

The Impact of a Pharmacy Resident Led Educational Sessions on Electronic Prescribing Errors on Surgical Wards

Abrrar Al Subhi, Mohammed Aseeri*, Sara Al Khansa, Nour Shamas, Zaher Mikwar, Ahmed Attar and Sherine Ismail

King Abdul Allah International Medical Research / King Saud bin Abdul Aziz University for Health Sciences, National Guard Health Affairs, Jeddah, Saudi Arabia

*Corresponding author: Mohammed Aseeri, King Abdul Aziz Medical City, PO Box 9515, c/o pharmacy, Jeddah 21423, Saudi Arabia, Tel: +966 2 624 0000; E-mail: AseeriMa@ngha.med.sa

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Abstract

Medication errors present a significant worldwide problem in a healthcare setting. Prescribing errors were reported as the most common type of medication errors (44%) in a local study in Saudi Arabia. Although Computerized Prescriber Order Entry (CPOE) systems reduce prescribing errors, the magnitude of the problem has not yet been evaluated in our setting.

Objectives: The primary objective of this study was to determine the proportion of prescribing errors before and after implementing pharmacy practice resident-led educational sessions to surgical residents. The secondary objectives were to identify the classes of medication(s) involved in errors, their categories, and the proportion of errors identified and corrected by pharmacist(s) or by the pharmacy resident.

Methods: A quasi-experimental study was conducted to evaluate the effectiveness of educational sessions on the percentage of electronic prescribing errors at the King Abdulaziz Medical City Western Region (KAMC-WR) for 3 months. Orders by surgical residents were reviewed for prescribing errors before and after the intervention phase. A sample of 890 orders for the pre and post-education sessions was estimated to provide a power of 80% with an alpha of 5% to detect a 50% reduction in prescribing errors post the intervention phase.

Results: A total of 890 orders in the pre and post educational sessions were reviewed. The interventional educational sessions had a 5.4% reduction ($P = 0.41$) in prescribing errors where 140 / 445 (31.4%) prescribing errors were reported in the pre-educational phase, and 116 / 445 (26%) prescribing errors were reported in the post-educational phase. All prescribing errors were identified and corrected by either in-patient pharmacists or the pharmacy practice resident. The most common class of medications involved was anti-infectives, with 59.3% and 61.2% in the pre and post intervention phase, respectively. The most common category of prescribing errors was the incorrect rate of drug administration with 45.9% and 53.4% in the pre and post intervention phase, respectively.

Conclusion: Educational sessions were not shown to be effective as a single tool to reduce surgical resident's prescribing errors. However, it may be added as a part of a multifaceted program to reduce electronic prescribing errors.

Keywords: Educational sessions; Electronic prescribing errors; Surgical residents; Medication safety

Introduction

Medication errors are a significant problem in the healthcare setting worldwide. Medication errors, as defined by the National Coordinating Council for Medication Error Reporting and Prevention (NCCMERP), are any preventable events that may lead to inappropriate medication use or cause patient harm when the medication is in the control of the healthcare professional, patient, or consumer [1]. Medication errors include prescribing errors, dispensing errors, medication administration errors, and patient compliance errors [2]. A recent study conducted over 1 year in Riyadh, Saudi Arabia by Al-Shaikh et al. [3] explored the rate of reported medication errors at a university teaching hospital. 949 medication errors were reported and the most common type was prescribing errors (44%) [3]. The American Society for Health System Pharmacists (ASHP) defined prescribing errors as incorrect drug selection (based on indications, contraindications,

known allergies, existing drug therapy, and other factors), dose, dosage form, quantity, route, concentration, rate of administration, or instructions for use of a drug product ordered or authorized by the prescriber [3].

In addition, prescribing errors were identified preliminarily following a Delphi process with a panel of 34 judges, comprising physicians, surgeons, pharmacists, nurses, and risk managers, and defined as any errors occurring with an unintentional significant reduction in the probability of treatment being timely and effective, or with an increased risk of harm in the prescribing decision, or prescription writing process. This definition includes lists of 27 situations that should be considered as prescribing errors, which can guide the decision on identifying prescribing errors [4]. Several studies attempted to understand prescribing error patterns and frequency, some of which also tried interventions that aimed to reduce the errors. Larson et al. [5] conducted a study in 2004 as a proactive step to reduce the frequency of prescribing errors in a surgical residency program in New Jersey, USA. The study showed 75 prescribing errors made by

surgical residents over 2 years in which knowledge deficit was responsible for 52% (39 / 75) of the errors. The first year surgical residents prescribed the majority of orders and were responsible for 43 of the 75 medication errors [5]. This study recommended that educational sessions should include all surgical residents in the residency program. In a recent study conducted at King Khalid University Hospital (KKUH) Riyadh, KSA. Prescribing errors were identified and rectified over a period of 1 month by the ward and practicing pharmacists who were on routine daily duty in the in-patient pharmacy. Approximately 113 (7.1%) prescribing errors were detected out of 1580 medication orders. Poor prescribing skills were the main cause of the errors [6]. Similar to Larson et al.'s study; this study concluded that the introduction of professional communication skills and education about prescribing errors within the medical team might help in reducing the incidence of these errors. Garbutt et al. [7] evaluated a multifaceted intervention to reduce prescribing errors in handwritten medication orders made out by house staff. A before and after design was used to evaluate the interventions, which included grand rounds, an interactive presentation for house staff, and reminders (a checklist, chart inserts, and requests for clarification). The results of this study showed that prescribing errors were more common among surgical residents than medical residents (1.08 errors / order versus 0.76 errors / order, $p < 0.001$) and that the mean number of prescribing errors per order (1.08 ± 0.23) was significantly reduced to 0.85 ± 0.11 ($p < 0.001$) after intervention [7].

These studies suggest that surgical residents are more commonly involved with prescribing errors and that there could be a role for educational sessions in reducing these errors. Another potential intervention to reduce prescribing errors and injury is the introduction of Computerized Prescriber Order Entry (CPOE) systems [8]; however the evidence for their effectiveness is limited by modest study designs and inadequately powered studies [9,10]. Franklin et al. [11] conducted a prospective nonrandomized pre- and post-CPOE implementation study in an adult general surgical ward of a teaching hospital, which measured prescribing errors as a study outcome. The intervention reduced prescribing errors from 3.8% to 2% of medication orders ($p < 0.001$) [11]. Although our institution has implemented CPOE 4 years ago for all in-patient orders, many prescribing errors are still being detected by pharmacists and communicated to the prescribers. The magnitude of the problem has not been objectively evaluated. Therefore, in an effort to address this problem at our hospital, a quasi-experimental study was conducted to evaluate the impact and effectiveness of pharmacy resident-led educational sessions on electronic prescribing errors on surgical wards over 3 months.

Objectives

Primary

1. To determine the proportion of prescribing errors before and after the implementation of educational sessions.

Secondary

1. To identify the classes of the medication(s) involved in medication errors.
2. To identify categories of prescribing errors involved, which may include incorrect dose, frequency, dosage form, route of administration, concentration, instruction, rate of administration, drug-drug interaction, duplication, and technical

errors, which are defined as: orders that do not follow institutional policy and procedure.

3. To determine the proportion of prescribing errors identified and corrected by in-patient pharmacist(s) / pharmacy practice resident.

Materials and Methods

Study Area / Setting

This study was conducted on the in-patient surgical wards at a tertiary care hospital, which is one of the leading healthcare facilities in KSA. The surgical wards include adult female and male surgery, paediatric surgery, and day case surgery, the orders of which are reviewed by the in-patient pharmacy. Pharmacists review all the prescribed orders and contact the prescriber for any clarifications or corrections related to the order before processing or dispensing the medications.

Study Subjects

The target subjects were all the in-house surgical residents at various training levels.

Inclusion Criteria

All orders prescribed by surgical residents for patients admitted to the surgical wards were included till the estimated sample size was achieved.

Exclusion Criteria

1. Insulin sliding scale orders.
2. Plain intravenous fluid orders.
3. Auto substitution orders that occur because of unavailability of a medication or dosage form in our formulary.

Study Design

It is a quasi-experimental study that aimed to assess the impact of pharmacy resident-led educational sessions on electronic prescribing errors among surgical residents. It was conducted over 3 months from November 2014 to January 2015. This study was conducted in three phases illustrated in Figure 1.

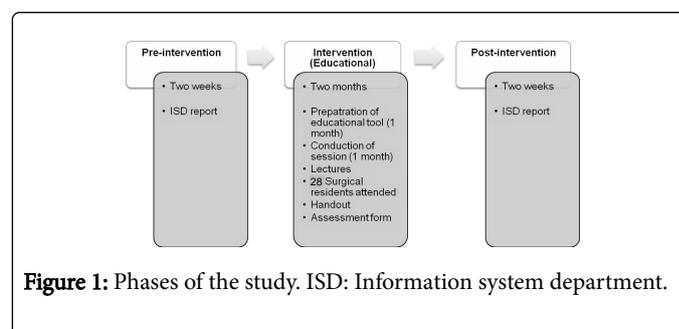


Figure 1: Phases of the study. ISD: Information system department.

A pilot study was conducted for 1 week to guide for the sample size calculation and to identify the rate of prescribing errors in our surgical wards.

First phase (Pre-intervention phase)

This phase of the study was conducted over a period of 2 weeks. A daily report was generated by the Information System Department (ISD) and included all orders that had been prescribed by all permanent surgical residents, patients' medical record number, and the type of orders. The pharmacy practice resident identified the prescribing errors that had been rectified by the in-patient pharmacists during routine daily practice. The resident reviewed all the orders for prescribing errors that were not identified by the pharmacist, and then contacted the physicians to correct such errors.

The ISD report included three types of orders:

New: all newly prescribed orders by physicians.

Change: orders that were changed by physicians.

Correction change: orders that were corrected by pharmacists.

All orders that had correction change and errors detected by the pharmacy resident during the review process of all new orders were considered as prescribing errors. Data was collected prior to the implementation of educational sessions to determine the pre implementation prescribing errors rate and to identify the most common type of prescribing errors.

Second phase (Educational phase)

The educational sessions were designed and tailored to address the knowledge deficits of surgical residents based on the results of the pre intervention phase. Three of the clinical pharmacists who are co-authors of this article mentored the pharmacy practice resident in the

preparation of the educational tool. Subsequently, all surgical residents were invited to attend the training session, which lasted for 30 min - 45 min. This session was repeated twice to accommodate the schedule of rotating surgical residents.

The educational session included three parts:

1. Theoretical information pertaining to medication safety
2. CPOE hands-on experience focused on appropriate methods for prescribing commonly used medications in the surgical wards
3. Available medication use related institutional policies, guidelines, and databases to educate residents on the proper use of the hospital's resources available on the intranet including the institution's IV manual, medication restriction lists, and clinical drug information databases.

A summary hand-out was distributed at the end of the session. An assessment exam was conducted at the end of the educational session for all attending surgical residents to assess their understanding of the presented information. This exam includes five questions with a passing score of 60%.

Third phase (Post-educational phase)

This phase of the study was conducted after the implementation of the educational sessions over a period of 2 weeks. A daily report was generated for the same surgical residents to identify the impact of these educational sessions on their prescribing patterns. The types of prescribing errors detected are defined and listed in Table 1 and were reassessed during the pre- and post-intervention phases.

Definition of Types of Prescribing Errors
Inappropriate dose Prescription of a drug in a dose below or above that recommended for the patient's clinical condition.
Inappropriate dosage form
Incorrect route of administration
Incorrect frequency
Missing instructions for use of a drug administration
Incorrect concentration. This includes but is not limited to: Prescribing a drug to be given by intravenous infusion in a diluent that is incompatible with the drug prescribed. Prescribing a drug to be infused via an intravenous peripheral line, in a concentration greater than that recommended for peripheral administration.
Incorrect rate of administration
Drug-drug interaction
Duplication
Action-based error: the performance of an action that was not what was intended Technical errors are a subset of action-based errors. They have been defined as occurring when "an outcome fails to occur or the wrong outcome is produced because the execution of an action was imperfect [13,14]" such as: Intravenous Piggyback instead of Intravenous Push Technical errors will be counted as any orders that have been prescribed by residents, which do not match the policies and procedures of the institution
Notes: The order and its correction were counted as one order.

Table 1: Definition of types of prescribing errors.

The prescribing error information collected included the name of the medication involved, the category of the prescribing error, and the class of the medication involved based on American Hospital Formulary System (AHFS) classification.

Methods of assessing prescribing errors:

1. The dose, frequency, dosage form, and route of administration appropriateness were assessed, using reliable drug information databases available in the hospital intranet.
2. The rate of administration and concentration of parenteral medications were assessed by using the institutional parenteral therapy manual.
3. Drug - drug interactions were assessed by using the comprehensive drug interaction analysis checker. Risks rating of class D (Consider Therapy Modification) and X (Avoid Combination) were counted as prescribing errors.

Statistical Analysis

We estimated that a sample of 445 orders in the pre-intervention phase and 445 orders in the post-intervention phase were needed to provide a power of 80% with an alpha of 5% to detect a 50% reduction in the prescribing errors upon implementation of the study intervention [11].

Descriptive statistics were used to specify the class of medication involved and the category of prescribing errors.

Chi-square test was used to assess the proportions of prescribing errors before and after implementing the educational sessions.

The proportions of the prescribing errors identified and corrected by the pharmacist and by the pharmacy resident during data collection were reported as percentages.

STATA 13 was used for data analysis.

Ethics / IRB Approval

The proposal was approved by institutional review board of King Abdullah International Medical Research Center on October 27, 2014.

The Medical Record Number (MRN) of patients and the badge number of surgical residents were coded. If there were errors that led to any complications, they would have been reported through the Safety Reporting System (SRS) according to institutional standard policy for medication errors.

Results

The pilot study focused on seven residents from different subspecialties and levels of practice. Sixty six orders met the inclusion criteria. Seven prescribing errors were detected (10.6%).

Fifty eight residents who have different training levels were invited to attend the educational sessions. Only twenty eight attended (48%); and only (21 / 28) passed the post session exam (75%). A total of 445 orders in the pre phase and 445 orders in the post phase were included (see Figure 2). The proportion of prescribing errors in the pre phase was 31.4% (140 / 445) versus 26% (116 / 445) in the post phase. The difference was not statistically significant (P = 0.41) (Figure 3). The number of prescribing errors that have been made by attended residents was 50 / 140 (36%) in the pre-phase while 57 / 116 errors in the post phase (49%).

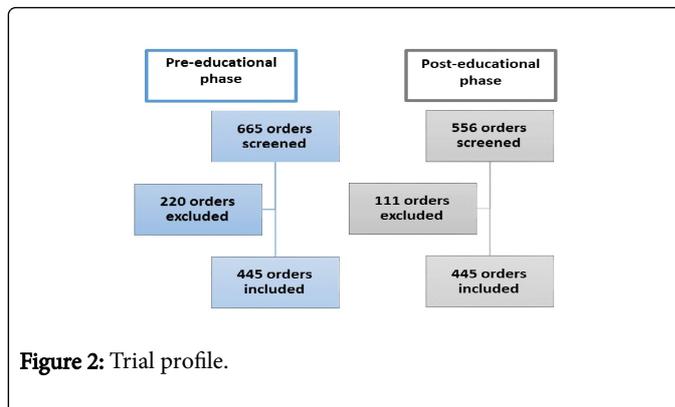


Figure 2: Trial profile.

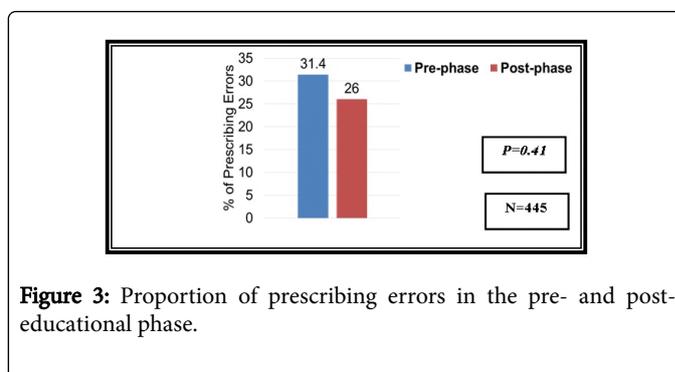


Figure 3: Proportion of prescribing errors in the pre- and post-educational phase.

The most common category of prescribing errors was “incorrect rate of administration” followed by “technical errors” in both phases (Figure 4). Anti-infectives were the most common class involved in prescribing errors (Figure 5).

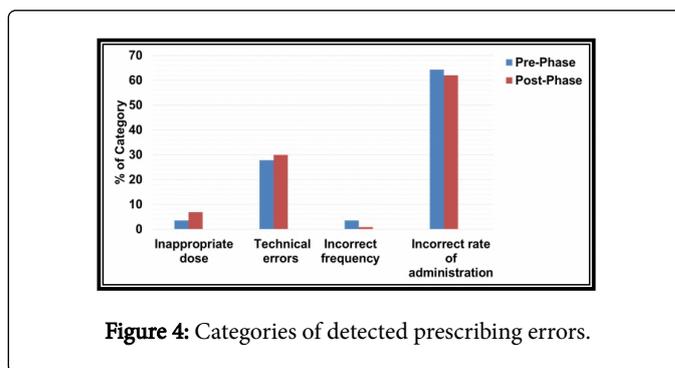


Figure 4: Categories of detected prescribing errors.

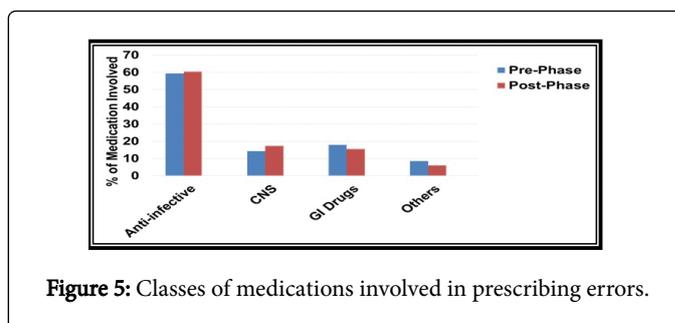


Figure 5: Classes of medications involved in prescribing errors.

Discussion

The prescribing training session was incorporated in the Mandatory Surgery Resident teaching activity. All prescribing errors were corrected by either the in-patient pharmacists or by the pharmacy practice resident in both phases (100%). The findings in our study on the percentage of reduction of prescribing errors between pre and post-interventional phase among surgical residents was higher (5.3%); although statistically not significant ($P = 0.41$). It might have clinical utility in terms of improving prescribing pattern and enhancing patient safety. Several studies have examined the importance of educational sessions in reducing prescribing errors such as the Chin and Ibrahim study that was conducted in 2011 in the out-patient department of the Kuala Kangsar Hospital, Malaysia. The investigators used multiple strategic plans such as distribution of bulletins with information related to drug interaction management and drug dosage for the cardiovascular system, endocrine system, and central nervous system to decrease prescribing errors and to evaluate the effectiveness of educational intervention plans. It was found that the total prescriptions containing one or more prescribing errors were reduced from 53.4% (1336 / 2500) to 49.9% (848 / 1699) after implementation of the intervention plan with a P-value of < 0.025 for a percent reduction of errors of 3.5%. The conclusion was that combined educational intervention programs can help in improving patient safety in the healthcare institute [12]. The incorrect rate of administration was the most common category of prescribing errors in our study, which may not be attributed to knowledge deficit of the surgical residents but rather to the failure of the electronic prescribing decision-support system as limited capabilities of using forced functions for rate of administration. According to the Institute for Safe Medication Practices (ISMP), there are some strategies used to reduce prescribing errors ranking from higher to lower impact in changing the behaviour of clinical practice. Education seems to have the lowest rank among other strategies which explains the non-significant findings of our study (Table 2).

Error Reduction Strategy	Power (Leverage)
Forcing function and constraints	High 
Automation and computerization	
Standardization	
Reminders and checklists	
Rules and policies	
Education and Information	

Table 2: Rank of effectiveness of various errors reduction strategies.

Our study has some limitations including first, the limited time for the pharmacy residency project to be designed, approved by the local IRB, and executed completely before the end of the residency year. So, the resident's project focused on education as a way to reduce prescribing errors rather than trying to implement other multifaceted tools. Second, the study focused mainly on the estimation of proportions rather than assessing the risk and complications of prescribing errors or identifying the potential impact of these prescribing errors on patient care. Third, only 28 of the scheduled surgical residents out of 58 (48%) attended the educational sessions which might have had a big impact on the results. Finally, the

generalizability of our study is limited to surgical residents who may have different skills and prescribing patterns compared to other specialty residents.

This study also has several strengths that aimed to minimize information bias and confounders. First, all educational sessions were organized with the surgical Residency Training Program (RTP) director so that other education activities with content similar to our sessions were postponed after the end of our study. Other irrelevant educational activities were allowed as scheduled to facilitate surgical resident's progress during their residency program. Second, all surgical residents were blinded with regard to their orders' evaluation before and after the interventional sessions. Third, our educational sessions study was tailored to the needs of the surgical residents identified in the pre-implementation phase.

Conclusion and Future Direction

The proportion of prescribing errors among surgical residents was not significantly reduced by implementing educational sessions. Future studies should aim to assess the utility of incorporating education with high leverage strategies such as forcing functions in electronic system and automation to reduce electronic prescribing errors effectively.

In the future, we plan to keep the prescribing training session as a part of the mandatory residents' training activities, implement forcing functions in our CPOE system in order to guide appropriate prescribing including standard infusion rates and others, and include training on institutional policies and procedures during resident orientation day as well as refreshment session during mid-year resident day.

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