Review Article

The impact of electronic prescribing systems on clinical pharmacy practice

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ABSTRACT

This review explores the impact of electronic prescribing (e-prescribing) systems on clinical pharmacy practice, highlighting the potential benefits and challenges associated with their use. Medication errors, a significant concern within healthcare settings, have been shown to decrease with the adoption of e-prescribing, offering a promising tool to enhance patient safety and reduce adverse drug events. However, the transition from traditional handwritten prescriptions to electronic methods introduces new challenges, including the emergence of new types of errors, such as incorrect drug selection, and potential increases in mortality rates, as observed in pediatric patient. Furthermore, it discusses the limited exploration of e-prescribing in primary care and community pharmacy settings, areas that require further investigation to fully understand the benefits and burdens of e-prescribing use. By examining barriers related to person, tasks, environment, tools and technologies, and organizational factors, this review emphasizes the importance of considering various aspects that influence the efficacy and safety of e-prescribing systems. The findings suggest a critical need for incorporating human factors principles in the design and evaluation of these systems to ensure they effectively support clinical pharmacy practice and enhance patient care.

Keywords: E-prescribing, Clinical pharmacy practice, Medication errors, Patient safety, Health information technology

INTRODUCTION

Medication mistakes represent a significant category of healthcare errors.[1] The magnitude and seriousness of issues related to medication errors are challenging to quantify. This difficulty arises because numerous errors remain either unnoticed or unacknowledged by healthcare professionals, often due to a lack of reporting or the frequent introduction of new pharmaceuticals.[2] The likelihood of encountering a prescribing mistake increases with the use of traditional handwritten prescriptions, which are linked to several risk factors. These include incomplete orders for medications, unclear handwriting, and missing patient information, all of which contribute to the difficulty in processing illegible prescriptions.[3]

E-prescribing/computerized physician order entry (CPOE), has emerged as significant tool to reduce medication error rates by addressing risks linked to handwritten prescriptions. Studies have shown that e-prescribing can substantially decrease incidence of medication errors.[4-6]

Despite these benefits, the adoption of e-prescribing is not without its challenges. New types of errors have emerged, such as incorrect drug selection, which represents about 8% of all errors associated with electronic systems, potentially leading to the dispensation of wrong medications.[7,8] Alarmingly, some studies have indicated that the implementation of electronic systems might inadvertently harm patients. A particularly tragic incident in the United States involved the deaths of 25 children due to medication errors over a decade.[9] In Middle Eastern countries, the risk associated with medication errors is reportedly higher than in other regions for several reasons, including inadequate clinical pharmacology services, lower-quality medications, and socio-economic factors that encourage the use of medication without proper consultation or by unqualified individuals.[10] The magnitude of the medication error issue in the Middle East is stark, with over 80% of reported errors deemed preventable, and 34% of these errors being medication-related. These errors contribute significantly to mortality, with 30% of deaths in the Middle East and Africa resulting from preventable incidents.[11,12] The majority of errors in the medication process originate from incorrect prescribing practices.[13]

Research on medication errors in regions like the Middle East, and specifically Egypt, remains limited compared to the extensive studies conducted in the USA and Europe. A 2013 review identified only three trials that examined medication errors in Egypt, focusing exclusively on inpatient and intensive care settings.[10] Recognizing need to address this issue, Egypt has initiated a national reporting program to identify and analyze medication errors. An analysis of reports submitted to this program over six months revealed that 57% of the errors involved prescribing and dispensing, with 13% causing harm to patients.[14] This initiative highlights the critical need for continued efforts to improve medication safety and underscores potential of e-prescribing systems to mitigate errors, provided their risks are carefully managed.

IMPACT OF E-PRESCRIBING

The impact of e-prescribing on patient safety and the quality of care in hospital settings has been extensively studied, highlighting both its potential benefits and drawbacks. While the use of e-prescribing in pharmacies and ambulatory care settings has garnered less attention, research conducted in hospital environments provides valuable insights for its application in community practice. The growing body of empirical evidence, particularly from the work of Ash and colleagues, has explored the negative impacts of e-prescribing on patient safety and prescriber workflow within hospitals.[15-20] These studies, utilizing both qualitative and quantitative methodologies, have identified significant unintended adverse consequences of e-prescribing systems, such as changes in communication patterns, generation of new types of errors, increased clinician workload, unfavorable workflow issues, overdependence on technology, need for continuous system upgrades, persistence of paper, negative attitudes towards technology, and shifts in power structure and work roles.[21,22]

The unintended consequences identified have affected both prescribers and pharmacists, leading to disruptions in workflow and changes in work system design.[23] Poor implementation has been highlighted as a major facilitator of new errors introduced by these systems in hospital settings.[21,24,25] For example, one study reported that 44.3% of errors occurring in the hospital were associated with the presence of e-prescribing system, suggesting these errors might not have occurred with traditional handwritten prescriptions.[25] Hospital pharmacists in this study played a critical role in addressing 524 erroneous medication orders, with intervention times ranging from 0.05 to 552 hours, highlighting that successful correction of e-prescription errors depended on their access to patients' clinical data and having sufficient time. Furthermore, studies have indicated that the detection of medication errors with e-prescribing systems is influenced by the setting, the system's design features, or the nature of prescribers' work. Home-grown systems or those with manual chart reviews have demonstrated a higher capacity for detecting medication errors.[26] However, design issues such as poor dropdown menus, suboptimal screen design, or inaccurate or incomplete patient medication lists can pose significant threats to patient safety.[27] Another study examining the relationship between prescribing errors, e-prescribing technology use, task complexity, and interruptions in healthcare settings found that common errors included incorrect medication selection, dosage, route, and formulation. Interruptions during e-prescribing tasks significantly increased the time needed to complete complex tasks, suggesting that these interruptions could contribute to medication errors, potentially due to a loss of concentration.[8]

PRIMARY CARE SETTINGS

In primary care environments, e-prescriptions are digitally created and dispatched to a pharmacy selected by the patient. Initially, the emphasis on e-prescribing was primarily within hospital contexts, with minimal focus on its application in primary car. However, over time, the benefits of e-prescribing in enhancing safety, quality, and efficiency in primary care during patient care have been recognized and endorsed by policymakers. This technology was anticipated to significantly improve safety in the prescribing and dispensing processes, although the advantages in patient safety and cost-effectiveness in ambulatory practice are still not fully established or understood.[28]

Adoption of e-prescribing in primary care settings is on rise, but its implementation has led to considerable shifts in the way medications are communicated and managed in community pharmacies.[29] Compared to hospital settings, there has been a limited amount of research evaluating impact of e-prescribing in primary care. There is a need for more studies to fully comprehend actual advantages and challenges associated with use of e-prescribing in these healthcare environments.

COMMUNITY PHARMACIES

In community pharmacies, patient safety is often defined as the avoidance of medication errors and the prevention of harm to patients.[28] A key strategy for enhancing patient safety is the widespread implementation of e-prescribing systems, which are aimed at improving the quality of care while reducing healthcare costs.[30] Among all health information technologies (HIT), e-prescribing has garnered the most attention for its potential to enhance patient safety in the medication use process.[31] Despite initiatives to minimize medication errors through e-prescribing, pharmacists play a crucial role in intercepting and correcting errors in the medication use process to ensure the accuracy of dispensed prescriptions.[28]

The safety of e-prescribing in community pharmacies is especially significant, given that these pharmacies are the end recipients of e-prescriptions. The research on safety issues related to e-prescribing in community pharmacies is limited compared to the volume of studies in hospital settings. Unlike hospitals, community pharmacies lack access to real-time patient information, which could aid in identifying inaccuracies on electronically received prescriptions. A UK study demonstrated that pharmacists play an essential role in documenting, intercepting, and preventing e-prescription errors before they can harm patients.[25] This research analyzed 7,920 medication orders for 1,038 patients, with pharmacists intervening in 675 (8.5%) of these orders, highlighting the need for pharmacists to understand and adapt to new types of errors introduced by technological advancements in healthcare, particularly e-prescribing.

Community pharmacists have reported frequent issues with e-prescriptions, such as receiving prescriptions for the wrong drug or incorrect instructions.[28] They have identified significant flaws in the implementation of e-prescribing, both in prescribers' offices and within pharmacy organizations. One study assessing community pharmacists' attitudes toward e-prescribing found that e-prescriptions are prone to unique and unforeseen errors, including incorrect dosage, directions, day supply, dosage form, and patient names.

Challenges associated with e-prescriptions, such as missing of essential information by prescribers, poor system design in pharmacies and prescribers' offices, and inherent technology limitations, highlight that while e-prescribing has potential to improve patient safety, poor design or implementation can pose risks. As use of HIT, including e-prescribing, becomes more prevalent across healthcare settings, recognizing and addressing the safety challenges associated with these technologies is increasingly important.[28]

E-PRESCRIBING CONCERNS

Concerns related to e-prescribing in primary care settings have implications for patient safety in community pharmacies. Despite the advancement of e-prescribing, many pharmacies either do not accept e-prescriptions from primary care or treat them as traditional paper prescriptions due to safety concerns, technological limitations, or incompatibilities with prescriber systems.[28] A study emphasized the importance of involving pharmacies in the e-prescribing process and focusing on work process redesign to fully achieve the quality, safety, and efficiency benefits of e-prescribing.[32]

The initial goal of e-prescribing in ambulatory care was to mitigate errors linked to poor prescriber handwriting and manual data re-entry into pharmacy systems. However, a comparison between electronic and non-electronic prescriptions revealed that e-prescriptions often require more pharmacist clarifications due to missing, inaccurate, or ambiguous information, which could jeopardize patient safety. While e-prescribing aimed to enhance efficiency and cost-effectiveness in transmitting and processing prescriptions, the necessity for frequent clarifications with prescribers may, paradoxically, diminish efficiency and cost-effectiveness for pharmacies. Challenges faced by prescribers in electronically sending prescriptions due to technology limitations or incompatibilities with pharmacy systems also contribute to reduced efficiency.[28]

Functional limitations of ambulatory e-prescribing systems are significant source of safety concerns.[33] Community pharmacists must remain vigilant to identify and address potential medication safety threats.[28] Dependence on prescribers to accurately input information into e-prescribing systems is critical; a study found that 1 in 10 computer-generated prescriptions included at least 1 medication error, with a 3rd of these errors being potentially harmful.[34] This suggests that e-prescribing has not unequivocally enhanced safety and quality in medication dispensing, despite eliminating errors related to illegible handwriting but introducing new types of medication errors.

The increased adoption of HIT, like e-prescribing, does not guarantee improved workflow efficiency and safety. The interaction between healthcare professionals and technology design can lead to safety hazards in patient care.[35] Poor e-prescription design can create technology hazards in both community pharmacies and hospitals, increasing the risk of adverse clinical outcomes.[36,37] Even seemingly harmless designs can undermine patient safety. It is crucial for pharmacists and technicians to proactively report technology hazards associated with e-prescribing

to prevent medication errors. Absence of direct patient harm does not imply safety of current e-prescribing practices in pharmacies. Proactive safety assessments of e-prescribing systems are essential to uncover and address unintended consequences on patient care.

The systems engineering initiative for patient safety (SEIPS) model proved effective in identifying key themes linked to significant elements of the work system that are connected with correcting e-prescribing mistakes in community pharmacies (Table 1).[38]

Table 1: Summarize factors influencing e-prescribing error recovery in community pharmacies.[39]

Component	Description
Person	Experience and training among pharmacy staff range from 3 to 9 years, highlighting that familiarity with e-prescription processes is crucial in managing errors. Those with greater experience are more adept at identifying and rectifying e-prescription errors due to their extensive training and on-the-job experience. The level of drug knowledge is also a significant factor, with well-informed technicians being more efficient in error recovery. Conversely, a lack of understanding about the prescribers' e-prescribing processes poses challenges, suggesting the value of closer collaboration or shadowing prescribers to enhance pharmacy staff's handling of e-prescriptions.
Tasks	Interruptions from phone calls, patients, and other staff members, along with high time pressures, particularly on busy days, pose significant barriers to the effective recovery from e-prescribing errors. These interruptions and pressures lead to multitasking and rushed processing of e-prescriptions, increasing the likelihood of missed errors. The high-pressure environment complicates task prioritization and overwhelms staff, making it challenging to maintain a thorough review process for identifying and correcting e-prescribing errors.
Environment	The physical setup of the pharmacy, including space limitations, noise, poor lighting, and temperature extremes, affects staff's ability to concentrate and communicate effectively, thereby hindering error recovery efforts. External factors such as insurance policies add to the complexity of error correction by necessitating additional steps and communication with prescribers, slowing down the resolution process and impacting the efficiency of handling e-prescriptions.
Tools and technologies	Pharmacy computer systems' design and functionality significantly influence the recovery process from e-prescribing errors. Features like clinical decision support (CDS) assist in detecting errors, but system design issues, such as poor visibility of prescription details and patient profile duplication, challenge efficient error management. Overreliance on technology for error detection without sufficient manual oversight may lead to overlooked errors, indicating the need for a balanced approach to technology use in error recovery.
Organizational factors	Teamwork, communication, training, and staffing levels within the pharmacy are crucial for efficiently addressing e-prescribing errors. Effective teamwork and clear communication, both internally and with prescriber offices, are essential for accurate error identification and correction. However, communication breakdowns can delay this process. Adequate training prepares staff to handle e-prescribing errors more effectively, while sufficient staffing levels ensure prompt and thorough error management, reducing the risk of backlog and the necessity for shortcuts that may compromise patient safety.

FUTURE DIRECTIONS

The lack of comprehensive studies on e-prescribing systems' design characteristics calls for urgent research to mitigate potential risks to patient safety and reduce user workload. Poorly designed systems can lead to clinical errors, increased user challenges, and delayed patient care. The need for user-friendly interfaces and a focus on how e-prescriptions are presented in pharmacies are crucial areas for future investigation. Adopting human factors principles in designing and evaluating e-prescribing systems is essential to enhance patient safety, aligning with successes in other healthcare areas.

This strategy aims to ensure e-prescribing technology supports efficient pharmacy workflows and contributes to improving patient care safety and efficiency.

CONCLUSION

E-prescribing systems have significantly improved clinical pharmacy by reducing medication errors and enhancing safety. However, this progress is accompanied by new challenges, including the emergence of specific error types and elevated risks, indicating the need for ongoing evaluation and system refinement to ensure optimal patient care outcomes.

REFERENCES

1. Donaldson MS, Corrigan JM, Kohn LT. To err is human: building a safer health system. 2000.

2. Bayazidi S, Zarezadeh Y, Zamanzadeh V, Parvan K. Medication error reporting rate and its barriers and facilitators among nurses. J Caring Sci. 2012;1(4):231.

3. Albarrak AI, Al Rashidi EA, Fatani RK, Al Ageel SI, Mohammed R. Assessment of legibility and completeness of handwritten and electronic prescriptions. Saudi Pharm J. 2014;22(6):522-7.

4. Nuckols TK, Smith-Spangler C, Morton SC, Steven MA, Vaspaan MP, Laura JA, et al. The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: a systematic review and meta-analysis. Syst Rev. 2014;3(1):56.

5. Hitti E, Tamim H, Bakhti R, Zebian D, Mufarrij A. Impact of internally developed electronic prescription on prescribing errors at discharge from the emergency department. Western J Emergency Med. 2017;18(5):943.

6. Hernandez F, Majoul E, Montes-Palacios C, Marie A, Bertrand C, Levon D, 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):e0134101.

7. Porterfield A, Engelbert K, Coustasse A. Electronic prescribing: improving the efficiency and accuracy of prescribing in the ambulatory care setting. Perspect Health Inform Manag. 2014;11(Spring):1g.

8. Magrabi F, Li SYW, Day RO, Coiera E. Errors and electronic prescribing: a controlled laboratory study to examine task complexity and interruption effects. J Am Med Inform Assoc. 2010;17(5):575-83.

9. Smith MD, Spiller HA, Casavant MJ, Chounthirath T, Brophy TJ, Xiang H. Out-of-hospital medication errors among young children in the United States, 2002-2012. Pediatrics. 2014;134(5):867-76.

10. Alsulami Z, Conroy S, Choonara I. Medication errors in the Middle East countries: A systematic review of the literature. Europ J Clin Pharmacol. 2013;69(4):995-1008.

11. Aveling E-L, Kayonga Y, Nega A, Dixon-Woods M. Why is patient safety so hard in low-income countries? A qualitative study of healthcare workers' views in two African hospitals. Global Heal. 2015;11:6.

12. Wilson RM, Michel P, Olsen S, Gibberd RW, Vincent C, El-Assady R, et al. Patient safety in developing countries: retrospective estimation of scale and nature of harm to patients in hospital. BMJ. 2012;344:e832.

13. WHO. Medication errors: technical series on safer primary care. In: World Health Organization Geneva; 2016. Available at: https://www.who.int/publications/i/item/9789241511643. Accessed on 2 January 2024.

14. Shehata ZHA, Sabri NA, Elmelegy AA. Descriptive analysis of medication errors reported to the Egyptian national online reporting system during six months. J Am Med Inform Assoc. 2016;23(2):366-74.

15. Ammenwerth E, Schnell-Inderst P, Machan C, Siebert U. The effect of electronic prescribing on medication errors and adverse drug events: a systematic review. J Am Med Inform Assoc. 2008;15(5):585-600.

16. Ash JS, Sittig DF, Dykstra R, Campbell E, Guappone K. The unintended consequences of computerized provider order entry: findings from a mixed methods exploration. Int J Med Inform. 2009;78:S69-76.

17. Ash JS, Gorman PN, Lavelle M, Payne TH, Massaro TA, Frantz GL, et al. A cross-site qualitative study of physician order entry. J Am Med Inform Assoc. 2003;10(2):188-200.

18. Ash JS, Berg M, Coiera E. Some unintended consequences of information technology in health care: the nature of patient care information system-related errors. J Am Med Inform Assoc. 2004;11(2):104-12.

19. Ash JS, Sittig DF, Dykstra RH, Guappone K, Carpenter JD, Seshadri V. Categorizing the unintended sociotechnical consequences of computerized provider order entry. Int J Med Inform. 2007;76:S21-7.

20. Ash JS, Sittig DF, Poon EG, Guappone K, Campbell E, Dykstra RH. The extent and importance of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc. 2007;14(4):415-23.

21. Donyai P, O'Grady K, Jacklin A, Barber N, Franklin BD. The effects of electronic prescribing on the quality of prescribing. Brit J Clin Pharmacol. 2008;65(2):230-37.

22. Campbell EM, Guappone KP, Sittig DF, Dykstra RH, Ash JS. Computerized provider order entry adoption: implications for clinical workflow. J General Internal Med. 2009;24:21-6.

23. Campbell EM, Sittig DF, Ash JS, Guappone KP, Dykstra RH. Types of unintended consequences related to computerized provider order entry. J Am Med Inform Assoc. 2006;13(5):547-56.

24. Webster L, Spiro RF. Health information technology: a new world for pharmacy. J Am Pharmacists Assoc. 2010;50(2):e20-e34.

25. Abdel-Qader DH, Harper L, Cantrill JA, Tully MP. Pharmacists' interventions in prescribing errors at hospital discharge: an observational study in the context of an electronic prescribing system in a UK teaching hospital. Drug Safety. 2010;33:1027-44.

26. Zlabek JA, Wickus JW, Mathiason MA. Early cost and safety benefits of an inpatient electronic health record. J Am Med Inform Assoc. 2011;18(2):169-72.

27. Smith M, Dang D, Lee J. E-prescribing: clinical implications for patients with diabetes. J Diabetes Sci Technol. 2009;3(5):1215-8.

28. Odukoya OK, Chui MA. E-prescribing: a focused review and new approach to addressing safety in pharmacies and primary care. Res Social Administrative Pharmacy. 2013;9(6):996-1003.

29. Armstrong EP, Chrischilles EA. Electronic prescribing and monitoring are needed to improve drug use. Arch Int Med. 2000;160(18):2713-4.

30. Hall LM, Ferguson-Paré M, Peter E, Debbie W, Jeanne B, Anne C, et al. Going blank: factors contributing to interruptions to nurses' work and related outcomes. J Nursing Management. 2010;18(8):1040-7.

31. Kaushal R, Kern LM, Barrón Y, Quaresimo J, Abramson EL. Electronic prescribing improves medication safety in community-based office practices. J General Internal Med. 2010;25:530-6.

32. Crosson JC, Etz RS, Wu S, Straus SG, Eisenman D, Bell DS. Meaningful use of electronic prescribing in 5 exemplar primary care practices. Ann Family Med. 2011;9(5):392-7.

33. Wang CJ, Marken RS, Meili RC, Straus JB, Landman AB, Bell DS. Functional characteristics of commercial ambulatory electronic prescribing systems: a field study. J Am Med Inform Assoc. 2005;12(3):346-56.

34. Nanji KC, Rothschild JM, Salzberg C, Carol AK, Katherine Z, Jim D, et al. Errors associated with outpatient computerized prescribing systems. J Am Med Inform Assoc. 2011;18(6):767-73.

35. Karsh B-T, Weinger MB, Abbott PA, Wears RL. Health information technology: fallacies and sober realities. J Am Med Inform Assoc. 2010;17(6):617-23.

36. Khajouei R, Hasman A, Jaspers MW. Determination of the effectiveness of two methods for usability evaluation using a CPOE medication ordering system. Int J Med Inform. 2011;80(5):341-50.

37. Khajouei R, Jaspers MW. CPOE system design aspects and their qualitative effect on usability. Studies Heal Technol Inform. 2008;136:309.

38. Holden RJ, Carayon P, Gurses AP, Peter H, Ann SH, Ozok AA, et al. SEIPS 2.0: a human factors framework for studying and improving the work of healthcare professionals and patients. Ergonomics. 2013;56(11):1669-86.

39. Odukoya OK, Stone JA, Chui MA. Barriers and facilitators to recovering from e-prescribing errors in community pharmacies. J Am Pharmacists Assoc. 2015;55(1):52-8.