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GENERAL REVIEW

Evaluation of the effectiveness of electronic prescription in reducing medical and medical errors (systematic review study)

Évaluation de l'efficacité de la prescription électronique dans la réduction des erreurs médicales et médicales (étude d'examen systématique)

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HIGHLIGHTS

- Efficacy of electronic prescription technology on errors caused by prescription.

KEYWORDS
Electronic Prescription;
Medical error;
Prescription error;
Electronic health;
Medication side effects

Summary
Introduction. — The use of electronic systems in prescription is considered as the final solution to overcome the many problems of the paper transcription process, especially with the outbreak of Coronavirus needs more attention than before. But despite the many advantages, its implementation faces many challenges and obstacles. Therefore, the present study was conducted to review the effectiveness of computerized physician order entry systems (CPOE) on relative risk reduction on medication error and adverse drug events (ADE).
Method. — This study is one of the systematic review studies that was conducted in 2021. In this study, searching for keywords such as E-Electronic Prescription, Patient safety, Medication Errors prescription, Drug Interactions, orginal articles from 2000 to October-2020 in the valid databases such as ISI web of Science PubMed Embase, Scopus and search engines like google was done. The included studies were based on the main objectives of the study and based on

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the inclusion criteria after several stages of review and quality evaluation. In fact, the main criteria for selecting articles were studies that compared the rate of medication errors with or without assessing the associated harms (real or potential) before and after the implementation of EMS.
Results. — Out of 110 selected studies after initial screening, only 16 articles were selected due to their relevance. Among the final studies, there was a significant heterogeneity. Only 6 studies were of good quality. Of the 10 studies prescribing error rates, 9 reported reductions, but variable denominators prevented meta-analysis. Twelve studies provided specific examples of systemic drug errors. 5 cases reported their occurrence slightly. Out of 9 cases that analyzed the effects on drug error rate, 7 cases showed a significant relative reduction between 13 and 99%. Four of the six studies that analyzed the effects on potential ADEs showed a significant relative reduction of between 35 and 98%. Two of the four studies that analyzed the effect of ADEs showed a relative reduction of between 30 and 84%.
Conclusion. — Finally, e-prescribing seems to reduce the risk of medication errors and ADE. However, the studies differed significantly in terms of setting, design, quality and results. More randomized controlled trials (RCTs) are needed to further improve the evidence of health informatics information.

MOTS CLÉS
Ordonnance électronique ;
Erreur médicale ;
Erreur d'ordonnance ;
Santé électronique ;
Effets secondaires des médicaments

Résumé
Introduction. — L'utilisation de systèmes électroniques dans la prescription est considérée comme la solution finale pour surmonter les nombreux problèmes du processus de transcription papier, en particulier avec l'épidémie de coronavirus qui nécessite plus d'attention qu'auparavant. Mais malgré les nombreux avantages, sa mise en œuvre se heurte à de nombreux défis et obstacles. Par conséquent, la présente étude a été menée pour examiner l'efficacité des systèmes informatisés d'entrée des ordonnances des médecins (CPOE) sur la réduction du risque relatif d'erreur de médication et d'événements indésirables liés aux médicaments (ADE).
Méthode. — Cette étude est l'une des études de revue systématique qui a été menée en 2021. Dans cette étude, la recherche de mots-clés tels que E-Electronic Prescription, Patient safety, Medication Errors prescription, Drug Interactions, articles originaux de 2000 à octobre 2020 dans les bases de données valides telles que ISI web of Science PubMed Embase, Scopus et les moteurs de recherche comme google ont été réalisées. Les études incluses étaient basées sur les principaux objectifs de l'étude et sur les critères d'inclusion après plusieurs étapes d'examen et d'évaluation de la qualité. En fait, les principaux critères de sélection des articles étaient les études comparant le taux d'erreurs médicamenteuses avec ou sans évaluation des méfaits associés (réels ou potentiels) avant et après la mise en place des SMU.
Résultats. — Sur 110 études sélectionnées après sélection initiale, seuls 16 articles ont été sélectionnés en raison de leur pertinence. Parmi les études finales, il y avait une hétérogénéité significative. Seules 6 études étaient de bonne qualité. Sur les 10 études prescrivant des taux d'erreur, 9 ont rapporté des réductions, mais des dénominateurs variables ont empêché la méta-analyse. Douze études ont fourni des exemples spécifiques d'erreurs médicamenteuses systémiques. 5 cas ont signalé leur survenue légèrement. Sur 9 cas qui ont analysé les effets sur le taux d'erreur médicamenteuse, 7 cas ont montré une réduction relative significative entre 13 et 99 %. Quatre des six études qui ont analysé les effets sur les EIM potentiels ont montré une réduction relative significative comprise entre 35 et 98 %. Deux des quatre études ayant analysé l'effet des ADE ont montré une réduction relative comprise entre 30 et 84 %.
Conclusion. — Enfin, la prescription électronique semble réduire le risque d'erreurs médicamenteuses et d'EIM. Cependant, les études différaient considérablement en termes de cadre, de conception, de qualité et de résultats. Davantage d'essais contrôlés randomisés (ECR) sont nécessaires pour améliorer encore les preuves de l'information sur l'informatique de santé.

Introduction

Using prescription drugs to provide medicine in the treatment of diseases is one of the most powerful tools in the treatment of diseases and on the other hand, one of the most common medical errors in the field of health occurs in prescribing and sometimes it has serious effects and endangers the patient's health [1].

The electronic prescription system improves the many problems of paper transcription and saves and reduces the cost of care, reduces prescription errors, medication errors, and adverse drug side effects and improves medication and patient health [2,3].

On the other hand, drug therapy is a powerful tool for treating patients. Unfortunately, in some cases, instead of treatment, it can cause loss of life and even death, especially when the prescription is done without recording accurate information about the patient (gender, weight, age, pregnancy, other diseases, etc.) [4].

In the literature, several studies investigate the effects of electronic prescribing on the prescription and medical errors. The findings of these studies showed a reduction in medication errors, although others showed negative effects or an increment in mortality. The existing reviews on this subject seem to not come to a clear inference on the total effects of electronic prescribing, so that published evidence is often insufficient.

About 100,000 people die each year in the United States from preventable medication errors. Medication errors are among the medical errors that are increasing day by day. These errors cause drug side effects and reduce patient's immunity. Statistics show that medication errors affect one in 10 hospitalized patients. However, it is estimated that 21% of prescriptions in the paper transcription system have at least one error in prescribing medication [5].

Research has shown that between 1.7 and 24% of prescriptions are erroneously delivered and 1.5 to 4% of these errors result in injury to patients. Therefore, considering that one of the most common medical errors is errors caused by paper transcription. Paper prescribing endangers the patient's safety and increases the potential for medical errors due to poor handwriting by physicians [6,7].

Today, the wide range of drugs and the large number of multidrug patients have significantly increased the number of drug errors despite the existence of instructions [8,9].

Therefore, it is necessary to conduct studies to examine the experiences of users of electronic prescriptions about the advantages and disadvantages and its role in controlling drug and medical error as one of the important issues related to prescriptions in the patient care system.

This study was aimed to investigate the effectiveness of electronic prescription and its effects in reducing and controlling prescription errors and also reducing medical errors as a systematic review study.

Methods

Research questions

This systematic review looking for answers to the following questions:

- what are the influence of E-prescription in reducing drug interaction errors;
- what are the influence of E-prescription in reducing medical errors(MEs);
- what are the difference of the effectiveness of EP over paper prescribing.

Search strategy

A specialist person developed the literature search strategy from the research questions through the largest online international databases including PubMed, Google Scholar, MEDLINE, Web of Sciences, Scopus, Cochrane Database from 2000 to October 2020 with the corresponding key search terms. The keywords used separately and in combination as following:

''Electronic Prescribing, Electronic Prescription, Medical Errors, Medication Errors, prescription, drug-drug interaction, Drug Interactions''.

The design of this review study was pursuant to the PRISMA guidelines.

Study eligibility

We set all full-text randomized clinical trial studies published with English language at the specified time interval. Intended interventions were an electronic prescribing strategy, that were compared with a control without electronic prescribing support. An EP strategy was determined as a computerized CDSS, or a COPE with or without an embedded clinical decision support system. All studies that have examined electronic prescription and compared it with routine or manual prescription and its effect on reducing medical and medication errors or the effectiveness of methods and presented it in the form of an original research article are included in our study. Also, studies that examined purposes other than the objectives of the study, as well as studies that did not have access to the full text, were excluded from the study, although as much as possible the corresspondig author was contacted to access the full text. Also, studies that reported incomplete results were excluded from the study.

Exclusion criteria were:

Studies just using event reports to recognize errors (due to the known underreporting of errors by incident reports.

Studies identifying PE by chart review and MAE by observation were excluded;the retrospective ones or studies in which; two EP strategies were compared;studies involved several interventions (educating on error decrement, teaching, prescribing reminders);.

Screening, data extraction, and presentation

Two researchers (F.O,M.A) assessed all titles and abstracts independently and Then, by reviewing the selected articles, they reached to a consensus in the entry of articles in the initial stage. Also, the author (MO) confirmed excluded and included studies.in the next stage, full text of included articles reviewed by all authors independently.

A validated data extraction form was deigned, following established theoretical concepts. We took all included publications, in which two categories of general information of

studies such as authors' names, year of study, type of study, purpose of study, target population, sampling method, place of study and in the second part, which is a special section, information about the study outcomes: effectivness on Drug and Medical Errors, Drug Side Effects, and Drug Interactions that are mostly related to the extent or percentage of reduction in the studied outcomes are entered. All of the cases of discordant data were resolved by discussion.

To identify ME rates and ADE rates, their provided definition in each paper used.

In cases where no absolute numbers were presented for ME or ADE, we calculated these numbers according to available information (e.g., if the number of ADEs was only available per1.000 patient-days, we calculated the absolute ADE frequency from the number of patient-days). Also we specified study size, based on the frequency of orders as an observation unit. On the other hand, if these numbers was not given, we used patient-days. In time-series analysis with multiple data, the last reported measurement was considered.

For papers that reported ME and/or PE, error definitions, number of patients, patient days, and error rates at baseline and after the intervention were extracted. For studies that measured mortality, we considered frequency of deaths at baseline and after EMS.

Quality assessment

A quality assessment tool was used for study. This rating process was carried out independently by all of the authors. Interrater reliability was 80%, which was acceptable. Any disagreements about ratings were discussed between all authors until consensus was reached. A score of 8 or more qualifies a study to be of good quality.

Results

Out of 1476 articles, 967 cases were screened and extracted from various databases in the first phase. In the next stage of screening (reviewing the title and abstract of studies) 110 articles were extracted and after receiving the full text of articles and reviewing by two authors and also considering the inclusion and exclusion criteria and after final agreement, finally 16 studies were included. Initially, the rate of agreement between the evaluators was 0.62 by Kappa Cohen criterion, which after discussion and exchange of views between the evaluators, it increased by 0.89, which shows a good value for internal agreement of the evaluators to enter final selected studies.

Descriptive results of the extracted studies

Sixteen studies were included. Key indicators of the studies are reported in Table 1. In these studies, in general, 3 methods were used to collect information separately.

Prospective studies (8 cases): These studies included reviewing of daily electronic prescriptions to identify medication errors. The role of the system in generating identified errors was determined using a predefined method before start of the study.

Drug Error Reporting Databases ($n = 4$) consisted of an unidentifiable drug error reporting program designed for hospitals and health systems that was able to collect and analyze drug errors systematically by accessing the Internet.

Generally, studies were published between 2005 and 2020. The majority of the studies used pre- and post-design, except for two uncontrolled time series studies, a controlled cross-sectional study, and a pre- and post-design study with the presence of control. In grading the quality of articles, it was concluded that 3 studies had a poor grade. 9 studies had moderate grading quality and 4 studies had good quality.

Changes in medication error rate (ME) before and after EMS

Five studies examined the effect of EMS on the incidence of ME, among which 4 studies of moderate quality were evaluated. Differences in the cases and denominators reported in the studies prevented the meta-analysis of these studies in examining the relationship between the introduction of EMS and ME rates.

A significant reduction in ME was reported in 2 of 4 moderate quality studies. One study in a pediatric hospital reported no significant change in error at 9 months after EMS. One study, which was conducted in the intensive care unit of an adult hospital, showed a significant increase in the rate of ME at 3 months of use after EMS.

Prescription error rate (PE) changes before and after EMS implementation

Seven studies evaluated the effect of EMS on PE levels with a range of reported values. Heterogeneity in error rate reporting and study design prevented meta-analysis of the relationship between EMS and PE rate.

EMS, with or without clinical decision support (CDS), was associated with a significant reduction in PE rates in all studies, except for one study, that, this study was also evaluated as poor in quality assessment and no significant change in PE rate was observed per 100 prescriptions. Only one study compared before and after changes in the control group and this study did not show any statistically significant change in PE in the control group.

Changes in medication prescription error rate (MAE) before and after EMS

Three studies evaluated the effect of EMS on MAE. Two studies reported a significant decrease in MAE rates after the intervention. Overall, studies have shown a significant reduction in MAE levels after EMS implementation.

Effect on potential side effects of the drug

Six studies reported ADE risk [10—15]. Three of these studies showed a significant relative reduction with a risk ratio between 0.02 and 0.65, which indicates a relative reduction in risk for potential ADEs between 35 and 98% [10,12,15]. Also three studies showed little effect. Both had relatively few samples. In one of these studies, [11,13,14] no events

Table 1 Characteristics of 16 studies on electronic prescribing.
Caractéristiques de 16 études sur la prescription électronique.

Aurhor country	Time of study	Study setting	Clinical setting	Patients included in study	Intervention	Outcome Medication error	Medical error	Adverse drug effects(ADE)	Significant decrease in measured responses after EMS
VanDoormaal [10] (Netherlands)	2009	CDSS + CPOE vs hand-written	Wards	Internal, gastro, rheum,geriatric *n* = 1195	New computerized order entry with limited clinical decision support	1. Medication errors 2. Dose errors Therapeutic errors Transcription errors Administrative errors		ADE Preventable ADE	Yes
Colpaert [17] (Belgium)	2006	CPOE vs hand-written	intensive care	Intensive care patients	Electronic prescribing was performed 10 months before the start of the study in the intensive care unit. The ICU was integrated with the CPOE system as follows: Protocol-based recommendations on medication, dosage and frequency, warnings about important drug interactions, and drug-related side effects, indicating patient allergy status	Medical errors	Dose Errors		No

Table 1 (*Continued*)

Aurhor country	Time of study	Study setting	Clinical setting	Patients included in study	Intervention	Outcome Medication error	Medical error	Adverse drug effects(ADE)	Significant decrease in measured responses after EMS
Walsh [18] (UK)	2008	To measure the effect of the electronic prescription system, the errors made in the prescribing process were compared using two different systems.	An electronic prescribing system was set up in the ten-bed ICU. Charts of paper and electronic prescription were run in parallel over a 5-month period under a parallel clinical trial	16 patients received 15 paper prescription charts and 16 electronic prescription charts	The electronically produced prescription contained fewer deviations (28 in 329 prescription, 8.5%) than the written prescription (208 in 408 prescription, 51%).				Only a prescription error was observed. There was no significant difference in medical error
Taylor [11] (USA)	2008	Prescriptions were analyzed by pharmacists in three 30-day periods for 3 consecutive years.	Cardiovascular and diabetes groups	In this study, pharmacists performed a 3-level analysis of medical prescriptions	The first course was selected in 2015, seven days after the implementation of the CPOE in both sections. The second and third courses were selected at the same time in 2014 (before CPOE implementation) and 2016 (one year after CPOE implementation), respectively.	Drug error *		ADE	No significant reduction was reported in the study of drug side effects

(*Continued*)

Aurhor country	Time of study	Study setting	Clinical setting	Patients included in study	Intervention	Outcome Medication error	Medical error	Adverse drug effects(ADE)	Significant decrease in measured responses after EMS
Davis [19] (USA)	2014	CPOE vs. handwritten	Hospitalization/surgery	Everyone 24767	In this study, the CPOE electronic prescribing system was performed using clinical support		Drug error * Dose error *		Yes
Devine et al. [20] (USA)	2010	CPOE vs. Handwriting	Various medical facilities under the auspices of the University of Washington	5153 Sample	A quasi-experimental, pretest-posttest study was performed to evaluate the effectiveness of the CPOE administration system	Wrong dose *	prescription error *		No significant reduction was observed for ADE
RamziShawahn [21] (Pakistan)	2010	Electronic prescription of CPOE vs. manual prescription	Hospital records (n = 3300) and 1100 drug clearance sheets	11 wards	In this study, the nature and incidence of prescribing errors were compared before and after the introduction of the electronic registration and prescribing system for hospitalized patients.	Dose error *	Medication error *		Yes

(*Continued*)

Aurhor country	Time of study	Study setting	Clinical setting	Patients included in study	Intervention	Outcome Medication error	Medical error	Adverse drug effects(ADE)	Significant decrease in measured responses after EMS
Usha Sethuraman [14] (USA)	2015	CPOE vs. Handwriting	Pediatric Emergency Department	7268 prescription before and 7292 prescription after CPOE	In this study, a prospective comparison of an outpatient sample was performed 5 months before and after CPOE with EMAS.	CPOE with EMAS was associated with a reduction in overall prescription errors	Dose error		NO
Ahmed Albarrak [12] (Saudi Arabia)	2014	Electronic prescription vs. handwritten prescription	Malek Khalid University Hospital.	Handwriten prescription were received from the clinical units of the Medical Outpatient Unit (MOPD), Primary Care Clinic (PCC) and the Outpatient Surgery Unit (SOPD), while electronic copies were collected from the pediatric ward.	Comparisons between manual and electronic version errors were evaluated based on a valid checklist adopted from previous studies. The readability and completeness of the prescription were assessed.	Dose errors were identified in about 71 (35.7%) of handwritten errors and 5 (2.5%) of electronic prescription errors.		* ADE ADE preventable *	Yes

(*Continued*)

Aurhor country	Time of study	Study setting	Clinical setting	Patients included in study	Intervention	Outcome Medication error	Medical error	Adverse drug effects(ADE)	Significant decrease in measured responses after EMS
Leung et al. [22] (USA)	2012	CPOE vs. Handwritten prescription	Massachusetts Local Hospitals	All patients 2000	In this prospective study, CPOE electronic prescription system was performed for some patients and manual prescription was performed for another group of patients.	Study Outcomes: Drug and Medical Errors, Drug Side Effects, and Drug Interactions	Dose error Dose time error * Dose elimination	Preventable ADE decreased Potential ADEs increased	yes
Marina Vaidotas [13] (Brazil)	2019	Electronic transcription versus traditional transcription	Emergency departments	N/s	In this study, a comparative study of medication errors related to the use of electronic prescriptions and conventional medical prescriptions was performed	Medication error Serious medication error * ME	Medical error *	ADE	Only in star cases was a significant decrease reported
Warrick [23] (UK)	2011	Use electronic prescriptions with CPOE system versus manual prescriptions	PICU	All patients $n = 624$	In this study, the electronic drug registration system was prescribed for children	Prescription prescription errors			NO

(*Continued*)

Aurhor country	Time of study	Study setting	Clinical setting	Patients included in study	Intervention	Outcome Medication error	Medical error	Adverse drug effects(ADE)	Significant decrease in measured responses after EMS
Garner [15] (USA)	2015	CPOE with clinical support system vs. handwritten prescription	NICU	Antibiotics for patients with late sepsis (LOS) *n* = 79	In this study, the electronic prescription of antibiotics was administered using a support system for patients with sepsis.	Medication error * Possible drug error * Dose error *		ADE	yes
Armada et al. [24] (Spain)	2014	N/S	ICU	Adults, heart ward	EMS Electronic drug system	PE, LOS, Mo			
Hinjosa-Amaya [15] (Moscow)	2016	retrospective charts review	General ward	Adults, children	Not reported	ME Medication errors			Yes
Hernandez et al. [16] (France)	2015	Direct observations observed before and after EMS	General ward	Adults, orthopedics	did not elaborate, but did report some warning actions, such as possible drug allergies and drug interactions.	PE*		MAE	Yes only a significant reduction in prescription error

were shown in the intervention group or in the comparison group, therefore, this study was excluded from further analysis. These findings show that the relative risk of ADEs is reduced by 30 to 84%.

The effect of EMS on drug interactions

The study, conducted by Tumblin et al as a cluster clinical trial in primary care, was designed to examine the computer prescribing support system for elderly patients over the age of 66 for specific procedures that were considered inappropriate. The system included drug interaction alerts. Physicians also did not use electronic health records for patients who needed intensive clinical care.

But independent computers with electronic decision support; It was intended for them. The baseline rate of inappropriate prescriptions of drug interactions was 2.5% and no improvement was observed during the study in the intervention group compared to the control group. In a prospective cohort study. One study examined the effect of CPOE on drug interactions in two internal sections. Although the sections were generally similar in terms of demographic characteristics, different providers and methods were considered for prescribing. In one of these sections, the prescription system was done with CPOE and in the other section, the prescription system was done manually. This study showed that 3 years after using CPOE system; This section was able to show a lower rate of drug interactions in the CPOE section during 6 months ($P < 0.01$). Another study found that of the 2522 drug errors reviewed, 1308 (51.9%) were related to CPOE. Of these, CPOE facilitated the error in 171 (13.1%) and potentially could have prevented the error in 1137 (86.9%). The most frequent categories of ''what happened to the patient'' were delays in medication reaching the patient, potentially receiving duplicate drugs, or receiving a higher dose than indicated. The most frequent categories for ''what happened in CPOE'' included orders not routed to or received at the intended location, wrong dose ordered, and duplicate orders [16]. E-prescribing also ensures that patients receive medication on time and also reduces errors due to illegible handwriting.

Another study found that electronic prescription errors were reduced when writing prescriptions, but the process of drug preparation and delivery was still hampered. Prescription errors can also be minimized using e-prescribing guidelines, but prescribing has increased the workload of pharmacists to meet orders, as well as errors in providing information when delivering drugs is electronic.

Discussion

Electronic prescribing is the modification of the prescription writing method using the electronic system through the automated process of adding data to the database using the software and closed transmission network in the hospital, which connects the prescription to the pharmacy [25].

This systematic study investigated use of electronic prescription system (EMS) in hospital wards that previously used paper prescription, with changes in ME (including at least PE and MAE) and any medication and medical errors. The overall effect on patient injury was related to the degree of drug error (data combination in ME, PE and MAE), along with studies that showed positive, negative or unchanged effects after using the EMS system [26,27]. In contrast, there was consistent evidence from the study that a change from a paper-based system to an EMS reduces the likelihood of medication errors, particularly prescription errors [28]. Studies that have reported SREs have shown that implementing a system that includes consistent, flexible, and system-compatible support in response to user input can reduce overall SREs and improve the safety of these systems [29—31].

As with other interventions designed to reduce medication errors, or to use checklists and guidelines, it is not yet possible to comment on whether EMS significantly affects drug-induced damage [32]. The results of the studies show a clear trend in which decisions to implement health information technology such as EMS are based on motivations other than the objectives of this research on effectiveness. Lack of evidence about the effects on the patient's injury in terms of medical error can be expressed in different ways.

First, previous studies and the present study have identified a lack of high quality studies [33,34].

The present systematic review study showed that the use of quasi-experimental study designs without control group, inadequate reporting of data collection methods and lack of reporting between group differences and consideration of potentially confounding variables were the main factors of low study quality. Second,according to this study the EMS system may not significantly affect the extent of drug-related injury in patients due to the functioning of the clinical support system. CDS is an important feature in EMS that is effective in targeting certain types of medication errors, but is limited in many of the EMS systems and has not been well described by researchers. Only three studies reported CDS performance beyond simple system alert notifications. Among the 3 studies that used the advanced CDS system [9,12,19], 2 studies assessed the change in prescription error rate, all of which reported a significant reduction in prescription error rate [9,12]. In these studies, 3 actual injuries were assessed for the patient, in which one injury was not reported and in the remaining 2 studies [9,19], a significant reduction was reported after the implementation of the advanced CDS system.

In this study, we found that the details of the implementation methods of the electronic prescription system in the included studies have not been completely reported. Therefore, it is difficult to determine how these factors can modulate the effectiveness of the system. Ignoring the importance of the organizational and social contexts of the place where EMS is implemented may have a significant impact on the effectiveness of the EMS system.

Implementing EMS can have immediate benefits in terms of standardizing prescription and eliminating routine errors such as illegible prescription, incomplete prescription, wrong doses, and so on.

three of the five studies examining the effect of e-prescribing on ADE drug error rates showed a significant relative reduction for ADEs of 30 to 84%. These findings, which are consistent with the results of other studies, suggest that e-prescriptions can significantly reduce the risk of medication errors, potential ADEs, and the risk of ADE. On the other hand, a small number of studies focused only on

ADE reporting. This may be because medication errors can be easily identified from ADEs.

Clinically, the observed effect size (e.g., up to 99% reduction in medication errors, up to 84% reduction in ADEs) seems very large. However, medication errors and ADEs can only be used as alternative outcomes and are not necessarily directly related to changes in patient outcomes [35].

although the authors reported a significant reduction in prescribing errors that had targeted CDS, no linear association was found between CDS functionality and error reduction, with different results generated across the 2 sites with the same system. These authors concluded that the manner of system implementation may have significantly moderated this association.

On the other hand, real improvements in medical treatment outcomes (e.g., reduction in mortality or hospitalization days) have not yet been sufficiently investigated with quantitative interventional studies [33,36]. In general, more systematic studies on the patient's medical outcomes should be performed in the future. This study includes evidence that the use of EMS is likely to reduce medication errors, especially prescription errors. However, there is less evidence of changes in the extent of harmful drug errors in the studies under review. In addition, few studies have examined the effects of medication error rates.

The successful adoption of EMS requires significant adaption of work practices, acceptance of innovation, and good organizational fit, and the methods of implementation and ongoing improvements in response to user-needs can significantly impact system effectiveness.

In this review study, several robust studies in terms of design and implementation were identified, especially in conjunction with the use of advanced systems with clinical decision support. Therefore, future controlled clinical trial (RCT) studies should be designed to detect changes in medication errors that lead to injury. In general, in this review, the quality of the report and the quality of the studies were not satisfactory in all cases. A major problem was that many studies did not provide sufficient information to properly evaluate intervention group comparisons.

Overall, the reports of some studies were not of sufficient quality. This should be taken into account when interpreting study results. On the other hand, efforts should be made to improve the quality of reporting and study design, as well as the analysis of evaluation studies.

In this study, we focused on medication errors and ADEs, as there was ample evidence and published studies in this area. Existing studies have shown significant heterogeneity. This can indicate the diversity of electronic prescription systems and their use in different studies. Also, studies comparing paper prescription to electronic prescription seem to show a relative decrease compared to studies comparing groups with different levels of electronic prescriptions. Such findings are not unexpected, as some types of errors, such as illegible prescribing, which are often found in paper prescription are completely eliminated with the electronic prescription.

Limitations

The present study also includes some limitations:

First, published studies on electronic transcription differed significantly in the use of terms [26,32,37,38]. In this study, we used different keywords to search for studies. In addition, there is a possibility of diffusion bias, because we only included published studies in this study. The second issue was that the definition of the measured response variable varied between studies.

In addition, our analysis in this study was based on the assumption that a prescription could have a maximum of one error. However, this was not explicitly reported in several studies. On the other hand, due to the large heterogeneity between studies, we could not use meta-analysis to combine the effect size.

Conclusion

Electronic prescribing systems with advanced decision support appear to show a relative reduction compared to those with limited or no decision support. Medication errors associated with improper prescribing are a significant threat to patient safety. Implementing an electronic prescription system with an electronic health record can improve multiple paper transcription problems and save and reduce care costs, reduce prescription errors, medication errors, side effects, improve medication and patient safety. Totally, it can increase the efficiency and quality of care.

Ethical statement

All authors have been personally and actively involved in substantive work leading to the manuscript. All procedures in this study were approved by the ethics board committee of tehran University of Medical Sciences, tehran, Iran ,reference number: IR.TUMS.MEDICINE.REC.1399.1152.

Disclosure of interest

The authors declare that they have no competing interest.

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