Medication Errors Recovered by Emergency Department Pharmacists

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Study objective: We assess the impact of emergency department (ED) pharmacists on reducing potentially harmful medication errors.

Methods: We conducted this observational study in 4 academic EDs. Trained pharmacy residents observed a convenience sample of ED pharmacists' activities. The primary outcome was medication errors recovered by pharmacists, including errors intercepted before reaching the patient (near miss or potential adverse drug event), caught after reaching the patient but before causing harm (mitigated adverse drug event), or caught after some harm but before further or worsening harm (ameliorated adverse drug event). Pairs of physician and pharmacist reviewers confirmed recovered medication errors and assessed their potential for harm. Observers were unblinded and clinical outcomes were not evaluated.

Results: We conducted 226 observation sessions spanning 787 hours and observed pharmacists reviewing 17,320 medications ordered or administered to 6,471 patients. We identified 504 recovered medication errors, or 7.8 per 100 patients and 2.9 per 100 medications. Most of the recovered medication errors were intercepted potential adverse drug events (90.3%), with fewer mitigated adverse drug events (3.9%) and ameliorated adverse drug events (0.2%). The potential severities of the recovered errors were most often serious (47.8%) or significant (36.2%). The most common medication classes associated with recovered medication errors were antimicrobial agents (32.1%), central nervous system agents (16.2%), and anticoagulant and thrombolytic agents (14.1%). The most common error types were dosing errors, drug omission, and wrong frequency errors.

Conclusion: ED pharmacists can identify and prevent potentially harmful medication errors. Controlled trials are necessary to determine the net costs and benefits of ED pharmacist staffing on safety, quality, and costs, especially important considerations for smaller EDs and pharmacy departments. [Ann Emerg Med. 2010;55:513-521.]

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INTRODUCTION

Background and Importance

Emergency departments (EDs) face special challenges in their mission of providing high-quality, efficient, and safe care to a diverse population of patients. Medical errors, and more specifically medication errors, are common in EDs and are often severe.[1,2] This is not surprising because more than three fourths of ED visits are associated with medication administration or

Editor's Capsule Summary

What is already known on this topic

Clinical pharmacists have been shown to reduce preventable adverse events in inpatient critical care settings.

What question this study addressed

This unblinded convenience sample study assessed the role of clinical pharmacists in the emergency department (ED) in preventing, recovering from, or mitigating medication problems. Clinical outcomes were not assessed.

What this study adds to our knowledge

Pharmacists intercepted or otherwise intervened in potential medication errors at a rate of roughly 3 per 100 medications ordered. Ninety percent of errors were intercepted before reaching the patient. There was considerable heterogeneity in pharmacists' activities among the 4 study sites.

How this might change clinical practice

Clinical pharmacists can improve medication practices at multiple levels in the ED, although the net costs and benefits of this intervention were not determined in this study and are still unknown.

prescribing, representing more than 210 million medication encounters annually in the United States.[3]

The "perfect storm"[4] of a stressful environment caused by crowded EDs, increasing numbers of admitted patients boarding in the ED, and understaffing results in a high-risk setting for medication errors.[5] Furthermore, there are challenges specific to safe ED medication use, including point-of-care orders, common use of verbal orders, incomplete medical records, multitasking with frequent interruptions and distractions, and the high prevalence of information gaps for patients.[6,7]

A recent systematic review of clinical pharmacists participating in inpatient care provides strong evidence that inpatient clinical pharmacists reduce preventable adverse drug events caused by medication errors,[8] especially in medical ICUs.[9] Pharmacists in EDs may be able to play a role similar to that in ICUs. Besides their traditional roles, including medication order review and toxicologic consultations, ED and ICU pharmacists have the opportunity to participate in decisionmaking before medications are ordered or administered.[10] Additionally, dedicated ED pharmacists may have the necessary time and access to clinical data not immediately available to physicians in the ED. However, to date only limited data have been available on the effects of ED pharmacists on medication safety.[11-13] Pharmacist time is expensive, and there is a national shortage of pharmacists so that if pharmacy staffing of EDs is to be justified, more data are needed to demonstrate the effects of ED pharmacists on safety, quality, and efficiency.

Goals of This Investigation

Our primary objective was to assess the effect of ED pharmacists on patient safety with regard to recovery of potentially harmful medication errors. Our secondary objectives were to characterize the error types and the nature of the pharmacist interventions used to recover errors.

MATERIALS AND METHODS

Study Design

We performed a prospective cross-sectional observation study of pharmacists who recovered medication errors in 4 EDs between August and December 2008. Consent for observation was obtained from the ED pharmacists. The study was approved by the Human Research Committees at all sites.

Setting

The study was conducted in 4 academic medical center EDs located in the Northeast, Southeast, Midwest, and West. The participating EDs are trauma Level I centers and ranged widely in size and annual visits (Table 1). One of the EDs treats only adult patients. Computerized physician order entry was used in 3 of the 4 EDs, including various levels of decision-supported alerts. All sites have established ED pharmacist programs. The ED pharmacists' staffing characteristics and responsibilities are provided in Table 1.

Selection of Participants

We observed ED pharmacists during the busiest periods of their work shifts, primarily weekdays between 4 PM and 10 PM. The study was limited to patients with ordered or administered medications reviewed by the ED pharmacist during the observation period or session. Each site used 2 or 3 postgraduate pharmacist residents trained as research observers and data abstractors.

Outcome Measures

For the purposes of this study, *pharmacist interventions* were defined as discrete activities by ED pharmacists related to patient care.[12] Pharmacist interventions witnessed by the observers as possible recovered medication errors were *suspected medication error interventions.* Suspected medication error interventions were rated by study investigators as confirmed *recovered medication errors* or excluded. Investigators were blinded as to the study site of the suspected medication error interventions. Confirmed errors were further classified and judged as to the potential severity of harm associated with an error, using a taxonomy that has been used in previous inpatient studies (see below).[14,15]

Table 1. Characteristics of the EDs and pharmacist programs.

Characteristics	Hospital A	Hospital B	Hospital C	Hospital D
Annual ED visits	77,000	37,000	104,000	56,600
ED beds	41	29	124	46
Pediatric patients	Yes	Yes	Yes	No
Observation unit in ED	No	No	Yes	Yes
Emergency medicine residency program	No	Yes	Yes	Yes
ED computerized physician order entry	Yes	Yes	No	Yes
Decision support alert capabilities	None	Drug-allergy, DDI	Not applicable	Drug-allergy, DDI, renal dosing, duplicate order
Years of ED pharmacy program	7	5	9	2
Full-time equivalent ED pharmacists	3	2.4	3	4
ED pharmacist coverage: hours per week	112	97	107	168
ED pharmacist coverage: time of day				
Weekdays	6 AM–midnight	7 AM–11 PM	8 AM–1 AM	Continuously
Weekends	1:30 PM-midnight	1:30 PM–10 PM	3 PM–1 AM	
ED pharmacist responsibilities				
ED patients with prospective medication order review (% of all ED patients)	60	65	40	70
Medication reconciliation	N	Y	N	N
Participate in resuscitations (trauma, arrest)	Y	Y	Y	Y
Provide clinical consultations to ED staff for patient specific recommendations	Y	Y	Y	Y
Review guideline/protocol adherence	Y	Y	Y	Y
Participate in ED staff/team patient rounds	N	N	Y	Y
Dispense or prepare medications	Y	N	Y	N
Screen for allergies and drug interactions	Y	Y	Y	Y
Monitor therapeutic responses/laboratory results	Y	Y	Y	Y
Care for boarded patients (daily review)	Y	Y	Y	Y

DDI, Drug-drug interaction.

The main outcomes of interest were recovered medication errors. *Medication errors* were defined as any error in the medication use process: prescribing, transcription, dispensing, administering, and monitoring. Medication errors with the potential to cause harm are also known as potential adverse drug events.[4] *Recovered medication errors* included (1) medication errors that were intercepted before reaching the patient ("early" intercepts, also known as near misses or *intercepted potential adverse drug events*); (2) medication errors caught after reaching the patient but before causing harm ("late" intercepts, also known as *mitigated adverse drug events*); and (3) medication errors caught after causing some harm but corrected before resulting in more serious harm (*ameliorated adverse drug events*).[15] Errors with little or no potential for harm, nonintercepted medication errors, and completed, missed, or nonpreventable adverse drug events were outside the scope of this study and excluded from analysis. We also excluded medication errors recovered by physicians and nurses.

Secondary outcomes of interest included (1) the type of recovered medication error intervention (wrong patient, wrong drug, drug omission, drug/class duplication, contraindication, allergy, drug-drug interaction, intravenous incompatibility, wrong dosage form, strength, route or technique, dose omission, extra dose, underdose, overdose, rate too fast or slow, wrong frequency or duration, wrong time, wrong therapy scheme, or inadequate monitoring);[16] (2) the proportion of recommendations for correcting recovered medication errors that were accepted or denied; and (3) the nature of the pharmacy intervention associated with a recovered medication error (for example, contacting the ordering physician of an incorrect order or the nurse of an incorrect medication preparation or administration).

Data Collection and Processing

The primary method of data collection was continuous observation, described by Barker and used in our previous research studies.[15,17] Observers did not solicit voluntary reporting of unobserved suspected recovered medication errors. The method of observation was not disguised; ED staff (physicians, nurses, pharmacists) were informed that observations were being conducted for a patient safety study. Observers underwent a Web-based training conference call, followed by two 4-hour practice observations for each observer. Observations were conducted during 3- to 5-hour observation sessions.

Research observers entered ED pharmacist interventions that were suspected recovered medication errors into paper template data forms (available at http://www.ptsafetyresearch.org/ED_Pharmacist_Study.htm) and transferred into a Microsoft Access database (Microsoft Corporation, Seattle, WA). Observers recorded the number of patients and medications reviewed by ED pharmacists during the sessions. Additional patient-level data for patients with suspected medication error recoveries included patient

Table 2. Observations of ED pharmacists and patient demographics.

Observations and Demographics	Hospital A	Hospital B	Hospital C	Hospital D
Observation sessions	60	49	64	53
Duration of observations (h)	198	196	193	200
Patients with pharmacist review of medications	2,365	975	1,150	1,981
Patients with medication review per observation session	39.4	19.9	18.0	37.4
Patients with recovered MEs, No. (%)	131 (5.6)	63 (6.5)	93 (8.1)	152 (7.7)
Female sex, No. (%)	60 (45.8)	29 (46.0)	46 (49.5)	87 (57.2)
Age, y, mean (SD)	60.8 (23.7)	44.7 (25.3)	50 (15.7)	57.2 (18.9)
Pediatric patients, No. (%)	9 (6.9)	12 (19.0)	2 (2.2)	2 (1.3)
ED location, No. (%)				
General ED	107 (81.7)	44 (69.8)	53 (56.9)	97 (63.8)
Fast track/urgent care	1 (0.8)	0	1 (1.1)	1 (0.7)
Trauma/critical care	22 (16.8)	10 (15.9)	36 (38.7)	5 (3.2)
Observation unit	1 (0.7)	0	3 (3.2)	16 (10.5)
Boarders/holding unit	0	9 (14.3)	0	33 (21.7)
Visit reason/chief complaint, No. (%)				
Shortness of breath	20 (15.3)	9 (14.3)	15 (16.1)	15 (9.9)
Chest pain	14 (10.7)	9 (14.3)	15 (16.1)	19 (12.5)
Neurologic problems	16 (12.2)	6 (9.5)	14 (15.1)	12 (7.9)
Acute injuries	5 (3.8)	14 (22.2)	10 (10.8)	7 (4.6)
Other pain without acute injury	5 (3.8)	4 (6.3)	10 (10.8)	15 (9.9)
Fever	18 (13.7)	1 (1.6)	0	11 (7.2)
Abdominal pain	9 (6.9)	2 (3.2)	5 (5.4)	14 (9.2)
Gastrointestinal	5 (3.8)	1 (1.6)	3 (3.2)	13 (8.6)
Other reasons for visit	39 (29.8)	17 (27)	21 (22.6)	46 (30.3)

ME, Medication error.
Pediatric patients: 17 years of age or younger.

age, sex, and chief complaint/reason for visit.[18] Discharge diagnosis, disposition, and outcomes were not included because of the limited duration of the observation sessions. Similarly, postobservation chart reviews were not conducted. Interrater reliability testing was conducted at each site, with research observers participating in 2 paired observation sessions.

Methods of Measurement

Two case reviewers, a physician (J.M.R. or J.D.S.) and a pharmacist (A.E., R.S., J.P., or A.S.) independently rated and classified suspected medication error interventions. Reviewers judged the presence of a recovered medication error by using a 5-point scale (definitely, probable, probably not, definitely not, unsure), the type of recovered medication error (intercepted potential adverse drug event, ameliorated adverse drug event, and mitigated adverse drug event), and the potential severity of harm, including insignificant (highly unlikely to cause symptoms such as a duplicate order for a single dose of ranitidine), significant (potential to cause harmful symptoms but little or no threat to life functions), serious (potential to cause temporary or permanent alteration of life function or organ injury but not life threatening), life-threatening, or unable to determine.[14,15] Suspected incidents not rated as recovered medication errors were excluded. Recovered medication errors were also classified according to stage of the medication process. Rater disagreements were resolved by discussion.

Primary Data Analysis

Incidents rates were compared with simple descriptive statistics. Prediscussion interrater judgments of suspected medication error interventions for incident classification and severity of harm were compared for level of agreement with the κ statistic.

RESULTS

Characteristics of Study Subjects

We observed 12 ED pharmacists, at the 4 different sites, with an average of 3.3 years of hospital pharmacy experience (range 1 to 8 years). Demographics for patients with recovered medication errors, including reason for ED visit, are provided in Table 2.

We conducted 226 observation sessions during 787 hours of observation (Table 2). Researchers observed pharmacists reviewing 17,230 medications for 6,471 ED patients (Table 3). During observation sessions (mean duration of 3.5 hours), we observed 76.6 medications reviewed by pharmacists for 28.6 ED patients, or 2.7 medications per patient. There were substantial site differences with regard to observed ED pharmacist activities. Hospitals A and D pharmacists reviewed medications for approximately twice as many patients per observation session than hospitals B and C. At the same time, hospital D had more than twice as many medications reviewed per observation session as hospital A.

Table 3. Medication errors recovered by ED pharmacists.

Medication errors	Hospital A	Hospital B	Hospital C	Hospital D
Medications reviewed by pharmacists	3,404	3,702	3,496	6,718
Patients with medication review per observation session (mean)	39.4	19.9	18.0	37.4
Medications reviewed per observation session (mean)	56.7	75.6	54.6	126.8
Recovered MEs (all), No. (%)	146	80	110	169
Intercepted potential ADE	130 (89.0)	68 (85.0)	96 (87.3)	162 (95.9)
Mitigated ADE	1 (0.7)	7 (8.8)	8 (7.3)	4 (2.4)
Ameliorated ADE	1 (0.7)	0	0	0
No potential for harm	14 (9.6)	5 (6.3)	6 (5.5)	3 (1.8)
Recovered MEs per 100 patients (95% CI)	6.2 (5.2–7.3)	8.2 (6.6–10.2)	9.6 (7.9–11.5)	8.5 (7.3–9.9)
Recovered MEs per 100 medications (95% CI)	4.3 (3.7–5)	2.2 (1.7–2.7)	3.2 (2.6–3.8)	2.5 (2.2–2.9)
Recovered MEs per 40 h of observation (95% CI)	29.5 (25.1–34.7)	16.3 (13.1 to –20.3)	22.8 (18.9–27.5)	33.8 (29.1–39.3)

ADE, Adverse drug event; *CI,* Confidence interval.

Main Results

We observed 634 suspected medication error interventions at the 4 study sites, with 505 (79.7%) determined by the raters to be recovered medication errors. The 505 recovered medication errors were in 6.8% of patients (439/6,471). The overall rate of recovered medication errors was 7.8 per 100 patients and ranged from 6.2 (hospital A) to 9.6 (hospital C) per 100 patients, corresponding to 2.9 recovered medication errors per 100 medications overall, with ranges of 2.2 to 4.3 recovered medication errors per 100 medications (Table 3). The majority of recovered medication errors were intercepted potential adverse drug events (90.3%), with fewer harmless medication errors, mitigated adverse drug events, and ameliorated adverse drug events. The observer pairs were 100% in agreement as to the presence of recovered medication errors and 88% in agreement as to the recovered medication error type.

The most common medication classes associated with recovered medication errors were antimicrobials (n=162; 32.1%), central nervous system drugs (n=82; 16.2%), anticoagulants and thrombolytics (n=71; 14.1%), cardiovascular drugs (n=64; 12.7%), and hormonal agents, including insulin (n=34; 6.7%). Medication errors were predominantly recovered during the ordering stage of the medication process (n=466; 92.3%), fewer during the administration stage (n=22; 4.4%) and the remaining divided among the transcribing, dispensing, and monitoring stages (n=17; 3.4%).

The severity of recovered medication errors was judged as potentially life threatening (n=23; 4.6%), serious (n =241; 47.8%), significant (n=183; 36.2%), and insignificant or unable to determine (n=57; 11.3%). The most common types of recovered medication errors were underdose, overdose, drug omission, and wrong frequency. Rates and examples of the types of recovered medication errors are provided in Table 4.

The ED pharmacists most often communicated the recovered medication error to physicians (91.1%), as well as nurses (8.1%) and other staff (0.8%). Pharmacist recommendations to change therapy associated with recovered medication errors (for example, cancelling an order, changing to a different medication or dose) were nearly always accepted by physicians or nurses (97.2%; 489/503), especially in 3 of the EDs (99.4%; 355/357). At hospital A, the acceptance rate was slightly lower (91.8%; 134/146), and the rejected recommendations included 3 recommendations leading to a change in therapy but different from the pharmacist recommendation and 9 recommendations denied by physicians, including 7 denials without physician justification given to the pharmacist. The levels of agreement (κ) for rating of incident classification as to the presence/type of medication error and severity of harm were 0.23 and 0.22, respectively.

LIMITATIONS

Our study was conducted in academic medical center EDs, and our findings may not be generalizable to smaller or nonteaching EDs. Our study was a convenience sample conducted during some of the busier times of day for ED pharmacists. The total number of recovered medication errors per 40 hours of observation may not be representative of the weekly work schedule of an ED pharmacist. The potential limitation of conducting our study in EDs with computerized physician order entry is mitigated by the expectation that most large EDs will acquire such systems in the near future. The study focused on recovering medication errors already committed by ED staff and did not assess the overall effects of ED pharmacists on patient safety. For example, we did not address the effects of ED pharmacists on preventing medication errors from occurring or other aspects of quality care such as optimization of therapy, reduced medication costs, and patient education. We did not follow the course of ED patients beyond the observation sessions or conduct subsequent chart reviews for admitted patients. Therefore, we did not assess the clinical outcomes of patients with recovered medication errors or study patients with medication errors that were not caught by the ED pharmacists. The ED pharmacists were not blinded to the observations and may have been biased toward achieving higher medication error recovery rates during the study. The level of agreement for incident ratings was only fair and may have reflected inexperience in incident rating by the pharmacist

Table 4. Types of medication errors recovered by ED pharmacists.

Type of Medication Error	No. (%)*	Example
Underdose	94 (16.8)	The emergency physician ordered a loading dose of 1,400 mg acetylcysteine to treat a 100-kg patient with an acetaminophen overdose. The pharmacist corrected the dose to 14,000 mg.
Overdose	87 (12.5)	The emergency physician ordered a heparin infusion rate at 500 units/h but was transcribed by the nurse as 500 units/kg per hour. The pharmacist intercepted the error before administered.
Drug omission	59 (10.5)	The emergency physician ordered calcium gluconate, sodium polystyrene sulfonate (Kayexalate), and insulin for a patient with severe hyperkalemia. The pharmacist noticed the blood glucose of 100 mg/dL and recommended adding 50 g intravenous dextrose to avoid iatrogenic hypoglycemia.
Wrong frequency	46 (8.2)	The pharmacist recommended changing the ED physician's incorrect order for prazosin 10 mg 3 times a day to 10 mg once daily.
Wrong drug	38 (6.8)	The emergency physician ordered succinylcholine for rapid sequence intubation of a patient with a serum potassium of 8.3 mmol/L. As succinylcholine can exacerbate hyperkalemia, the pharmacist recommended changing to the alternative paralytic agent rocuronium.
Duplicate drug or drug class	26 (4.6)	The emergency physician prescribed atazanavir 600 mg daily and Reyataz 600 mg daily, not realizing they are the same medication. The pharmacist corrected the error.
Allergy	25 (4.5)	The emergency physician ordered Zosyn to treat diverticulitis for a patient with a history of anaphylactoid reactions to penicillin. The pharmacist recognized the allergy and recommended an alternative antibiotic.
Wrong schedule	25 (4.5)	The emergency physician ordered the heparin protocol for treating thromboembolism (loading dose 80 units/kg and maintenance dose 18 units/kg/h) for a patient with an acute coronary syndrome. The pharmacist corrected the error to the acute coronary syndrome schedule/protocol (loading dose 60 units/kg and maintenance dose 12 units/kg per hour).
Failure to monitor (including laboratory test results)	23 (4.1)	A patient was receiving a heparin infusion after a heparin bolus for antithrombotic therapy. The ED pharmacist alerted the staff 10 min after the last partial thromboplastin time result was completed, high at 128 seconds, and recommended holding the infusion for an hour and resuming at a lower dose as per the protocol.
Wrong route	22 (3.9)	The emergency physician ordered 10 units subcutaneous regular insulin for treatment of severe hyperkalemia. The route was corrected to intravenous.
Wrong strength	19 (3.4)	The emergency physician ordered Kaletra (lopinavir/ritonavir) strength of 20/50 every 12 hours. The ED pharmacist corrected the order to 400/100 every 12 hours.
Wrong dosage form	15 (2.7)	The emergency physician ordered 35 mg intramuscular methylprednisolone acetate (Depo-Medrol). The pharmacist checked with the physician, who corrected this to his intended intravenous methylprednisolone sodium succinate (Solu-Medrol).
Contraindication	14 (2.5)	A patient who just completed an iodinated contrast imaging study in the ED was ordered metformin. The ED pharmacist recommended holding the metformin for 48 hours and monitoring renal function.
Other	68 (12.1)	The emergency physician ordered a loading dose of fosphenytoin (1-g phenytoin equivalent) at 150 mg/h for a patient with status epilepticus. The pharmacist corrected the rate to 150 mg/min.

*Recovered medication errors may be associated with more than 1 type of error. The 505 recovered errors were associated with 561 error types.

investigators and the training of the definitions used in the study. Interrater reliability testing of observers was conducted within institutions because the 4 study sites were widely distributed. Differences in observation methods between sites may have contributed to the different sites' rates of observed recovered medication errors.

DISCUSSION

Our study is one of the largest multicenter observational studies of ED medication safety. We found that pharmacists frequently reduced the potential of patient harm from medications that were ordered or administered by ED staff. Most medication errors were caught before reaching the patients, and about half were potentially serious or life threatening. Extrapolating our results to a 40-hour workweek covering busy ED activity times in a large academic ED, about 25 potentially harmful medication errors are recovered weekly by 1 full-time ED pharmacist (Table 3), which represents just one aspect of ED pharmacists' practice.

The Harvard Medical Practice Study found that adverse drug events were the most common type of adverse event (19%) in hospitals, and the ED was the site of 3% of hospital adverse events. Although the overall rate of negligent hospital adverse events was 27.6%, negligence was judged to be greatest for the ED adverse events (70.4%).[19] In a study of adult inpatient medication errors excluding missed doses, Bates et al[20] found a rate of 2.5 medication errors per 100 orders. The most comprehensive inpatient pediatric study found 5.7 medication

errors per 100 orders.[21] More limited data are available about the baseline rate of medication errors in EDs. Chin et al[22] found that among ED patients aged 65 years or older, 3.6% were given a potentially inappropriate medication. Kozer et al[23] found a medication error rate of 16.2 per 100 orders, though more than half were considered of insignificant risk for harm.

Medication errors in EDs may result, in part, from medication use practices unique to EDs. A survey of ED nurses recently described several perceived barriers to The Joint Commission's 2006 medication-safety-related National Patient Safety Goals, including the absence of standardized handoff communication, failure to use read-backs for verbal orders, and lack of independent double-checks of nurse-prepared intravenous infusions.[24] Pham et al[25] analyzed 2000-2004 ED medication error reports from a national confidential and anonymous medication error reporting program. Among the nearly 14,000 reported medication errors, the leading causes were failure to follow procedure/protocol (17%) and poor communication (11%). Previous studies have also found knowledge deficits to be an important cause of medication errors.[19,22] These differences from the findings by Pham et al[25] are likely due to the nature of reporting programs, which encourage reports of systems failures and the reluctance of self-reporting of individual failures.

Although future health care system redesign will likely aim to reduce ED crowding, improve operational efficiency, and improve the emergency care workforce,[26] evidence to date suggests that these conditions will likely persist, at least for the near term.[27] The American Society of Health-System Pharmacists Statement on Pharmacy Services to the Emergency Department recommends that every hospital pharmacy "provide its ED with the pharmacy services that are necessary to support safe and effective patient care."[28] Integration of clinical pharmacists into the health care team in other areas of the hospital has been shown to be cost-effective and improve patient safety.[8] However, to date, few data are available about the benefits of ED pharmacists.

A 2008 survey of pharmacy directors found that only 6.8% of hospitals had a pharmacist assigned to the ED for any period, though this proportion was 54.2% in hospitals with 600 or more beds.[29] The survey also found that pharmacists prospectively reviewed only a small percentage of ED medication orders before administration of the first dose. Additionally, prospective pharmacy review of ED orders is often challenging because of few interfacing ED and inpatient information systems.[29] Pharmacists conducting medication reconciliation in EDs have been found to significantly reduce erroneous medication histories.[30] In a retrospective study of 490 medication orders, Brown et al[11] found that ED pharmacists reduced medication errors by two thirds, from 16.1 to 5.4 per 100 orders, correlating to the recovery of 10.7 medication errors per 100 orders. It is likely that our rate of 2.9 recovered medication errors per 100 medications is far lower because we excluded medication errors with little or no potential for harm. Lada and Delgado[13] reported that ED pharmacist interventions such as formulary interchange, dosing, route adjustments, and alternative therapies were associated with impressive estimated cost savings.

The Institute of Medicine's Committee on the Future of Emergency Care recommends ED pharmacists' inclusion in team approaches to improve ED medication safety and cost-effectiveness.[5] Data suggest that recommendations by ED pharmacists are usually accepted and that both nurses and physicians believe that ED pharmacists improve the quality of care.[12,31] One of the interesting findings in our study was the near-universal acceptance of the pharmacists' recommended changes in response to a recovered medication error. The exception was hospital A, which also had the highest rate of recovered medication errors.

We found a wide variation in the rate of observed ED pharmacist recoveries between the study EDs. These differences were likely due to (1) possible differences in the baseline rates of ED medication errors; (2) differences in ED pharmacist roles in the EDs, with some pharmacists reviewing most orders, whereas other ED pharmacists troubleshoot high-risk medications or provide advice only on request; (3) differences in the personalities and practice style of the ED pharmacists, with some pharmacists proactively interacting with ED staff members, similar to pharmacists attending ICU rounds,[9] while other pharmacists took more reactive roles; and (4) differences in the thoroughness of the observation methods by observers between sites.

The numerous responsibilities of ED pharmacists[32] may leave insufficient time for a single ED pharmacist to review most of the medication orders and administrations before or soon after they are initiated, therefore limiting their role in recovering medication errors. The Joint Commission's 2008 National Patient Safety Goals includes the goal to accurately and completely reconcile medications across the continuum of care, including EDs.[33] Operationalizing this, however, has been challenging. Schenkel[34] estimated that for a 50,000-annual-visit ED, and only for admitted patients, 1,000 to 2,000 pharmacist-hours per year would be needed just for medication reconciliation. This workload is unlikely to be sustainable for a small or new ED pharmacist program that has many competing demands.

Randomized controlled studies are needed to determine the overall effect of ED pharmacists on patient care, their cost, and where and how best to utilize them, especially in busy EDs or with lean pharmacy staffs. Future studies should evaluate the effect of ED pharmacists on overall adverse drug event rates, hospital admission rates, lengths of stay, and return ED visits. Research is needed to explore how ED computerized physician order entry systems with robust decision-supported medication alerts and electronic medical records with automated medication reconciliation will affect the role and benefits of ED pharmacist programs. Last, other interventions to reduce ED medication errors, such as team training to create a stronger safety net to recover medication errors, should be studied.

In summary, ED pharmacists prevent many potentially harmful medication errors from reaching patients.

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DIAGNOSIS

Medial subtalar (talocalcaneal) dislocation. Subtalar dislocation is an uncommon injury in which the talocalcaneal and talonavicular joints are dislocated simultaneously, without a fracture of the neck of the talus (Figure 3).[1] The injury is usually a result of a high-energy mechanism, such as a motor vehicle crash or a fall from height. However, this injury has been reported during low-energy inversion injuries such as the one described above. The talocalcaneal and talonavicular ligaments are responsible for transmitting weight between the foot and the ankle and are stressed when a forceful inversion injury causes the talus to pivot on the sustentaculum tali, leading to a medial subtalar dislocation (Figure 4). Failure to reduce properly may result in damage to the talocalcaneal and talonavicular ligaments. Appropriate reduction procedure includes adequate sedation, providing in-line traction, and initially maintaining the foot in plantar flexion. Abduction should then be applied to the foot while everting and dorsiflexing the foot.[2]

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