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Original Article

Development of computerized physician order entry with decision support system and preconceived physician attitude towards CPOE by end user satisfaction

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ABSTRACT

Computerized Prescribing System with embedded decision support can check doses during prescription order entry along with drug name, category, formulations available, doses, drug interactions, and special monitoring. It would also display alerts when prescribed doses are out of range. Electronic prescribing systems Computerized Physician Order Entry (CPOE) with embedded Clinical Decision Support (CDS) can reduce Adverse Drug Event (ADE) and medication errors by ensuring that prescriptions are entered completely and unambiguously, and by flashing warnings about possible problems such as drug interactions and excessive doses. The database was developed hierarchically after which CPOE with Decision Support System (DSS) was evolved. End-user satisfaction questionnaire was developed, and 25 physicians from various departments participated in the study. The mean of the selected statements was found to be 4.108. The participants in our study positively rated the following characteristics: 1. achieving high level of patient safety, 2. saves time, 3. reduce the risk of medication error, and 4. ease to use. But the participant's expressed doubts about the reliability and completeness of data. The questionnaire was significant in measuring the ideal characteristics of CPOE with DSS. 88% of participants, agreed to the use of CPOE with DSS in our hospital setting.

Keywords: CPOE, Indian Hospital, DSS, Patient safety, Drug interaction, medication error, End user satisfaction

INTRODUCTION

Computerized Physician Order Entry (CPOE) allows physicians to order medications, other treatments and investigations electronically, creating legible, complete, correct, and rapidly actionable orders [1]. Identifying, preventing and resolving Drug Related Problems (DRP) is an important issue in pharmaceutical care process [2]. One intervention that has substantial potential for improving the medication ordering process is CPOE in which physicians write orders online. The computer can assist the physician at the time of ordering by suggesting appropriate doses and frequencies, displaying relevant laboratory data, and screening orders for allergies and drug–drug and drug–food interactions [3]. CPOE with embedded Clinical Decision Support (CDS) can reduce Adverse Drug Event (ADE) and medication errors by ensuring that prescriptions are entered completely and unambiguously, and by displaying warnings about possible problems such as drug interactions and excessive doses [4]. The largest single proportion of ADEs originates from errors that occur in medication ordering [5]. A study conducted at two tertiary care hospitals over a 6-month period found that approximately 28% of ADEs are preventable [6]. CPOE systems have the potential to improve patient safety through decrease of adverse drug events [7]. Several studies performed with systems designed in the 1970s and 1980s which dealt only with antibiotic administration by CPOE have shown some benefit in both cost savings and patient outcome. Many studies introduced medication errors as a surrogate marker for the actual adverse drug events [6, 8]. In 1988, Bates et al. reported that CPOE system had reduced the incidence of non-intercepted serious medication errors by 55% in the USA [6]. Studies in different countries demonstrated that the

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introduction of electronic health records represented change in doctors work flow and imposed a greater burden on them.[9, 10] The most significant barrier to implement CPOE systems is the physicians do not like to work with. If the system is developed with the physician's acceptance and collaboration, it would reduce the resistance to implement CPOE system.

In non-CPOE hospitals, paper-based order sets are available for clinical use**.** Implementation of standardized order sets improves patient's safety [11]. Comparison between traditional prescription system, CPOE prescription order with DSS, and Computerized Order Entry prescription order with DSS is depicted below in figure 1. Building CPOE systems require designs that can provide rather important additional advantages such as safety of clinical work [12]. Lee et al [13]. Created the Physician Order Entry User Satisfaction and Usage Survey (POESUS) and used it in a study of 112 physicians and 93 nurses at the Brigham and Women's Hospital (BWH) in Boston. Hoonakker et al [14]. used POESUS questionnaire and measured the CPOE end user satisfaction by studying on 52 participated physicians.

OBJECTIVES

The main objectives of this study are

1. To develop a comprehensive drug database for CPOE with DSS within the hospital which on implementation provides information on drug allergy, appropriate doses, special monitoring requirement, and drug interactions.
2. To assess the preconceived physician attitude towards CPOE with DSS by end- user satisfaction.

METHODS AND MATERIALS

Development of Database: Database is a structured set of data held in a computer, especially one that is accessible in various ways. Database Management System (DBMS) [15] are designed software applications that interact with the user, other applications, and the database itself to capture and analyze the data. Well known DBMSs include My SQL, MariaDB, PostgreSQL, SQLite, Microsoft SQL server, Oracle, SAP HANA, dBASE, FosPro, IBM DB2, LibreOffice Base and FileMaker Pro. We have used Microsoft SQL server for the development of the database entry programme. Herculean task of comprehensive drug data entry was made into this system by using subscribed UPTODATE drug information. CPOE system usage is depicted in the figure 2

Assessment of End User Satisfaction: End-user satisfaction is conceptualized as "the affective attitude towards a specific computer application by someone who interacts with the application directly" [16]. End users are defined as "individuals who interact directly with the computer".

Instrument to measure the end user satisfaction: There are several methods available to measure end-user satisfaction, such as examining actual use of computer systems and applications, conducting interviews with end-users, and using end-user questionnaires. Using a questionnaire is a relatively simple method to collect and analyze data. It is very important to use valid and reliable questionnaires when doing research, an observation which may be considered all too obvious.

Data analysis: For the statements the percentage respondents agreeing (score of 5 on the Likert scale) was calculated. Participants were shown how to work with CPOE system and navigate to the order entry screen, prior to performing their evaluations. Participants were asked to explore the various system interfaces and document their observations and comments as they related to these principles. The study was carried out in Sri Ramachandra University, a 1600 bedded tertiary care teaching hospital. The departments involved in analyzing the study outcomes are General Surgery, General Medicine, Reproductive Medicine, Obstetrics and Gynaecology, Pulmonology, Pediatrics, Oncology, Emergency Medicine, Oral maxillofacial surgery and Radiotherapy. The sample size of the study was 25 questionnaires filled up the Physicians, and Medical Residents.

Questionnaire instrument: Questionnaires were developed targeting physicians. The reliability, ease of use, timeliness, impact on patient safety, efficacy, and outcome were studied [17]. Participants could answer 5 point likert scale method 'Agree/ Strongly Agree/ Cannot say/ Disagree/ Strongly Disagree. In an open-ended question respondents were asked to mention advantages as well as disadvantages of the system. The closed end questions were asked to get the opinions/ comments from the participants. Steps involved in filling up questionnaire are depicted in the figure 3.

RESULTS

The developed CPOE with DSS was able to provide information and warnings on appropriate doses, drug allergy, drug interactions and special monitoring within the prescribed drugs for a patient. In our study 25 physicians participated and 84% of participants agreed that CPOE is easy to use and also felt that risk of medication errors could be reduced. 68% and 8% of participants agreed and disagreed respectively that CPOE saves

time. Statement 'ability of CPOE to achieve high level of patient safety' was accepted by 84% of the participants. There was dilemma about CPOE to cause doubts on the reliability/ completeness of the data by 40% of participants, while 28% disagreed to it. All the participants agreed that CPOE provides potential drug interaction alert. Graphical representation of responses towards CPOE questionnaire statements are depicted from figure 4-11. The participants in our study rated the following statements as positively: achieving high level of patient safety (mean=4.2, standard deviation=0.707), saves time (mean=3.88, standard deviation=0.927), reduce the risk of medication error (mean=4.36, standard deviation=0.757), and ease to use (mean=4.28, standard deviation=0.8426). On the other hand, CPOE causes doubts about reliability or completeness of data (mean=3.32, standard deviation=1.107) a somewhat negative characteristic of CPOE as perceived by participants.

DISCUSSION

To successfully implement CPOE system, a proper analysis of the existing system is necessary. Medication errors are unnoticed in many hospitals and results in long stay hospitalization. In order to avoid medication errors and ADE's utmost, we have developed our own CPOE that fits to our practice. Although commercial software is available in market, we want to establish our own CPOE that is acceptable by most of our physicians. DSS provides the correct dose as a default value [18] [19]. However in our CPOE system, DSS provided information after the physician had made any mistake in calculating the appropriate dose. Drug Interactions alert are provided not only with the current medications but also with the previously given medications, this enables the physician to change the prescription accordingly. Drug allergy alert provides the physician not to enter the same drug during hospital stay and also after discharging the patient. Our CPOE system was able to display warnings for drugs that require special monitoring. This enables the physician to adjust the dose accordingly. CPOE is widely used in developed countries. For determining our physician's attitude towards CPOE, we compared our results with study done by Hoonakker et al. and is depicted in table 1. Our study focused on the measurement of characteristics like reliability, ease of use, timeliness, impact on patient safety and outcome. Our questionnaire contains 21 statements, out of which 4 statements are demographics of participant, 14 statements were open ended questions and 3 statements were close ended questions. Out of 14 statements, 5 statements were selected which are practical, significant and resemble to the POESUS questionnaires and are studied. Most of our questionnaires are filled by physicians who had clinical experience of greater than 8years. The mean of the selected items was found to be 4.108 while the Hoonakker et al. study had a mean of 4.06. Results of our study show significantly higher scores on the different aspects of user satisfaction. The standard deviation of this study was comparatively less when compared to Hoonakker et al. study. Due to the existence of CPOE from many years in the latter study, there was more reliability on the data entry by prescribers. We found statistically difference on the CPOE characteristic viz. doubts about reliability/ completeness of data (mean=3.32) than with Hoonakker et al. study. While other CPOE characteristics of this study were significant with the Hoonakker et al. study.

CONCLUSION

CPOE with DSS systems are being increasingly implemented in hospitals and other healthcare settings. 88% of participants, agreed to the use of CPOE with DSS in our hospital setting. Our physician's attitude towards CPOE with DSS was a positive outcome to implement the same in our hospital and frequently update the drug information, and there is a need to utilize different physician's comments to bring up an effective Clinical Decision Support System. End- User Satisfaction study should be retested periodically to know the change in outcomes with respect to the current study. Hospitals that implement this technology need to evaluate the impact of the CPOE technology on end users in order to identify problems with implementations and to plan continuing optimization initiatives. CPOE with DSS aids the physician and doesn't replace the physician authority.

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Figure 1: Comparison between Traditional medication order entry, CPOE and Computerized Order Entry (COE)

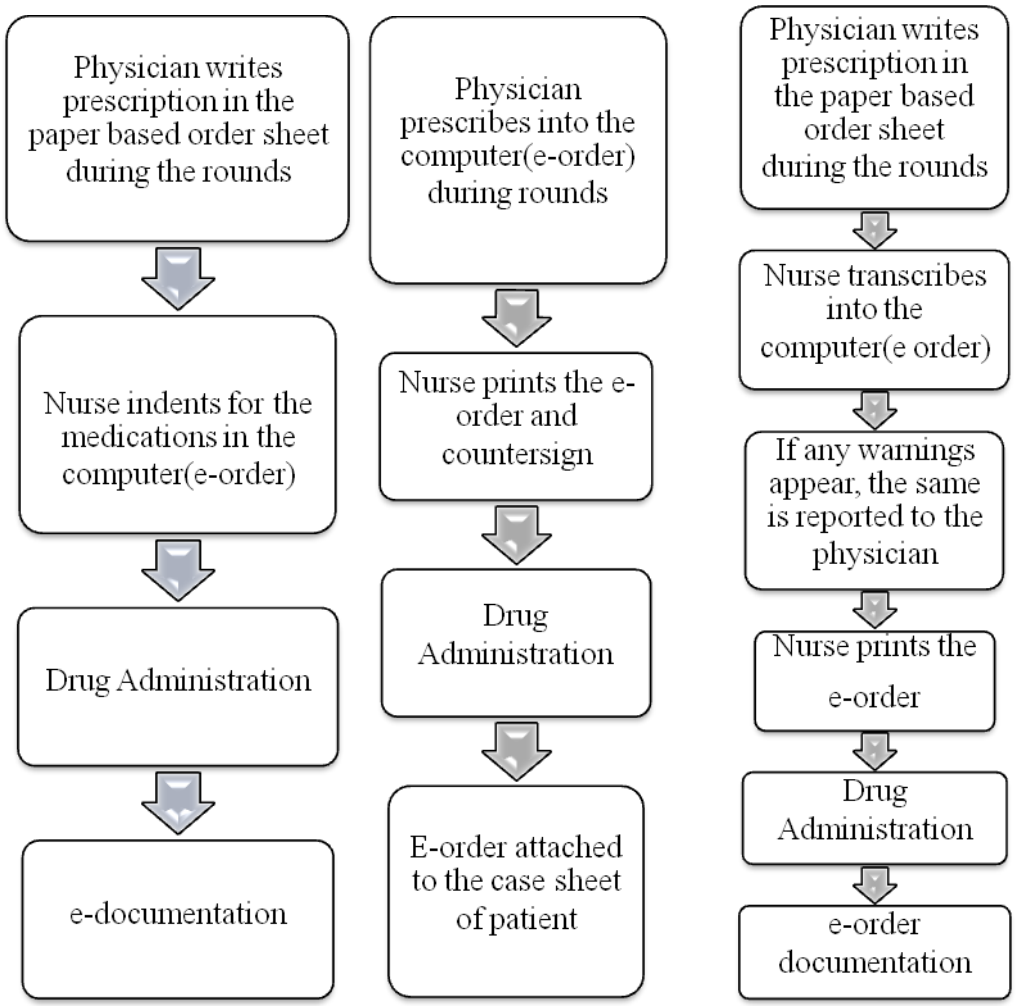
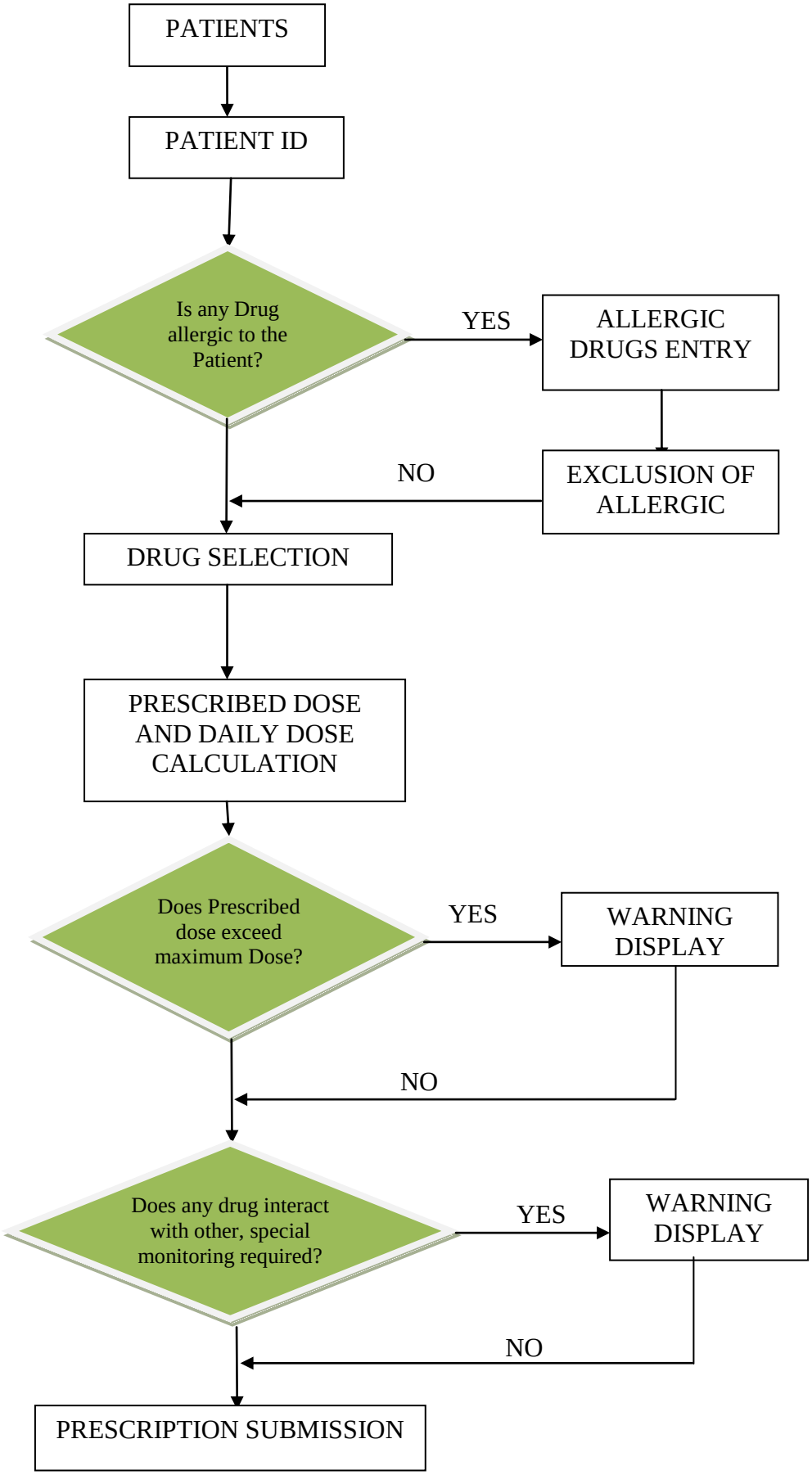


Figure 2: CPOE system usage



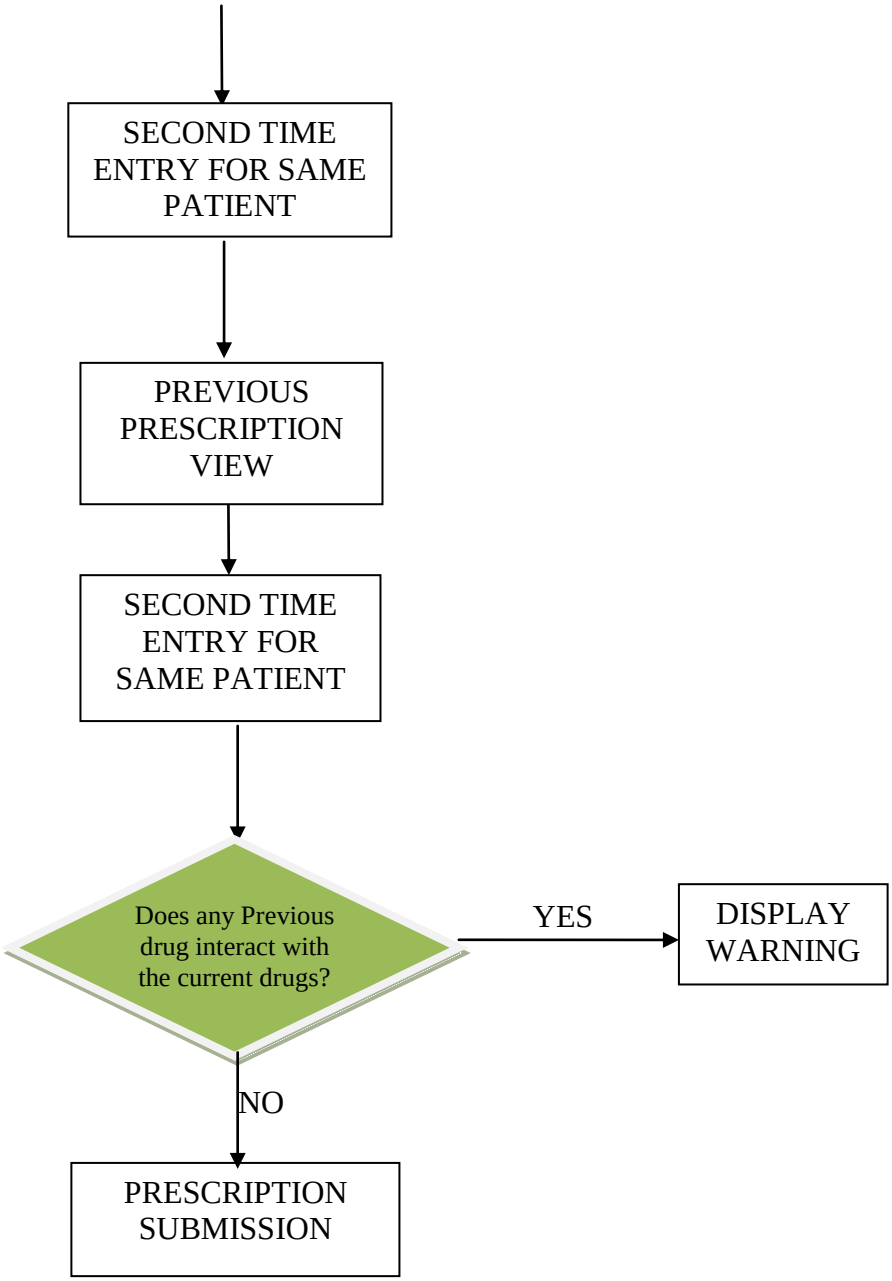

SECOND TIME ENTRY FOR SAME PATIENT
PREVIOUS PRESCRIPTION VIEW
SECOND TIME ENTRY FOR SAME PATIENT
Does any Previous drug interact with the current drugs?
YES
DISPLAY WARNING
NO
PRESCRIPTION SUBMISSION

Figure 3: Steps involved in filling up questionnaire

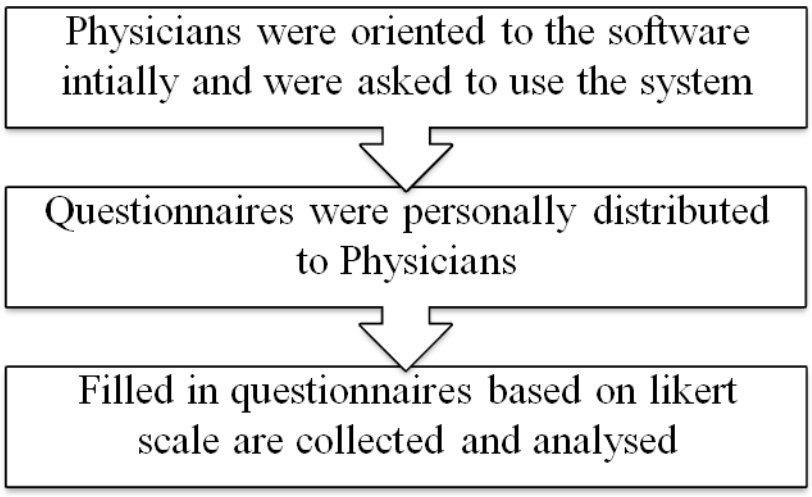


Figure 4:

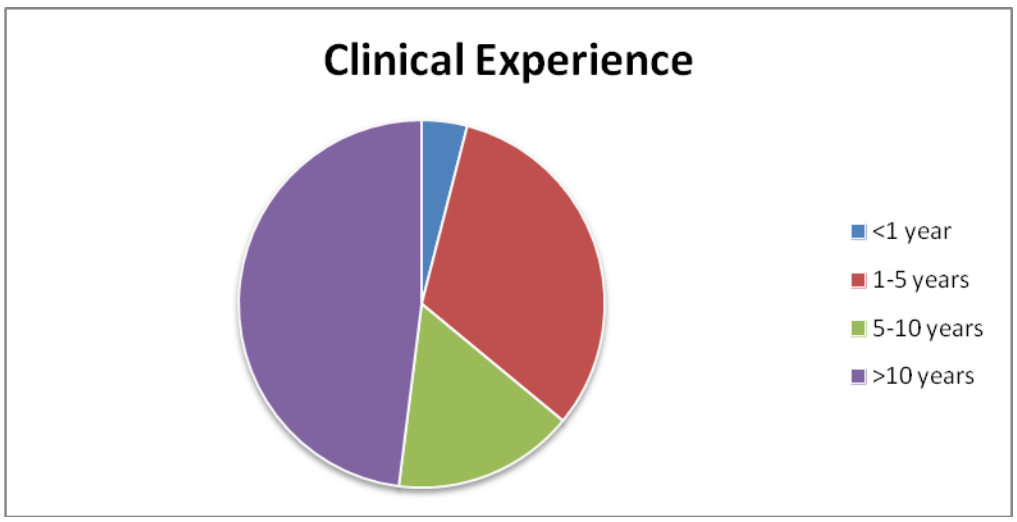


Figure 5:

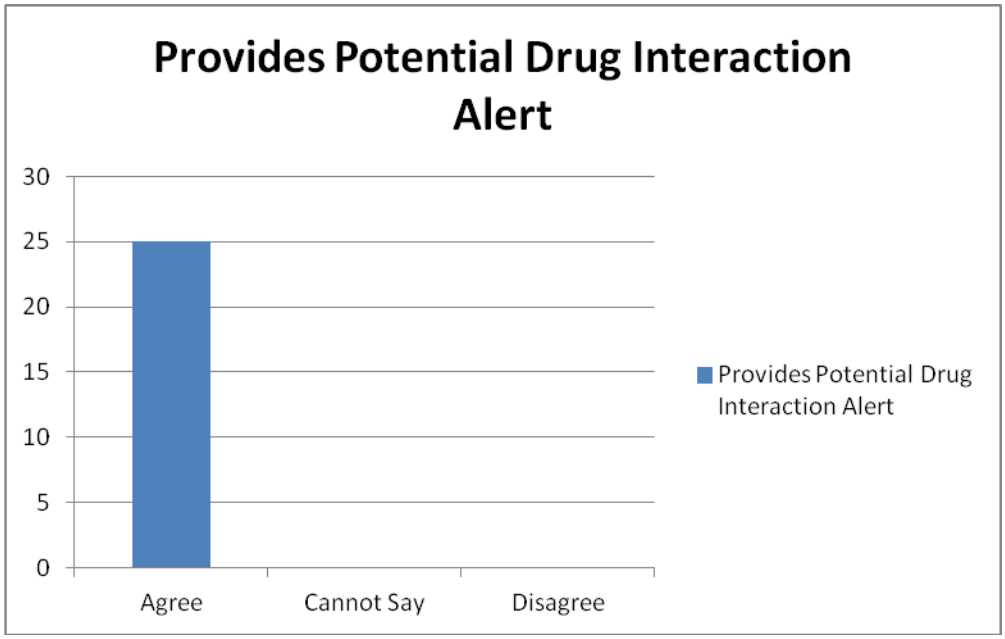


Figure 6:

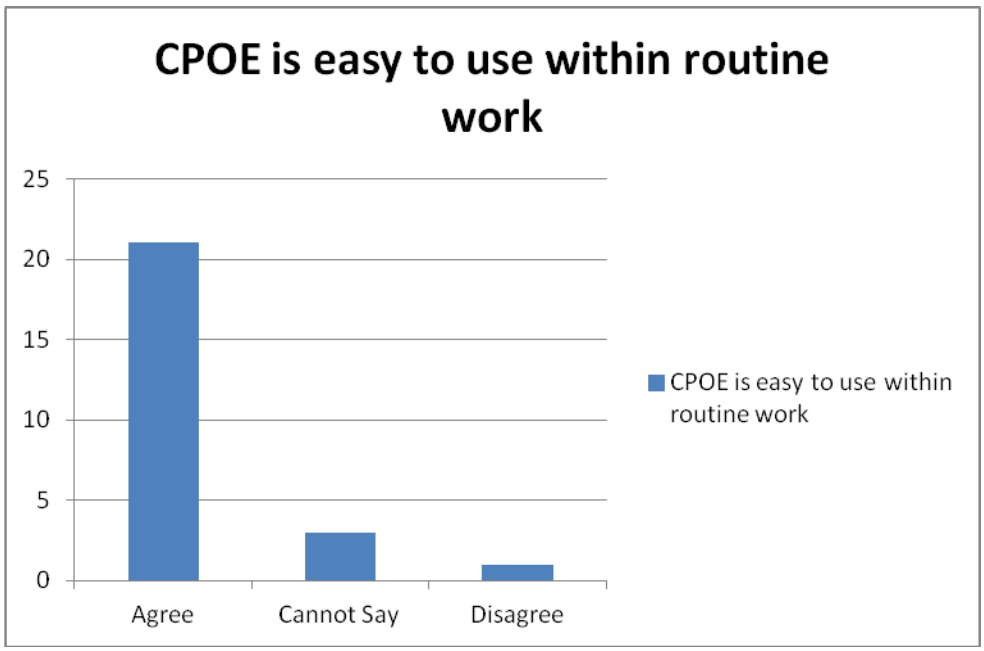
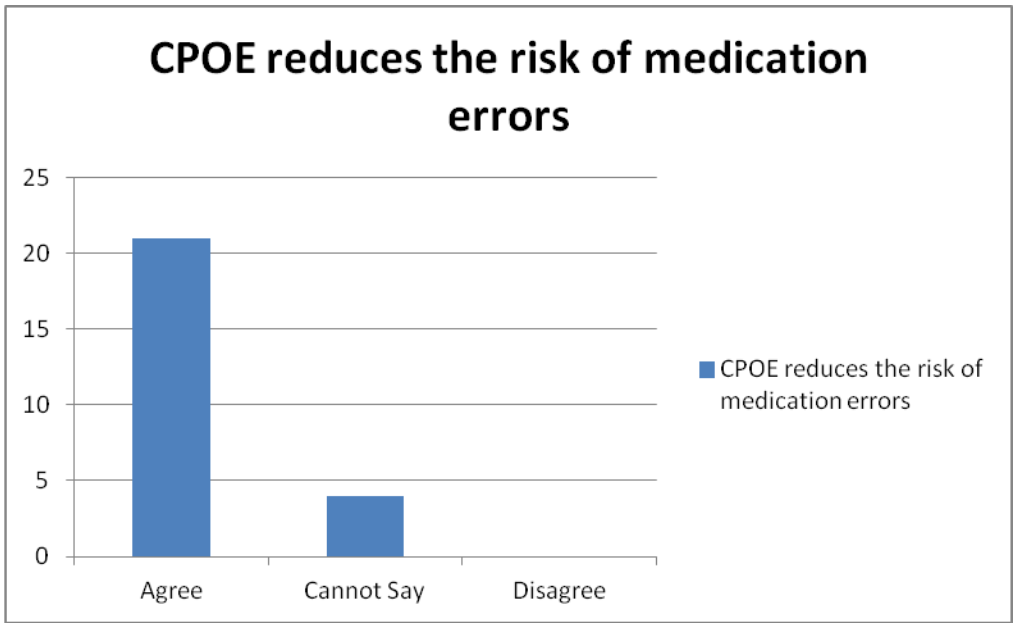


Figure 7:



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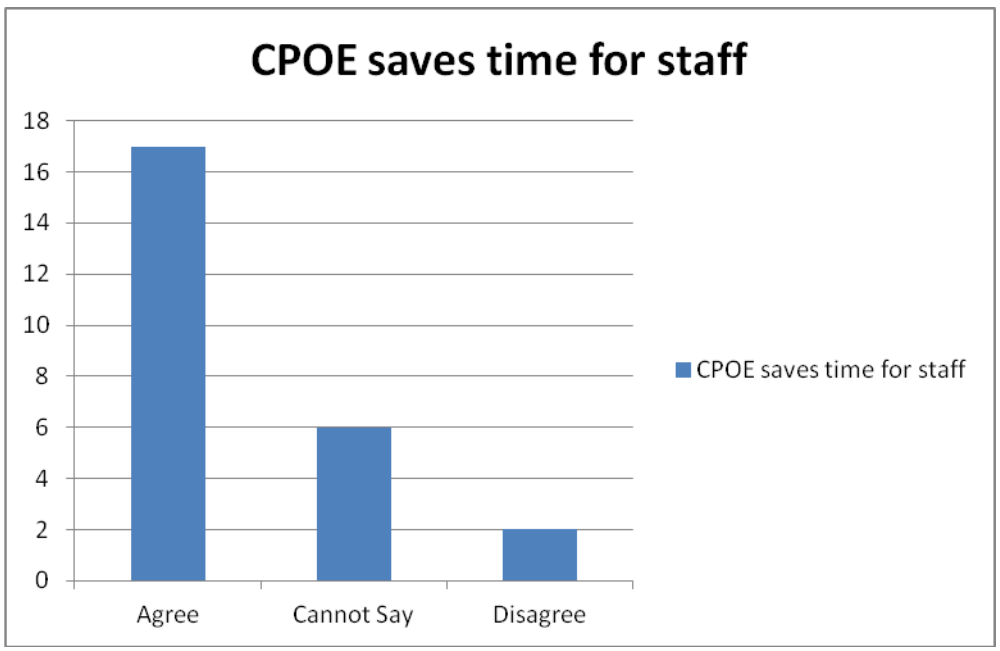

Figure 9:

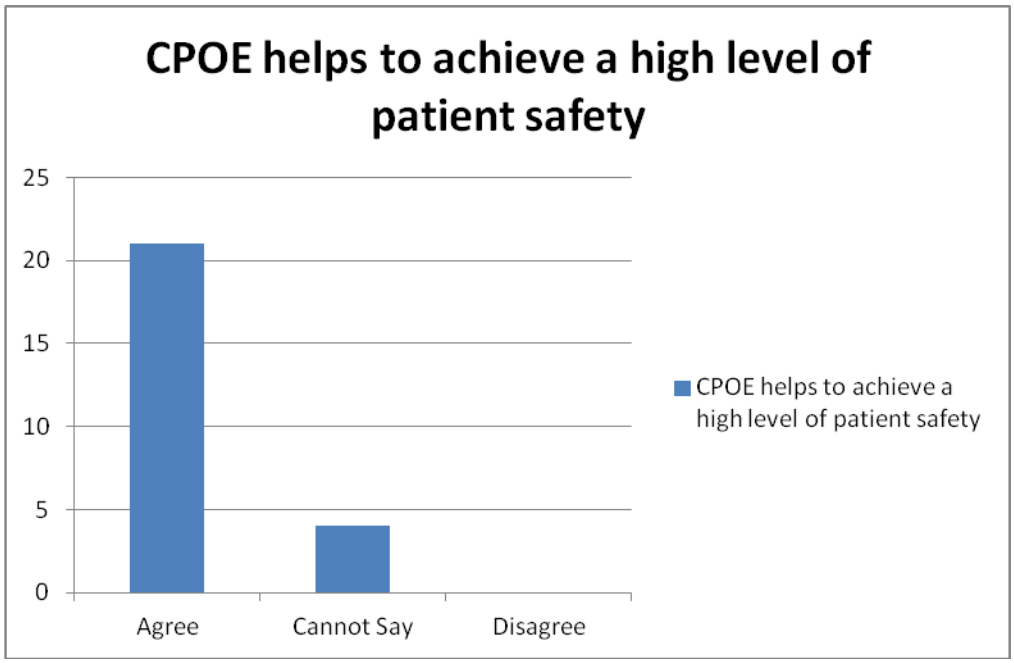

Figure 10:

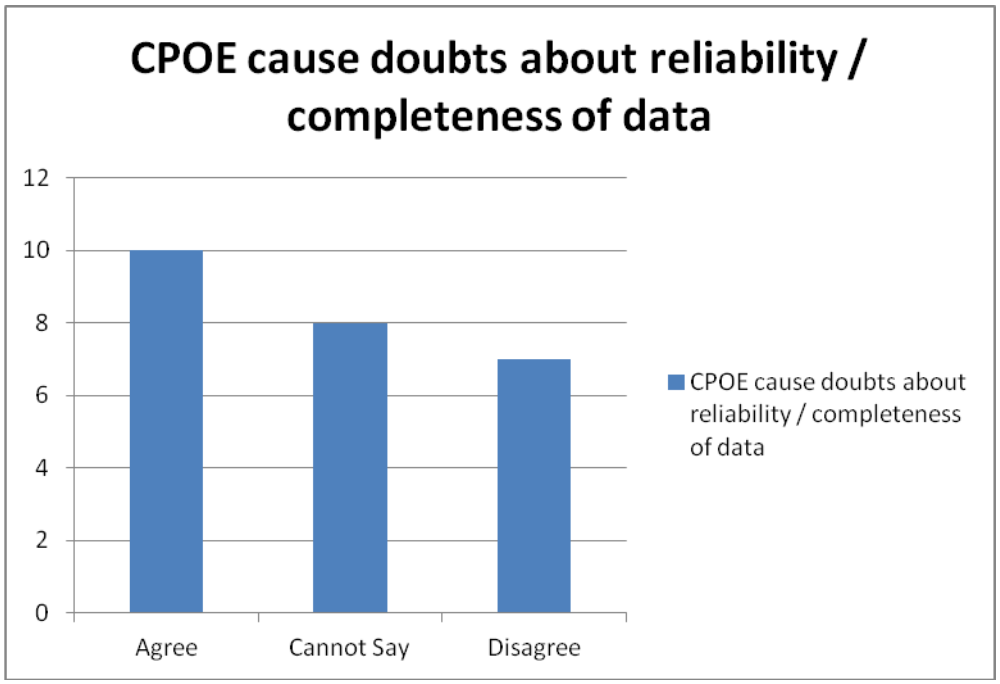

Figure 11:

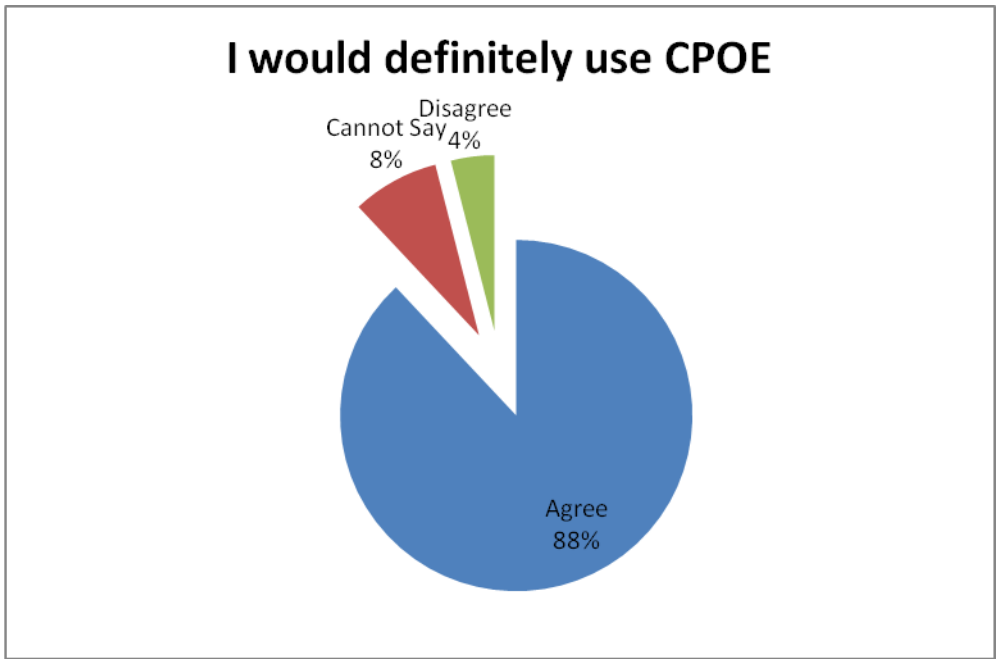

Table 1: Comparison of our study results with Hoonaker et al.

Items	Our study	Hoonakker at al
Order entry is easy to use within the routine work	Mean: 4.28 SD: 0.8426 [N = 25]	Mean: 4.22 SD: 1.54 [N = 51]
Order entry reduces the risk of medication errors	Mean: 4.36 SD: 0.757 [N = 25]	Mean: 4.53 SD: 1.16 [N = 52]
Order entry saves time for staff	Mean: 3.88 SD: 0.927 [N = 25]	Mean: 4.21 SD: 1.71 [N = 52]
Order entry helps to achieve a high level of patient safety	Mean: 4.2 SD: 0.707 [N = 25]	Mean: 4.67 SD: 1.14 [N = 51]
Order entry cause doubts about reliability / completeness of data	Mean: 3.32 SD: 1.107 [N = 25]	Mean: 5.94 SD: 1.0 [N = 52]

SD- Standard Deviation, N- Total number of participants

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