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E-Prescribing: A Focused Review and New Approach to Addressing Safety in Pharmacies and Primary Care

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Summary

E-prescribing, the health information technology (HIT) that enables prescribers to electronically transmit prescriptions to community pharmacies has been touted as a solution for improving patient safety and overall quality of care. However, the impact of HIT, such as e-prescribing on medication errors in acute care settings has been widely studied and show that if poorly designed or implemented, HIT can pose a risk to patient safety by introducing a source of medication errors. Unlike acute care settings, safety issues related to e-prescribing in primary care settings (where e-prescriptions are generated and transmitted) and pharmacies (where e-prescriptions are received) have not received as much attention in the literature. This paper provides a focused review of patient safety issues related to using e-prescribing systems in primary care and pharmacies. In addition, the paper proposes using human factors engineering concepts to study e-prescribing safety in pharmacies and primary care settings to identify safety problems and recommendations for improvement.

Introduction

Introduction to electronic prescribing (e-prescribing)

Handwritten prescriptions have been the primary means of communicating drug choice and therapy of a patient between prescribers and pharmacists. Over time, the hazards associated with handwritten prescriptions such as difficulties with legibility, risk of misinterpretation, and falsification of handwritten prescriptions prompted the adoption of electronic prescriptions (e-prescriptions).¹ Consequently, the use of e-prescribing was promoted as a means of reducing medication errors in pharmacies caused by illegible handwritten prescriptions.² E-prescriptions are generated within e-prescribing systems and are electronically transmitted to pharmacies via a secure network between prescribers and pharmacies.³ E-prescribing involves direct computer-to-computer transmission of prescriptions from physician offices to community pharmacies.^{4,5}

E-prescribing was initially intended to allow for all medication orders to be received and processed electronically thereby completely eliminating the use of paper in the processing of prescriptions in pharmacies. The ultimate goal of implementing e-prescribing was to achieve the following: reduce medical errors, decrease pharmacy costs, improve both prescriber and pharmacy efficiency, eliminate handwriting interpretation errors, reduce phone calls between pharmacists and physicians, reduce data entry, and expedite prescription refill requests.⁶ The use of e-prescribing systems has led to an increase in the number of e-prescriptions being processed pharmacies.⁷ In 2009, 190 million e-prescriptions were processed, compared to 68 million in 2008 and 29 million in 2007. A potential reason for

increasing e-prescription receipt in pharmacies is the allocation of funds worth approximately \$48 billion to encourage the adoption and use of e-prescribing by prescribers. Consequently, the number of e-prescriptions routed to pharmacies grew by 72% between 2009 and 2010.⁷ A growing concern among community pharmacists who are the recipients of e-prescriptions sent by prescribers are the patient safety implications of new kinds of medication errors and information omissions caused by use of e-prescribing.⁸

On the prescribing end: hospital settings

The effect of e-prescribing on patient safety and quality of patient care in hospital settings has been rigorously studied.⁹ Because safety issues associated with using e-prescribing in pharmacies and other ambulatory care settings have received less attention, investigations of e-prescribing use in hospital settings can inform e-prescribing research in community practice. There is a growing body of empirical data on the negative impact e-prescribing can have on patient safety in hospital settings. Ash and colleagues have investigated extensively the implications of using e-prescribing systems in hospital on prescriber's workflow and patient safety.^{10–14} These studies adopted both qualitative and quantitative methods to investigate the major unintended adverse consequences produced by e-prescribing systems in hospital settings. Results from these studies described how prescribers used e-prescribing systems, and the problems and inefficiencies associated with its use. The findings from this line of research have shed light on the unexpectedly high level of unintended consequences and potential patient safety concerns that may arise from the use of this relatively new technology. Examples of such unintended consequences included: changes in communication patterns, generation of new kinds of errors, more and new work for clinicians, unfavorable workflow issues, overdependence on technology, continuous demands for system upgrades, persistence of paper, negative emotions toward the technology, changes in power structure and work roles.^{15,16,15,16}

The identified unintended consequences of e-prescribing systems were reported to have affected both prescribers and pharmacists who were using this technology. Implementation of e-prescribing systems in hospital settings has commonly resulted in disruptions in workflow and changes in work system design.¹⁷ Poor implementation has also been suggested to be the major facilitator of new kinds of errors produced by these systems in hospital settings.^{6,15,18,19} One study reported that 44.3% of errors that occurred in the hospital happened because of the presence of an e-prescribing system and would likely not have happened with traditional handwritten prescriptions.¹⁸ Hospital pharmacists in this study intervened upon 524 erroneous medication orders and the time required for the interventions ranged from 0.05 to 552 hours. These pharmacists were able to correct the e-prescription errors only if they had access to patients' clinical data and had sufficient time. The study also reported that unintentional omission on the part of the prescriber, wrong drug selection, and wrong dosage regimen errors were the most frequent types of prescribing errors that occur with e-prescribing systems.

Generally, the research findings on the effect of e-prescribing on medication errors were at least partially attributed to their settings, the system design features, or the nature of prescribers' work. Studies conducted on home-grown systems (vs. commercial products/systems) or on systems with manual chart review show a higher ability to detect medication errors with e-prescribing.²⁰ One study stated that design features of e-prescribing such as poor drop-down menu, poor screen design, or inaccurate or incomplete patient medication lists especially in certain diseases can pose a threat to patient safety.²¹ Another study that examined the relationship between prescribing errors, use of e-prescribing technology, complexity of tasks and interruptions in healthcare settings reported that common errors that occurred include: selection of incorrect medication, dose, route, and formulation.²² When prescribers were interrupted when performing tasks on e-prescribing systems, they required

almost three times longer to complete complex tasks when compared to simple tasks. Interruptions when using e-prescribing systems was suggested to be a possible contributing factor to medications errors when using this technology possibly due to loss of concentration by the user.

On the prescribing end: primary care settings

In primary care settings, e-prescriptions are electronically entered and sent to the pharmacy of the patient's choice. In the early stages of promoting e-prescribing, it was originally recognized as important primarily in hospitals²³ with little consideration given to its use in primary care environments.²⁴ Over time, the potential of e-prescribing to improve safety, quality, and efficiency in primary care settings during patient care was recognized and recommended by policy makers.^{1,25} It was assumed that this technology would lead to a significant improvement in safety in the process of prescribing and dispensing medications²⁴ even though improvement in patient safety and cost benefits are not well established or understood in ambulatory practice.^{26,27}

E-prescribing use in primary care settings is now growing rapidly⁷, but its introduction has brought about significant changes in how drugs are transmitted and processed in community pharmacies.²⁴ In comparison with hospital settings, a relatively small number of studies have evaluated the impact of e-prescribing use in primary care setting. More research is needed to understand the true benefits and burdens of e-prescribing use in these healthcare settings.

On the receiving end: community pharmacies

Patient safety is commonly thought of in healthcare settings as the freedom from medication errors and patient harm.²⁸ Currently, a leading initiative to enhance patient safety is the universal adoption of e-prescribing systems to increase quality of care while reducing costs.^{29,30} Of all commonly used HIT, e-prescribing has received the most attention for its potential to improve patient safety in the medication use process.³¹ Irrespective of e-prescribing initiatives to reduce medication errors, pharmacists are charged with the responsibility to intercept and mitigate errors in the medication use process before they reach the patient thereby ensuring the accuracy of dispensed prescriptions.¹⁸

Studies on safety of e-prescribing in community pharmacies are particularly important as they are the recipients of the product (e-prescriptions) of e-prescribing systems. The literature on the safety issues related to e-prescribing use in community pharmacies is sparse when compared to studies that have been conducted in hospital settings. Unlike hospital settings, community pharmacies do not have access to real-time patient information that may help them detect when incorrect information is present on the electronically received prescription. A study conducted in a UK hospital showed that pharmacists document, intercept, and prevent errors associated with e-prescriptions before they reach the patient and cause harm.¹⁸ Researchers in this study evaluated 7,920 medication orders for 1,038 patients and pharmacists intervened on 675 (8.5%) of the prescription orders. The study concluded that pharmacists need to understand the new kinds of prescribing errors generated using new technologies used in healthcare delivery, especially related to e-prescribing technology use, for them to be better equipped to detect and prevent errors.

Community pharmacists have indicated that the most frequent issue with e-prescriptions is with prescribers sending the wrong drug or wrong direction on the e-prescription.³² Pharmacists perceive that there are significant weaknesses in how e-prescribing had been implemented in prescribers' offices and in their own pharmacy organizations. One study evaluated community pharmacists' attitudes to e-prescribing.³² Researchers in this study

found that problems exist with e-prescriptions particularly related to new and unanticipated kinds of errors. Examples of such errors include wrong dosage, wrong directions, wrong day supply, wrong dosage form, and incorrect patient name. A follow up study indicated that e-prescribing decreased pharmacy efficiency.⁸ Using e-prescribing resulted in lengthy delays for pharmacists and patients as they await clarification from prescriber offices. Community pharmacists in this study required an average of 6.07 minutes to resolve problematic e-prescription orders resulting in an incremental dispensing cost of \$4.74. However, the study did not compare the rate and time of pharmacists' interventions on e-prescriptions with other types of prescriptions.

Issues associated with e-prescriptions in pharmacies have been reported to be caused by omission of vital information by prescribers, poor design in pharmacies and physician office and other inherent technology limitations. E-prescribing, like other types of HIT has the potential to improve patient safety in pharmacies but if poorly designed or implemented can poses a risk to patient safety.³³ Issues arising from using such HIT safely are increasingly being recognized as more healthcare organizations across the health system implement these technologies.³⁴

E-prescribing concerns originating in primary care that can impact safety in community pharmacies

Many pharmacies are yet to accept e-prescriptions from prescribers in primary care settings³⁵, or may accept e-prescriptions but handle them as conventional paper prescriptions due to perceived safety issues that arise from receiving these prescriptions or due to technology limitation/incompatibilities with prescriber systems. A study on e-prescribing use in ambulatory care reported that paying attention to pharmacy involvement in the use of e-prescribing and a focus on work process redesign necessary is required to fully realized quality, safety and efficiency gains of e-prescribing.³⁶

The original intent of e-prescribing in ambulatory settings was to prevent errors or problems caused by poor prescriber handwriting and manual reentering of data into the pharmacy dispensing system. A study comparing non e-prescriptions and e-prescriptions reported that e-prescriptions necessitated more pharmacist clarification from the prescriber due to missing, inaccurate, or ambiguous information which could negatively impact safety of the patient.¹ Although e-prescribing was intended to improve efficiency and cost effectiveness transmitting and processing prescriptions between prescribers and pharmacists³⁷, it appears that using this technology may also reduce efficiency and cost effectiveness for pharmacies when frequent calls of clarification need to be made to the prescriber.⁸ In addition, a possible reason for reduced efficiency with e-prescribing is because prescribers experience numerous challenges when electronically transmitting prescriptions to pharmacies because of technology limitations or incompatibilities with pharmacy systems.³⁸ The limitations of the functional characteristics of ambulatory e-prescribing systems are a primary cause of safety issues with this technology.³⁹ A resultant effect is that many community pharmacists receiving these prescriptions have to be vigilant to intervene to prevent threats to medication safety and effectiveness in pharmacies.^{4,8,40} Pharmacists are dependent on prescribers to input accurate information into their e-prescribing system. A recent study found that one in 10 computer generated prescriptions such as e-prescriptions included at least one medication error, and a third of these errors were potentially harmful.⁴¹ This indicates that e-prescribing technology has not necessarily improved safety and quality in the dispensing of medications. Although e-prescribing use has eliminated the possibility of error due to illegible prescriber handwriting, it has generated the potential for new kinds of medication errors.

Increased use of HIT such as e-prescribing by healthcare professionals does not automatically translate to workflow efficiency and safety. Interactions between healthcare

professionals (users) and technology design can create patient care safety hazards.³⁴ Poor design of e-prescriptions can create technology hazards in community pharmacies as has also been shown in hospital settings.^{42,43} Technology hazards can increase the risk of bad clinical outcomes. Seemingly benign designs can be unsafe and unintentionally compromise patient safety. Pharmacists and technicians need to report technology hazards with e-prescribing even before a medication error occurs. A lack of actual patient harm does not indicate that e-prescribing technology as currently being used in pharmacies is safe. It is by assessing proactively the safety of e-prescribing systems that the unintended consequences on patient care may be discovered.

Application of Human Factors Engineering to Address Safety of E-Prescribing

What is human factors engineering (HFE)?

New patient safety concerns arise from the use of HIT which are related to the human-computer interaction/interface and proper integration of computer system design to the work structure. System failures and unintended consequences that arise from a mismatch between technology design and work structure create room for potential errors and inefficiencies in workflow.⁴⁴ Patient safety experts have recommended the integration of human factors engineering techniques to redesign HIT⁴⁵, since these methods have been shown to improve patient safety in other industries such as aviation and manufacturing.⁴⁴ Human Factors Engineering (HFE) is a science focused on studying the interactions between people, work systems, environment and how all these important elements might affect safety and human performance.^{46,47} The application of HFE principles to modify the design of HIT has been found to be useful in advancing safety and performance of healthcare professionals.⁴⁸ Human factors approaches involve taking into consideration the knowledge of human abilities and limitations when designing systems or technology to ensure that they are safe, efficient, and comfortable to use.⁴⁹ HFE tools, methods, concepts and theories have been slow to diffuse into healthcare and have often been recommended as key parts to patient safety improvement.⁴⁶

Using HFE to improve safety in technology use in pharmacy

Well known patient safety researchers have recommended the integration of human factors and ergonomics methods to improve patient safety.⁴⁵ However, pharmacy has been slow to incorporate HFE methods to improving patient safety. A potential reason for the slow pace in adopting HFE methods in pharmacy may be due to lack of pharmacists with knowledge of HFE. HFE specialists study the interaction between people and the elements of the system in which they work in, which typically includes technologies, tasks, physical environments, and organizational conditions. Important to HFE is designing better technology to maximize overall system performance and patient safety. Industries such as a commercial aviation and nuclear power industries have traditionally applied HFE methods to systematically identify safety hazards and develop effective and feasible solutions that fit in their existing work system.

Pharmacies can also proactively reduce safety risks related to using e-prescribing technology using HFE methods to identify underlying causes of e-prescribing errors and improve shared situational awareness about issues related to using e-prescribing technology. For example, one study applied a HFE theory to examine differences in design of e-prescribing interfaces in community pharmacies.⁵⁰ Using this approach, the researchers identified strengths and weaknesses of three pharmacy systems used for processing e-prescriptions. In another study, Systems Engineering Initiative for Patient Safety (SEIPS) work system model, a HFE concept was used to assess pharmacy work system characteristics that may impact care

processes.⁵¹ Applying the HFE model helped to identify specific facilitators and barriers that are important to pharmacists' providing cognitive pharmaceutical services such as Medication Therapy Management. HFE approaches to examining e-prescribing usage can help to identify unsafe or uncomfortable work situations to improve efficiency in community pharmacies. The use of this approach to evaluate and improve technology used in community pharmacies is still in its infancy. Concerns about the safety of e-prescribing systems are raising the awareness about the need to address patient safety issues of using these systems. The application of HFE science may help to best understand pharmacists' concerns about safety of e-prescribing, and to improve design of e-prescribing in pharmacies and give a better understanding of how to design safer and effective systems for pharmacies. HFE techniques provide a framework to guide the initial design and continuous redesign of HIT so as to improve quality of patient care.

A primary principle of HFE states that, in order to improve any system or technology it is important to obtain input from end-users who interact frequently with the technology.⁵² This is because the end users are in a unique position to identify its characteristics that are beneficial to day-to-day practice or that can pose a risk to safe delivery of care. In the case of e-prescribing, the end users are prescribers and pharmacists. Because e-prescribing involves users in different work environment, a multidisciplinary team based approach is needed to identify, eliminate or mitigate known errors that can inadvertently result in great harm to patients. HFE principles could play a significant role in improving the design and use e-prescribing⁵³ which may be of benefit to healthcare professionals and reduce the burdens associated with its use. Recommendations obtained through a multidisciplinary approach can assist designers of the technology to better understand the tasks required for end users, variances and preferences in users' physical and cognitive abilities.

HFE approaches are currently being applied to evaluate the benefits and challenges with HIT in hospital settings⁵⁴ but have not been widely used in pharmacies or ambulatory care. Patient safety experts are increasingly obtaining guidance from HFE on how to improve usability of e-prescribing design in hospital settings but no research has looked into community pharmacy. It is clear that usability testing of any HIT is a necessity.⁵⁵ A fundamental design principle of technology usability is transparency and visibility. Qualitative studies of use of computerized provider order entry systems in hospital settings applying HFE approaches have uncovered challenges with usability involving physicians and nurses which lead to errors.⁵⁴ Application of HFE concepts and techniques to improve e-prescribing safety will require collaborative effort from e-prescribing vendors, prescribers, and pharmacists.

Discussion

Patient safety is a global concern and the evidence of the effectiveness of using e-prescribing to enhance patient safety in pharmacies is inconclusive.²⁸ E-prescribing systems can remove certain errors while generating new kinds of errors. Irrespective of the paucity of empirical evidence on the effectiveness of e-prescribing in these settings, regulators still promote the adoption of e-prescribing systems to avoid and prevent medication errors. Disparities in the results on the effects of e-prescribing on medication errors may be due to a lack of time for pharmacy organizations and pharmacists to accurately document all errors associated with e-prescriptions.

The literature on the effect on e-prescribing in community pharmacy practice is sparse, relative to that on physician use in hospital settings. Therefore, research that explores the impact of e-prescribing on pharmacy practice and its benefits to patient safety is warranted. A primary implication of rising volume of e-prescriptions received in community pharmacy

is that errors with e-prescriptions might increase. Some of these errors might also be undetected and result in patient harm and increased healthcare costs in treating adverse drug events if proactive methods of identification of safety issues are not employed. Application of human factors engineering techniques in primary care, where e-prescriptions are generated, and pharmacies, where e-prescriptions are received, may be of benefit to identifying design flaws of e-prescribing systems and provides valuable recommendations for redesign to vendors and policymakers to improve safe use by pharmacists and prescribers. Conducting more e-prescribing research in pharmacy can help create awareness for prescribers on the common problems associated with the creation and transmission of e-prescriptions that are received in pharmacies that can lead to poor patient health outcomes. E-prescribing may have great potential for improving patient safety, pharmacy workflow and communication with prescribers. However, pharmacies have received minimal monitoring for errors and usability.⁵⁶ In order to reduce safety concerns with using this technology in pharmacies, behavioral, cultural and technical changes that accompany using this technology in ambulatory and pharmacies need to be examined.⁵⁶

Future Research

Although the use of e-prescribing has been studied in various settings, very little scientific evidence is available on the design characteristics and capabilities of the available systems.³⁹ Poor software design of e-prescribing systems can be a benign hazard in healthcare settings that can lead to undesirable events. Bad design increases the risk of harmful clinical outcomes and requires more work from the user which also causes delays in patient care as users face challenges in their interaction with the system. Also, no research has been conducted on the various presentations of e-prescriptions in pharmacies and how this might affect patient safety. The application of human factors principles in designing and evaluating e-prescribing in pharmacies may help to positively impact patient safety as has been the case in other settings⁵⁷ and address potential patient safety concerns that may arise from the use of this new technology in pharmacies.

Conclusion

Although e-prescribing can help to address safety issues related to poor handwritten prescriptions it creates new safety concerns in pharmacies that need to be addressed for it to attain optimal potential for improving patient safety and pharmacy staff efficiency. Few studies have looked into the unintended consequences and usability of e-prescribing in community pharmacies. The adoption of technology to support pharmacy services may not always be safer because technologies have limitations. Frequently, these technologies can create new complications in the work system. The unintended consequences of prescriber use of e-prescribing systems may translate to pharmacies who are receiving the e-prescription. This paper proposes integrating concepts from the field of HFE to identify safety hazards and recommendations for improving e-prescribing in pharmacies and other outpatient settings. Such methods have recognized as important for improving patient safety when using HIT in other healthcare settings. Pharmacies and ambulatory care settings should consider embracing HFE techniques to make progress in improving safety of e-prescribing systems.

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