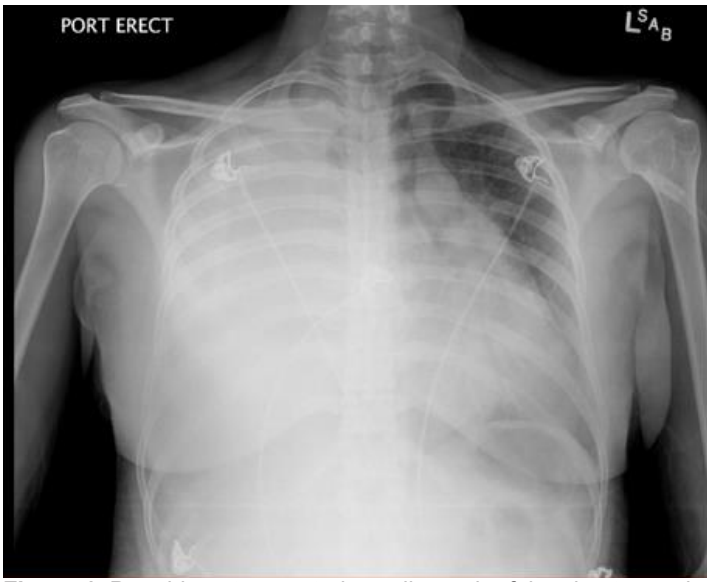

Figure 1. Portable anteroposterior radiograph of the chest reveals complete atelectasis of the right lung (white arrow), adjacent right-sided pleural effusion (arrowhead) and leftward mediastinal shift (black arrow) consistent with tension hydrothorax.

Because of worsening abdominal pain and distention, on hospital day 4 a CT of the abdomen/pelvis was ordered and revealed a pelvic mass of unclear uterine or adnexal etiology, with abdominal implants and ascites, suspicious for malignancy. A follow–up pelvic ultrasound was less suggestive of malignancy, and revealed two solid uterine lesions and an enlarged right ovary with cyst. Magnetic resonance imaging of the abdomen and pelvis revealed bilateral complex cystic adnexal structures with hemorrhage; a tubo-ovarian abscess was suspected.

On hospital day 14, the patient underwent laparoscopy with biopsy. Laparoscopy revealed blue-tinged lesions on the

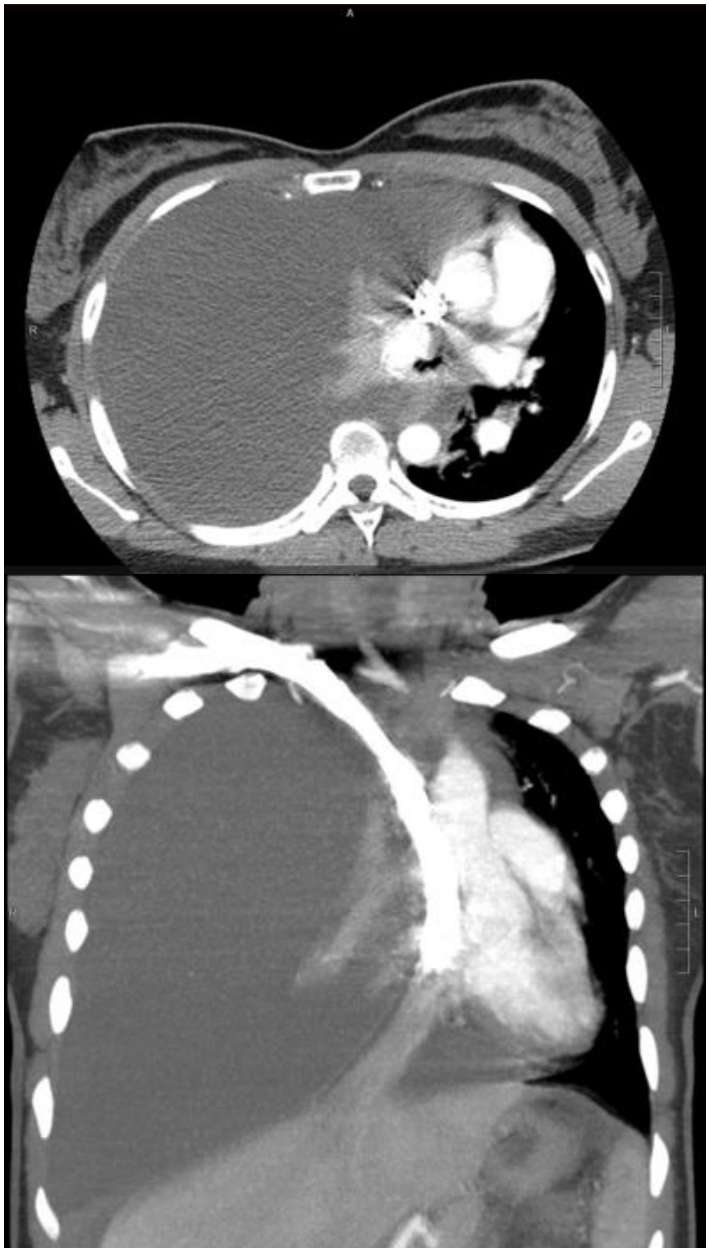

Figure 2. Axial (A) and coronal (B) computed tomography angiogram images of the chest showing a large right pleural effusion (arrows) and near-complete atelectasis of the right lung (arrow heads) with leftward mediastinal shift.

central omentum, a nodular omental lesion, and pelvic wall nodule. The peritoneum was described as having a fibrinous exudate with mucinous appearance along the surface. Biopsies of the omental and pelvic nodules confirmed the lesions to be consistent with endometriosis and a pelvic wall abscess. The final diagnosis was disseminated endometriosis resulting in tension hydrothorax and pelvic inflammatory disease. The patient was discharged on hospital day 22 to complete an outpatient course of antibiotics.

DISCUSSION

Tension hydrothorax is defined as a large pleural effusion that increases intrathoracic pressure enough to cause a shift in mediastinal structures and decrease venous return.[1] It differs from tension pneumothorax in that symptoms may develop slowly over time until a critical intrathoracic pressure is reached. As fluid accumulates in the pleural space, this causes the lung volume on the affected side to decrease, resulting in tachypnea, decreased breath sounds, and hypoxia.[2] As the volume and pressure within the pleural cavity increases, venous return to the right ventricle decreases.[2] If untreated, tension hydrothorax and tension pneumothorax share a common terminal pathophysiology. Tachycardia, hypoxemia, jugular venous distention, and hypotension are observed due to the severe elevation of intrathoracic pressure in conjunction with decreased venous return and compression of the right ventricle.[2]

In the adult population, malignancy and infection are the primary causes of tension hydrothorax.[1] Additional causes described in the literature include: ventriculopleural shunting;[2,3] peritoneal dialysis;[4,5] migration of ventriculoperitoneal shunts;[1] cirrhosis (hepatic hydrothorax);[6] ovarian hyperstimulation syndrome;[7] and central venous catheterization.[8]

Most patients will present with obvious pulmonary pathology, including dyspnea, decreased or absent breath sounds, tachypnea and hypoxia. A CXR will confirm the diagnosis. Depending upon the patient's acuity, a chest CT can provide additional information. Findings on laboratory studies are inconsistent, and depend on the etiology of the tension hydrothorax. Management of tension hydrothorax involves immediate drainage. Depending on the patient's hemodynamics, this may involve therapeutic thoracentesis, or more commonly, tube thoracostomy. This typically will result in immediate improved hemodynamics, improved oxygenation and decreased dyspnea. Once drained, the pleural fluid should be sent for gram stain, cultures (aerobic and anaerobic), AFB and cytology. Additional studies may be required to identify the etiology of the pleural fluid and allow for definitive management.

Interestingly, we could not find a case of tension hydrothorax related to endometriosis in the literature. The thorax is a rare site of endometriosis.[7] There are two forms of thoracic endometriosis: the pulmonary and the pleural form. The pulmonary form presents as catamenial hemoptysis and pulmonary nodules. The pleural form includes catamenial pneumothorax (pneumothorax associated with menstruation); catamenial hemothorax; catamenial pneumomediastinum; and chest pain.[7] Of these, catamenial pneumothorax is the most common manifestation of thoracic endometriosis (73%), followed by catamential hemothorax (14%), catamenial hemoptysis (7%) and lung nodules (6%).[7] The pathogenesis of thoracic endometriosis is not well understood; the two predominant theories are microembolization and peritoneal-pleural based migration.[7] Interestingly, the right hemothorax is involved in more than 90% of all cases of thoracic endometriosis,[7,9] and the peak incidence of thoracic endometriosis is between 30 and 34 years old;[9] our

patient clearly fit the profile.

CONCLUSION

We describe the first published case of a tension hydrothorax presenting as a complication of disseminated endometriosis in a young woman.

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Frozen Funding on Firearm Research: "Doing Nothing Is No Longer an Acceptable Solution"

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December 2015 saw another Congressional budget standoff and threatened government shutdown. This omnibus bill was particularly important for public health, because – for the first time in years – it contained language that would have reversed a 19-year-old prohibition on Centers for Disease Control and Prevention (CDC) funding for research on firearm injury. Unfortunately, 2016's final Omnibus Appropriations bill did not reverse this prohibition. And so another year begins with the United States – and the world – debating how to solve the problem of firearm violence in this country, without the benefit of objective public health research.

What is the Funding "Ban"?

The so-called funding ban began in 1996, when Representative Jay Dickey, a junior Republican from Arkansas, inserted a rider into the federal spending bill, with support and lobbying from the National Rifle Association. The rider stipulated that no CDC funds "may be used to advocate or promote gun control." Congress also cut CDC's budget by exactly the amount dedicated to firearm injury research. Although the amendment did not prohibit research per se, it was interpreted as doing so. As such, it has had a chilling effect on research, effectively halting federally-funded research on firearm injury and freezing the number of publications.[1,2] By 2011, similar language had been extended to cover the National Institutes of Health (NIH).

In January 2013, in response to the shooting at Sandy Hook Elementary School in Newtown, Connecticut, President Obama released a plan to reduce gun violence. This plan included a presidential memorandum clarifying the meaning of the Dickey amendment and directing the CDC and other scientific agencies within the Department of Health and Human Services (including the NIH) to "conduct or sponsor research into the causes of gun violence and the ways to prevent it."[3] Since then, the NIH has funded three studies explicitly related to firearm injury,[4] and the National Institute of Justice awarded nearly $2 million in funding for firearms-related research in 2014.[5] Yet Congress has continued to quietly – and sometimes not so quietly – block additional funds for firearm research and restrict the CDC's budget to limit activities related to firearm violence.

Though his amendment remains in force, Rep. Dickey's views have changed. In December 2015, he published an open letter to Congress urging action on firearm injuries and lamenting the way his intent (to avoid federal funding for politicized gun control advocacy) was distorted to obstruct scientific and public health progress. "Research could have been continued on gun violence without infringing on the rights of gun owners, in the same fashion that the highway industry continued its research without eliminating the automobile," he wrote. "It is my position that somehow or someway we should slowly but methodically fund such research until a solution is reached. Doing nothing is no longer an acceptable solution."[6]

Unfortunately, in the face of the 2016 Omnibus Appropriations bill, we are being asked to continue to "do nothing" in the research realm.

What Does This "Ban" Mean for Emergency Physicians?

In emergency medicine, we deal with firearm injuries and their effects on a daily basis. With our pre-hospital and surgical colleagues, we treat the victims of acute violence (be it from domestic violence, other assaults, mass shootings, or self-inflicted wounds) and survivors suffering from chronic physical and mental sequelae of firearm injuries.

We know that comprehensive research strategies have

dramatically decreased total motor vehicle deaths and age-adjusted death rates over the past three decades, even after accounting for increases in road travel (Figure). Had we, as Rep. Dickey and others have suggested,[1,7,8] applied similar strategies from public health and medical research to firearm injury, we might be in a very different spot today. But because we lack critical information on the epidemiology of firearm violence and on the effectiveness of various strategies to prevent it, the number and rates of firearm deaths have remained steady.

While we know how to resuscitate a patient with a gunshot wound, prevention matters, too. Many who die from firearm injuries never make it to through our emergency departments' doors; this is especially true for firearm suicides, which have a case fatality rate of 85%.[9] And triage and prevention is part and parcel of our specialty: we are expected to first predict who is at high risk for myocardial infarction, arrhythmia, suicide, and stroke, and then to intervene appropriately. For firearm injury, we are largely at a loss. Which patients are at highest risk for injury? How can we prevent future firearm injury for the adolescent in a gang, the woman in an abusive relationship, or the depressed older man? How should we counsel our patients about firearm storage or ownership? Which policies should we, as medical professionals, advocate for as evidence-based solutions? The CDC's website contains myriad fact sheets and reports about motor vehicle safety, but almost nothing about firearms. For example, the online CDC A-Z Index "lists topics with relevance to a broad cross-section of CDC.gov's audiences….The items are representative of popular topics, frequent inquiries, or have critical importance to CDC's public health mission."[10] There are over 2,300 topics listed in the index, ranging from "abrasive blasting" to "Zika virus," topics that each have a whole webpage and fact sheets. "Fireworks" and "nail guns" each have an entry, as does "motor vehicle injuries," but both "firearm" and "gun" are missing completely.

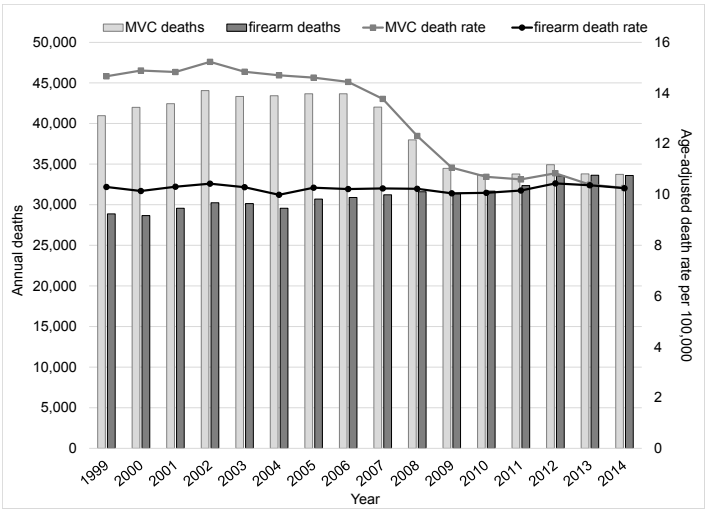

Figure. Firearm and motor vehicle collision (MVC) deaths (US, 1999-2014).[17]

So What Can Emergency Physicians *Do?*

The scarcity of federal funding for firearm research may slow us down, but we cannot allow it to stop the quest for truth and improving the public's health. Rather than throwing up our collective hands, we can and should take steps –even if they're small steps– forward. We can do so in four ways.

First, we need to engage junior investigators in firearm-related research. The dearth of funding has not only stopped projects but has also dried up the pipeline of scientists entering the field. Only a handful of experienced investigators in firearm violence are actively working in the United States. It is critically important for junior investigators to work with these senior investigators; opportunities for collaboration can include writing, presentations, and participation in workgroups or research projects.

Second, recognizing that funding is the sine qua non of high-quality research, we must pursue alternate sources of funding while federal funding lags. For instance, some researchers have successfully obtained foundation money to conduct firearm injury prevention research. Engaging foundations in our research enterprise is critical for developing a new research workforce and trustworthy outcomes. Yet we must also continue to apply for federal funding, including from the NIH, to enhance the scope and prominence of projects. It is key to remember that no actual "ban" exists and federal funding is possible, albeit inadequate and difficult to obtain.

Third, we need continued leadership from emergency medicine organizations.[11,12] The American College of Emergency Physicians (ACEP) recently convened an expert group to develop a prioritized research agenda related to firearm violence, due to be published this year. ACEP also publicly called for more federally-funded firearm injury research, joined by six physician professional societies (American Academy of Family Physicians, American Academy of Pediatrics, American Congress of Obstetricians and Gynecologists, American College of Physicians, American College of Surgeons, and American Psychiatric Association), the American Public Health Association, and American Bar Association.[13] These organizations, with the help of their members, can also encourage expansion of the national surveillance systems – such as the National Violent Death Reporting System, which collects epidemiologic data on violent deaths – with which more rigorous injury prevention research could be conducted.[14]

Finally, we need to use respectful conversation and collaboration to help bridge the political chasm over firearm injury prevention.[15] We should not assume that responsible gun owners are opposed to research aimed at reducing firearm injury, nor should we assume that the National Rifle Association accurately represents the views of most gun-owning Americans. Similarly, we should not assume that non-gun owners are trying to confiscate guns or otherwise infringe

on Constitutional rights. An estimated 41% of emergency physicians own a firearm, based on a 2011-2012 survey of a sample of ACEP members.[16] Leadership from gun owning physicians in calling for more funding and research in firearm injury prevention could be particularly powerful.

In conclusion, we need research to know what works to prevent firearm injury, when, with whom, and how. We must not lose sight of the larger goal of increasing federal support for firearm violence research, but we also must not lose time waiting for the money to appear before we take action. Our patients and our communities deserve safety.

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In Response to: Poisonings with Suicidal Intent Aged 0-21 Years Reported to Poison Centers 2003-12

DOI: 10.5811/westjem.2015.11.28886
Sheikh S, Hendry P, Lynch S, et al. Poisonings with Suicidal Intent Aged 0-21 Years Reported to Poison Centers 2003-12. *West J Emerg Med*. 2015;16(4):497-502.

To the Editor:

It was with great interest that we read the paper by Sheikh et al. that attempted to use Poison Control Center (PCC) data to explore the clinical features of self-poisonings with suicidal intent in children. Understanding the features of youth-attempted suicide by poisoning is necessary to effectively identify and treat those patients at highest risk for serious outcomes.

The study was able to characterize several clinical features of the 52.2% of subjects in the 15-18 year old age group. We question why the authors performed a subgroup analysis on children <10 years of age, since this group represented <1% of the study patients. It seems that an in-depth analysis of the 15-18 year old age group would have yielded a more useful conclusion. As clinicians, we view the most clinically significant population as those who attempted and ultimately completed suicide. The data provided to readers in this regard were incomplete. Details regarding the exact age, substance ingested and details surrounding the cause of death would be useful in determining risk factors of the population and how the substance may have contributed to mortality. Given the relatively small number of deaths, this information could have easily been provided for a more complete assessment.

Finally, the authors conclude that undiagnosed attention deficit hyperactivity disorder (ADHD) predisposes pediatric patients to self-harming behaviors. This conclusion is completed unsupported by any data. No information about medical history is mentioned and readers cannot assume that patients that overdosed on ADHD medications did so because they had the diagnosis themselves. Medications may be from siblings, friends or any other number of possibilities. Furthermore ADHD medications have a variety of clinical applications outside of treatment for ADHD.

This study was further hindered by the inherent limitations of analyzing PCC data. We suggest that it could have been strengthened by focusing on the group that is at highest risk, providing past medical history and prescribed medications, and focusing on mortality as a more significant outcome. Providing readers with this information would have strengthened the conclusions and enabled further interpretation of the data.

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In Reply:

We chose to perform a sub-analysis on patients younger than age 10 as we were surprised to see such a relatively large number of intentional self-harming behaviors performed by patients in this age group. Given the paucity of published data for this age group we thought it important to characterize and discuss this particularly vulnerable population.

Details for the cases resulting in death, such as the exact ages, names of the 52 substances ingested, clinical effects, and therapies used, were analyzed but not included due to space limitations as this manuscript was submitted as a brief report. For those interested, the results are provided below (Tables 1-4).

Table 1. Deaths by reported age.

Age (years)	Number of patients
14	1
16	1
17	2
18	3
19	5
20	2
21	3

Table 2. Substances reported in death cases.

Substance	Cases
Unknown	15
Aspirin	4
Tylenol 500mg	3
Benadryl or diphenhydramine	2
Motrin 800mg	2
Seroquel	2
Adderall 20mg tablet	1
Amitriptyline 10mg	1

Table 2. Continued. Substances reported in death cases.

Substance	Cases
Anafranil 25mg	1
Benicar 5mg	1
Cartia xt 240mg	1
Depakote 250mg	1
Effexor 75mg	1
Euthanasia solution, T-61	1
Flecainide	1
Flexeril 10mg	1
Geodon	1
Ibuprofen	1
Lamictal 150mg	1
Lexapro 10mg	1
Methadone	1
Methamphetamine	1
Opiates	1
Paxil 40mg	1
Potassium	1
Pseudoephedrine	1
Trazadone	1
Strattera 18mg	1
Wellbutrin XL 150mg	1
Vicodin	1
Xanax	1

Table 3. Therapies used in death cases.

Therapies	Cases
Oxygen	15
Ventilator	13
Intubation	13
IVF	12
Alkalinization	10
Vasopressors	6
CPR	5
Atropine	4
Benzodiazepines	4
Charcoal, single-dose	4
Naloxone	3
NAC	3
Glucagon	2
Antiarrhythmics	2
Hemodialysis	2
Whole-bowel irrigation	2

IVF, intravenous fluids; *CPR,* cardiopulmonary resuscitation; *NAC,* N-acetyl cysteine

Table 3. Continued. Therapies used in death cases.

Therapies	Cases
Insulin	1
Flumazenil	1
Calcium	1

Table 4. Clinical effects reported in death cases.

Clinical effects	Cases
Cardiac arrest	12
Asystole	11
Respiratory arrest	10
Coma	9
Tachycardia	8
Hypotension	7
Vomiting	5
Hyperventilation/tachypnea	4
Conduction disturbance	3
Drowsiness/lethargy	3
Nausea	3
Hyperglycemia	3
Acidosis	3
Respiratory depression	3
ECG change (other)	2
Hypertension	2
Seizure (single)	2
Mydriasis	2
Tinnitus	2
Diaphoresis	2
Bradycardia	2
Confusion	1
X-ray findings (+)	1
Abdominal pain	1
CPK elevated	1
Dysrhythmia (other)	1
AST, ALT >1000	1
Seizures (multiple, discreet)	1
Syncope	1
Chest pain (noncardiac)	1
Increased creatinine	1
Dizziness/vertigo	1
Diarrhea	1
Increased anion gap	1
Cyanosis	1

ECG, electrocardiogram; *CPK,*creatine phosphokinase; *AST,* aspartate aminotransferase; *ALT,* alanine aminotransferase

Several studies, performed in the U.S. and internationally, have shown a relationship between ADHD and self-harm in the pediatric population.[1,2] Impey M. performed a review of the literature and concluded based on the findings of 25 studies that patients with ADHD were more likely to have suicidal ideas and commit suicide attempts. This was true across all age groups (including the pediatric population).[3] Our findings in conjunction with the literature brought us to suggest screening for ADHD in addition to mental health disorders in those patients presenting with self-harming behavior.

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