

Documentation of pharmacists' interventions in an emergency department and associated cost avoidance

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The National Hospital Ambulatory Medical Care Survey, which collected data on care provided by hospital emergency departments (EDs) from 1992 through 2002, estimated 110.2 million visits to EDs for 2002.¹ Medications were administered or prescribed during 76%, or 83.75 million, of those visits.¹ Approximately 2.3 medications are prescribed or dispensed per ED visit, resulting in 192.6 million medication orders for 2002.¹ It is unlikely that pharmacists reviewed the vast majority of those medication orders. In 2001, the United States Pharmacopeia's (USP's) MedMARx medication-error database reported approximately 2000 medication errors in the ED.² Twenty-three percent of those errors were detected before medication administration. This is comparatively lower than a 39% rate recognition of potential medication errors in the inpatient setting.² The absence of a pharmacist review of medication orders in the ED is currently being reexamined by the Joint Commission on Accreditation of Healthcare Organizations.³ Previously, EDs received

Purpose. An analysis was conducted of pharmacist interventions and resuscitation experiences, including pharmacist participation in a hospital emergency department (ED), and the potential cost avoidance associated with the interventions made by the pharmacists.

Methods. All pharmacists working in the ED prospectively documented the pharmacist interventions that were accepted by physicians and nursing staff and entered into a spreadsheet on a weekly basis, between September 1, 2003, and December 31, 2003. Intervention categories included the provision of drug information; recommendations for dosage adjustment, formulary interchange, initiation of medications, alternative drug therapy, discontinuation of drug therapy, changes in medication therapy due to allergy notification, drug therapy duplication prevention, or changes in the route of drug administration; questions from nursing staff; order clarifications; drug compatibility issues; patient information; toxicology; and drug interaction identification. Intervention data were analyzed

and the likelihood of harm was scored; interventions were classified and analyzed by calculating average cost, probability of harm, and potential cost avoidance.

Results. During the study, 2150 pharmacist interventions were documented. Pharmacists participated in the care of 1042 patients triaged to the resuscitation area of the ED. Cost avoidance during the study was determined to be \$1,029,776.

Conclusion. The most commonly documented interventions made by pharmacists involved in the care of patients visiting the ED included provision of drug information, dosage adjustment recommendations, responses to questions from nursing staff, formulary interchanges, and suggestions regarding initiation of drug therapy. The potential cost avoidance attributable to the pharmacist interventions during the study period was over \$1 million.

Index terms: Dosage; Drug information; Economics; Hospitals; Interventions; Pharmaceutical services; Pharmacists, hospital; Pharmacy, institutional, hospital; Substitution
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a situational exemption because the physician controls ordering, dispensing, and administration of the drug.

Pharmacy practice has evolved dramatically over the last four decades. In many settings, the pharmacist's role has shifted from a primary

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focus on medication dispensing to a focus on providing patient care. Historically, the practice of pharmacy has been that of interpreting, evaluating, and implementing medical orders and dispensing medications.⁴ However, the practice of pharmacy has expanded to include determining optimal evidence-based medication management, monitoring for adverse drug events, educating patients and caregivers on medication use, and collaborating with physicians and other health professionals in the management of acute and chronic diseases.^{4,5}

The literature is replete with publications that describe the expanding role of pharmacists in a variety of practice settings.⁴⁻¹² The pharmacist's role has been documented in the hospital setting illustrating cost control and reduction, antimicrobial policy adherence, optimization of antimicrobial use, prevention of adverse drug events, pain and anticoagulation management, and the detection and control of hypertension.^{4,7-9,11} Recognized pharmacy practice specialties include critical care, infectious diseases, nutrition, oncology, pharmacotherapy, psychiatry, and toxicology.¹³⁻¹⁷ Consistent with this trend toward specialization in pharmacy practice, there has been a movement toward the establishment of emergency medicine (EM)-based pharmacy services.¹⁸⁻²² However, there is limited published literature on EM pharmacists.^{23,24}

In the 1970s, the pharmacist's role in emergency care was limited to participation on cardiopulmonary resuscitation teams or to the preparation and distribution of emergency drug boxes.^{18,21,24-26} Bond and colleagues²⁵ noted a decreased mortality associated with pharmacists' code team participation. The authors described the role of the pharmacist in dosage calculations, drug information, parenteral medication admixture, and documentation of administered medications. Rapp and colleagues²⁶

further stated that a pharmacist's education and training are well suited in assisting physicians and nurses in code situations.

There are approximately 5000 EDs in the United States, but less than 1% have dedicated clinical pharmacy services available.²⁴ There are approximately 19 known EM pharmacists with varying practice types in the United States.²⁴ The American Society of Health-System Pharmacists has currently accredited one EM specialty pharmacy residency program and one EM and critical care specialty pharmacy residency program.²⁷ The EM pharmacists practicing in the sites with these programs are providing expanded services to their EDs, such as appropriate medication selection, medication dosing, patient monitoring, patient and caregiver education, drug information provision, and participation on cardiac arrest response teams.

The purpose of this study was to perform a descriptive analysis of pharmacist interventions and resuscitation experiences, including pharmacist participation in the ED. Evaluation of potential cost avoidance associated with interventions made by pharmacists was included as a secondary outcome.

Methods

Setting and patient population.

The study was conducted at Detroit Receiving Hospital (DRH), a 340-bed, university-affiliated, urban level-I trauma center for adult patients in Detroit, Michigan. DRH has specialty care units committed to the care of traumatic brain injury, burn patient care, and spinal cord injury. In 2001, over 84,000 adult patients were seen in DRH's 100-bed ED. Approximately 4% of these patients were initially seen in the resuscitation area, while 37% of the patients were triaged directly to the general treatment areas. Approximately 15% of visits in 2001 resulted in hospital admissions.

At DRH, EM pharmacy services are provided 24 hours a day through an ED satellite where pharmacists are equipped to dispense commonly prescribed oral medications and prepare necessary i.v. medications. Types of services provided by pharmacists include drug information consultations, pharmacokinetic consultations, anticoagulation services, medical staff inservices, emergency resuscitation team participation, antimicrobial surveillance, patient recruitment for research, order entry and dispensing of medications, formulary interchange, and sample medication provision to indigent care patients.

Data collection and analysis.

All pharmacists working in the ED prospectively documented the interventions that were accepted by physicians and nursing staff and entered the interventions into a spreadsheet on a weekly basis between September 1, 2003, and December 31, 2003. The time of day that each intervention was made was also recorded. Intervention categories included the provision of drug information (i.e., review of evidence-based medicine as it pertains to specific patients and corresponding recommendations made to physicians); recommendations for dosage adjustment, formulary interchange, initiation of medications, alternative drug therapy, discontinuation of drug therapy, changes in medication therapy due to allergy notification, drug therapy duplication prevention, or changes in the route of drug administration; questions from nursing staff (i.e., interventions such as recommendations for rate of drug administration or therapeutic drug monitoring that would not result in patient medication order changes); order clarifications; drug compatibility issues; patient information (i.e., provision of counseling on drug therapy or medication history interview and counseling); toxicology (i.e., drug identification, recommendations

for management of poisonings or overdoses, or suggestions regarding therapeutic drug monitoring); and drug interaction identification (i.e., prevented or determined by the pharmacist). The types of interventions documented were tabulated for three work shifts (first shift, 7:00 a.m. to 2:59 p.m.; second shift, 3:00 p.m. to 10:59 p.m.; third shift, 11:00 p.m. to 6:59 a.m.).

Pharmacist involvement in the care of critically ill patients was evaluated through medical and trauma resuscitation efforts in the ED. Pharmacists dispense medications for administration to patients in the resuscitation area 24 hours a day, seven days a week. Medical resuscitation includes advanced cardiac life support, management of status asthmaticus and status epilepticus, rapid sequence intubation, and management of toxicologic emergencies. Patients requiring emergency airway support; patients with neurotrauma, spinal trauma, or penetrating and blunt traumas; and those involved in multivehicular collisions are triaged for advanced trauma life support (ATLS). All critically ill patients are triaged directly into the resuscitation area and are logged into a registry. Information collected from this registry evaluated the volume of medical versus ATLS resuscitations during the study period. Pharmacist interventions during medical and ATLS resuscitation efforts were not recorded because of the difficulty in documenting all interventions during such high-stress situations.

Potential cost avoidance was determined using the Veterans Affairs (VA) model by Lee and colleagues.²⁸ A determination of the average probability of harm was explained and defined as judging the harm on an estimated probability scale (0–1.0) in which harm would have occurred without the pharmacist intervention. Each intervention was evaluated by a physician who was board certified in internal medicine and a

pharmacist who had completed two postgraduate pharmacy residencies; both evaluators had at least five years of clinical experience. When these evaluators concluded that no harm would have occurred without pharmacist intervention, a score of 0 was assigned. A score of 0.5 was given if harm was deemed neither likely nor unlikely, and a score of 1.0 was assigned if the evaluators determined that harm to the patient was very likely if no intervention was performed. The percentage of cases in which the evaluators agreed on the level of harm was determined, and the average probability of harm was calculated.

Using this model, we reevaluated interventions by pharmacists in the ED and removed any interventions that were determined not to have any association of harm. It was determined whether the remaining interventions were associated with the likelihood of causing or preventing harm to the patient. Allergy notification and drug therapy duplication comprised the adverse drug events, as there was no specific intervention dedicated to collecting adverse events. Interventions deleted from this calculation included formulary changes, nursing questions, compatibility issues, and patient information and counseling. The remaining interventions were further delineated into four categories, including drug–drug or drug–disease interactions or incompatibilities avoided, therapeutic recommendations, adverse drug events prevented, and medication errors prevented. The items were then scored in the same manner as described by Lee and colleagues.²⁸

Intervention data were analyzed by calculating daily averages, along with S.D.s, on the basis of monthly totals, using Excel 2003 (Microsoft Corporation, Redmond, WA). The mean number of interventions \pm S.D. was also calculated for each work shift. Based on the mean number of interventions accepted per day dur-

ing the study period, the data were extrapolated to estimate the number of interventions expected over one year. The likelihood of harm was scored from 0 to 1.0, and interventions were reclassified and analyzed by calculating average cost, probability of harm, and potential cost avoidance. Our average cost avoidance per intervention was formulated from the VA drug acquisition costs, which also incorporated the hourly wage of the pharmacist along with supplies and potential duration of therapy.²⁸ This value was multiplied by the number of EM interventions that qualified by the average probability of harm to give the final potential cost avoidance for that specific classification.

Results

Pharmacist interventions. During this four-month study, 2150 interventions were documented. Approximately 31%, 33%, and 36% of the interventions were performed during the day, afternoon, and night shifts, respectively. The mean \pm S.D. number of interventions performed in a 24-hour time frame was 17.5 ± 1.43 . During the day shift, the average number of interventions was $6.77 (\pm$ S.D. 1.04). For the afternoon and night shifts, there were 5.76 interventions (\pm S.D. 0.73) and 6.35 interventions (\pm S.D. 0.56), respectively. On the basis of the mean number of interventions accepted per day during the study period, approximately 6400 interventions would be expected over one full year.

The most common interventions involved provision of drug information, dosage adjustment recommendations, response to nursing questions, formulary interchanges, and suggestions for the initiation of drug therapy (Table 1).

Pharmacist participation in resuscitation events. During the study period, 4% ($n = 1042$) of patients were triaged directly to the resuscitation area. Approximately 35% ($n = 364$) of patients arrived based on

ATLS classifications. The remaining 65% ($n = 678$) of patients were seen for various other critical medical conditions that needed emergent one-on-one care in the resuscitation area. Pharmacists were present and participated in the care of all patients seen in the resuscitation area.

Cost avoidance. After reclassification of the pharmacist interventions to correlate with the model of Lee et al.,²⁸ the number of applicable interventions was decreased from 2150 to 1393. Cost avoidance during the study period was determined to be \$1,029,776. When the data were extrapolated to one year, our study

demonstrated a potential cost avoidance of \$3,089,328 (Table 2).

Discussion

A beneficial effect of having a clinical pharmacist involved in patient care in the ED was observed in our study, based on the number of accepted pharmacist interventions and the potential cost avoidance of over \$3 million. An earlier study evaluating EM pharmacist interventions was also conducted at DRH by Levy (1989–91).²⁰ Two major intervention classes in that study consisted of appropriate medication selection and more appropriate medication dose.

Cost savings associated with each intervention were evaluated. The savings were estimated on the basis of the material cost of the medication plus any adjunctive equipment needed for the delivery of the medication (e.g., syringes, needles, i.v. fluids, tubing sets), but they did not include intellectual capital.²⁰ In the first year of the study, a total of 9,700 interventions were documented. During the final year of the study, total interventions increased to 15,637 (cost-saving interventions totaled 1,541) with an associated savings of \$93,561.22.²⁰ Our study was not able to evaluate a cost savings using Levy's²⁰ costs since medications, equipment, and diagnostic capabilities have changed dramatically since the original evaluation.

The role of the pharmacist during emergency resuscitation has been well described in the literature.^{25,26,29-31} The pharmacist's duties include ensuring adequate medication stock for the emergency resuscitation cart (par levels, special supplies needed to deliver medication), immediate preparation of medications, serving as the medication resource person (providing the correct medication, correct dose, correct route, and rapid calculations and addressing compatibility concerns and infusion rates), and coordinating and directing the flow of medications.^{25,26,29-31}

The amount of time required of the pharmacist involved in the care

Category	No. Interventions
Drug information	362
Dosage adjustment	353
Nursing questions	316
Formulary interchanges	181
Suggest initiation of drug therapy	180
Order clarifications	164
Change to alternative drug therapy	157
Compatibility issues	143
Patient information	77
Change route of administration	66
Discontinue drug therapy	58
Toxicology	43
Allergy notification	40
Drug therapy duplication	8
Drug interaction	2
Total	2150

Type of Intervention	No. Interventions	Average Cost Avoidance per Intervention (\$)	Average Probability of Harm	Cost Avoidance (\$)ª
Drug–drug or drug–disease interactions or drug incompatibilities identified	334	1,647	0.54	297,053
Therapeutic recommendation	523	1,188	0.44	273,383
Adverse drug event prevented	48	1,098	0.44	23,190
Medication error prevented	488	1,375	0.65	436,150
Total	1393	1,029,776

ªThe extrapolated cost avoidance for a one-year period = \$3,089,328.

of patients in the ED varies greatly, depending on the acuity of each patient. Rapp and colleagues²⁶ evaluated pharmacist participation in emergency resuscitation events and found that the pharmacist averaged 35 minutes in resuscitation efforts (ranging from 5 minutes to over 4 hours). Although the amount of time involved for pharmacist participation in emergency resuscitation events was not documented in our study, if Rapp's methods are applied, approximately 608 hours (5 hours per day) are estimated to have been spent by pharmacists caring for the critically ill patients in the resuscitation area.

Typically, in a large urban ED, evening and weekend shifts are more arduous and demanding for all of the ED staff. In this study, some interventions may have been overlooked and not documented during those times. Because of the hectic nature of those shifts, our study's finding may not be a true representation of clinical pharmacists' interventions. This emphasizes a greater need for the clinical EM pharmacists' availability to be tailored toward nontraditional working hours.³²

In the study conducted by Lee et al.,²⁸ the most frequent type of recommendation that was determined to have prevented harm to the patient was the identification and prevention or management of a medication allergy. An associated probability of harm was dependent on whether the recommendation occurred in the inpatient or outpatient setting (0.54 or 0.44, respectively). In our study, the interventions involving medication allergies were documented 40 times. If we solely evaluated preventing and managing medication allergies for a period of one year, we could achieve 120 interventions. Some of those patients would be safely discharged or require an admission; therefore, averaging the inpatient and outpatient harm would give our study a potential cost avoidance of \$46,224

per year for the prevention or management of a medication allergy.

In addition to financial benefits, current trends in medicine highlight the necessity of clinical pharmacists in busy EDs, which coincides with the current heightened public awareness of adverse medication events that have occurred in the ED.³³⁻³⁶ The pharmacist's role in medication safety is integral. The pharmacist can potentially minimize medication errors and adverse events, answer general medication questions, and recommend cost-saving equivalent therapies, as well as provide patient-specific medication education.

Our study had several limitations, including the pharmacist's comfort levels with making recommendations, since pharmacists rotate shifts and are not consistently in the ED. Study documentation was dependent on each pharmacist documenting his or her activity; therefore, interventions may not have been documented because of increased workloads during particular shifts. The failure to detect some errors and potential interventions may have also occurred because of the varying practice behaviors of different pharmacists in the ED. There also could have been classification bias; one pharmacist may have listed a question as a nursing question when it may have been a dosage adjustment. This study's time frame could also be another limitation in that it was chosen to rule out potential outliers with larger than usual interventions expected for the months of July and August coinciding with the start of new residents to the hospital. Time invested in teaching medical residents, attending physicians, nursing staff, and Emergency Medical Service personnel in the ED was not evaluated during this study.

The evaluation of our cost-avoidance data is potentially another limitation. Our cost analysis is derived from a model used in a VA medical center, and it has not been

validated. Also, this evaluation may be an underestimation, as the VA has stronger purchasing power and, therefore, lower medication-acquisition costs. The VA model did not evaluate EDs; patients that presented to our ED would be significantly different in their acuity of illness or injury and in their general patient-population characteristics. The cost avoidance derived in this study may not fully reflect the actual potential for harm. In fact, the VA model may provide a conservative number, given the seriousness of an ED visit and a greater potential for medication misadventures.

This study provides the basis needed to further explore EM clinical services and to expand on the current role of the EM pharmacist. After more than 20 years of ED clinical services at DRH, the pharmacists are maintaining a high level of quality interventions, ensuring patient safety, and continually containing costs. The addition of a clinical EM pharmacy specialist and an EM-trained pharmacist will foster collaboration with other ED staff to improve overall performance and care while optimizing a safer and more productive environment for all patients and members of the health care team. Future EM research direction should focus on the development and subsequent validation of an economic model for the evaluation of pharmacist-provided emergency care.

Conclusion

The most commonly documented interventions made by pharmacists involved in the care of patients visiting the ED included provision of drug information, dosage adjustment recommendations, responses to questions from nursing staff, formulary interchanges, and suggestions regarding initiation of drug therapy. The potential cost avoidance attributable to the pharmacist interventions during the study period was over \$1 million.

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