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Scoping Review of Computerized Physician Order Entry Systems in Reducing Medical Errors

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ABSTRACT

Background: Medical errors have dramatic clinical and economic consequences. Using various information technology can reduce medical errors and improve services' quality via preventing medical errors. In this study, the role of a computerized medical order entry system was investigated in reducing medical errors.

Methods: This study was conducted as a scoping review. The research question was formulated; then, the inclusion and exclusion criteria, keywords (such as medical errors, adverse event, physician order entry system and control) and search strategy were determined. International databases(Scopus, ProQuest, and PubMed) and manual searches were used. The studies that had the inclusion criteria were entered into the study and were evaluated qualitatively, then information of studies was extracted and summarized.

Results: In total, 16 studies were included. Most studies were about medication errors and adverse medication events. So, it is possible to claim more confidently about reducing medication errors to adverse medication events, since in studies, the impact of this system on medication errors had been further discussed. Some studies have pointed to an increase in error reports due to better checking and error entry with this system, and in general, the positive impact of this action has been mentioned in minimizing errors, especially medication errors and adverse medication events. Positive and significant effects have also been reported on prescribing errors, especially medication prescriptions.

Conclusion: Computerization of medical orders through its positive effects, can be considered a useful and appropriate intervention in increasing patient safety if implemented completely and correctly.

Key words: Medical error, Adverse event, Computerization, Medical order, Scoping review

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Introduction

Contrary to expectations, health systems' existence has not resulted in complete safety for patients worldwide leading to the unavoidable occurrence of medical errors (1, 2). According to a study conducted in 2005 in the US, medical errors accounted for the death of 44,000 to 98,000 hospitalized patients out of 33.6 million cases—a proportion higher than the US annual mortality rate due to accidents, breast cancer, or HIV in the same year (3). Preventing medical errors is among the most important factors for ensuring the quality of care (4) as such mistakes have significant clinical and economic outcomes. Most medical errors cause a few injuries to patients, but some lead to irreparable losses and serious consequences (5). Because of the threat they pose to a patient's welfare and health, they should not be repeated (6).

To reduce medical errors, especially those related to medication, researchers introduced two types of technologies: the computerized physician/provider order entry (CPOE) system and the clinical decision support system (6). Computerized systems for the entry of medical orders enable doctors to order diagnostic tests, prescribe medications, and implement other processes (7). These innovations have been implemented in some hospitals to reduce the rate of medical error occurrence (8). Their role in reducing such errors has been supported by previous research (9), with some studies indicating an 81 % reduction in medication-related mistakes (10). To further illuminate this issue, the current scoping review was carried out to investigate the role and effects of computerization in reducing medical errors, including those associated with the medication.

Materials and Methods

The secondary data collection and data analysis conducted in this paper are described as follows.

A. Identifying studies

Studies published from 2005 to 2018 were searched in the Scopus, ProQuest, and PubMed databases using the following keywords: "medical errors," "preventable medication error," "adverse event," "adverse drug event," "reduction," "prevention," "control," "provider order entry system," "medical order entry system," "physician order entry," "system," "electronic prescribing system," and "computerized order entry systems." Both electronic and manual searches were carried out.

B. Included studies

The inclusion criteria were as follows: studies published in the English language from 2005 to 2018, studies that compared computerized order systems and manual systems, clinical trials, cohort studies, and before-and-after studies.

C. Excluded studies

The exclusion criteria were studies that presented insufficient information on interest and studies that examined several ordering measures simultaneously.

D. Extracting information

After the searches were completed, repetitive cases were eliminated, and other studies for investigation were selected based on the inclusion and exclusion criteria. The texts of the articles were reviewed to extract relevant information. Specifically, the author(s) and years of study, methods used, research locations, baseline error rates, effects under investigation, and research results were also collected. All the extracted information was entered into an information summary form. The results were summarized and reported based on three general categories based on frequency, namely adverse events, medication errors, and prescription errors.

Table 1. Keywords and search strategy

Keywords				
medical errors preventable medication error adverse event adverse drug event	and/ +	provider order entry system medical order entry system physician order entry system electronic prescribing system computerized order entry systems	and/ +	reduction prevention control

Results

This section describes the results of study selection and elaborates on the reviewed studies' characteristics as follows.

A. Study selection

The searches initially yielded 840 documents, out of which 594 studies remained after the elimination of repetitive cases. The remaining studies were subjected to preliminary screening, which involved the review of study titles and summaries. This stage ended with 28 eligible documents, whose quality and texts were reviewed in full based on the inclusion criteria. Next, four studies were excluded because they probed into several medical error reduction measures simultaneously, three were eliminated because of differences in methods, and four others were excluded for failing to pass the qualitative evaluation. We ended with a final sample of 16 studies for analysis. Figure 1 shows the search and selection stages employed in this work.

In general, 16 studies were conducted between 2005 and 2018. One was a clinical trial, one was a quasi-experimental study, two were cohort studies, and 13 were before-and-after interventional studies. Most of them (six studies) were conducted in Intensive Care Units (ICUs), three studies were carried out in hospital wards, four studies were performed in Chemotherapy Units, two studies were conducted in a Surgery Unit, and one study was conducted in a CCU. Table 2 shows final studies under investigation that have been extracted and summarized.

B. Medication errors

The computerization of medical order systems has enabled the rapid identification of errors and the determination of increases in the number of entry errors (11). Computerized systems determine some of the errors that cannot be identified through manual approaches (12). The reviewed studies showed that computerized systems' implementation had reduced the incidence of medication errors (13–15). For example, Shulman et al. (16) indicated that the use of computerized medical order entry systems has minimized considerably small and negligible errors but that significant errors continue to increase (15). One of the studies, conducted in an ICU, reported that using a computerized system for pharmaceutical order entry causes a significant decrease in the intensity and incidence of pharmaceutical errors, specifically four times lower than the error incidence occurring in manual systems (13).

In chemotherapy units, orders' computerization is also a powerful tool with decreased medication errors, particularly those associated with prescriptions (14, 17, 18). Medication errors are less frequent when computerized systems are used than when manual systems are employed. The studies found that the adoption of CPOE systems is related to reducing medication error rates (15), thus ultimately ensuring safe service for patients (16, 18). The rate of serious medication errors in children's wards has been reduced by 7 %, but this percentage decline is less than that observed in adult wards (19).

The use of CPOE and a pharmacist checking medication orders in an orthopedic surgery unit reduced medication errors in the prescribing and administration stages (20). Various studies have highlighted that this system's use improves the quality of service and safety (21,22).

C. Prescription errors

The studies revealed that implementing computerized order systems reduces prescription error occurrence by up to 30 % and errors associated with transfers and calculations (23). The same reduction was also reported for adult wards (24).

D. Adverse events

CPOE systems reduce the occurrence of adverse but preventable medication events. They also minimize medication selection errors and distribution errors (25). The implementation of this technology resulted in increased identification of adverse events, but the system's best advantage is reducing the number of major adverse events that are preventable (26).

Table 2. Final studies under investigation

Study (year)	Study design	Setting	Baseline error rate	Outcome	Conclusion
Shulman et al, (2005)	Cohort	General ICU	41.1 %	Proportion of ME before after 6.7 4.8	A small decrease in medication errors
Colpaert et al, (2006)	A controlled trial	ICU	98.0 %	Incidence of MPEs before after 27.0 3.4	A decrease in medication prescription errors
Huertas et al, (2006)	Before/After	Chemotherapy unit	-	Median of errors before after 0.0 5.0	Help to reduce error
Holdsworth at al, (2007)	Cohort	PICU/ wards	-	ADE/ 100 admissions before after 6.3 3.1	Implementation of COPE associated with a reduction in adverse drug events
Walsh et al, (2008)	Before/After	NICU, PICU, wards	48.2	Error rate before after 44.7 50.9	No effect on pediatric injuries caused by an error
Small et al, (2008)	Before/After	Chemotherapy unit	-	Error rate before after 20.4 11.8	Help to reduce errors
Stone et al, (2009)	Before/After	surgery unit	22.0	Medication error before after 16.0 % 21.0 %	No significant impact on the rate of Medication errors
Shawahna et al, (2011)	before/after	wards	83.8	Error rate before after 16.9 4.4	Significant effect on the reduction of prescribing errors
Mendendez et al, (2012)	Before/After	wards	5.0	Prescribing error per discharge	An increase in medication error
Leung et al, (2013)	Before/After	wards	42.3	Rate of ADE/100admission before after 14.6 18.7	A decrease in the preventable ADE rate
Elsaid et al, (2013)	Before/After	Chemotherapy unit	-	Error rate before after 16.7 11.7	Significantly reduced all types of prescribing errors
Meison et al, (2014)	Before/After	Chemotherapy unit	-	Error rate before after 4.2 0.1	Errors reduced by CPOE
Armada at al, (2014)	Before/After	CCU	-	Error rate before after 44.8 0.8	Reducing preventing errors
Hernandez et al, (2015)	before-after observational study	surgery unit	-	Prescribing error before after 30.2 2.4 administration errors before after	Electronic prescribing led to a decrease in prescribing errors and a decrease in administration errors.

Study (year)	Study design	Setting	Baseline error rate	Outcome	Conclusion
Khammarnia et al, (2016)	before-after prospective study	ICU	-	17.1 14.2 prescription errors before after 19.0 3.0 error rate	Reduced the prescription errors
Pontefract et al, (2017)	Pre intervention/post intervention study	ICU	-		Reductions in the rate of high-risk prescribing errors

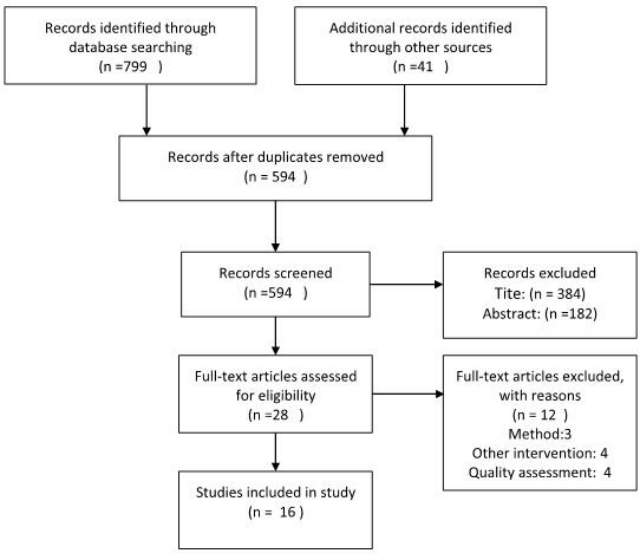

Figure 1. The Process of study selection

Discussion

The scoping review showed that using CPOE systems facilitates the improved identification of medical errors and adverse events at a patient's bedside. Most of the reviewed studies focused on medication errors and adverse events in different clinical environments. Some of the studies mentioned that using CPOE systems increases the rate of reported errors, and most indicated that these technologies reduce medication and prescription errors and exert positive effects on preventable adverse events.

A study on ICU patients reported an increase in the number of forgotten doses (27) attributed to the failure of a manual system to identify this type of mistake (19). The other systematically evaluated studies demonstrated that using CPOE systems reduces medication errors (4, 28). These systems also minimize the risk of potential and preventable adverse medication events (28–32). Few studies have been conducted on adverse medication events; therefore, medication errors can be addressed more confidently than previous events (30). A review study mentioned, "The wrong dose" and "wrong drug" were the most frequent types of errors. Also, the percentage of CPOE-related medication-prescription errors ranged from 6.1 to 77.7 % (31). Eighty-five percent reduction in medication prescribing error rates and a 12 percent reduction in ICU mortality rates were associated with transitioning from paper-based ordering to commercial CPOE systems in ICUs (34). Accordingly, this discussion is directed primarily toward findings on medication errors and the positive impact of CPOE systems on such mistakes.

CPOE systems are similarly indispensable tools for reducing prescription errors (27, 35-37). Such

errors were reduced in the studies conducted in ICU environments (13, 15, 16, 27, 36). However, an important requirement is that CPOE systems be correctly implemented to minimize prescription-related mistakes (38) effectively.

As can be seen, CPOE systems are suitable for reducing risks related to adverse drug events and medication errors (4), but how such systems are operated is an influential factor in their success or failure (38). As previously stated, the correct implementation of these systems should be taken into consideration to ensure that the positive results provided in the studies are also observed in practice.

The reduction of errors and unwanted events will increase the safety of patients (39). The implementation of CPOE systems also improves the quality and value of care for patients (40). A measurable outcome of safety is a change in the number of potential and preventable adverse events (41-44). The review showed that favorable effects on such occasions would increase the safety of patients. At the beginning of using this system, it is thought that the incidence of errors has increased while the error detection has improved, and over time, the number of errors becomes more logical.

The limitation of the review is worth noting. However, all medical errors were incorporated into the inclusion criteria, the initial searches, and the initial and final screening. The final sample comprised only the studies concentrating on medication errors and adverse events and CPOE systems' effects on these problems. Studies on other medical errors, such as improper surgeries and procedures, were not reviewed.

Conclusion

Patient safety and reducing the incidence of medical errors have become priorities for health service providers. On the other hand, in recent years, technology use in this regard has become prevalent. To reduce the risk of drug errors, prescription errors, and unexpected incidents, CPOE systems are a significant step. The implementation of these systems allows drug and prescription errors to be identified quickly and increased. Reducing the number of severe and unwanted, but preventable accidents is one of the most significant benefits of these schemes, as recognizing these issues would result in safer patient care, about treatment. However, an important consideration is that method of implementation is also a factor in the success or failure of this measure. Without proper implementation and the required infrastructure, positive results cannot be achieved. Essential requirements also include ensuring the beneficial effects of CPOE systems on patient safety and quality of care.

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Conflict of Interests

The authors declared no conflict of interests.

Authors' contributions

Alizadeh G and Khosravi MF designed research, conducted research, reviewed the literature, extracted and summarized the results, and wrote manuscript. Jafarzadeh A summarized data and reviewed the literature. All authors read and approved the final manuscript.

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References

1. Miller RA, Gardner RM, Johnson KB, Hripcsak G. Clinical decision support and electronic prescribing systems: a time for responsible thought and action. Journal of the American Medical Informatics Association. 2005; 12(4): 403-9.
2. Teich JM, Osheroff JA, Pifer EA, Sittig DF, Jenders RA. Clinical decision support in electronic prescribing: recommendations and an action plan: report of the joint clinical decision support workgroup. Journal of the American Medical Informatics Association. 2005; 12(4): 365-76.

3. Kawamoto K, Houlihan CA, Balas EA, Lobach DF. Improving clinical practice using clinical decision support systems: a systematic review of trials to identify features critical to success. Bmj. 2005; 330(7494): 765. doi: 10.1136/bmj.38398.500764.8F.
4. Kaushal R, Barker ON, Bates DW. How can information technology improve patient safety and reduce medication errors in children's health care?. Archives of Pediatrics & Adolescent Medicine. 2001; 155(9): 1002-7.
5. Wideman MV, Whittler ME, Anderson TM. Advances in Patient Safety Barcode Medication Administration: Lessons Learned from an Intensive Care Unit Implementation. Henriksen K, Battles JB, Marks ES, Lewin DI, editors. Rockville (MD): Agency for Healthcare Research and Quality (US). 2005; p. 125-128.
6. Cohen M. Medication Errors. American Journal of Pharmaceutical Education. 2007; 79(3): 59.
7. Mantas J. Electronic health record. Studies in Health Technology and Informatics. 2002; 65: 250-7.
8. McCartney PR. Using technology to promote perinatal patient safety. Journal of Obstetric, Gynecologic, & Neonatal Nursing. 2006; 35(3): 424-31.
9. Ajri-Khameslou M, Abbaszadeh A, Borhani F, Farokhnezhad Afshar P. Contributing factors to nursing error in emergency department: A qualitative study. Hayat. 2017; 23(1): 17-32. [In Persian]
10. Kabirzadeh A, Bozorgi F, Motamed N, Mohseni Saravi B, Baradari A, Dehbandi M. Survey on Attitude of Chief Managers of Hospitals Towards Voluntary Incident Reporting System, Mazandaran University of Medical Sciences, 2010-2011. Journal of Mazandaran University of Medical Sciences. 2011; 21(84): 131-7. [In Persian]
11. Darabi F, Amolaee K, Assarezadegan M, Seifi F, Razlansari H, Darestani K, et al. Frequency of Nursing and Midwifery errors in referred cases to the Iranian Medical Council and Imam Reza Training Hospital in Kermanshah. Journal of Kermanshah University of Medical Sciences. 2009; 13(3): 261-6. [In Persian]
12. Khammarnia M, Ravangard R, Ghanbari jahromi M, Moradi A. Survey of Medical Errors in Shiraz Public Hospitals: 2013. Journal of Hospital. 2014; 13(3): 17-24.
13. Alijanzadeh M, Mohebifar R, Azadmanesh Y, Faraji M. The Frequency of Medication Errors and Factors Influencing the Lack of Reporting Medication Errors in Nursing at Teaching Hospital of Qazvin University of Medical Sciences 2012. Journal of Health. 2015; 6(2): 169-79.
14. Siabani S, Alipour AA, Siabani H, Rezaei M, Daniali S. A survey of complaints against physicians reviewed at Kermanshah. Journal of Kermanshah University of Medical Sciences. 2009; 13(1): 15-26.
15. Taheri MR, Khorvash F, Hasan Zadeh A, mahdavi rad M. Assessment of mental workload and relationship with needle stick injuries among Isfahan Alzahra hospital nurses. Medical Journal of Mashhad University of Medical Sciences. 2016; 58(10): 570-7. doi:10.22038/mjms.2016.6765. [In Persian]
16. Shulman R, Singer M, Goldstone J, Bellingan G. Medication errors: a prospective cohort study of hand-written and computerised physician order entry in the intensive care unit. Critical Care. 2005; 9(5): 516.
17. Bagherian Mahmoodabadi H, Setareh M, Nejadnick M, Niknamian M, Aubian A. The Frequency and Reasons of Medical Errors in Cases Referred to Isfahan Legal Medicine Center. Health Information Management. 2012; 9(1): 22-34.
18. Tofighi H, Shirzad J, Ghadi Pasha M. Survey on medical errors reduced to death referred the commission of national legal medicine center from 1995 to 1999. Journal of Forensic Medicine. 2002; 8(27): 5-8.
19. Donaldson MS, Corrigan JM, Kohn LT. To err is human: building a safer health system. Washington: National Academies Press; 2000. p. 129-31.

20. Hernandez F, Majoul E, Montes-Palacios C, Antignac M, Cherrier B, Doursounian L, et al. An observational study of the impact of a computerized physician order entry system on the rate of medication errors in an orthopaedic surgery unit. PloS one. 2015; 10(7).
21. Khammarnia M, Sharifian R, Zand F, Barati O, Keshtkaran A, Sabetian G, et al. The impact of computerized physician order entry on prescription orders: A quasi-experimental study in Iran. Medical Journal of the Islamic Republic of Iran. 2017; 31(1): 1-5.
22. Pontefract SK, Hodson J, Slee A, Shah S, Girling AJ, Williams R, et al. Impact of a commercial order entry system on prescribing errors amenable to computerised decision support in the hospital setting: a prospective pre-post study. BMJ Qual Saf. 2018; 27: 725–36.
23. Adr SS, Ghadyani MH, Zadeh B, Asghar A. Assessment of records of complaints from medical malpractice in the field of orthopedic, in the coroner's Office of Forensic Medicine, province of Tehran, during 1988 to 2003. Journal of Forensic Medicine. 2007; 13(2): 78-86.
24. Abualhasani N. Legal challenges of medical tourism. Bioethics Journal. 2014; 4(12): 81-100.
25. Darwazeh D. Medical Tourism: Establishing a Sustainable Medical Facility: University of Waterloo; 2011.
26. Dabagh A, Akbatri E, Fathi M. Medical errors in the health system. Annals of Military and Health Sciences Research. 2006; 8(2): 43-51.
27. Doshmangir L, Torabi f, Ravaghi H, Akbari Sari A, Mostafavi H. Challenges and Solutions Facing Medical Errors and Adverse events in Iran: A Qualitative Study. Journal of Hospital. 2016; 15(1): 31-40.
28. Ammenwerth E, Schnell-Inderst P, Machan C, Siebert U. The effect of electronic prescribing on medication errors and adverse drug events: a systematic review. Journal of the American Medical Informatics Association. 2008; 15(5): 585-600.
29. Agha L. The effects of health information technology on the costs and quality of medical care. Journal of Health Economics. 2014; 34: 19-30.
30. Baron JM, Dighe AS. Computerized provider order entry in the clinical laboratory. Journal of Pathology Informatics. 2011; 2(3): 35-41.
31. Peikari HR, Zakaria MS, Yasin NM, Shah MH, Elhissi A. Role of computerized physician order entry usability in the reduction of prescribing errors. Healthcare Informatics Research. 2013; 19(2): 93-101.
32. Newell L, Christensen D. Who's counting now? ROI for patient safety IT initiatives. Journal of Healthcare Information Management. 2003; 17(4): 29-35.
33. Korb-Savoldelli V, Boussadi A, Durieux P, Sabatier B. Prevalence of computerized physician order entry systems–related medication prescription errors: A systematic review. International Journal of Medical Informatics. 2018; 111: 112-22. doi: 10.1016/j.ijmedinf.2017.12.022.
34. Prgomet M, Li L, Niazkhani Z, Georgiou A, Westbrook JI. Impact of commercial computerized provider order entry (CPOE) and clinical decision support systems (CDSSs) on medication errors, length of stay, and mortality in intensive care units: a systematic review and meta-analysis. Journal of the American Medical Informatics Association. 2016; 24(2): 413-22.
35. Koppel R, Metlay JP, Cohen A, Abaluck B, Localio AR, Kimmel SE, et al. Role of computerized physician order entry systems in facilitating medication errors. Jama. 2005; 293(10): 1197-203.
36. Stone WM, Smith BE, Shaft JD, Nelson RD, Money SR. Impact of a computerized physician order-entry system. Journal of the American College of Surgeons. 2009; 208(5): 960-7.
37. Menendez M, Alonso J, Rancaño I, Corte J, Herranz V, Vazquez F. Impact of computerized physician order entry on medication errors. Revista De Calidad Asistencial. 2012; 27(6): 334-40.

38. Small MD, Barrett A, Price GM. The impact of computerized prescribing on error rate in a department of oncology/hematology. Journal of Oncology Pharmacy Practice. 2008; 14(4): 181-7.
39. Armada ER, Villamañán E, López-de-Sá E, Rosillo S, Rey-Blas JR, Testillano ML, et al. Computerized physician order entry in the cardiac intensive care unit: effects on prescription errors and workflow conditions. Journal of Critical Care. 2014; 29(2): 188-93.
40. Fernández MJH, Bautista MJM, Arellano EA, Palacios MVG. Impact of computerised chemotherapy prescriptions on the prevention of medication errors. Clinical and Translational Oncology. 2006; 8(11): 821-5.
41. Elsaid K, Truong T, Monckeberg M, McCarthy H, Butera J, Collins C. Impact of electronic chemotherapy order forms on prescribing errors at an urban medical center: results from an interrupted time-series analysis. International Journal for Quality in Health Care. 2013; 25(6): 656-63.
42. Shawahna R, Rahman NU, Ahmad M, Debray M, Yliperttula M, Decleves X. Electronic prescribing reduces prescribing error in public hospitals. Journal of Clinical Nursing. 2011; 20(21-22): 3233-45.
43. Dickens DS, Sinsabaugh D. Impact of computerized prescriber order entry on the incidence of adverse drug events in pediatric inpatients. Pediatrics. 2008; 122(3): 678-9. doi: 10.1542/peds.2008-0084.
44. Leung AA, Schiff G, Keohane C, Amato M, Simon SR, Cadet B, et al. Impact of vendor computerized physician order entry on patients with renal impairment in community hospitals. Journal of Hospital Medicine. 2013; 8(10): 545-52.