Original Article

Implementation of a 24-Hour Pharmacy Service with Prospective Medication Review in the Emergency Department

Billy Sin, PharmD, BCPS^{*}; Linda Yee, PharmD, MPH, BCPS[†]; Maria Claudio-Saez, PharmD, BCPS[‡]; Qazi Halim, RPh[§]; Lewis Marshall, MD, JD[¶]; and Mary Hayes-Quinn, RN, MSN, CEN^{**}

ABSTRACT

Background: It is reported that more than 128 million patients are seen in emergency departments (EDs) annually. Patient overcrowding had been associated with an increased occurrence of medication errors.

Purpose: Due to increased patient volume and the need for improved patient safety, a 24-hour pharmacy service was established for our institution's ED. The purpose of the study is to quantify and demonstrate the impact of a 24-hour pharmacy service in an urban ED.

Methods: This was a retrospective descriptive study conducted at a regional level 1 trauma center. The study period occurred between December 2012 and July 2013. The following variables were quantified and analyzed: number of medication orders reviewed, number of intravenous medications compounded, and number of clinical interventions that were recommended by the ED pharmacy team (EDPT) and accepted by ED clinicians.

Results: A total of 3,779 medication orders were reviewed by the EDPT. Of these orders, 3,482 (92%) were prospectively reviewed. A total of 3,068 (81.2%) and 711 (18.8%) orders were reviewed for the adult and pediatric ED, respectively. During the study period, the EDPT procured 549 intravenous admixtures and conducted 642 clinical interventions. Most of the interventions involved providing drug information for physicians and nurses (45.9%), adjusting drug dosages (21.1%), and recommending antimicrobial therapy (15.1%).

Conclusion: The implementation of a 24-hour pharmacy service at our institution was an innovative practice that increased the role of pharmacists in the ED. The EDPT conducted prospective medication review, procured intravenous admixtures from a sterile environment, and provided therapeutic recommendations for the ED interdisciplinary team.

Key Words—emergency department, pharmacy practice, prospective medication review

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FACTORS CONTRIBUTING TO MEDICATION ERRORS IN THE ED

The emergency department (ED) is the front line for providing medical care. It is also the safety net for persons who seek immediate health care, as it is required to provide, within its capabilities, any stabilizing treatment regardless of payer status. Thus,

the patient population that is served by EDs is not limited to critically ill patients requiring emergent medical care. It is estimated that more than 128 million patients were seen in EDs annually.¹ The ED is often challenged with the task of providing optimal medical care with limited resources and space.¹⁻⁵ In fact, most EDs operate at overcapacity. Patient

^{*}Emergency Medicine Clinical Pharmacist, [†]Clinical Pharmacist, Internal Medicine, [‡]Assistant Director, Pharmacy Services, [§]Director, Pharmacy Services, [¶]Chairman, Emergency Medicine, ^{**}Director, Emergency Medicine Nursing Services, Brookdale University Hospital Medical Center, Brooklyn, New York. Corresponding author: Billy Sin, PharmD, BCPS, Assistant Professor of Pharmacy Practice, LIU Pharmacy, Arnold & Marie Schwartz College of Pharmacy & Health Sciences, 1 University Plaza, Brooklyn, NY 11201; phone: 718-488-1987; e-mail: billy.sin@liu.edu

overcrowding was reported in at least 90% of EDs located in New York (90%), Florida (92%), and Texas (95%).³ Patient overcrowding had been associated with an increased occurrence of medication errors. A prospective, observational study reported a proportional relationship between patient volume and incidence in medication errors such as inappropriate dosing, frequencies, or routes.⁵ Medication errors are frequently reported in the ED.⁴⁻⁶ In fact, clinical data indicate that the rate of medication errors or adverse events is approximately 4%.^{2,7-9} Many errors were considered preventable, but the cost of managing them exceeded \$10 billion.^{1,4} At a time when institutions are operating with stringent resources, it is imperative to avoid financial burdens induced by medication errors or adverse reactions.

Clinical literature had noted that most medication errors occur at the prescribing phase of the medication use process.^{1,10} There are mixed conclusions regarding the effectiveness of computerized physician order entry (CPOE) systems to reduce medication errors. The implementation of CPOEs has been shown to minimize the incidence of medication errors.¹¹⁻¹⁷ However, it has also been suggested that the positive benefits of CPOE can be compromised by human-computer interaction. Horsky et al¹⁸ described a prescribing error that led to patient overdosing on intravenous (IV) potassium. The error occurred because the prescriber failed to include an appropriate discontinuation time on a previous order. It has also been noted that inappropriate user training, inconsistent behavior in data entry fields, or unfamiliarity with system operations are common root causes that contribute to medication orders.¹⁸ Horsky et al also cite various examples of CPOE-generated errors such as key-pad entry (typographical error), drop-down menu (wrong selection from drop-down box), and duplicate medication (2 orders written for the same medication due an absence of a flagging system).

Due to the unique nature of the ED, medication review by a pharmacist prior to administration may not be a common practice. In an attempt to balance safety, efficiency, and practicality, some institutions have developed practice models for retrospective medication review. In this model, pharmacists review the appropriateness of a prescribed order after the drug has been administered to the patient. Although this process fulfills regulatory requirements for medication review, it does not ensure optimal pharmacotherapy nor does it prevent medication errors from reaching the patient.

In EDs where pharmacy services are not available, the task of IV compounding usually falls on the nursing staff. However, in a fast-paced, high-volume critical care unit, it is not recommended for nurses to prepare IV admixtures with aseptic technique. Michael Cohen, President of the Institute for Safe Medication Practices (ISMP), suggested that situations in which nurses have to compound IV admixtures in crowded areas of the nursing unit, with other medications nearby and with potential interruptions and distractions, are not conducive to safe drug preparation.¹⁹ In addition, most EDs are not equipped with sterile hoods for IV compounding.

METHODS

Study Setting and Patient Population

The Brookdale University Hospital and Medical Center is an urban community teaching hospital with 530 certified acute-care beds. The institution is a full service medical, pediatric, surgical, psychiatric and ambulatory care provider. The ED is a level 1 trauma center with over 100,000 annual patient visits. It is divided into 3 units – one for adults, one for pediatrics, and one for psychiatric services. At the time of the study, the average daily census was 120 to 160 patients. Usual staffing included 15 to 20 nurses, 5 to 7 physicians, and 2 physician assistants or nurse practitioners per shift. The ED frequently operated at overcapacity. Medications were dispensed from 6 automated dispensing cabinets (ADCs). The pharmacy satellite was responsible for dispensing medications that were not stocked in the ADCs or that required sterile compounding with aseptic technique. Due to an increased patient volume and need for improved medication safety, an administrative decision was made to establish pharmacy services in the ED.

The pharmacy satellite was staffed with one full-time equivalent (FTE) throughout the day, evening, and overnight shift. The members of the ED pharmacy team (EDPT) included a clinical specialist who was certified in pharmacotherapy with postgraduate year-2 (PGY-2) training in emergency medicine during the day shift (8:00 a.m. - 4:00 p.m.), and a rotating staff pharmacist during the evening (4:00 p.m. - 11:30 p.m.) and overnight (11:30 p.m. - 8:00 a.m.) shifts. Pharmacy services were provided from the satellite during all 3 shifts. During the overnight shift, if an unexpected circumstance required the pharmacist to relocate in order to ensure adequate coverage for the entire institution, services for the ED were provided from the central pharmacy. Weekend coverage was shared between the clinical specialist and rotating staff

pharmacists on alternating basis. The shifts for pharmacy technicians were similar to those of the pharmacists. However, due to shared responsibility for all patient care areas, their primary roles were to restock and check for expired medications in the ADCs.

The ED pharmacy satellite was equipped with 2 computer terminals, a multi-line telephone, an electronic label printer, a laminar flow hood, an ADC, and multiple drug references. The components of pharmacy services included conducting prospective medication review, preparing IV admixtures under the laminar flow hood, and providing drug information services. The ED clinical pharmacotherapy specialist also participated in medical emergencies, conducted educational seminars, designed medication use processes, created therapeutic treatment protocols, and established inventory levels for medications stocked in the ADCs. In the ED, medications are dispensed from 6 ADCs. Our study included ED patients who were prescribed drug therapy by an ED clinician.

Study Design

This was an 8-month retrospective descriptive study approved by the institution's investigational review board. The objective of the study was to demonstrate and evaluate the impact of pharmacy services in the ED. The primary outcomes were the number of medication orders reviewed, number of interventions that were recommended and accepted, and the number of intravenous admixtures prepared.

Process for Prospective Medication Review

Clinical literature has noted that most medication errors occur at the prescribing phase of the medication use process.^{1,19} Prospective medication review (PMR) was a vital component of our service, because it provided an opportunity for pharmacists to intervene on potential medication errors before they occurred. The process began when clinicians placed new medication orders in the CPOE. These orders were then identified and flagged by the CPOE. Once the presence of a new order was recognized, the pharmacist proceeded to review the appropriateness of the order. If an intervention was necessary, a recommendation was made to the clinician who placed the order. If the recommendation was accepted, documentation was made by the pharmacist in the pharmacy drug therapy management system (PDMS). When the order was deemed appropriate, the pharmacist placed a verification message in the CPOE. This message was vis-

Table 1. Medications exempt from prospective medication review

Acetaminophen/oxycodone	Glucagon
Adenosine	Haloperidol
Albuterol	Ipratropium
Amiodarone	Ketorolac
Atropine	Lorazepam
Aspirin	Magnesium
Calcium gluconate	Mannitol
Clopidogrel	Morphine
Dopamine	Nitroglycerin
Diphenhydramine	Phenytoin
Epinephrine	Rocuronium
Etomidate	Ticagrelor
Fentanyl	Sodium bicarbonate
Furosemide	Vasopressin

ible for multidisciplinary review and was an official part of the patient's medical records. Subsequently, the pharmacist entered the order's drug, dose, and route into the PDMS. Once the order was entered, the drug was available for removal from the ADC. To maximize patient safety via an interdisciplinary approach, nurses were required to acknowledge the pharmacist's verification message in the CPOE. To provide efficient patient care during medical emergencies, a committee comprised of physicians, nurses, and pharmacists designed a comprehensive formulary of medications that did not require PMR prior to dispensing from the ADCs. Medications that were deemed necessary for medical emergencies or emergent situations were added to the formulary (Table 1). Orders for these medications were reviewed retrospectively by the pharmacist.

RESULTS

The study period occurred between December 2012 and June 2013. A total of 3,779 medication orders were reviewed by the ED pharmacy team (EDPT). Of the total reviewed orders, 3,482 (92%) were prospectively reviewed. A total of 3,068 (81.2%) and 711 (18.8%) orders were reviewed for the adult and pediatric ED, respectively. The EDPT procured 549 IV admixtures. A total of 642 clinical interventions were conducted. A summary of the interventions provided by the EDPT is presented in Table 2.

Table 2. Number of interventions recommended by pharmacists and accepted by emergency department clinicians

Type of interventions	No. (%) of interventions
Drug information - RN	178 (27.7)
Adjust dosage or frequency	136 (21.1)
Drug information - MD	117 (18.2)
Antibiotic recommendations	97 (15.1)
Titration of intravenous drug therapy	60 (9.3)
Initiation/change drug therapy	33 (5.1)
Drug therapy duplication	21 (3.2)

DISCUSSION

The roles of the pharmacist in the ED is well-described in the literature.^{1,2,20-23} Pharmacists play active roles in creating programs that improve antimicrobial use, prevent adverse drug events, enhance pain and anticoagulation management, and optimize medication inventory.^{23,24} Pharmacists' interventions have also been associated with cost avoidance. Lada et al²⁵ reported that during a 3-month period, the potential cost avoidance attributed to 1,393 pharmacist interventions was over \$1 million. Examples of interventions that led to potential cost avoidance include recommendation of appropriate therapy, identification of drug incompatibilities, and prevention of medication errors or adverse events. Despite the availability of these data, ED pharmacy services are not commonly provided. In a survey disseminated to 99 academic EDs, 30% reported coverage by a dedicated ED pharmacist, 22% reported partial coverage, and 6% reported the presence of a pharmacy satellite.²⁴

According to the American Society of Health-System Pharmacists (ASHP) guidelines on emergency medicine pharmacist services, a pharmacist's intervention is most valuable when it is performed prior to medication administration.²⁰ This concept was further supported when Patanwala et al²¹ conducted a study to determine whether pharmacist activities led to the interception of medication errors. Of a total of 364 medication errors documented from 16,446 patients, it was found that 34.9% were intercepted due to medication review. Most errors (82.4%) were found to occur during the prescribing phase of the medication use process.

Literature describes the implementation of pharmacy services in the ED.^{1-2,22-25} However, most of these studies focused on implementing clinical services.

Furthermore, literature that describe the implementation of PMR, including non-admitted ED patients, is limited. To the best of our knowledge, our study is the first to fully describe the process of implementing PMR as a consistent pharmacy service in the ED.

There were a number of interesting findings from the implementation of pharmacy services at our institution's ED. First, during the study period, a total of 642 interventions were recommended and accepted. Most of the interventions involved providing drug information consults (ie, review the literature as it relates to a case and provide therapeutic recommendations, respond to inquiries about IV compatibility, or monitor parameters for a specific medication). These results suggested that pharmacists played an active role as a medication educators in the ED. We believe this was possible because the pharmacist was easily accessible within the ED. Second, despite the implementation of a formulary that included medications that did not require PMR, the EDPT prospectively reviewed over 90% of medication orders placed by ED clinicians. Third, although it was not measured, the EDPT may have increased patient care time for the ED nursing staff by procuring more than 500 IV admixtures. If pharmacy services were not available, ED nurses would have been responsible for procuring these medications. Although nurses have the option of requesting the admixture from the central pharmacy, this process requires nurses to physically leave the ED to retrieve the medication. Last, with the exception of unexpected sick calls or need for increased coverage at the central pharmacy, medication verification occurred in the ED pharmacy satellite. We believed this provided pharmacists with increased opportunities to participate in various activities that ensured safe and effective medication use.

There were several limitations in our study. The number of interventions performed and IV admixtures prepared were collected from documentations made by the EDPT. Due to the volume of patients our ED served, there were situations where the pharmacists were not able to document all services provided. There were no methods established to account for undocumented services. Due to software limitations, the PDMS was only able to provide reports of interventions that were accepted by clinicians. Due to the resources allotted for the research, we were unable to conduct a cost-savings analysis.

CONCLUSION

The implementation of a 24-hour pharmacy service at our institution was an innovative practice

that increased the role of pharmacists in the ED. The EDPT conducted prospective medication review, procured IV admixtures from a sterile environment, and provided therapeutic recommendations for the ED interdisciplinary team.

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The authors declare no conflicts of interest.

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