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Implementation of Computerized Physician Order Entry (CPOE) with Clinical Decision Support (CDS) Features in Riyadh Hospitals to Improve Quality of Information

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Abstract. In this paper, we have conducted a preliminary study of the applied Clinical Decision Support (CDS) features in adopted Computerized Physician Order Entry (CPOE) systems. The study was conducted in three hospitals in Riyadh, the capital city of Saudi Arabia. The results show that the adoption of CPOE with a Clinical Decision Support System (CDSS) is not yet mature. CPOE systems allow physicians to enter their medication orders electronically, but many of the applied CPOE systems do not contain alerts to advise physicians of potentially dangerous interactions caused by incorrect medications. Hospitals are advised to enhance the role of CDSS with the CPOE to reduce medication errors, improve patients' safety and increase information quality.

Keywords. Computerized Physician Order Entry (CPOE), Clinical Decision Support System (CDSS), Medication Errors, Saudi Hospitals, Quality of Information.

Introduction

Hospital medication errors are a common and fatal problem in hospitals that negatively affect approximately 770,000 people in the United States each year. There are many causes of medication errors. One study revealed that 56% of medication errors occurred during the ordering stage, 34% occurred during administration, 6% occurred in transcribing, and 4% occurred during dispensing [1]. The Institute of Medicine (IOM) released the "To Err Is Human" report in 2000, which revealed that the main reason for medical errors is not poor health care personnel but rather poor systems, which must be modified and upgraded to provide a safer environment for patients [2].

Studies have suggested that the use of Computerized Provider Order Entry (CPOE) systems may reduce the number of medication errors [3,4]. CPOE applications help to reduce medication errors by providing warnings to health care personnel in the event of

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a potential error, giving personnel the opportunity to review and correct the ordered medication. The CPOE also supplies health care personnel with drug information to continuously update them on medications and drug-drug interactions. In a systematic review of 10 studies, the use of CPOE with Computer Decision Support Systems (CDSS) produced a significant decrease in medication errors in five of the ten studies. Four of the ten studies concluded that the decrease in medication error was not significant, and one study demonstrated no change in medication errors with the use of CPOE with CDSS [5]. Other studies have shown that CPOE applications reduced the rate of medication errors by 55% [6] and 70% [7].

Although studies have demonstrated the benefits of the use of CPOE, other studies have shown that the CPOE system application actually increased medication errors. A study conducted by Koppel et al found that CPOE systems may facilitate medication errors [8]. Another study showed that the implementation of CPOE may generate new kinds of errors due to overdependence on technology and may introduce a greater workload for physicians as well as workflow issues [9]. Nonetheless, CPOE has been shown to reduce medication errors and to improve patient safety within hospitals [5,6,9].

In Saudi Arabia, prescribing errors affect 18.7% of all prescriptions, and their impact varies from minor to serious [10]. Another study that examined medication prescribing errors in a pediatric inpatient tertiary care setting in Saudi Arabia found that the overall medication error rate was 56 per 100 medication orders. Dosing errors were the most prevalent (22.1%), followed by routing errors (12.0%), errors in clarity (11.4%) and frequency errors (5.4%). Other types of errors included incompatibility (1.9%), incorrect drug selection (1.7%) and duplicate therapy (1%) [11]. Few studies in the literature have examined the use of CPOE systems in Saudi Arabia and their impact on patient safety. Thus, the purpose of this paper is to measure the implementation of CPOE applications for CDSS features in three leading hospitals in Saudi Arabia, Riyadh.

1. Methods

1.1. Setting and Participants

This preliminary study was conducted from December 15, 2010 to January 15, 2011 and included three hospitals within the capital city. Hospital A is recognized as a teaching hospital, a critical care facility, and a secondary care facility. It has a capacity of 500 beds, a total of 365874 outpatients, 160482 written prescriptions, and a total of 50 medical errors. Hospital A has its own in-house CPOE system, which was implemented in 2007 for outpatients and in 2009 for inpatients. Hospital B is recognized as a tertiary care facility. It has a capacity of 1200 beds, a total of 300000 outpatients and 17 registered medical errors. Hospital B utilizes a commercial CPOE system that was implemented in 2007, with 500 physicians currently using the system. Hospital C is recognized as a secondary care healthcare center. It has a capacity of 800 beds, a total of 42772 admitted patients in 2010, and 723286 outpatients. The hospital operates a commercial CPOE system that was implemented in 2006.

Each hospital has a multidisciplinary team responsible for developing the CPOE system. From these teams, one physician and one clinical pharmacist were selected to

participate in the preliminary study to evaluate the CDSS features implemented in their hospitals' CPOE.

1.2. Data Collection Tools

This research used a cross-sectional, self-administered questionnaire that was adapted from the Leapfrog CPOE standard. The Leapfrog CPOE standard was developed by the Leapfrog Group for Patient Safety to improve healthcare quality, increase patient safety, and advocate the use of CPOE systems. It addresses nine types of decision support for medication errors and three types of decision support that evaluate system efficiency [12]. For the purposes of this study, ten types of clinical decision support were used to evaluate CPOE-CDSS implementation in the three hospitals in Riyadh: therapeutic duplication, single and cumulative dose limits, allergies, contraindicated routes of administration, drug–drug interactions, drug–food interactions, drug–diagnosis interactions, and contraindication/dose limits based on age and weight, laboratory studies, and radiology studies.

All three hospitals were assessed to determine the implementation status of their CDSS: implemented and functional, still undergoing implementation or not considered for implementation. Additional information was collected during the survey administration, such as the type of hospital (primary care, secondary care, or tertiary care). Furthermore, statistics were collected on bed capacity, number of outpatients, number of admissions and number of electronic prescriptions and medication errors for 2010. The survey included one qualitative element regarding challenges encountered during CPOE implementation.

1.3. Statistics

The quantitative data were entered into tables using Microsoft Excel. For each CPOE CDSS feature frequencies of implementation status were calculated. For the qualitative data, the authors reviewed the information and provided an impression of the participants' responses.

2. Results

2.1. Clinical Decision Support System Features

The results of the survey showed that CDSS were not fully implemented in all three hospitals included in the study. Hospital A had implemented only one CDSS feature, contraindicated routes of administration. Some features were still undergoing implementation, such as therapeutic duplication, single and cumulative dose limits, allergies and cross-allergies, drug-drug interactions, contraindication/dose limits based on laboratory studies. Other features were not part of implementation plan, including drug-food interactions, contraindication/dose limits based on patient diagnosis, and contraindication dose limits based on patient age and weight. In contrast, hospital B had fully implemented three features, allergies and cross-allergies, contraindicated routes of administration, and contraindicated dose limits based on laboratory studies. The implementation of single and cumulative dose limits, drug-drug interactions, and

contraindicated dose limits based on radiology studies were in progress. Hospital C had fully implemented seven of ten CPOE features: therapeutic duplication, single and cumulative dose limits, allergies and cross-allergies, contraindicated routes of administration, drug-drug interactions, contraindicated dose limits (patient diagnosis), and contraindicated dose limits (patient age and weight).

Table 1. Survey results

CDSS Features	Implemented	In progress	Not implemented
Therapeutic duplication	C	A	B
Single and cumulative dose limits	C	A,B	None
Allergies and cross-allergies	B,C	A	None
Contraindicated route of administration	A,B,C	None	None
Drug-drug interactions	C	A,B	None
Drug-food interactions	None	None	A,B,C
Contraindicated dose limits (patient diagnosis)	C	A	B
Contraindicated dose limits (patient age and weight)	C	None	A,B
Contraindicated dose (laboratory studies)	B	A	C
Contraindicated dose (radiology studies)	None	B	A,C

Legend: *Letters A, B, C represent the hospitals in the study; None indicates none of the hospitals. Column 1 (Implemented) indicates that the CDSS feature is implemented and used by hospital staff. Column 2 (In progress) indicates that the CDSS feature implementation is in progress. Column 3 (Not implemented) indicates that the CDSS feature is not considered part of the CPOE implementation plan.*

2.2. Challenges in Implementing CPOE CDSS

The results of the qualitative question on challenges encountered in implementing the CPOE CDSS showed that one of the major challenges for all three hospitals was the cost of the CPOE CDSS, including the cost of development, implementation, and maintenance per year. The respondents also noted that off-the-shelf CPOE packages required customization for each hospital, which could be expensive. Within each of the hospitals, some physicians preferred not to use CPOE because they reported that it was time consuming and difficult to use. Another challenge faced by the hospitals was the lack of qualified and experienced health informaticians who were familiar with international and national standards related to healthcare and who could articulate the technology business requirements of the hospital.

3. Discussion and Conclusion

CPOE systems have been recognized as a key to improving patients' safety. The implementation of such technology benefits service productivity by decreasing medication errors and increasing patient satisfaction. Based on the preliminary study, we can say that the adoption of CPOE CDSS systems in Riyadh hospitals is not yet mature. Hospitals must implement additional CDSS features, such as drug-food interactions, allergies and cross allergies, and drug-lab interactions, and they must move toward advanced clinical documentation aligned with the Healthcare Information

and Management Systems Society (HIMSS) guidelines. The development of a requirement checklist that includes clinical decision support and workflow configuration may increase the success of CPOE implementation. Moreover, hospitals may adopt CPOE or CDSS standards to select and evaluate CPOE implementation. A major aspect of CPOE implementation is physicians' awareness of and preparation for the system as well as physicians' role in reducing medication errors through the system.

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