IMPACT OF A DECISION SUPPORT SYSTEM ON PHARMACY INTERVENTIONS IN AN EMERGENCY DEPARTMENT

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ABSTRACT

Introduction: Medication errors and adverse drug events (ADE) are a constant challenge for healthcare providers. The fast pace and unpredictable setting of an emergency department is especially prone to errors, contributing to 3% of all hospital related adverse events. This study evaluates the impact of computerized physician order entry (CPOE) used in conjunction with a decision support system (DSS) on the prevalence and types of interventions by pharmacy staff during the prescription-filling process in an emergency department (ED).

Method: We conducted a retrospective cohort study comparing 6 months of pharmacy interventions before and after implementation of DSS in an academic tertiary care medical center ED located in Singapore. The primary outcome measure was overall incidence of prescription interventions made by pharmacy staff during the study period. The secondary outcome measure was the difference in the incidence of prescription interventions made by pharmacy staff within each category of intervention type. A Chi-square test was used to compare the difference in the prevalence of prescription interventions performed before and after implementation of DSS.

Results: Pharmacy staff intervened to avert 1560 medication prescribing errors (836 before and 724 after DSS) for a total of 83912 patient encounters. The use of CPOE with DSS was associated with a statistically significant reduction ($p < 0.01$) in the total percentage of interventions. Interventions related to avoidance of adverse drug event, clarification of drug order and inappropriate dosage regimen decreased significantly ($p < 0.01$) after implementation of DSS. In addition a significant increase ($p < 0.01$) in therapeutic substitution was observed after DSS.

Conclusions: Implementation of DSS was effective in reducing the overall number of prescription interventions performed by pharmacy staff and this implies its efficacy in reducing the number of medication errors due to prescribing errors in the ED.

Introduction

Medication errors and adverse drug events (ADE) present a constant challenge to healthcare providers.[1-3] This challenge is intensified in the emergency department (ED) as it is a fast paced environment with an unpredictable setting. Studies have shown that these factors contribute to the occurrence of 3% of all hospital related adverse events.[4] The Institute of Medicine (IOM) suggests that 1.5 million preventable ADE occur annually in the United States, making it one of the most costly and common sources of preventable harm.[1] Errors resulting in preventable ADEs occurred most often at the prescribing stage, accounting for more than 50% of errors.[5-6]

The use of computerized physician order entry (CPOE) with decision support systems (DSS) has been shown to be effective in reducing prescribing errors and preventable ADE.[7-10] This improvement in medication safety has been achieved through the provision of timely and relevant patient specific information to assist doctors in the prescribing process.

Prescription intervention by pharmacy staff has been useful in identifying prescribing errors and thereby decreasing potential medication error. [11-12] Hence it is useful for us to look at the number of prescription interventions performed by pharmacy staff to determine the prescribing error rate.

We implemented the use of CPOE at our institution in 1999 and integrated the use of DSS in December 2012. As there have also been studies to show that the use of DSS increases medication error rates,[13] resulting in an increased number of interventions by pharmacy staff, [14-15] we seek to investigate the impact DSS had on our ED prescribing error rates through the study of the prevalence of prescription interventions by pharmacy staffs.

Method

Study Design and Setting

We defined a medication error as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is under the control of the health care professional, patient, or consumer.[16] This includes any omission of therapy of a drug that is considered standard of care in a patient without a contraindication.

We have chosen the prevalence and type of prescription interventions performed by emergency department pharmacy staff members (we will call them pharmacy staff) to be the surrogate marker of the prevalence of medication error in the emergency department. Any reduction in the number of prescription interventions performed by pharmacy staff implies a reduction in the number of actual and potential medication errors which resulted from prescribing errors.

In this retrospective cohort study, we compared the data on prescription interventions by pharmacy staff which were performed 6 months before and after the implementation of DSS in an academic tertiary care medical center ED located in Singapore. The ED consisted of a 24-bed Emergency Observation Ward and a 7-bed Emergency Cardiac Care Unit, with an annual census of approximately 135,000 patients. All discharge prescriptions were ordered by doctors using CPOE to be filled at an onsite emergency department pharmacy. The DSS implemented highlighted potential duplicate orders, potential drug-drug interactions, renal dose adjustment, maximum daily dose and patient allergy information to the prescriber at the point of prescribing. Doctors could then either choose to accept or override the recommendation from DSS. Subsequently emergency department discharge prescriptions generated by doctors were reviewed by pharmacy staff during the prescription-filling process. Pharmacy staff would contact the ordering doctor for any interventions required to prevent medication errors and optimize medication therapy on patient discharge from the emergency department.

Selection Criteria

All patient encounters in the emergency department pharmacy during the study period were included in this study. The study period was May 2012 and October 2012 for the pre-implementation period and May 2013 and October 2013 for the post-implementation period. We selected the 6 month period of May to October because DSS was implemented on December 2012. A patient encounter was defined as a record of a patient's arrival in the emergency department pharmacy for any discharge prescriptions to be filled. Patient encounters were excluded if the patient did not require any medication from pharmacy, or if the patient left the emergency department without presenting his discharge prescription at the pharmacy for collection of medication.

Data Collection and Processing

All prescription interventions performed by pharmacy staff were documented through the use of standardized electronic form. Education was provided to emergency department pharmacy staff on documentation procedures using the electronic form, including the definition and classification of the interventions into 11 types. The classification of these intervention types was adapted from the Strand Criteria[17] and the American College of Clinical Pharmacy Guidelines for Therapeutic Interchange.[18] These included the omission of drug therapy, no indication for drug ordered, therapeutic duplication, improper drug selection, therapeutic substitution, inappropriate dosage regimen, avoidance of adverse drug event, drug interaction, clarification of drug order, monitoring parameters recommendation and wrong patient (Table 1). Prescription intervention data was retrieved from the pharmacy database for the above specified study period.

Intervention Type	Description
Omission of Drug Therapy	Patient has a medical problem that requires drug therapy but is not receiving a drug for that indication or is not adequately controlled with drugs at optimal doses and requires additional drugs
No Indication for Drug Ordered	Patient is taking a drug for no medically valid indication
Therapeutic Duplication	Patient is taking more drugs than required, usually from the same therapeutic class, for the same indication
Improper Drug Selection	Patient has a drug indication but is taking an inappropriate drug, e.g. drug contraindication, drug unable to reach target site, inadequate response to the drug at optimal dose and require switch to alternative drug or evidence to support use of one drug over another
Therapeutic Substitution	The use of a chemically different drug that is considered to be therapeutically equivalent to, and often with similar toxicity profiles as the prescribed drug. Includes IV-to-PO substitution due to drug unavailability and cost considerations
Inappropriate Dosage Regimen	Patient has a medical problem that is being treated with a less than optimal regimen of the correct drug, e.g. disease state not responding or signs of toxicity, low or elevated serum drug level, inadequate or excessive duration of therapy, and patient with unusual dosage requirement
Avoidance of Adverse Drug Event	Patient may have a medical problem that is the result of an ADE which can be an extension of the drug's pharmacologic effects or an allergic/idiopathic reaction
Drug Interaction	Patient may have a medical problem that is the result of a drug-drug, drug-food, or drug-laboratory interaction
Clarification of Drug Order	Order is ambiguous or incomplete and requires further clarification
Monitoring Parameters Recommendation	There is issue relating to investigations or parameters for monitoring adverse or therapeutic effects of drug therapy
Wrong Patient	Patient is prescribed a medication that is meant for a different patient

Table 1 Definition of 11 intervention types

Data Analysis

The primary outcome measure was the overall incidence of prescription interventions made by pharmacy staff during the study period. The secondary outcome measure was the difference in the incidence of prescription interventions made by pharmacy staff within each category of intervention type. Prevalence of prescription intervention was based on the percentage of prescription interventions performed. This was calculated by dividing the number of prescription interventions captured by pharmacy over the number of patient encounters in the emergency pharmacy. A Chi-square test was used to compare the difference in the prevalence of prescription interventions performed before and after implementation of DSS. The level of significance was set at 5%.

Results

In the 83912 patient encounters during the study period, pharmacy intervened on 1560 medication prescribing errors. Of these, 836 prescribing errors occurred before the implementation of DSS and 724 prescribing errors occurred after the implementation of DSS. The total percentage of interventions declined from 2.06% to 1.67% ($p < 0.01$) with the implementation of DSS.

The types of interventions are summarized in Table 2. Of the 11 categories, 3 showed a significant decrease in the number of interventions, 1 showed a significant increase in the number of interventions, 5 showed no statistical difference in the number of interventions and 2 showed zero interventions.

Intervention Type	Pre-DSS	Post-DSS	p-value
Avoidance of Adverse Drug Event	111 (0.27%)	33 (0.08%)	<0.01
Clarification Of Drug Order	178 (0.44%)	42 (0.10%)	<0.01
Drug Interaction	31 (0.08%)	48 (0.11%)	0.13
Improper Drug Selection	76 (0.19%)	91 (0.21%)	0.504
Inappropriate Dosage Regimen	145 (0.36%)	91 (0.21%)	<0.01
No Indication For Drug Ordered	19 (0.05%)	13 (0.03%)	0.286
Omission of Drug Therapy	15 (0.04%)	13 (0.03%)	0.719
Therapeutic Duplication	29 (0.07%)	32 (0.07%)	0.996
Therapeutic Substitution	232 (0.57%)	361 (0.83%)	<0.01
Monitoring Parameters Recommendation	0	0	NA
Wrong Patient	0	0	NA
Total Patient Encounters	40606	43306	

Table 2 Impact of decision support system (DSS) on pharmacy interventions

The types of interventions that decreased after DSS implementation were avoidance of adverse drug event (0.27% to 0.08%), clarification of drug order (0.44% to 0.10%) and inappropriate dosage regimen (0.36% to 0.21%). However an increase in therapeutic

substitution (0.57% to 0.83%) was observed after DSS. There was no change in the percentage of interventions in the category of drug interaction, improper drug selection, no indication for drug ordered, omission of drug therapy and therapeutic duplication.

Discussion

Our results suggest that the implementation of DSS in an emergency setting is associated with a significant reduction in total prescription interventions by pharmacy staff, implying also a significant reduction in total number of medication errors resulting from prescribing errors. Based on our current workload, we estimate that the use of DSS brings about an avoidance of 300 prescribing errors per year.

The DSS alerts doctors on renal dose adjustment, maximum daily dose and patient allergy at the point of prescribing and this has led to a decline in the need for pharmacy staff to intervene on inappropriate dosage regimen and avoidance of adverse drug event. However alerts for potential duplicate orders and drug-drug interactions have not resulted in any significant change in the number of prescription interventions by pharmacy staff. Perhaps the prevalence of prescribing errors related to therapeutic duplication and drug interactions in an emergency discharge prescription is inherently low because doctors and pharmacy staff are able to discern between clinically meaningful and theoretically relevant duplications and interactions. Further studies are required to analyze the accuracy, specificity, clarity and clinical relevance of current duplicate and drug-drug interactions decision rules. There may be a need to revise these rules to target specific drug pairs commonly intervened by pharmacy staff while suppressing alerts with little evidentiary basis or clinical relevance.

The significant decline in pharmacy intervention on clarification of drug orders that are ambiguous or incomplete and require further clarification may have been confounded by the implementation of medication route and unit of measure restriction in CPOE, which took place at the same time as DSS implementation. The shortened list of appropriate route and unit of measure specific to each medication decreased the risk of juxtaposition error.[11,19] Since

doctors were less prone to choose the incorrect adjacent route or unit of measure from a the drop-down list, pharmacy staffs had fewer erroneous orders to clarify with doctor.

With the implementation of DSS bringing about a decreased need for pharmacy staff to carry out certain types of interventions as described above, this has made available pharmacy resources to perform other clinically meaningful drug optimization interventions. Therapeutic substitution which is the use of a chemically different drug that is considered to be therapeutically equivalent to, and often with similar toxicity profiles as the prescribed drug to improve drug compliance is an example of such an intervention. This could be the reason for our observation of an increased incidence of interventions for therapeutic substitutions including intravenous to oral substitution and substitution due to drug availability and cost considerations. Future work can be done to design DSS that can recommend preferred drug use and rationale for substitution at the point of initiation to doctors. With the development of such alerts, there can be greater adherence to evidence based prescribing and adherence to the institution's therapeutic interchange policy.

Conclusions

Implementation of DSS was effective in reducing the overall number of prescription interventions performed by pharmacy staff and this implies its efficacy in reducing the number of medication errors due to prescribing errors in ED. With DSS alerting doctors on potential duplicate orders, potential drug-drug interactions, potential dosage adjustment and patient allergy information at the point of prescribing; this takes away the need for pharmacy staffs to perform these interventions. Pharmacy staff members are then able to redirect these resources to perform other types of prescription interventions such as optimization of a patient's therapy possibly resulting in improved patient outcomes.

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