Relationship between availability of emergency department-based clinical pharmacy services and incidence of medication errors in emergency departments: a systematic review

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ABSTRACT

Objective: This systematic review reveals the relationship between the availability and types of clinical pharmacy services provided in the emergency departments of hospitals that have active emergency departments and the incidence of medication errors that occur in emergency departments. This could help pharmacy directors in acute care hospitals having active emergency departments make informed proposals to their hospital administration with regard to the provision of certain clinical pharmacy services at their emergency departments.

Materials and Methods: A comprehensive search of PubMed, MEDLINE, EMBASE, International Pharmaceutical Abstracts (Rx IPA), Google Scholar and bibliographies of relevant articles published through July 2011 was undertaken. All studies that followed an objective, systematic approach in comparing the rate of medication errors, in the presence or absence of ED pharmacists’ interventions were reviewed and critiqued.

Results: Four studies met the inclusion criteria. Despite the different designs of the four studies, their results showed a statistically significant positive association between providing specific clinical pharmacy services in the emergency departments of teaching hospitals and the reduction in the incidence of medication errors.

Conclusion: There is adequate evidence to demonstrate positive medication safety outcomes associated with the provision of certain clinical pharmacy services in the emergency departments of teaching hospitals. Such evidence in addition to the Joint Commission’s recommendations renders the provision of specific emergency department-based clinical pharmacy services viable.

Key words: Emergency Department, medication errors, clinical pharmacy, pharmacist, interventions

Citation


INTRODUCTION

The number of drugs provided by the Emergency Departments (EDs) in the United States is as high as 212.1 million per year and the number of ED visits has increased by 32% between 1996 and 20061. Medication errors in EDs are associated with a higher rate of adverse drug events than those that occur in other levels of acute health care, such as intensive care units, surgical units and medical units2.

EDs treat more than 110 million patients a year. Progressively, more patients are admitted in EDs for protracted intervals of time until an inpatient bed becomes vacant. This contributes to the congestion of the innately overwhelmed emergency care system. Another factor for such congestion is the use of EDs by many patients as main locations to receive primary medical care. The mixture of extremely sick patients, boarded inpatients waiting for vacant beds, and patients seeking primary care renders an ED one of the most frenzied environments in hospitals. In the middle of this commotion, patients are at increased risk of receiving less than optimal pharmacotherapy compared to that provided to inpatients and outpatients2.

The Joint Commission, which was formerly known as the Joint Commission on Accreditation...
of Healthcare Organizations (JCAHO), mandates that medical institutions conduct prospective medication order reviews by pharmacists in the ED before the medication is administered to the patient, unless a licensed independent practitioner controls the ordering, preparation, and administration of the medication. An exception to this requirement would be urgent situations when the resulting delay would harm the patient, including those in which the patient experiences a sudden change in clinical status.

According to the American Society of Health Systems Pharmacists (ASHP) 2008 national survey of pharmacy practice in hospital settings, only 6.8% of hospitals had ED-based pharmacists. In another survey, it was found that pharmacists prospectively review a diminutive percentage of ED medication orders prior to administration of the first dose, and that only 40.7% of hospitals review ED medication orders retrospectively for prescribing errors.

Roles of ED pharmacists include direct interaction with patients who have complex medication histories, reviewing patient medication during ward rounds to provide patient-specific drug information and drug-related recommendations, establishing guidelines and protocols for the utilization of certain medications, implementing medication safety measures such as look alike-sound alike and high alert medication management, and those with Advanced Cardiac Life Support (ACLS) training, participating in trauma and cardiac arrest management.

Numerous studies have demonstrated that involvement of clinical pharmacists in the direct care of hospitalized patient is associated with fewer medication errors. A significant number of hospitals in the United States have clinical pharmacy services. Such services are offered at different levels of care in hospital settings, but rarely in the ED.

The literature is replete with articles and descriptive studies that demonstrate the important role of ED pharmacists in medication safety. For example, a descriptive observational study was conducted in the EDs of four teaching hospitals to determine the number of medication errors detected by ED pharmacists. 787 hours of observation yielded 505 medication errors discovered by 12 pharmacists. 2.9 medication errors were recovered per 100 medication orders. 90.3% of such errors were corrected by pharmacists before reaching the patients (near misses); of such near misses, 4.6% were evaluated by the investigators as potentially life threatening, 47.8% as potentially serious, and 36.2% as significant. The rate of intervention acceptance was high at 97.2%.

In addition to improving the quality of care, assigning pharmacists to ED may be associated with financial benefits as well. This is shown by a descriptive observational study conducted in a 340-bed teaching hospital that operates an ED satellite pharmacy 24 hrs./day 7 days/week. All pharmacists working in the ED satellite pharmacy documented their interventions during the study period. The cost avoidance during the study period (only four months) was $1,029,776. The average cost avoidance estimation was conservative in that it was based on the US department of Veteran Affairs (VA) hospitals’ costs of medications procurement.

Despite the abundance of articles that describe the role of ED pharmacists in reducing medication errors, studies that objectively examine such a role are scarce. The purpose of this systematic review is to investigate the role of clinical pharmacists in increasing medication safety through medication error reduction in EDs, and to look into the rate of acceptance of such interventions by healthcare providers in the ED.

MATERIALS AND METHODS

A comprehensive search of PubMed, MEDLINE, EMBASE, International Pharmaceutical Abstracts (Rx IPA), Google Scholar and bibliographies of relevant articles published through July 2011 was undertaken. Studies that followed an objective approach in comparing the rate of medication errors, in the presence or absence of ED pharmacists’ interventions were reviewed and critiqued (Figure 1). Four studies met the inclusion criteria. Relative risk values and p-values were manually calculated utilizing MedCalc software Version 11.6.1. For one of the four studies (Fairbanks et al), such calculation was necessary because it was not performed nor reported in the study; this was not unexpected knowing that the study mainly dealt with adverse drug events rather than medication errors. For the other three studies, such calculation was done for verification purposes.
RESULTS

Three of the four reviewed studies demonstrated statistically significant positive association between clinical pharmacy interventions and reduction in the rate of medication errors in EDs. Although the fourth study did not demonstrate a statistical significance, the Relative Risk Reduction (RRR) was observed to move in the same direction of the Relative Risk Reduction values of the other three studies (Table 1).

In a retrospective follow up study, medical charts of all patients admitted to the ED of a 426-bed tertiary care hospital were reviewed for medication errors. Patients admitted to the ED between 6th November and 6th December 2005 formed the control group, as there was no ED pharmacist appointed during this period. Patients admitted to the ED between 6th November and 6th December 2006 were the intervention group, as there was an ED pharmacist scheduled in each shift during this period. Charts were reviewed for medication errors including dose omission, omission of height, weight and/or allergy, unauthorized drug administration, wrong dose, wrong dosage form, wrong administration technique, wrong time, or extra dose. In the intervention group, 14 medication errors were identified (5.4% of medication orders), compared to 37 medication errors (16.1% of medication orders) in the control group. The Relative Risk Reduction (RRR) in favor of the intervention group was 66.6% with a recovery of 10.7 medication errors per 100 orders. The authors attribute the difference to the ED pharmacists’ interventions. The rate of acceptance of pharmacists’ interventions by physicians was found to be 98.6%. The main limitation of this study is that the primary evaluator is not blinded to the intervention group.

A retrospective follow up study was conducted in a 350-bed teaching hospital which focuses on the role of ED-pharmacists in reducing medication errors. Pharmacists obtain medication histories of elderly patients, who are 60 years or older, take >4 medicines routinely, have >3 co-morbidities or have been admitted to the hospital within the previous three months, in the ED triage area. Pharmacists then provide such information to ED physicians prior to pre-admission medication ordering process. The duration of the study was six weeks for the control group (ED pharmacists absent and no pre-admission medication reconciliation was performed, n=45) and five
weeks for the intervention group (ED pharmacists present and pre-admission medication reconciliation is performed, n=29). In the control group, pharmacists compile medication histories after the medication ordering process. The average number of commission errors (wrong drugs given to patients) in the control group was 1.04 doses per patient versus 0.00 in the intervention group. Average number of omission errors (not administering drugs prescribed to patients) in the control group was 2.35 doses per patient versus 0.24 in the intervention group for both parameters. RRR is 92.9%. To determine the impact on the health outcome, a multidisciplinary panel evaluated the impact of the omissions and ranked them as follows: 0-4 of impact on health outcome (0: no impact; 1: minor impact; 2: significant impact; 3: very significant impact; 4: life

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Findings</th>
<th>Critique</th>
</tr>
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<tbody>
<tr>
<td>Brown et al. Am J Health-Syst Pharm. 2006;63:530-4.</td>
<td>Retrospective chart review of patients admitted to ED for medication errors: control group (n=94; no ED pharmacist present) vs. intervention group (n=104; ED pharmacist present)</td>
<td>490 medication orders written Demographics of the two groups are similar. Medication errors identified: - Control group: 37 - Intervention group: 14 Medication error rate (per 100 orders) - Control group: 16.09 - Intervention group 5.38 RRR = 66.6% (P=0.0001) in favor of the intervention group The ED pharmacists completed 183 recommendations; 98.6% of such recommendations were accepted.</td>
<td>Main Limitations: - The Primary evaluator is not blinded to the intervention group - The control group is not concurrent; it is however composed of ED patients who visited the ED within the same period of time during the previous year. Main strengths: - Differences between arms are statistically significant. - A prearranged form with set definitions of medication errors is utilized to enhance the objectivity of the analysis - An independent panel of pharmacists assessed the clinical significance of each potential medication error. This particular panel is blinded to the intervention group to reduce the effect of investigator bias</td>
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<td>Vasileff et al. Pharm World Sci. 2009; 31:373-9.</td>
<td>Retrospective chart review of patients admitted to ED for medication errors: control group (n=45; no ED pharmacist present) vs. intervention group (n=29; ED pharmacist present)</td>
<td>74 medication profiles reviewed Demographics of the two groups are similar. Omission medication errors identified (number of doses per patient) - Control group: 2.35 - Intervention group: 0.24 Commission medication errors identified (number of doses per patient) - Control group: 1.64 - Intervention group: 0 RRR = 92.9% (P&lt;0.05) in favor of the intervention group The ED pharmacists completed 29 recommendations; 100% of such recommendations were accepted</td>
<td>Main limitation: - Recruitment is done during morning shifts only. Main Strengths: - Differences observed between arms are statistically significant, and are deemed clinically significant by a multidisciplinary panel - The control group is concurrent</td>
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<td>Jellinek et al. J Emerg Nurs 2010; 36:105-10.</td>
<td>Prospective review of medication administration records of patients admitted to ED for medication administration errors: control group (n=146; no ED pharmacist intervention), vs. intervention group (n=146; with ED pharmacist intervention)</td>
<td>146 medication administration records reviewed before and after pharmacists’ interventions Rate of medication errors identified: - Control group: 36.3% - Intervention group: 1.5% RRR = 95.8% (P&lt;0.0001) in favor of the intervention group The ED pharmacists completed 53 recommendations; 95.8% of such recommendations were accepted</td>
<td>Main limitations: - Sampling of patients is done on convenience basis (8 AM-11 PM) - The method of determining the clinical significance of errors is not explicitly discussed in the study Main strengths: - Concurrent control group - Differences observed between arms are statistically significant</td>
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<td>Fairbanks et al. The Emergency-Pharmacist Research Center [Internet]. Rochester (NY): University of Rochester Medical Center; 2006 [cited 2011 June 15]. Available from: <a href="http://www.emergencypharmacist.org/toolkit">http://www.emergencypharmacist.org/toolkit</a></td>
<td>Prospective review of medication profiles of patients admitted to ED for adverse drug events and medication errors: control group (n=8113; no ED pharmacist present), vs. intervention group (n=2111; ED pharmacist present)</td>
<td>Demographics of the two groups are similar. Medication errors identified: - Control group: 69 - Intervention group: 21 Rate of medication error reduction (per 100 orders) - Control group 0.85 - Intervention group 0.99 RRR = 14.1% (P=0.548) in favor of the intervention group 99% of pharmacist’ interventions were accepted</td>
<td>Main limitation: - The study is not powered to detect a statistically significant difference in medication errors between the two arms, as its primary outcome is to detect a difference in adverse drug events Main strengths: - A comprehensive study that looks at multiple outcomes of ED pharmacists’ interventions; one of such outcomes is the reduction of medication errors</td>
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The multidisciplinary panel categorized 6% of the errors as 3 “very significant impact” and 52% as 2 “significant impact”. None was categorized as life threatening and the remaining errors were either categorized as having no or minor impact on health outcome. The authors concluded that pre-admission medication reconciliation performed by ED-based pharmacists reduces commission and omission medication errors significantly in elderly patients with more than four routine medications or more than three co-morbid conditions, or who have been recently admitted to acute care hospital. ED pharmacists’ interventions acceptance rate is 100%. The main limitation of this study is that recruitment was done during the morning shift only.

In a prospective follow up study that illustrates an important error, of wrong medication administration time and frequency, the positive role of ED pharmacists is evident. The study was conducted in the emergency department of a 705-bed hospital. It looked at the role of pharmacists’ interventions (such as facilitating the issue of patient-specific medications from the pharmacy, clarifying modification orders with the physician, as well as verifying such orders, and direct dispensing of medications when needed) in reducing wrong medication administration time and frequency errors, in patients boarded in the ED. The inclusion criteria were age of 18 years or more who were admitted to the hospital but still physically located in ED with active inpatient medication orders. 79 patients were included in the study with 266 medication administration openings, 146 of which were ED medication administration openings. It was determined that ED nurses administered timely medication (1 hour prior to - 1 hour post the scheduled administration time) 63.7% of the time. ED pharmacists prospectively reviewed medication administration records and intervened whenever it was determined that that the administration of a certain dose was not timely; thus, leading to 53 ED pharmacist interventions. Successful interventions were documented when the medication is administered within 1 hour from the time of intervention. The rate of wrong medication administration time and frequency in the intervention group (with ED pharmacists’ interventions) was 1.5% compared to 36.3% in the control group (no ED-pharmacists’ interventions). The Relative Risk Reduction in favor of the intervention group is 95.8%. The rate of acceptance of pharmacists’ interventions was 95.8%. The main limitation of the study is that sampling of patients was done on convenience basis (between 8:00 AM and 11:00 PM).

A large-scale prospective follow up study was conducted by University of Rochester School of Medicine to evaluate whether there was a reduction in the frequency of medication errors and potential adverse drug events during the times when the ED pharmacist was on duty. The hypothesis of the study was that ED pharmacists improve medication safety and quality of care. The primary objective of the study was to assess the effect of the presence of an ED pharmacist on the rate of adverse drug events (ADEs), while the secondary objective was to determine the rate of medication errors. 10,224 patients were included in the study (5098 pediatric patients, 2873 geriatric patients, and 3245 critically ill patients). Age, sex, race, and insurance status were similar in the intervention group (ED pharmacist present) and the control group (ED pharmacist absent). The ED pharmacists’ main role was to prospectively review medication orders, in addition to providing drug information to physicians and nurses. The overall percentage of uncovered medication errors in the intervention group was 0.99% versus 0.85% in the control group. The Relative Risk Reduction (RRR) in favor of the intervention group is 14.1%. The highest rate of medication error reduction among the subgroups of the study was observed with respect to the critically ill patients (RRR=40.5%; followed by pediatric patients (RRR=38%)). The lowest rate of medication error reduction was in the geriatric subgroup (RRR=1.5%). The main limitation of the study is that the times of patients’ arrival to the ED were different between the two groups; however, the control group and the intervention group were concurrent. Another limitation is that the study is not empowered to detect a statistically significant difference in medication errors between the two arms, as its primary outcome was to detect a difference in adverse drug events. The rate of pharmacists’ interventions acceptance was 99%.
DISCUSSION
While there are a number of trials on ED pharmacy interventions, frequently indicating clinically significant benefits, many of such trials have not been successful in changing practice or healthcare policy. Thus, a focused evidence syntheses, such as a systematic review is needed. Nevertheless, systematic reviews of practice research present some unusual methodological challenges, as well as issues with searching, interpreting, and evaluating the existing studies.

EDs are more prone to medication errors than other clinical settings, and ED patients are at increased risk of receiving wrong pharmacotherapy agents. Budget issues of hospitals and the shortage of well-trained clinical pharmacists in general may render assigning full time pharmacists to EDs not a priority for many hospitals.

Although the descriptive observational study conducted by Leda et al demonstrates financial feasibility of clinical pharmacy services, there is an opportunity for a prospective well-designed study to further examine such feasibility.

The main practical challenges that ED clinical pharmacists usually face are the significant amount of time needed for clinical pharmacy interventions’ documentations. Another important challenge is that some ED nurses and physicians expect ED pharmacists to dispense medications that are not available in the ED as floor stock, although there is a mechanism for dispensing such medications from central inpatient pharmacies. This can potentially put additional emotional and physical burden on ED pharmacists and creates a dilemma for them to concentrate on their non-distribution patient-centered functions that they are assigned to perform. There is a good opportunity, however, for a systematic research to measure the effect of these two variables on measurable medication safety outcomes, such as medication errors, as well as the overall performance of ED clinical pharmacists.

Strengths
The search of evidence has been comprehensive and the studies available for the topic that met the inclusion criteria have been selected. To ensure reducing the risk of selection bias, only studies which objectively compared rate of medication errors in the presence or absence of certain clinical pharmacy services were included in the review. Three of the four studies included demonstrated statistically significant positive association between clinical pharmacy interventions and reduction in the rate of medication errors in EDs. Although the fourth study did not demonstrate statistical significance, the Relative Risk Reduction shows a trend similar to that in the Relative Risk Reduction values in the other three studies.

This review is a focused synthesis that addresses a specific medication safety question. The conclusion is based on a comprehensive evaluation of the available literature rather than on the results of a single site setting trial.

Limitations
The interventions under study are procedures or sets of actions. None of the four studies provides accurate definitions of such sets of actions, nor do they provide adequate details about the interventions. Although this is common in practice research, it has rendered the external validity of each of the reviewed studies questionable, as applicability is largely dependent on the distinct methodology of performing the clinical pharmacy interventions, the unique characteristics of each facility, the clinical pharmacy practice skills of the pharmacists performing such services and the professional attitudes of such pharmacists as well as of the health care team members with whom those pharmacists interact.

CONCLUSION
Certain ED clinical pharmacy interventions are associated with reduction in the incidence of medication errors in EDs. Such interventions are highly accepted by healthcare providers in EDs.

RECOMMENDATION
Hospitals with active EDs should contemplate assigning well-trained ED clinical pharmacists to prospectively review medication orders whenever clinically possible. It is also recommended that each hospital with an active ED performs acquainted analysis of medication errors occurring in its ED, in order to determine their origin and then establish the necessary ED-based clinical pharmacy services, the sets of actions needed to
provide such services, as well as the skills which their ED pharmacists must possess or acquire in order to be capable of producing desired outcomes.

References