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Original Contribution

On-site pharmacists in the ED improve medical errors☆,☆☆

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Abstract

Objective: The objective of the study was to compare errors in the emergency department (ED) with pharmacists present (PPs) for resuscitations and traumas vs with pharmacists absent (PAs). Our hypothesis was that errors would be significantly fewer during PP than PA times. We also hypothesized that times with PP would affect patients greater when disposition was to more critical areas (intensive care unit, or ICUs).

Methods: The study was conducted during a 3-month period in 2009 in a level 1 trauma center with an emergency medicine residency. This was a cross-sectional cohort study comparing a prospective analysis of patients during the time (10 hour/day) with PP and a retrospective review of the time on the same days (14 hours/day) with PA. Demographics of age, race, and sex were recorded. Patient disposition was either ICU, operating room, non-ICU wards, observation unit, or discharge. Main outcome was errors recorded including medications given but not ordered, medication ordered but not given, and time delays for medications. For demographics and prevalence, descriptive statistics and percentages were used. Percent differences and 95% confidence intervals (CIs) and χ^2 were derived. Logistic regression used predictor variables of age, race, sex, disposition, and presence or absence of pharmacists. An a priori power analysis was performed. The study was powered at 80% with 186 subjects per group (PP vs PA), to find a difference of 20% between the 2 groups in percent of medical errors.

Results: There were 694 patients included in the 3-month period. A total of 242 presented during PP times and 452 during PA times. There were 383 (55%) male, 301 (43%) female, and 10 (2%) unknown sex. Mean age was 45 ± 18 years in PP group and 48 ± 20 years in PA group (*P*, nonsignificant). There was no difference in ethnicity between groups. There were 6 (3%) patients with errors recorded during PP times and 137 (30%) with errors recorded during PA times (difference, 27%; 95% CI, 23-32). Controlling for age, race, sex, and disposition, medical errors were 13.5 times more likely during PA than during PP times (adjusted odds ratio, 13.5; 95% CI, 5.7-31.9).

Conclusion: With pharmacists absent, over 13 times more errors are recorded in our ED than with pharmacists present. An on-site pharmacist in the ED may be helpful in reducing medical errors.
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1. Introduction

Research regarding the contributions of on-site pharmacists in the ED is limited possibly because of their lack of ED staffing coverage. According to independent surveys, 10% of hospitals in 2003 had a dedicated ED pharmacist, whereas only 79 health care organizations in the nation in 2006 had dedicated ED pharmacists [1,2].

Despite this scarcity of data, quality assurance literature has shown that medication errors do occur frequently and contribute significantly to adverse patient events [3]. Furthermore, the few studies that are available suggest that pharmacists help in reducing medication errors, reduce health care costs, and are a valuable resource for other ED personnel, including nursing staff and physicians [1,2,4-19]. Data suggest that hospital pharmacists also improve patient care in the ED by various other mechanisms, including reducing the rate of noncompliance with *Advanced Cardiac Life Support Guidelines* by 28% when a pharmacist is present during cardiac resuscitations, and through pharmacy-driven medication adherence programs [14,20]. In another venue, on-site intensive care unit (ICU) pharmacists have been shown to reduce medication errors there as well [21-23].

Our study site was unique in that pharmacists are available 10 hours/day only. This made it possible to compare times when pharmacists were present to times when they were absent during the same days at the same institution. This study was performed to add to the current literature on the contributions of ED pharmacists in promoting patient safety. Our scientific hypotheses were as follows: that the presence of an ED pharmacist (1) would result in significantly reduced medication error and (2) would reduce more errors in patients requiring higher level of care (ie, ICU dispositions).

2. Methods

2.1. Study design

The study was a cross-sectional cohort study of patients with major trauma and resuscitation presenting to the ED during an 88-day study period between January 19 and April 10, 2009. For 10 hour/day, pharmacists were present in the ED (pharmacist present, or PP) and attended all major trauma and resuscitations. For 14 hours/day, pharmacists were not present in the ED (pharmacist absent, or PA). Both PP and PA groups were exclusive and comprehensive of the cohort and were compared on multiple dimensions.

2.2. Setting

The study was performed in a 68-bed academic ED with an annual census of approximately 60 000 adults at a level 1 trauma center. There is a separate resuscitation area for the more acutely ill patients with 7 beds in addition to the 68 nonresuscitation beds. At the time of the study, computerized physician order entry (CPOE) was not in use.

2.3. Patient selection

Male and female patients 18 years or older who presented to our resuscitation and trauma areas (considered major illness or injury) during the 12-week study period were included. Because the study comprised only information gathering, there was no consent required. No patients who met the inclusion criterion were excluded.

2.4. Methods of measurement

The study involved 88 days of data collection in which 1 of 2 clinical pharmacists was physically present in the ED. For some shifts, 1 of 2 pharmacy students was present as well and sometimes collected demographic data. These students were trained in the study format and data collection practice and were supervised by 1 of the 2 pharmacists on duty at the time.

Observations were made and recorded by the pharmacists for this time. Any interventions made recorded. Errors made were recorded as well. Specific interventions included requesting intubation or postintubation medications, changing asthma or chronic obstructive pulmonary disease medications, requesting cardiac medications (nitroglycerin, antihypertensives) and seizure medications, recommending specific antibiotics or changing them because of incorrect choice (most frequent), recommending a more appropriate pain medication and appropriate antiemetics, and reminding the physician about tetanus/diphtheria boosters (Table 4).

The pharmacist or pharmacy student involved in the study filled out the data form during or directly after a resuscitation or trauma patient presented to the ED. Data were gathered prospectively by pharmacists and pharmacy students during the hours 3 PM to 1 AM (PP) and retrospectively by resident physicians on patients presenting during the hours from 1 AM to 3 PM (PA). All PA cases were reviewed by the same pharmacists who were present during the PP periods. Human Research Review Committee approval was obtained before the initiation of the study.

2.5. Data collection and processing

The data forms included demographic information (including age, race, sex, diagnosis). For medical resuscitations, drugs given, timing to medications given, and drip medications were recorded. For trauma resuscitations, intubation medications, other medications, and timing were recorded (see Fig. 1).

Date: _____/_____/_____ Time of Arrival in Resus/Trauma: _____:_____AM or PM

Age: _____ Gender: Male or Female

Race/Ethnicity:
___American Indian/Alaska Native ___Hispanic ___White
___Native Hawaiian/Pacific Islander ___Black/African American ___Asian

Approximate Weight: _____kg or lbs Diagnoses:

Medications: none or please list - Allergies: NKDA or please list -

Medical Resuscitation:
Dosages assisted:

CPR medications
drug name: time of arrest: time of admin:

Intubation medications
drug name: time of intubation decision: time of admin:

Post-intubation medications
drug name: time of intubation: time of admin:

Asthma medications
drug name: time of exacerbation: time of admin:

Cardiac medications
drug name: time of event: time of admin:

Heparin time of event: time of admin:

Seizure medications
drug name: time of seizure: time of admin:

Antidote: time of event: time of admin:

Drip medications (insulin, ativan, diltiazem,etc.)
drug name: time of event: time of admin:

Other medications
drug name: time of event: time of admin:

Fig. 1 ED pharmacy study data form.

Medication errors that were averted because pharmacists were present (PP) were recorded. This included incorrect orders, wrong medications, wrong dosages, wrong rates, timing if more than 30 minutes, and errors due to drug allergies.

Emergency department (ED) disposition of patients in comparison with medical errors and presence or absence of pharmacists was recorded. Possible dispositions were admittance to ICU, operating room (OR), non-ICU wards or routine hospital bed, ED observation unit, or discharge to mental health or home. Also, PP vs PA times were compared for the number of medical errors based on the patient disposition.

For the times when pharmacists were absent in the ED, 2 residents collected the same data as above on resuscitations in a retrospective fashion. The abstracters were trained in the process of data acquisition before commencing the study. Interrater and intrarater reliability was assessed in selected data between residents and with the pharmacists.

The form used for data collection is shown in Fig. 1. These results were then reviewed by one of the pharmacists who completed the forms during PP times. This was reviewed by a physician (A.A.E.), and the severity index was determined according to the error classification table (Table 4). All patients who were deemed to have had a

Dosages corrected (list drugs):
Alternative medications suggested:
Were they used: Y or N
Trauma Resuscitation:
Dosages assisted:
Intubation medications
drug name: time of intubation decision: time of admin:

Post-intubation medications
drug name: time of intubation: time of admin:

Other medications
drug name: time of event: time of admin:

Dosages corrected (list drugs):
Alternative medications suggested:
Were they used: Y or N

Medication Error Averted:
___Medication given but not ordered
___Medication ordered but not given
___Wrong drug given from what was ordered
___Wrong dose
___Too much
___Too little
___Wrong administration technique (e.g. rate)
___Wrong route
___Wrong dosage form
___Wrong time (>30 min from order)
___Error related to patient information (e.g. allergy, drug interaction, renal or hepatic disease)
___Other (describe):_____
Medication Interactions:

Adverse Outcomes/Complications:

Disposition:
___MICU ___TSI ___PICU ___OR
___SAC ___Regular Bed ___Obs ___DC

Date of Disposition: _____/_____/_____ **Time of Dispostion**: _____:_____AM or PM

Name or Initials of Person Completing Form:_____

NOTES:

Fig. 1 (*continued*).

medical error were reviewed to determine the medical severity index of that error to the patient [24,25].

The same data form was used for PA and PP.

2.6. Medication error: definitions and classification

Examples of medication errors we assessed included inappropriate medication use and delay in timing of medications given in patients with resuscitations and trauma. Specifically, the errors included medications given but not ordered, ordered but not given, wrong drug given, wrong dose (too much or too little), wrong administration techniques (ie, rate), wrong route (eg, intravenous instead of intramuscular), wrong dosage form and wrong time (delay of >30 minutes), and errors related to patient information (Table 4). Severity was based on previous study and classification technique. This was based on the National Coordinating Council (NCC) on Medication Error Reporting and Prevention [25,26] (see Table 4).

2.7. Data collected

The datasheet allowed for full explanation of any errors that occurred during either the PA or the PP study times. The recorded information included the following specific information:

1. The type of patient illness encountered
2. Timing to administration of medications
3. Medication errors and whether they were averted.

4. Any alternative medications used,
5. Patient disposition
6. Presence or absence of the pharmacist

2.8. Outcome measures

The main outcome was the presence or absence of a medication error. These errors were defined as any errors that occur in the patient management process whether or not there had adverse consequences [22,26].

2.9. Data analysis

For demographics and prevalence, descriptive statistics and percentages were used. Two-way contingency tables were used to compare PP to PA times. Percent differences with 95% confidence intervals (CIs) and χ^2 were computed. In our univariate and bivariate analyses, χ^2 analysis was used for nominal data and t tests for parametric.

Univariate results with $P < .05$ were used as entry criterion into a multivariable logistic model with the presence of a medical error as the outcome variable; maximum model was based on one predictor for every 10 medical errors. Adjusted odds ratios (OR) for regression analysis comparisons were used among disposition groups.

An a priori power analysis was performed assuming a prevalence of a significant number of medication errors based on prior studies in EDs. With at least 5 resuscitations and traumas per day, there would be a total of at least 420 entries. The study was powered at 80% with 186 subjects per group (PP vs PA), to find a difference of 20% between the 2 groups in percent of medical errors.

A κ statistic was calculated to measure agreement in observations between authors for the retrospective part of the study.

3. Results

There were 694 patients with major trauma and resuscitation included in the 12-week period. There were 242 who presented during PP times and 452 during PA times. There were 383 (55%) male and 301(43%) female (10 [2%] with unknown sex). Thirty percent were white, 39% Hispanic, 11% American Indian, and 21% other. Mean age overall was 47 years; in PP groups, it was 45 years, and in PA, it was 48 years (P, nonsignificant). There was no difference in ethnicity between groups. There were significantly greater PA times in non-ICU ward admits. Table 1 summarizes these results and the patient dispositions.

The pharmacist was present for 242 (35%) patients and PA in 452 (65%) patients. There were 143 (20.6%) of 694 patients with errors, of these 6 (2.5%) of 242 were with PP and 137 (30.3%) of 452 were with PA. Some patients had more than 1 error recorded. There were 181 total errors in 143 patients with medical errors: 7 (in 6 patients) in the PP group and 174 (in 137 patients) in the PA group. In the PP group, there were 17 times fewer errors across all dispositions (risk ratio, 17.4; 95% CI, 7.4-39.4) with a slightly smaller adjusted odds ratio (13.5; 95% CI, 6-32) when adjusted for disposition, age, and race.

Table 1 Demographics

	PP	PA	Difference (95% CI)
n	242	452	
Patients with medical errors, n (%)	6 (2.5) *	137 (30) *	27 (23-32)
Age (y)	45 ± 18	48 ± 20	NS
Race, n (%)			
White	82 (34)	129 (29)	NS
Hispanic	91 (38)	176 (39)	NS
American Indian	24 (10)	50 (11)	NS
Miscellaneous	45 (19)	97 (22)	NS
Sex (%male)	129 (53)	254 (56)	NS
Disposition, n (%)			
ICU	52 (22)	105 (23)	NS
OR	22 (9)	16 (3.5)	NS
Non-ICU admits	39 (16)	161 (36)	20 (13-26)
OBS	7 (3)	33 (7)	NS
D/C or MHC	63 (26)	136 (30)	NS
Missing	59 (24)	1	
Diagnostic group, n (%)			
Trauma	101 (42)	154 (34)	8 (0.1-34)
Medical	136 (56)	298 (66)	10 (2-17)
Missing	5 (2)	0	NS

OBS, observation unit; D/C, discharge; MHC, Mental Health Center.
* Statistically significant difference.

Table 2 summarizes the errors and types with PP vs PA. The medication type involving the most errors involved antibiotics. There were also many errors with PA in pain medications, cardiac medications, and gastrointestinal medications/antiemetics. The largest numbers of errors were a medication given but not ordered, a medication ordered but not given, and greater than 30 minutes from order time until time given.

When pharmacists were present, their interventions were frequent and consisted of dosage corrections (22 cases) and alternative suggestions (35 cases). Because the pharmacist was in control of medication distribution, all necessary dosages were corrected by the pharmacist. In addition, alternate choices were accepted by the physicians 91% of the time (32 of 35 cases).

Table 3 compares the PP group with the PA group in numbers of medical errors based on disposition. There were no significant differences between ICU and non-ICU patients in age, race, or PP. The ICU patients had significantly more male patients (63% vs 52%, P =.02). Comparison of the percentage of medical errors based on disposition to ICU vs all others was statistically significant (35% vs 19%; difference, 16%; 95% CI, 8-25).

Table 2 Total medication errors based on medication types and error categories

	PP	PA
n	7	174
Medication types		
Intubation/postintubation medications and sedatives	0	19
Pulmonary/asthma medications	0	10
Cardiac medications	1	28
Seizure medications	1	3
Antibiotics	3	41
Pain medications	1	31
GI medications/antiemetics	0	26
Tetanus	1	9
Other	0	7
Medication errors (can be >1 per patient)		
Medications given, not ordered	0	57
Medications ordered but not given	1	31
Wrong drug given; not what was ordered	0	0
Wrong dose, too much	1	5
Wrong dose, too little	3	7
Wrong administration technique (eg, rate)	1	13
Wrong route	0	0
Wrong dosage form	0	2
Wrong time (>30 min from order time)	0	30 (average, 1.5 h late)
Error related to patient information (allergy, drug interaction, renal or hepatic dose)	1	14 (all allergies)
Other	0	15

GI indicates gastrointestinal.

Errors were recorded in 143 total patients of 694. The ICU patients had the most errors, 35% had at least 1 error. Moreover, 27.5% of non-ICU admissions had errors; 22.5% of patients in the ED observation unit, 16% of those going to the OR, and 10% of those discharged to mental health or home (Table 3). With disposition to the ICU, there were 11 times more errors with PA (risk ratio, 11; 95% CI, 4-33). With disposition to a non-ICU bed, there were 9 times more errors with PA (risk ratio, 9; 95% CI, 2-39). Table 3 shows the percent errors when PP vs PA as well. Sixty (8%; 59 in PA group and 1 in PP group) had unknown dispositions, but none of these patients experienced medical errors. Errors did not result in an upgrade in disposition in any of our patients, however.

There was no significant effect of age, race, or sex using a logistic regression model. Table 3 also shows the adjusted odds ratios from the logistic regression model with medical error as the outcome variable and disposition, age, race, and sex as predictors.

Table 4 shows the error classification based on the NCC on Medication Error Reporting and Prevention [25,26]. Most errors were those with capacity to cause harm but did not actually cause harm. However, 10 of the errors resulted in some harm to the patient (level D or above) requiring at least monitoring or intervention (all were when pharmacists were absent).

Comparing resident and pharmacist data collections processes, there was complete agreement in the forms tested (approximately 44% tested of retrospective results; $\kappa = 1$; 95% CI, 0.98-1).

4. Discussion

Medication errors in the ED are a common occurrence. Up to 59.4% of patients will have a medication error in the ED, with most being prevented before reaching the patient. Patients with a high number of medications ordered or administered are at increased risk of experiencing an error [15]. Medications ordered in the ED are often high priority. They are prepared and administered with increased urgency, making errors more likely [27]. Most of these medication errors occur during the administration phase [28]. With this in mind, on-site pharmacists have successfully been incorporated into EDs. Emergency department pharmacists have been shown to provide information regarding drug dosing, pharmacokinetics, hospital formularies, toxicology, alternative medications, and resuscitation medications [12,29]. Emergency department pharmacists have been

Table 3 Patients with medical errors depending on disposition in the PP vs PA groups

Disposition	n	Total patients with errors (n = 143)	Patients with errors, PP group (n = 6)	Patients with errors, PA group (n = 137)	Risk ratio (95% CI)	Adjusted odds ratio (95% CI)
D/C home or MHC	199	18 (9%)	0 (0%)	18 (13.2%)	1.5 (1.4-1.7)	Comparison
ICU	157	55 (35%)	4 (7.7%)	51 (48.6%)	11 (4-33)	6.8 (3.7-12.7)
OR	38	6 (16%)	1 (0.4%)	6 (37.5%)	3.2 (2-5)	3.8 (1.3-11.2)
Non-ICU admits	200	55 (27.5%)	2 (5.1%)	53 (32.5%)	9.0 (2-39)	3.6 (1.9-6.5)
ED observation	40	9 (22.5%)	0 (0%)	9 (27.3%)	NS	2.5 (1.0-6.3)
Unknown	60 (8%)	0 (0%)	0 (0%)	0 (0%)		
Total	694		6 (2.5%)	137 (30.3%)	17.1 (7.4-39.4)	

None of the patients with unknown dispositions had medical errors.
D/C, discharge; MHC, Mental Health Center.

Table 4 Error classification for 143 patients with errors [a]

Category	Definition	PP, n	%	PA, n	%
A	Events with capacity to cause error	1	0.4	77	17
B	Error occurred but error did not reach the patient	0	0	0	0
C	Error occurred that reached the patient but did not cause harm	4	2	50	11
D	Error occurred that reached the patient and required monitoring to confirm that it resulted in no harm to patient or required intervention to preclude harm	1	0.4	6	1.3
E	Error occurred that may have contributed to or resulted in temporary harm and required intervention	0	0	3	0.7
F	Error occurred that may have contributed to or resulted in temporary harm to the patient and required initial or prolonged hospitalization	0	0	1	0.2
G	An error occurred that required intervention necessary to sustain life	0	0	0	0
H	Error that required intervention necessary to sustain life	0	0	0	0
I	Error occurred that may have contributed to or resulted in death	0	0	0	0

[a] The highest category of error for each patient; some patients had more than 1 error.

shown to improve adherence to hospital medication reconciliation policies [11]. Emergency department staff is generally receptive to the suggestions of pharmacists, following 90% to 99% of recommendations [12,30]. Surveys of ED staff where on-site pharmacists are present have shown that 99% of physicians and staff feel that an ED pharmacist improves patient care and that 93% had used the service [10]. It has been suggested that implementing an ED pharmacy program is cost-effective [4]. Estimates vary, but it has been suggested that the cost savings of having an on-site pharmacy program can be up to 3 million dollars annually [12]. Previous studies have suggested that on-site pharmacists reduce errors by 66% to 78%. This effect has been demonstrated on the wards, ICU, and ED [5,22,31].

Our study showed a 27.5% decrease in medication errors when pharmacists were present. The reason for this more modest reduction is that our total number of patients experiencing a medication error was lower than previously reported. Nonetheless, the effect of an on-site pharmacist appears to be significant because errors were 13.5 times more likely in their absence. Our study is unique because pharmacists are on-site 10 hours/day, enabling us to compare the effects of the presence and absence of pharmacists within the same institution on the same days.

Studies of contributions made by ED on-site pharmacists are rare. Our site is the only site where pharmacists are available 10 hours/day. In other sites, pharmacists are available 24 hours/day once the program is begun [9,15,17], making it impossible to actually compare times with and without pharmacy presence in the same institution. We were able to compare in our own institution and show that fewer errors were made when pharmacists were on-site. Another unique aspect at our site is the fact that pharmacists specifically participate in major medical and traumatic emergency patients. They are present at all intubations and assist in medication dosages and make suggestions and corrections as needed. They are not on an on-call basis.

The medications associated with the highest number of errors in this study were antibiotics. Antimicrobials made up 22% of errors categorized by drug class. This is consistent with an observational study of errors in 4 EDs where antimicrobials were associated with the most errors comprising 32.1% of total errors [17]. Medications associated with frequent dosing, mathematical calculations, and infusions have been associated with increased errors in critically ill patients [28]. However, these medications are used less frequently in the ED because critically ill patients often represent a smaller portion of the total patient population. Antibiotics are frequently prescribed, often prophylactically, and may require repeat dosing during a patient's stay. The high volume of orders and complexity of this medication group increase the likelihood of errors.

During our study, 19 patients had errors involving intubation medications, with the majority being a failure of the physician to order postintubation sedation. Because these medications are often ordered in the later stages of resuscitation, it seems likely that they are at a higher risk for errors. No patients had an error during intubation when pharmacists were present. More study is needed to determine whether pharmacists may improve patient care in this arena.

Intensive care units involve complex care and severe illnesses, and as a result, there is a higher risk for iatrogenic events. Although nursing ratios are higher in ICUs, medical errors are more commonly seen there and have increased morbidity and mortality. It has been suggested that almost every patient in the ICU will have a potentially life-threatening medical error during their hospitalization, and 78% of these will be medication errors [28,32]. It has been suggested that there are, o average, 1.7 events per day per ICU patient, and nearly all will experience a life-threatening error at some point of the ICU stay [33]. Patients having more than 2 adverse events are at a 3-fold increased risk of death [34]. The need for on-site pharmacists was suggested in a study of errors in 7 ICUs that recorded errors in 15.5% of

patients, with 11% being adverse drug events [35]. This risk for errors in critically ill patients appears to extend to the ED as the group with the highest number of medical errors in our study occurring in patients whose disposition was to the ICU; 35% of patients whose disposition was to the ICU had medication errors. The presence of pharmacists in our study decreased the number of errors in these ICU patients by 41% suggesting a substantial benefit in critically ill patients. Although it is unlikely that any of the errors resulted in patients going from routine ward admission to ICU status, patients who are more complex from the start generally have more errors [28,32].

Most errors in an ED are thought to be significant [17]. However, despite the high number of errors in the ED, it has been suggested that most errors do not cause patient harm [15]. Table 4 demonstrates the negative consequences of medication errors that occurred in this study. Errors are grouped into categories based on the NCC of Medication Error Reporting and Prevention error classification system [25,26]. Most errors in our study fell into categories A-D, errors that do not cause harm or require intervention. However, 4 patients had errors that required either intervention or prolonged hospitalization. All of these errors occurred when pharmacists were absent, and it is possible that the presence of an on-site pharmacist could have helped avoid these. The details of these 4 errors include a patient given albuterol/ipratropium nebs too frequently and developing supraventricular tachycardia, a patient given atropine with a known allergy developing hallucinations, dopamine ordered at 20 μg kg^{-1} min^{-1} but started at 5 μg kg^{-1} min^{-1} and norepinephrine ordered at 20 μg kg^{-1} min^{-1} but started at 5 μg kg^{-1} min^{-1}, and epinephrine administered via the wrong technique (given intravenous instead of intramuscular). All required hospitalization, 2 to the ICU.

A 2009 study found that only 6.8% of hospitals had an on-site ED pharmacist. Fifty-two percent of the hospitals that have more than 600 beds did, however, have ED pharmacists on-site [36]. More information about the effects of pharmacists in the ED is needed, not only for interventions in major traumas and resuscitations as in our study.

Some future directions are important to consider from the results of this study. This study addressed the effect of pharmacists on resuscitation patients only. We were able to compare times with and without pharmacists in the same ED, making this a unique study. Although it is likely that they would reduce errors, the effect of pharmacists on the entire ED population has yet to be studied in a prospective manner. Another area of potential study involves whether there is an effect of pharmacists related to CPOE. Many institutions, including ours, have transitioned to CPOE, but it is still too early to determine the effect on medication errors. Should the number of errors increase, the need for an on-site pharmacist could become increasingly important. The effect of a pharmacist on reducing errors in a computerized system remains a potential area of future study.

5. Limitations

Our data were obtained from one ED and may not be reflective of national trends in medication errors. The fact that the study was conducted at a facility where pharmacists are on-site part time provided a unique opportunity to evaluate errors in their presence and absence while controlling for environmental factors. Pharmacists were present in the afternoons and evenings. It is possible that errors are more common during times when ED staff experience more fatigue or lack of concentration. Data from when pharmacists were absent were collected retrospectively and may have been influenced by charting. Errors related to renal and hepatic dosing and medication administration may be underrepresented in the retrospective portion of the study. Every effort was made to capture errors through charting, and the data collection forms were reviewed by a pharmacist to identify additional errors that were overlooked. The pharmacists and data collectors were not blinded to the purpose of the study, and pharmacists were potentially more vigilant for errors during the study period.

Only 2 pharmacists and students entered data during the PP times. They were not blinded to the purpose of the study. However, the forms were reviewed by one of the physician authors of the study (A.A.E.), and were errors determined based on the classification system. The portion of the study when pharmacists were absent (PA) was done retrospectively with all the inherent problems of retrospective studies. However, one of the same pharmacists looked at these data as well for completeness and consistency.

Another threat to the validity of the study was the use of a single city-based level 1 trauma teaching hospital. Although it was positive that we had availability of times both with and without pharmacists to perform a cohort comparison of patients, we do not know how these results would translate to private ED settings or other type of ED.

Computer physician order entry had not begun at the time of this study; since then, it has commenced. Now pharmacists in our ED have real-time access to all of the physician orders at or before the time they are implemented by nursing staff. This could potentially allow the pharmacists to intervene more quickly when a dose or other medication error is about to occur. It remains to be seen how this will affect this type of study in the future.

6. Conclusion

With pharmacists absent, over 13 times more errors are recorded in our ED than with pharmacists present. An on-site pharmacist in the ED may be helpful in reducing medical errors. Adjusting for age, race, and sex those patients who go to the ICU are 7 times more likely to have medical errors without a PP than those discharged home.

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