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REVIEW

Causes and consequences of e-prescribing errors in community pharmacies

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Abstract: Major national policy forces are promoting the adoption and use of health information technology (health IT) to improve the quality, safety, and efficiency of health care delivery. One such health IT is electronic prescribing (e-prescribing), which is the direct transmission of prescription information from a provider to a pharmacy. Given research showing that handwritten prescriptions are unsafe and associated errors can lead to tremendous inefficiency for patients and pharmacists, e-prescribing has many potential benefits. However, as with the introduction of any new technology, unintended, adverse consequences may result. The purpose of this review is to explore the causes and consequences of e-prescribing errors in community pharmacies, which are pharmacies not affiliated with a hospital or clinic. Many new types of errors – including provider order entry errors, transcription errors, and dispensing errors – appear to result from e-prescribing. These lead to important consequences for pharmacies, including safety threats to patients, reduced efficiency for pharmacists, processing delays, and increased pharmacy cost. Increased attention to system design and pharmacist training, as well as additional research in this area, will be critical to realize the full benefits of e-prescribing.

Keywords: electronic prescribing, medication errors, community pharmacies

Background

Medication errors are common, costly, and result in significant patient harm, making them a major public health concern. The 2006 Institute of Medicine (IOM) report, *Preventing Medication Errors* estimated that over 1.5 million preventable adverse drug events (ADEs) occur annually in the USA.[1] Many of these occur in the outpatient setting. National costs for preventable ADEs are estimated to be $3.5 billion annually.[1]

Until recently, nearly all prescribing occurred using handwritten prescriptions. Handwritten prescriptions have several associated potential dangers, including the potential for misinterpretation errors due to illegibility. A study evaluating over 9,000 prescriptions written by 78 primary care providers in New York and Massachusetts found that illegibility errors occurred on average more than once per prescription – an alarmingly high rate.[2] In addition to the dangers associated with poor legibility, the need for pharmacy clarification can result in significant extra work for pharmacists as well as delays for patients in obtaining prescriptions.

In order to improve the safety of and efficiency in health care delivery in this country, national policies are promoting the adoption and use of health information technology (health IT).[3,4,5] One of the main types of health IT being targeted through these programs is electronic prescribing (e-prescribing). E-prescribing is the direct computer-to-

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computer transmission of prescription or prescription-related information from the prescriber to a pharmacy, pharmacy benefit manager, or health plan. Prescription information is generated within the context of an electronic order entry system, which often provides the prescriber with clinical decision support (CDS) to aid in the correct prescribing of medications at the point of care.

As a result of these policies, use of e-prescribing has increased dramatically. As of 2013, 7 in 10 community-based physicians were utilizing e-prescribing, 95% of pharmacies were accepting e-prescriptions, and over 6 billion transactions occurred in that year.[6] That is compared to only 7% of physicians e-prescribing as of 2008.[7]

There are many theoretical benefits associated with the increased use of e-prescribing. From a safety perspective, these include a reduction in medication errors as a result of fewer illegible prescriptions, improved prescription ordering due to the CDS embedded in e-prescribing systems, and better ability to track prescriptions. Indeed, studies evaluating the safety effects of e-prescribing in the ambulatory setting have been promising. Multiple studies have shown that e-prescribing can reduce prescription errors.[8–11] Other potential benefits include improved efficiency for pharmacists and providers, decreased need for pharmacy clarification of prescription information via phone calls, and decreased patient wait time for prescriptions.

Despite its potential, it is important to recognize that there are important unintended and adverse consequences that can result from adoption and use of e-prescribing. While most research on unintended consequences has focused on the interplay between prescribers and e-prescribing systems, pharmacists play an integral role in ensuring that patients receive medication safely and have been greatly impacted by the introduction of e-prescribing systems.

The objective of this review article is to examine the causes and consequences of e-prescribing errors in community pharmacies. Community pharmacies are pharmacies not directly affiliated with hospitals or clinics, and are where the majority of prescriptions are filled. A considerable challenge for community-based pharmacists in that unlike hospital-based or clinic-based pharmacists, they generally do not have access to the patient's electronic health record (EHR) and thus have far less information at hand to recognize potential errors.

This review is organized into four sections. The first section is a description of the methodology used to identify relevant articles. The second section reviews the causes of e-prescribing errors, organized according to stage of the medication process. The third section reviews the consequences of e-prescribing errors, organized into three major categories (pharmacy rework, delays for patients, and cost). The last section discusses the implications of this review with a focus on the health policy perspective. Understanding causes and consequences of errors experienced in community pharmacies as a result of e-prescribing will be critical to developing more comprehensive safety strategies and to ultimately realizing the full potential of e-prescribing.

Methods

A comprehensive search was performed in December 2014 by a medical librarian to identify literature on e-prescribing errors among community pharmacies. Potentially relevant articles were found by searching the biomedical electronic databases Ovid MEDLINE, Ovid EMBASE, and The Cochrane Library. A combination of controlled vocabulary and text words were used and translated appropriately to the relevant databases. Results were limited to English language. The primary search was conducted in MEDLINE by use of the terms: exp Electronic Prescribing/OR Clinical Pharmacy Information Systems/OR ((electronic or online or computer$ or automat$) adj3 (prescri$ or medication$)).mp. OR e-prescri$.mp. OR prescri$ system$1.mp. OR erx.mp. AND (safe$ or err$ or adverse).ti, ab. OR exp medication errors/or exp Risk Management/or exp Quality of Health Care/or exp Medical Errors/or exp *Safety/or medical audit/ AND Pharmacies/OR Community Pharmacy Services/OR ((communities or community) adj pharmac$).mp.

This search yielded a total of 268 results. The author reviewed the title and abstract for all articles and reviewed any article in its entirety if it appeared to meet inclusion criteria (focused on causes or consequences of e-prescribing errors in the community pharmacy setting). All references for full articles were also reviewed to identify any additional articles not captured in the original literature review.

Results

Causes of errors

There are many different types of errors related to e-prescribing seen in community-based pharmacies. For the purposes of this review, they have been organized into three broad categories: order entry errors from the provider side, transcription errors, and dispensing errors. Each will be discussed in turn. A summary table is also provided (Table 1).

Table 1 Summary table: causes of e-prescribing errors in community pharmacies

Type of error	Association with e-prescribing
Order entry error from the provider side	
• Wrong drug, pharmacy, patient	• Easy to select incorrectly from drop-down menus
• Incorrect directions, conflicting information	• Autopopulated information may be incorrect or carried over incorrectly from prior prescriptions
• Wrong quantity errors	• Many systems require providers to enter the quantity and type of unit to be dispensed, forcing providers to "guess" if they are unaware
• Refill errors	• Obsolete or incorrect information may be propagated when old refill prescriptions are used as templates
Transcription errors	
• Incorrect physician or a patient selected by pharmacist	• Provider/patient appear differently in order entry and pharmacy databases so pharmacists may guess when multiple choices appear
• Incorrect information entered by pharmacist into pharmacy system	• Provider order entry and pharmacy systems do not directly interface, forcing pharmacists to print prescriptions or memorize information to enter it into pharmacy system
	• System may interface but not all necessary prescription information is available on a single screen
Dispensing errors	
• Errors associated with modified prescriptions	• Because providers cannot modify a sent prescription, they may send two back-to-back, which makes it unclear which is correct
• Incomplete processing of all prescriptions for a single patient	• Prescriptions for the same patient may not arrive at a single time or may be mixed with those of other prescriptions
	• Patients may have e-prescriptions and paper prescriptions (ie, for controlled substances)
• Dispensing of discontinued medications	• Providers may incorrectly assume that simply discontinuing a prescription from the provider side will filter to the pharmacy once that prescription has already been processed
• Duplicate dispensing	• Pharmacy may process a prescription twice if they receive two requests (ie, electronically and by facsimile)

Order entry errors from the provider side

One of the most critical roles for community pharmacists is to recognize and intercept prescription errors before they can reach a patient and cause harm. Thus, new types of ordering errors introduced by e-prescribing are a major concern for pharmacists. A study of 3,850 e-prescriptions generated by providers in three states found that 11.7% contained errors, of which 35.0% were considered potential ADEs.[12] In this study, the most common types of errors were omitted information (particularly duration, dose, or frequency), unclear or conflicting information, and clinically incorrect information.[12] Other studies investigating types of e-prescribing errors related to order entry have found that wrong drug quantity, wrong duration of therapy, wrong dosing directions, and wrong dosing formulations occur frequently.[13–15] Wrong patient and wrong drug errors have also been reported to occur with some regularity.[15]

It is likely that at least some of these errors are a direct consequence of e-prescribing and were generally not seen (or seen with much less frequency) with handwritten prescriptions. For example, it is easy to select the wrong patient, wrong pharmacy, or wrong drug from drop-down menus.[16] Information that is autopopulated into certain prescription fields may help to foster errors such as incorrect directions or conflicting information errors.[13] Many e-prescribing systems require prescribers to enter the medication quantity and type of unit to be dispensed as discrete fields. In contrast, with handwritten prescriptions, providers often wrote "quantity sufficient" in the dispense field, relying on the pharmacist to dispense the appropriate unit and package size. Incorrect guesses on these fields by providers lead to wrong quantity errors.[17] In addition, many providers use old e-prescriptions as the basis to generate refills; failing to update information may result in incorrect or obsolete information being propagated onto the refill prescription.

Transcription errors

While one of the theoretical benefits of e-prescribing is the direct transmission of prescription information to pharmacies, difficulties in directly interfacing and connecting order entry systems with pharmacy technology has resulted in certain types of transcription errors. For example, mismatches between how patient and physician names are stored in

provider and pharmacy data systems can lead to difficulty for pharmacists in identifying the correct provider or patient. In one study, pharmacists reported guessing (sometimes incorrectly) the patient or prescriber for prescriptions when multiple options were possible, or having to spend time clarifying the information with the prescriber's office.[18]

Other studies have reported that pharmacists frequently have to manually transcribe some or all information from e-prescriptions into the pharmacy system due to incompatibilities with pharmacy software, or have to print out e-prescriptions to be able to read all the fields on their computer software.[19] Another workaround used by pharmacists is memorizing information from one screen to allow inputting of information in a different screen.[20] All of these workflow strategies greatly increase the potential of transcription errors.

Dispensing errors

Dispensing errors represent an important concern for pharmacists. A study of dispensing errors in 2003 found that 3% of new prescriptions had associated dispensing errors, which, extrapolated to the number of prescriptions written annually, would represent more than 45 million dispensing errors on an annual basis.[21] There is data to suggest that direct transmission of e-prescriptions to pharmacies, even compared with prescriptions generated using electronic order entry but that are printed or faxed, reduces dispensing errors.[22] However, there remain important types of dispensing errors resulting from e-prescribing that have been identified.

One type of error results from modified prescriptions; because providers cannot alter an e-prescription once it has been sent, pharmacists at times receive back-to-back e-prescriptions for the same patient.[13] This results in confusion on which prescription should be filled, with potential for error. Moreover, because of this, providers often have to call the pharmacy to clarify which prescription should be filled, reducing efficiency for both providers and pharmacists.

Errors around e-prescribing refills have also been described. Providers have been reported to miss electronic refill requests issued by pharmacists, resulting in patient delays in receiving prescriptions and pharmacy rework in calling providers.[19] Pharmacists have also reported concern around incorrect refill prescriptions. This may be a result of the fact that less well-trained staff are sending refill prescriptions because of the ease of ordering these prescriptions electronically compared with handwritten prescriptions that required the provider to write the entire prescription or at least review it before signing.[15]

Another dispensing challenge relates to timing and bundling of e-prescriptions. With traditional paper prescriptions, patients typically arrive in the pharmacy with all prescriptions in hand and there is an expected wait time as the prescription is filled. With e-prescriptions, studies have found that patients may arrive at the pharmacy thinking that the prescription is already filled, when in fact it has not yet been sent or processed.[23] In addition, e-prescriptions for multiple patients may arrive simultaneously, making it more complex to fill all the prescriptions for a single patient at one time. Unless patients have an e-prescription receipt, they may not be completely aware of how many prescriptions are due to be filled. A particular area of difficulty arises from controlled substances, which generally require paper prescriptions. Thus, a patient may have a mixture of paper and electronic prescriptions, again potentially jeopardizing timely filling of all prescriptions for one patient.[18]

Pharmacy dispensing of discontinued medications is another important source of errors related to e-prescribing. One study found that 1.5% of discontinued medications were dispensed, with potential harm in 12% of these cases.[24] It is likely that many physicians incorrectly assume that simply discontinuing a prescription through order entry will result in the prescription being discontinued on the pharmacy end. A related issue surrounds dispensing duplicate medications to patients. At times, pharmacies may receive a facsimile and e-prescription for the same medication.[19] Particularly, if processed by different pharmacists, there is greatly increased potential for duplicate dispensing.

Lastly, research suggests that pharmacists may be more vulnerable to making errors when processing e-prescriptions rather than paper prescriptions because e-prescriptions are not portable unless printed.[20] With paper prescriptions, pharmacists have a tangible, mobile memory aid that can be carried when completing tasks not involving the computer (such as dispensing a medication) or that they can easily refer to when interrupted mid task. In one study, pharmacists at times forgot about tasks completely when distracted while processing an e-prescription.[20]

Consequences of e-prescribing errors

E-prescribing errors can have important consequences for community pharmacists. Three major categories of consequences include the following: 1) rework and reduced efficiency for pharmacists; 2) delays for patients; and 3) cost burden for pharmacies. Each of these will be discussed in turn (Table 2).

Reduced efficiency for pharmacists

With any prescription error, pharmacists must spend time investigating the error in order to safely dispense

Table 2 Summary table: consequences of e-prescribing errors

Consequence	Association with e-prescribing
• Reduced efficiency and rework for pharmacists	• Significant time burden spent investigating errors (often greater than with paper prescriptions) • Decreased time allotted to other important tasks (dispensing medications, counseling patients, administering vaccines)
• Delays in processing for patients	• Increased patient frustration – patients may have unrealistic expectations about wait times because they do not need to bring in the prescription to initiate the dispensing process • Patient harm – result of delays in dispensing important medications due to need for pharmacy clarification
• Increased cost	• Many pharmacies pay a transaction cost for each e-prescription • Incorrect or duplicate prescriptions lead to extra transaction costs • Unfilled prescriptions more common with e-prescriptions leading to increased cost • Cost associated with pharmacist time investigating e-prescription errors

medications to a patient. This can be a significant time burden for pharmacists. A study performed in Sweden found that 2.0% of new e-prescriptions required pharmacist clarification, which was actually significantly more than nonelectronic prescriptions.[25] Notably, nearly 90% of the suggested pharmacist recommendations were accepted by prescribers, underscoring the importance of pharmacists in intercepting potential errors. A similar US-based study found that pharmacists had to intervene on e-prescriptions 11.7% of the time, which was no different than handwritten prescriptions but significantly more than faxed prescriptions and verbal orders.[26]

The impact of problematic e-prescriptions on workflow for pharmacists is striking. One study evaluating the impact of pharmacist workflow on e-prescribing found that after implementation of an e-prescribing system, pharmacists spent 12.9% more time correcting prescription problems and 45.8% more time in problem-solving activities around prescriptions.[27] In addition, there was a small decrease in time actually spent filling prescriptions and communicating with patients. A different study that looked at time to issue resolution for problematic e-prescriptions found that while one-third of issues were resolved in less than 30 minutes, nearly 25% took more than 8 hours to be resolved.[15]

Time away from direct communication with patients may negatively impact some of the more important roles served by pharmacists. This includes counseling patients about medication and side effects, administration of vaccines (now often an important role filled by community pharmacies), and disease management. This is an important area for further study.

Processing delays for patients

As mentioned earlier, because filling an e-prescription does not require a patient to present that prescription to a pharmacist, at times patients arrive in pharmacies incorrectly thinking their e-prescription has been already been processed.[19] This leads to frustration and delays for patients. Several studies have noted patient delays, sometimes lengthy, while pharmacists try to clarify e-prescription errors.[13,14]

Delays in dispensing medications to patient can also be an important source of patient harm. For example, one study of pharmacy callbacks to 22 primary care practices to clarify prescriptions found that pharmacy callbacks were common. Notably, problems for "acute" medications, defined as medications where delays in administration could lead to worsening of a medical condition or prolonged pain, were not resolved on the same day 34% of the time.[28]

Increased cost

There are several types of associated costs for pharmacies that may result from e-prescribing errors. Pharmacies often are responsible for the transaction costs associated with e-prescription processing. Thus, incorrect or duplicate prescriptions may result in the accrual of significant fees for pharmacies. One study, for example, found monthly e-prescription transaction fees of thousands of dollars for a single pharmacy, a large proportion of which was a result of erroneous prescriptions.[19] This same study also found higher rates of unfilled e-prescriptions compared with paper prescriptions, likely due to the fact that filling could be initiated without the first step of the patient bringing in the prescription to the pharmacy.[19] Unfilled prescriptions not only cost pharmacies money for the e-prescription processing fees, but also associated restocking costs. Of course, unfilled prescriptions can also have important health consequences for patients. A study of 195,930 e-prescriptions found that only 78% were filled, with even lower fill rates for new medications.[29] Many of these were medications for chronic conditions, including hypertension, diabetes, and hyperlipidemia.

In addition, the time required by pharmacists for addressing e-prescription errors has important implications for dispensing costs. A study of 68 pharmacies in five states found pharmacists had to intervene 102 times on 2,690 e-prescriptions.[14] The average intervention time required by pharmacists was 6.07 minutes. The authors estimated this represented an incremental dispensing cost of $4.74.

Discussion

This review of causes and consequences of e-prescribing errors among community pharmacies shows that there are a wide variety of errors associated with e-prescribing which can have significant effects on patient safety, efficiency, and cost. While the focus of this review article is community pharmacies, of paramount concern are the potential safety implications for patients associated with the prescribing errors and dispensing delays described earlier. It is estimated that 1.5 million patients experience a preventable ADE annually, leading to 7,000 deaths at a direct medical cost of nearly $21 billion.[30,31] Pharmacists clearly play a critical role in identifying errors and mitigating these numbers, but the public health burden remains substantial and underscores the need for more work in this area.

As shown through this review, an error at any stage can also have a myriad of downstream consequences. For example, an ordering error that requires pharmacist intervention will result in pharmacist time spent clarifying the prescription. This forces the pharmacist away from other roles, such as counseling patients or dispensing medications. Delays in dispensing prescriptions leads to increased patient frustration and potential health impacts if critical medicines (such as antibiotics) are not able to be taken in a timely manner. Lastly, there are increased costs associated with dispensing due to the extra time required by pharmacists to complete all their daily tasks.

From a policy perspective, it is clear that greater research and monitoring into the causes and consequences of e-prescribing errors in community pharmacies needs to be performed. Locally, organizations can create e-prescribing incident report tools to better track errors occurring internally. This has successfully been used to elicit pharmacist perspectives on errors.[15] National organizations, such as the American Medical Informatics Association, have been advocating for additional research investigating the unintended consequences of health IT.[32] The Office of the National Coordinator for Health IT even recently released a guide for health care organizations entitled *Guide to Reducing Unintended Consequences of Electronic Health Records*.[33] Use of these tools may help organizations prioritize system refinements, facilitating safe EHR use and potentially improving provider satisfaction with these systems. Importantly, however, this research must move beyond its traditional focus on providers and health care organizations to pharmacists as well.

There also needs to be an ongoing partnership between providers, pharmacists, and the vendor community to continue to focus on optimizing the design of EHRs and the e-prescribing functionality using a human factors approach. This includes order entry screens, CDS, and the interface between pharmacy and e-prescribing systems. Otherwise, serious order entry, transcription, and dispensing errors will continue to occur. In recognition of the potential negative effects on safety and quality that suboptimal system design can have, increasing national focus is addressing the usability of health IT.[34,35]

Lastly, there needs to be greater attention paid to the training of pharmacists on use of these systems as well as on error and task interruption recovery. Studies have found that many pharmacists receive little or no formal training on use of e-prescribing systems, particularly hires after the systems go-live.[23] Dissemination around best practices for implementation and training, as well as resources for pharmacists and patients, have been developed and may be useful in this regard. For example, the Agency for Healthcare Research and Quality developed a toolkit for pharmacies on e-prescribing.[36] However, ongoing studies must continue and resources developed on an ongoing basis given how rapidly technology changes and advances.

Limitations

There are several limitations to this review. First, our literature search was limited to articles published in English and indexed in Ovid MEDLINE, Ovid EMBASE, and the Cochrane Library. Thus, there may be relevant articles that were not identified. Second, the methodology utilized in the included studies was variable and this review did not perform an objective evaluation of the quality of the individual articles included.

Conclusion

In sum, it is clear that health IT and e-prescribing are critical for advancing health care in this country. Compared with most major industries, health care is way behind. However, there are significant unintended consequences that have been introduced as a result of e-prescribing. Only through careful and ongoing work to understand the causes, consequences, and potential solutions to these unintended consequences, will we be able to truly maximize its potential. Specific recommendations include the following: 1) organizations must monitor unintended consequences locally and more research must be performed broadly in order to better maximize the expected safety benefits from e-prescribing; 2) vendors and pharmacists must partner to optimize the design of e-prescribing systems to better fit pharmacist workflow;

3) organizations must formally train pharmacists on how to best utilize e-prescribing systems, ideally guided by best practices developed and disseminated throughout this health care sector.

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