

Effect of pharmacists on medication errors in an emergency department

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Since 1999, when the Institute of Medicine published "To Err Is Human: Building a Safer Health System,"¹ there have been remarkable developments in the measurement and analysis of patient safety and medication errors.² Medication errors have historically been defined as occurrences of inappropriate use of medications, regardless of outcomes.³ This broad definition encompasses all adverse drug events (ADEs) related to medication use, including potentially harmful events that have been prevented from reaching the patient. Such errors have been documented in almost all areas of the health care system, with emergency departments (EDs) having the highest rate of preventable ADEs in hospitals.⁴

The nation's EDs treated over 114 million patients in 2003.⁵ This large number of patients, in combination with a sometimes chaotic environment, makes the ED an ideal setting for pharmacist interventions to reduce medication errors. The Joint Commission, in an effort to minimize the risks associated with medication errors, now requires a review of "all medication orders in hospitals unless a licensed practitioner con-

Purpose. The frequency of medication errors in an emergency department (ED) before and after an ED pharmacist was assigned to check medication orders was studied.

Methods. A retrospective chart review was conducted for any patient admitted to the ED of a large rural hospital between November 6, 2005, and December 6, 2005 (control group), or between November 6, 2006, and December 6, 2006 (intervention group). For the control group, no pharmacist was present in the ED to check drug orders; for the intervention group, a pharmacist was present. Potential errors in medication orders were identified and validated.

Results. A total of 490 medication orders written for 198 patients were evaluated for errors. The control group ($n = 94$) and the intervention group ($n = 104$) did not

differ significantly with respect to age, sex, race, or number of medication orders. A total of 37 and 14 medication errors were identified for the control and intervention groups, respectively. The rate of errors was 16.09 per 100 medication orders for the control group compared with 5.38 per 100 orders for the intervention group, a 66.6% difference ($p = 0.0001$). The ED pharmacists made 183 recommendations, of which 98.6% were accepted.

Conclusion. The rate of medication errors in the ED decreased significantly when pharmacists prospectively reviewed ED medication orders.

Index terms: Errors, medication; Hospitals; Interventions; Medication orders; Pharmaceutical services; Pharmacists, hospital; Pharmacy, institutional, hospital

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trols the ordering, preparation, and administration of the medication."⁴ This requirement does not mandate that a pharmacist be present in the ED, but recent evidence from other practice settings suggests that an ED-based pharmacist may reduce medication errors.^{1,6,7} Also, it has consistently been shown that pharmacist participation in a hospital ED

offers the potential for substantial cost savings.^{1,8-11}

Almost 60% of medication errors are the result of the prescriber's lack of knowledge about the drug, lack of information about the patient, transcription errors, or memory lapses during drug ordering and delivery.¹² Having a clinically trained pharmacist present in the ED allows for multiple

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layers of patient protection, reducing the potential for errors to occur or to reach the patient.¹ A literature search revealed no studies quantifying the impact of an ED-based pharmacist on medication errors in that setting.

The purpose of this study was (1) to determine the frequency of medication errors in an ED before and after pharmacists were assigned to prospectively review medication orders and (2) to evaluate physician acceptance of the pharmacists' recommendations.

Background

The study was conducted in the ED of a 426-bed tertiary care hospital in rural North Carolina. A clinical pharmacist was assigned to the ED for consultation with and other assistance to the health care providers during all hours of each shift. The pharmacists' duties in the ED included clinical consultation, patient education, order screening, staff education, and emergency preparedness.

The ED is divided into two units, one for adults and one for children. The adult unit officially has 44 assigned rooms but frequently operates over capacity. The pediatric unit has 13 designated beds. The average combined daily census is 250–270 patients. Usual staffing includes 15–18 registered nurses in the adult unit and 4–6 registered nurses in the pediatric unit; 4 physicians and 2 physician assistants are responsible for both units per shift. The adult unit admits approximately 20% of patients and the pediatric unit less than 5%. The average time in the ED is four hours for patients who are subsequently discharged and not admitted to the hospital. For patients who are admitted, the average time in the ED is seven to eight hours.

Pharmacists in this health system are responsible for reporting all clinical interventions through the computer system (Siemens Corp., Malvern, PA). The use of the Siemens program was implemented in the hospital in

October 2004 and was adopted as an institutionwide medication-order-review system. This program provides pharmacists with the means to document interventions and is accessible only through a personal computer with network access. The program provides data on the number and type of pharmacist recommendations and the percentage of recommendations accepted.

Methods

Definitions. A medication error was defined as any preventable event that may lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional.¹³ Categories of medication errors were omission of dose, omission of information, unauthorized drug, wrong dose, extra dose, wrong route, wrong form, wrong technique, and wrong time.¹⁴

Procedures. The study protocol was approved by the hospital's institutional review board. The study was designed as a retrospective review of the charts of all patients, regardless of age, who were admitted to the ED between November 6, 2005, and December 6, 2005 (control group) or between November 6, 2006, and December 6, 2006 (intervention group). For the control group, no pharmacist was present in the ED to check drug orders; for the intervention group, a pharmacist was present. Patient records were selected by convenience sampling by the medical information department. Patients with incomplete charts or no medication orders were excluded.

All medication errors were identified by an independent evaluator who reviewed the medical records, including all progress notes, drug orders, and laboratory test results, using the chart-review techniques described by Flynn et al.¹⁴ To document the errors, the evaluator used a structured form that was organized and analyzed with Microsoft Access (Microsoft Corp., Redmond, WA).

Each drug order was analyzed for medication errors. A medication error, if generalized to include more than one medication order (as when drug allergy information was missing), was documented only once and not multiple times. After the evaluator identified medication errors, a blinded panel of three pharmacists assessed each one for validity. A majority decision was necessary to validate an error.

Data on the number and types of pharmacist recommendations and the percentage accepted were provided by computer. The ED pharmacists completed a report describing each recommendation that might have led to a change in a medication order.

Statistical analysis. The study was designed to have an 80% power to detect a 66% relative risk reduction (RRR) in the rate of medication errors historically occurring in at least 10% of ED medication orders.^{6,15} Sample-size calculations showed that 56 chart reviews, or 224 medication orders, were required per study group to find a 66% RRR at the two-tailed significance level of 0.05.¹⁶ Historical estimates were used for medication error frequency because of a lack of relevant documentation at the health care facility.

The chi-square test was used to compare the groups with respect to sex, race, and medication error rates. Differences in age and number of medications were analyzed with Student's *t* test and analysis of variance, respectively. Descriptive statistics were used to assess pharmacist recommendations. All statistical analyses were performed with JMP, version 6.0.3 (SAS Institute Inc., Cary, NC).

Results

A total of 490 medication orders written for 198 patients were evaluated for errors. The control group (*n* = 94) and the intervention group (*n* = 104) did not differ significantly with respect to age, sex, race, or number of medication orders (Table 1).

NOTE Medication errors

A total of 37 and 14 medication errors were identified for the control and intervention groups, respectively. The rate of errors was 16.09 per 100 medication orders for the control group and 5.38 per 100 orders for the intervention group, a 66.6% difference ($p = 0.0001$).

The pharmacists made 183 recommendations (Table 2). Practitioners accepted 72 (98.6%) of 73 recommendations documented by the pharmacists; 110 recommendations were undocumented as accepted or declined. The most common recommendations involved dosage calculations (29%); inappropriate dosages, drugs, routes, or schedules (26%); order clarifications (16%); and drug allergies (12%).

Discussion

The results of this study suggest that pharmacists assigned to an ED played a role in reducing the rate of medication errors by two thirds. This reduction is consistent with the 66–78% rate reductions observed in previous studies in other hospital settings.^{6,7} Almost all the pharmacists' recommendations were accepted by other health care professionals. The 99% acceptance rate in this study was higher than the acceptance rates reported for the EDs at other institutions but similar to the rates reported for other settings at other institutions.^{6,8,17,18}

The study has several limitations. First, the evaluator was not blinded to the intervention group; this was considered impractical because of the ubiquitous presence of date identifiers in the medical records. However, a structured form with standard definitions of medication errors was used for documentation to increase the objectivity of the analysis. Also, a panel of pharmacists was used to assess the clinical validity of each potential medication error. The panel was blinded to the intervention group, reducing the potential impact of investigator

Characteristic	Control Group (n = 94)	Intervention Group (n = 104)
Mean $\pm$ S.D. age, yr	32.3 $\pm$ 23.1	37.0 $\pm$ 21.3
Race, no. (%) pts		
African American	40 (43)	55 (53)
Caucasian	48 (51)	45 (43)
Other	6 (6)	4 (4)
Sex, no. (%) pts		
Male	47 (50)	45 (43)
Female	47 (50)	59 (57)
Total no. medications ordered	230	260
Mean $\pm$ S.D. no. medications per pt	2.44 $\pm$ 1.36	2.46 $\pm$ 1.60
Admitted to hospital, no. (%) pts	5 (5.3)	9 (8.6)

^ap not significant for any comparison.

Type of Recommendation	No. Intervention (%)
Dosage calculation	53 (29)
Inappropriate dosage, drug, route, or schedule	48 (26)
Order clarification	29 (16)
Identification of drug allergy	22 (12)
Miscellaneous or unspecified	14 (8)
Approval of nonformulary medication	7 (4)
Identification of duplicate therapy	7 (4)
Clarification of medication history	2 (1)
Identification of drug interaction	1 (1)
Total	183

bias. A second limitation is the absence of a concurrent control group. The decision to omit a concurrent control group was based on the lack of a comparable unit without a pharmacist's presence. A third limitation is the use of patient medical records for detection of medication errors. Since direct observation has been shown to be more efficient and accurate than chart review, the rate of medication errors detected may have underrepresented the true rate.¹⁴ Finally, the study was limited to patients admitted to the ED; the results may not be generalizable to other specialty units.

Conclusion

The rate of medication errors in an ED decreased significantly when pharmacists prospectively reviewed ED medication orders. Virtually all of the pharmacists' recommendations were accepted by other health care providers.

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