The using and influencing of Computerized Provider Order Entry (CPOE) on medication errors in Saudi Arabia: Systematic Review

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**ABSTRACT**: Background: In the past decade, the safety of patients was the superior priority for the health field and an important goal for using information technology in improving health services. Medication errors are an issue facing the health organization globally due to high cost and negative impact on health. CPOE plays a role in reducing these errors and improving the quality and safety of patients by the adoption of it and integrating with the EHR system.

Method, this paper conducted in March 2019 and defined systematic review as a study design from 2009 until 2019 including published articles, journals, and papers regarding adopting CPOE and its influence on Medication errors by using famous websites.

Results, seven studies conducted in Saudi Arabia show a positive impact on medication errors, but challenges were facing the use of CPOE that need solutions, principles of advice and experiences and work to resolve them in collaboration with advisors and stakeholders.

Conclusion, Medication errors can be reduced by using e-prescriptions through CPOE, ensuring quality of the services and patients’ safety.

Keywords: Computerized Provider Order Entry (CPOE), medication errors, impact, Saudi Arabia.
integrates with a clinical decision support system (CDSS) [6]. In general, CPOE systems include these functionalities: alert interaction, medication dosage support and clinical decision support which used in decreasing medication-related errors [2,5]. Despite several papers reported that the systems of CPOE have a big role in decreasing medication-related errors, but some studies found that CPOE systems can induce errors [5,7].

In the United States, in 2008 around 9% of hospitals (Acute Care) had a basic EHR with CPOE system and the numbers of adoptions were increased to 44% and the outcomes from using CPOE were accepted and satisfied. Furthermore, the appearance of e-Health Information Technology for Economic and Clinical Health (HITECH) in 2009 had a role in encouraging EHR adoption & incentivize the hospitals that adopt the EHR system and meet the Meaningful Use (MU) criteria. However, in Meaningful use step 1 requirements, executing a CPOE system with CDSS is required [8]. On the other hand, only 34.5% of the hospitals in Riyadh City of Saudi Arabia had CPOE systems integrated with CDSSs [9]. Moreover, the study reported that in spite of the potential reduction of medication errors through using CPOE systems, a few hospitals had a CPOE system due to challenges face them in adopting this tool [10].

So, the execution of a CPOE system is not an easy task for health organization, but there is a lot of factors if considered correctly will lead to successful implementation of CPOE such as change readiness, prerequisites of organizational and structural of the hospital, abundant resources of technology and finance, role of leadership, training of end-user and chose the best system that meets the needs of organization [11,12]. The paper aims to evaluate the impact of Computerized Provider Order Entry (CPOE) on medication errors in Saudi Arabia to find out the level of CPOE adoption and its influence as well.

Method

Protocol and Registration

First Despite that this paper is considered its methodology as a systematic review, so no need for the involvement of human beings. The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) Statement was used as a guideline for applied for systematic reviews and meta-analysis [18]. The registration number with PROSPERO is CRD42013004543 [18].

Eligibility Criteria

About seven studies were included and met the criteria, all the studies conducted in Saudi Arabia. Four of the included studies used a survey and questionnaire as study design, the remaining studies used different study designs which exploratory qualitative – group discussion, literature review, and prospective and retrospective study respectively. The dates of study publications were ranged from 2009 until 2019.

Information Sources

The sources in this paper were by using scientific research websites e.g. PubMed, Google Scholar, and Scientific Direct. We searched Literature’s English Language about CPOE and its influence on medication errors. By using famous websites such as PubMed, Google Scholar, ScienceDirect and figure out about the subject. Keywords such as "computerized provider order entry", "medication errors", "impact", "Saudi Arabia" and "CPOE" are included in the search. All journals, articles, and papers are written in the English Language which describes or evaluates the CPOE and its impact on medication errors. About seven publications are selected and included in the assessment.

Study Selection

The paper conducted in March 2019 and defined the systematic review and meta-analysis as a study design from 2009 until 2019 including published articles, journals, and papers regarding using of CPOE and its
influence on Medication errors. By the PubMed website, the results of the search found seven articles, and via Google Scholar the results were five hundred and thirty-three. Besides, the results of the search through Science Direct found one hundred. After checking all journals and removing the duplications, about seven papers fit the criteria and considered accepted studies in the research selection. The following figure shows the strategy of the search.

Fig. 1. Selection of studies

**Data Collection Process**

The For data collection, we extracted the data from articles about the authors, titles, year of publication, study methods, and outcomes. All the studies conducted in Saudi Arabia in various health organizations. The description of CPOE and its influence on medication error was the primary variable, the secondary variables were about the rate of medication errors, technical issues, adverse drug reactions. Also, the role of CPOE to reduce these problems and supported by the Clinical Decision Support System (CDSS).

we used the Effective-Public Health Practice Project (EPHPP) as a tool to assess the quality of methodology of quantitative studies which were included [19]. This tool was considered and recognized as appropriate to use it in the systematic review. By using the tool, the rate of quantitative studies will be as strong, moderate, or weak depend on eight-point: selection bias, study design, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity, and analysis [19].

**Result**

we categorized the statistical analysis about the influence of the CPOE on medication error. From the consequences of studies, we grouped the measure of (description of CPOE and its influence, rate of medication errors, technical issues, adverse drug reactions, and CDSS's support for CPOE). Four studies used quantitative methods (survey and questionnaire), one of them points out that there was an increase in the respondent rate of the pharmacist in Saudi Arabia for utilization of technology in managing the transcribing and prescribing of medications [9]. Another one indicated the variation between three hospitals regarding the pharmacy information system about the functionalities by using Chi-square tests to check the significant p-value (<.05) of variation between these hospitals and by using Kruskal Wallis test to test the variation of mean rank between healthcare providers [15]. Also, another study shows the difference between students from two universities (King Saud University and Dammam University) about taking medical informatics in their Curricula regarding improvement in the acceptance of computerized clinical systems in the future. SPSS package to test the reliability by using Cronbach's alpha test including the descriptive statistics (means, frequencies, and proportions). The results show a variation between two universities, the response rate was 89.7 % of King Saud University and 60.7 % of the University of Dammam. The mean age of respondents to study was 20.74 years, the participants of males were 75 and females 103. The significant p-value in using CPOE in the
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Future between two groups was 0.021, and 0.003 of the p-value of using CDSS in the future [16]. Furthermore, there was a study used questionnaire and conducted in three hospitals in Riyadh City, to measure the executing of CPOE applications supported by CDSS features about drug-drug reactions, dose limits (single and cumulative), allergies, interactions of drug-diagnosis and interactions between drug – food. All data collected from these hospitals were about bed capacity, numbers of outpatients and admissions, and numbers of medication errors and e-prescriptions. The quantitative data analyzed by using Microsoft Excel, the outcomes mentioned that CPOE is not fully adopted in all three hospitals due to challenges such as expensive annual costs of improvement, installation, and maintenance [17]. A qualitative study was conducted in Saudi Arabia to explore the opinions of healthcare practitioners to identify the obstacles facing medication safety to improve it. By using the group discussion method, the participants in the study separated into nine round-table. All discussion meeting was videotaped and coded, the number of participants was 65 and the majority from them were females 41 out of 65. The outcomes explained from the perspective of the participants that the design and compatibility of CPOE must be considered the effectiveness of functionality and modalities to work together, otherwise, the CPOE will failures and not improve patient safety [10]. The prospective and retrospective method was used in the study conducted at King Abdulaziz University Hospital. The sample size was 600 patients, the inclusion criteria were every patient who admitted in medical wards whatever gender, the exclusion criteria were any patient who not received drug therapy, or transferred, or discharged from admission within 48hrs. the results of data analysis were summarized in numbers and percentages by using the Chi-square test to test the significant p-value at < 0.05 and made a comparison between two types of study [14].

Medication errors are a global issue that affects medication safety and patients' health. In the Kingdom of Saudi Arabia, these errors affect about 18.7% of all prescriptions, and their influence differs from mild to severe. For example, at a pediatrics inpatient tertiary care, the rate of medication error reaches around 56 per 100 medication orders. Moreover, the dosing error was the highest prevalent (22.1%), followed via routine errors (12.0), clarity errors were (11.4) and frequency errors (5.4%). Furthermore, incompatibility was (1.9%), select of the wrong drug (1.7) and duplicate therapy was (1%) [9].

According to Aljadhi, and others (2013), they addressed in their study that there were many factors affect medication safety such as limitation of technology used, the access to medicines from many hospitals and pharmacies are unrestricted, lack of communications between healthcare organizations, absence of accurate programs of medication safety, untrained staffs who use a medication safety as guidelines including medication safety officers, no commitment to programs' policies and procedures; absence of appropriate medications labels, not following the standardization lists of drugs look-alike and sound-alike, unavailability of medication reconciliation. Also, unclear physicians' handwriting, all these factors contributed to prescription errors; the participations mentioned that "if we have to reduce these errors, we should have excellent CPOE in our hospitals" [10].

Another study by Qureshi and others (2011) summarized that medication errors considered a global problem that has a large role to play in increased morbidity and mortality rates, resulting in huge costs and legal issues. So, the status of drug errors is frequent in hospitals and healthcare centers, which influenced the opinions of the public interested in the health field. They expressed confidence in the health
systems that can be best used to contain these problems by developing preventive plans such as measurements and monitoring the quality of settings of all health care including private settings which are a significant part of all health care systems of the Kingdom of Saudi Arabia [13]. In 2012, there was a study conducted at a teaching hospital in Saudi Arabia about the impact of the pharmacovigilance on adverse drug reactions (ADRs), the study show variation in retrospective and prospective studies. In a retrospective study, the ADRs' incidence rate was 3.1, however, in the prospective study was 5.5%. The highest episode of ADR (15% of retrospective and 14.5% of perspective) was noticed in patients who received more than 10 medications. The age of patients (<60) was the highest with ADR frequency and was in retrospective 52.7% and perspective 54.5%. Moreover, 48.5% of prospective and 36.9% of retrospective were more frequently in antibiotics. The gastrointestinal tract system was involved in ADR containing the 47.4% of retrospective and 57.6% of perspective. These results indicate a lack of awareness among doctors and medical staff of the importance of recording and restricting the symptoms associated with drugs and keeping inpatient records. Also, there was increasing in the number of drugs may be to increase the proportion of symptoms in both cases. Nevertheless, they found the possibility of using CPOE systems to control and reduce these incidence rates of ADR [14].

In the Eastern province of Saudi Arabia, the authors conducted their study in three hospitals regarding assessment pharmacy system performance, they found that all three hospitals were used a hybrid of electronic health record (EHR) system (paper and electronic). This EHR has integrated with a pharmacy information system and CPOE system supported by clinical decision support (CDS). The functionalities of the PIS system include six steps of medication processing (prescribing, transcribing, dispensing, monitoring, administration, and education of patient). All of them used CPOE to order all prescriptions and send them to the pharmacy information system digitally. The majority of using PIS and CPOE by healthcare providers was 37.5% (5 – 10 years of work experience) and 43.6 % of using PIS/CPOE (2-5 years' experience). The rate used of PIS regarding drugs uses and precautions of patient education was 14.7, the rate 14.5 was a frequency of monitoring certain medication of patients' response. There was interesting in the adoption of CPOE, but there were challenges may be facing the use of it and need to be carefully studies and a full understanding to enhance patient safety [15].

**Discussion**

Based on the outcomes of previous studies in Saudi Arabia [9,10,13,14,15,16,17], the COPE was used as an electronic system instead of a paper form to avoid the errors of repeated drugs. There was interesting from different health organization to use it in improving the quality and safety of drug therapy provided to patients. The CPOE was a system and considered as a key in the role of improving the safety of patients. Furthermore, the benefits of this tool described in growing the satisfaction of patients and reducing medication errors. Moreover, preventing drug misuse, improvement of medications system. Supported by a study conducted in 2015 [16] for medical students' curricula in Saudi Arabia about importance of medical informatics, the result of study summarized in strongly agree by respondents and was the highest value about 54.9% regarding benefit using of CPOE to decrease errors related medication names and makes better of the quality and safety of patients. Also, others benefit such as preventing errors by ensuring standardized, legible, and completer orders. Also, it improves compliance with the guidelines and efficiency of hospitals. Combining CPOE with clinical decision
support system (CDSS) have more benefits in processing the orders and support the EHR system in assisting healthcare providers in timely and efficient decision making, warnings and recommendations for users like (contraindications, IV incompatibilities, and duplicate therapies), prevention of clinical errors like (drug-drug interactions, drug allergies), saving cost and time, enhancement of patient safety and improvement in quality of care [17]. Otherwise, there was a challenge facing using CPOE such as unlimited costs, resistance to change by providers, an absence of qualified health informaticians who don't have experience and familiarity with standards of international and national regarding implementing of CPOE and CDSS, lack of integrated knowledge sources. Those interested in CPOE application should understand the study of obstacles carefully and work on them for solving to facilitate the application of CPOE in the health information system for optimal utilization and achieve the desired outcomes.

**Limitation Of The study**

There is insufficient familiarity with the application of a CPOE system for reducing medication errors in hospitals; a majority still uses the paper prescription in writing medicines. Since few health organizations have CPOE applications, they indicated that some challenges facing them about the costs of improvement, training, and maintenance and resistant to change from healthcare providers. Lack of experts and experiences in dealing with these challenges. There was a weak bias from respondents in some included studies regarding adopting CPOE [10,13]. Few studies conducted in Saudi Arabia about the importance of CPOE in reducing medication errors. This work needs advanced research in the future to explore the importance of CPOE and its challenges, benefits and requirements.
## Review of Computerized Provider Order Entry in Saudi Arabia

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<th>No</th>
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<td>N.A. Qureshi, Y. Neyaz, T. Khoja, M.A. Magzoub, A. Haycox, and T. Walley</td>
<td>Physicians’ medication prescribing in primary care in Riyadh city, Saudi Arabia. Literature review, part 3: prescribing errors</td>
<td>Literature review</td>
<td>2011</td>
<td>Prescribing errors are caused by providers</td>
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<td>2</td>
<td>Lateef M. Khan, Sameer E. Al-Harthi, Omar I. Saadah, Ahmed B. Al-Amoudi, Mansour I. Sulaiman, Ibrahim M. Ibrahim</td>
<td>Impact of pharmacovigilance on adverse drug reactions reporting in hospitalized internal medicine patients at Saudi Arabian teaching hospital</td>
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<td>2012</td>
<td>multiple factors related to health care providers, consumers, and systems, and can occur during any stage of using medication. However, CPOE shows there are benefits in reducing these errors.</td>
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<td>3</td>
<td>Mohammed S. Alsultan, Fowad Khurshid, Heba J. Salamah, Ahmed Y. Mayet, Ahmed H. Al-jedai</td>
<td>Hospital pharmacy practice in Saudi Arabia: Prescribing and transcribing in the Riyadh region</td>
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<td>CPOE system has the potential to reduce medication-related errors due to the elimination of handwritten orders, improvement in communication between health care providers, and standardization of patient care.</td>
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<td>Challenges to and the future of medication safety in Saudi Arabia: A qualitative study</td>
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<td>Lack of medication safety programs and challenges like underreporting of medication errors and adverse drug reactions, multilingualism and differing backgrounds of healthcare professionals, lack of communication between healthcare providers and patients, and high workloads. Lead to the need to use CPOE to decrease errors.</td>
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<td>6</td>
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<td>Azza El.Mahalli, Sahar H. El-Khafif, and Wid Yamani</td>
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<td>Cross-sectional, two structured survey</td>
<td>2016</td>
<td>The implementation of the program prevents drug misuse, improve medication safety system, prevent medications errors, improve patient outcome and avoid unnecessary economic burden on health care organizations.</td>
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Conclusion And Recommendation

Medication errors are a global issue affecting the health and quality life of patients. Besides, have a cost-effective and are considered expensive in those health organizations. CPOE has the ability and proposed as a significant solution to facilitate the e-prescribing through EHR system to reduce medication errors and improve the quality and safety of patients. Although there were a few studies show the positive impact of CPOE on medication errors in Saudi Arabia, challenges were facing using CPOE need solutions to facilitate the process of implementation. Also, the awareness of physicians is a major aspect of adopting CPOE and an essential role in reducing medication errors via the system. The recommendations summarized in working with stakeholders and taking the principles of advice, solutions, and experiences regarding solving challenges of CPOE using and facilitate the adoption of it to improve the quality and safety of patients and maintain the safety of medications.

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The article discusses the use of CPOE in Saudi Arabia and its influence on medication errors.

The article's title is translated as: "The using and influencing of Computerized Provider Entry (CPOE) on medication errors in Saudi Arabia.

The main points are:

- The importance of using CPOE in healthcare to improve patient safety and service quality.
- The role of CPOE in reducing medication errors.
- The need for collaboration with healthcare professionals and stakeholders.

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The article concludes with the need for continuous research and improvement in the implementation of CPOE in Saudi Arabia.