Unrealized potential and residual consequences of electronic prescribing on pharmacy workflow in the outpatient pharmacy

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ABSTRACT

Introduction Electronic prescribing systems have often been promoted as a tool for reducing medication errors and adverse drug events. Recent evidence has revealed that adoption of electronic prescribing systems can lead to unintended consequences such as the introduction of new errors. The purpose of this study is to identify and characterize the unrealized potential and residual consequences of electronic prescribing on pharmacy workflow in an outpatient pharmacy.

Methods A multidisciplinary team conducted direct observations of workflow in an independent pharmacy and semi-structured interviews with pharmacy staff members about their perceptions of the unrealized potential and residual consequences of electronic prescribing systems. We used qualitative methods to iteratively analyze text data using a grounded theory approach, and derive a list of major themes and subthemes related to the unrealized potential and residual consequences of electronic prescribing.

Results We identified the following five themes: Communication, workflow disruption, cost, technology, and opportunity for new errors. These contained 26 unique subthemes representing different facets of our observations and the pharmacy staff’s perceptions of the unrealized potential and residual consequences of electronic prescribing.

Discussion We offer targeted solutions to improve electronic prescribing systems by addressing the unrealized potential and residual consequences that we identified. These recommendations may be applied not only to improve staff perceptions of electronic prescribing systems but also to improve the design and/or selection of these systems in order to optimize communication and workflow within pharmacies while minimizing both cost and the potential for the introduction of new errors.

INTRODUCTION

Electronic prescribing systems have often been promoted as a tool for reducing medication errors and adverse drug events. Recent evidence has revealed that adoption of computerized and electronic prescribing systems can lead to unintended consequences such as the introduction of new errors. Outpatient pharmacy staff members have increasingly expressed concerns about these errors, since they cause unnecessary delays in the dispensing process and may cause serious patient injuries. In addition, research in inpatient settings has demonstrated that while electronic prescribing has the potential to reduce the incidence of medication errors, it may also lead to unrealized potential or residual consequences in terms of workflow and communication. The unrealized potential and residual consequences have been less well studied in the outpatient setting and as a result, they may hamper the universal adoption of electronic prescribing, limit its effectiveness, and harm patients. Unrealized potential refers to issues that result from the suboptimal design or incomplete implementation of an end-to-end bi-directional electronic prescribing system, and may be improved by fully implementing and/or optimizing these systems. Residual consequences refer to problems inherent in e-prescribing systems that would likely remain even after full system implementation and optimization.

Few studies also exist on the prescribing errors identified by pharmacy staff, and these studies focus largely on manual prescribing processes. Literature on the unintended consequences of electronic prescribing has largely been from the prescriber’s perspective, while the pharmacy staff perspective is uncommonly described. However, the pharmacy staff perspective is critical as electronic prescribing systems have the potential to be a two-way communication system between prescribers and pharmacists, and pharmacists are usually the last safety check before ambulatory patients receive prescribed medications. The purpose of this study is to identify and characterize the unrealized potential and residual consequences of electronic prescribing on pharmacy workflow in an outpatient pharmacy.

MATERIALS AND METHODS

Site selection

We selected our study site based on size and level of independence, including a pharmacy with a sufficiently large staff so that we could learn about a range of perceptions. Observations and interviews were conducted at a large independent pharmacy in Massachusetts with 11 retail pharmacy staff including 3 pharmacists, 4 pharmacy technicians, 1 intern, 1 manager, 1 information technologist and 1 pharmacy owner. The pharmacy started receiving electronic prescriptions in 2008 and processes between 300 and 400 prescriptions per day. At the time of the study, they received 60% of their prescriptions via electronic transmission (termed e-prescribing) and an additional 25% were computerized prescriptions that were printed out and not electronically transmitted. The remaining 15% were manually written prescriptions. Both manual prescriptions and computerized prescriptions that
were not electronically transmitted were excluded from our analysis.

Selection of subjects
We observed all aspects of e-prescribing and all pharmacy staff member activities. For interviews, we purposively selected individuals identified by pharmacy leadership as playing key roles in e-prescribing.

Direct observations
Following Institutional Review Board approval, we conducted direct observations of workflow in the study pharmacy. Observations were conducted by a registered pharmacist and a research assistant, who each recorded field notes in real time. To conduct our observations we used the Rapid Assessment Process, a method developed by Ash and colleagues.\(^{17,18}\) Observers were trained during a one-day course in using this method. Examples of information collected during observations included prescription-related telephone calls made and received by pharmacy staff, prescriptions and refills received, conversations, deliveries received, and disruptions to workflow, including missing information, and unresolved questions regarding prescriptions. The first 4 h of observation were conducted by both observers, and their independent field notes were compared to ensure that they were capturing the same information. Subsequent observations were independently conducted by the two observers. We obtained consent from pharmacy staff to participate in the observations.

Interview guide
Based on prior work related to the implementation of both CPOE\(^{7,19–22}\) and pharmacy bar code scanning systems,\(^ {23}\) we developed a semi-structured interview guide to elicit the pharmacy staff’s perceptions of the unrealized potential and residual consequences of electronic prescribing systems. Online supplementary appendix A includes the questions we asked, although the interviewers were free to probe areas of interest and ask clarifying detailed questions. Interviews were designed to last approximately one half hour and were conducted by at least one investigator on the research team who recorded field notes in real time. Participants were provided with a written summary of the interview and given an opportunity to comment on its accuracy.

Data analysis
We analyzed the direct observation and interview field notes for common subthemes with the aid of ATLAS.ti software (Scientific Software Development, Berlin). Through iterative readings of the field notes using a modified grounded theory approach,\(^ {10,24–25}\) we developed a list of codes to characterize the unrealized potential and residual consequences of electronic prescribing. We defined unrealized potential of e-prescribing as issues that were due to suboptimal design or incomplete implementation of an end-to-end bi-directional electronic prescribing system, and may be improved by fully implementing and/or optimizing these systems. Residual consequences refer to problems inherent in e-prescribing systems that would likely remain even after the system has been fully implemented and optimized.

Using this code list, four independent reviewers (JMR, JJB, CAK, EGP) iteratively reviewed all of the transcripts for themes and subthemes, modifying the theme and subtheme lists and definitions as necessary, until they reached consensus on all the themes and subthemes.\(^ {7,26}\) The reviewers met regularly to discuss emerging themes and subthemes and further delineate the relationships among them.

RESULTS
We conducted 10 observation sessions, for a total of 40 h over 10 weeks in 2010. We also interviewed six subjects, including a pharmacy intern, a pharmacy technician, a staff pharmacist, the pharmacy manager, the pharmacy information technologist and the pharmacy owner. We continued the observations and interviews until we reached information saturation, a point at which we were no longer gaining new information or insights from successive informants.

Table 1 lists our themes (communication, workflow disruption, cost, technology, and opportunity for new errors) and subthemes. While the vast majority of subthemes represented the unrealized potential associated with the electronic prescribing system, the remaining few represented residual consequences associated with its use.

Theme 1: communication
We observed frequent communications between prescribers and pharmacists, pharmacists and patients, and among pharmacists.
Communication issues often led to disruptions in workflow and extra work for pharmacy staff, although workflow issues also surfaced independently.

**Prescriber-pharmacist communication**
Communication between prescribers and pharmacies was predominantly uni-directional (from prescribers to pharmacists) and electronic, causing pharmacists to rely on telephone and facsimile to clarify issues regarding prescriptions, specifically related to refills, modifications and missing and/or conflicting information.

**Refills**
Many pharmacists reported that prescribers often missed electronic refill requests by the pharmacy or may even have had this feature turned off. This led to additional follow up facsimiles and telephone calls by the pharmacists to request refills. The facsimiles were standardized paper forms that allowed the prescribers to make hand-written modifications or comments related to the prescription, sign the request and return it by facsimile to the pharmacy. On several occasions, the pharmacists did not have the prescriber’s current facsimile number or there was a technical problem with either the sending or the receiving facsimile machine. The pharmacy typically made follow-up attempts on three consecutive days prior to phoning the prescriber. Participants reported that this process was seen with both electronic and traditional prescriptions.

**Modifications**
Pharmacists also frequently telephoned prescriber offices to clarify medication doses and modifications. Pharmacy staff noted that in these cases, doses were unclear, missing, or seemed unusual such that they felt they should verify with the prescriber. Furthermore, many of the pharmacy staff members were so distrustful of the electronic changes that they reported telephoning prescribers’ offices for clarification more often than with manual prescriptions. If the pharmacist reached the prescriber by telephone and s/he confirmed the prescription as written, it was processed and dispensed. However, prescribers were often unreachable and processes may not have been in place to allow them to immediately respond to queries. In cases where the prescriber was unreachable by telephone, the pharmacist left messages either with office staff or on an answering machine.

While waiting for a reply, these outstanding issues were detailed on paper and placed in the ‘Doctor Call’ pile, which regularly contained between 30 and 50 cases including drug clarifications, dose clarifications, instruction clarifications, drug formulation changes (such as from regular to extended release tablets) and refill requests. Refill requests were the most frequent issue found in the Doctor Call pile. A pharmacist sorted through the Doctor Call pile every 2 days by checking whether the prescriptions were filled in the computer. If an issue in the Doctor Call pile was resolved, the prescription would be filled in the computer, and the pharmacist could discard the doctor call slip. If the prescription had not been filled in the computer, the pharmacist would place additional telephone calls and send facsimiles to the prescriber’s office. Sorting through the Doctor Call pile was a manual and very time consuming process that our respondents reported was seen with electronic, computerized and manual paper prescriptions, resulting in delays in medication dispensing for the patients.

Prescribers were also unable to electronically cancel or modify prescriptions that were already sent electronically, Prescribers instead telephoned the pharmacy to request that the pharmacist ignore a prescription that was sent and wait for a corrected one to arrive. In one instance, a prescriber called the pharmacy to provide a verbal correction to a prescription.

**Missing and/or conflicting information**
Pharmacists reported frequently encountering missing and/or conflicting information such as patient instructions or quantity to dispense on electronic prescriptions, contributing to the unrealized potential of electronic prescribing systems. Additionally, in several instances, the prescriber requested that the patient instructions be translated into Spanish, a service that the study pharmacy was not able to provide. Thus, patient instructions were missing in these cases, further contributing to the unrealized potential of these systems. The same process for reconciling missing and/or conflicting information was followed as for dose modifications, and this process resulted in the introduction of new errors as described below.

Other information that was often missing or incorrect on electronic prescriptions included patients’ insurance details and prescriber Drug Enforcement Agency (DEA) and/or National Provider Identifier (NPI) numbers, especially on electronic prescriptions that originated from systems whose functionality did not require this information to be present prior to sending the prescription. Finding a prescriber’s DEA and/or NPI number was necessary to fill the prescription and often time-consuming. The pharmacy subscribed to an on-line service that allowed pharmacists to look up this information. If the internet speed was adequate, it took 1–2 min to log in to the system and locate the DEA and/or NPI number. On certain days, the internet speed was slower than normal and it took 5–10 min to find the required information, which was then transcribed onto a piece of paper and retyped into the pharmacy software system. Occasionally, the pharmacist was unable to locate the necessary information and instead telephoned the prescriber to obtain the information.

**Pharmacist-patient communication**
Communication between pharmacists and patients occurred either by telephone or in person. Patients often called the pharmacy to inquire about whether their prescriptions were ready for pickup and/or when they would be delivered, heightening the pharmacy staff’s expectations that electronic prescribing would allow for quicker prescription filling than manual prescribing. In one instance, the pharmacist was speaking with the prescriber on one telephone line and the patient on another telephone line in order to determine which prescriptions to fill and the correct doses and instructions. In several cases, patients arrived in the pharmacy to pick up electronic prescriptions that were not yet received by the pharmacy or had not been processed, resulting in increased patient wait times and disruption to pharmacy workflow.

**Pharmacist-pharmacist communication**
Communication between pharmacies typically occurred by telephone. We observed numerous conversations around prescription transfers between pharmacies when patients transferred their care to a different pharmacy. In these cases, the new pharmacy required access to the patients’ prescriptions in order to verify and dispense the proper medications. This process did not occur electronically. The pharmacy with the existing electronic prescription verbally provided the required information to the new pharmacy. This verbal order was written on a blank prescription and read back to ensure the information was
transcribed correctly. It was subsequently entered manually into the receiving pharmacy’s system.

Theme 2: workflow disruption
The pharmacy software did not provide complete seamless electronic end-to-end communication, from the prescriber’s electronic prescription entry to the patient’s receipt of the prescribed medication, and this resulted in workflow disruption. The pharmacists sometimes printed electronic prescriptions and manually entered the information including the drug, quantity, refills and patient instructions into the pharmacy software system. Often, there was insufficient space for a second monitor to display the electronic prescription so that it could be transcribed into the pharmacy system. Also, due to space constraints, the printer was located far away from the prescription drop-off area.

With the electronic prescribing system, prescriptions were sent directly from the prescriber to the pharmacy, and the patient’s delivery of a paper prescription to the pharmacy was no longer a critical step in the filling process. This resulted in a higher rate of electronic and/or computerized prescriptions that were filled but not picked up by patients. If the prescription was for a new patient, the pharmacy processed the information but suspended the prescription while waiting for the patient to arrive so that the insurance information could be confirmed. These prescriptions were held for up to a month before being restocked. While having the prescription ready in advance saved time for patients, many prescriptions were not picked up and had to be restocked. The pharmacy did not track the number of filled prescriptions that were not picked up or their restocking costs.

Furthermore, we observed instances when prescriptions were dually transmitted, by the electronic prescribing system and by facsimile. These duplicate prescriptions were processed by different pharmacists within the pharmacy, resulting in the potential to dispense the medication twice. This dangerous practice also resulted in inefficiencies as multiple pharmacy personnel worked on filling the same medication, causing frustration among staff with duplicated work. Training new employees in this setting provided additional distraction.

Theme 3: cost
The pharmacy absorbed all of the transaction costs associated with processing electronic prescriptions as well as the fees charged by insurance companies to process the associated insurance claims, termed insurance adjudication and insurance transaction costs. The pharmacy reported that the total transaction costs range from 25 to 50 cents per prescription (25 cents per electronic communication between pharmacy and prescriber), and the insurance adjudication costs (eg, wrong day supply, non-formulary medication, missing prior authorization) ranged from 5 to 20 cents per prescription. On several occasions, the same prescription was sent twice and the pharmacy was responsible for paying the associated fees twice. While specific total costs were not disclosed, we learned that the pharmacy’s monthly transaction costs for electronic prescribing were in the thousands of dollars per month, with a significant proportion of the costs due to the incorrect or incomplete prescriptions.

Theme 4: technology
We observed numerous technology issues involving the use of different software versions as well as the interface between pharmacy and prescribing systems. Connectivity issues impacted the pharmacists’ abilities to look up prescriber, patient and drug information as well as to receive electronic prescriptions.

Connectivity issues resulted in certain prescriptions being received instantaneously while others were delayed up to several hours. This led to dissatisfaction among prescribers and patients who often assumed that the prescriptions were received instantaneously. The delays also resulted in pharmacists working on multiple patient prescriptions simultaneously.

Another phenomenon observed was ‘dual transmission’ where a copy of a prescription that was sent electronically via the pharmacy software would also automatically arrive via facsimile. While the root cause of this phenomenon is unknown, our informants speculated that perhaps excess server load caused the system to transmit prescriptions using a different channel until the server had sufficient capacity to electronically transmit it.

Several technology usability issues were also observed. For example, due to a mismatch in text box size, the pharmacist would sometimes see an incomplete display of the drug name, which resulted in the pharmacist having to look in a second location for the drug name. Another example was observed when electronic prescriptions were printed in the pharmacy and often the information was not displayed in the same sequence as on the screen. Further complicating the pharmacists’ efforts to manage these issues, the pharmacy had cluttered counters due to space constraints, and an insufficient number of telephones and computer stations for all staff members during peak hours.

Theme 5: opportunity for new errors
The communication issues, workflow disruption, cost and technology limitations described above all led to opportunities for new errors. For example, in many instances, the pharmacy software required manual transcription of some or all of the information in the electronic prescription. This introduced the possibility of a transcription error, especially in cases where prescription details, modification or clarifications were reconfirmed by phone as described above.

In addition to transcription errors, verbal orders, corrections or clarification that occurred at the pharmacy level resulted in the opportunity for repeat errors on prescription refills. For example, if there was incomplete or conflicting information, or an error in the original prescription, the pharmacist would take a verbal order from the prescriber, transcribe it on paper and enter it into the system. However, these changes were not made in the prescriber’s software. Thus, when a refill request was subsequently sent by the prescriber, the original incorrect prescription was resent to the pharmacy.

Prescriptions were occasionally submitted with formulary issues such as a medication that was no longer manufactured or covered by the patient’s insurance, requiring the prescriber to select a different drug. Formulary issues resulted in additional telephone calls to the prescriber to clarify his or her intentions, with the resulting possibility of introducing additional errors as described above.

Finally, we observed prescriptions that were electronically sent to the pharmacy for the wrong patient. In these cases the prescriber had selected the incorrect patient, which might be easier to do with electronic prescribing as we did not see similar errors with manual prescriptions.

DISCUSSION
Using a qualitative approach to analyze the unrealized potential and residual consequences of electronic prescribing on pharmacy workflow in an outpatient pharmacy, we identified five major themes: Communication, workflow disruption, cost,
technology, and opportunity for new errors. These themes were associated with 26 subthemes, the vast majority of which represented the unrealized potential of electronic prescribing systems due to their current design and/or incomplete implementation such that they are running in parallel with manual prescribing processes. The remaining represented residual consequences of electronic prescribing systems that would likely persist even when e-prescribing systems have been fully implemented and optimized.

Our results are consistent with the existing literature on retail pharmacy electronic prescribing systems. Odukoya and colleagues used the sociotechnical systems framework to study staff perceptions of electronic prescribing in retail pharmacies and they described a mismatch in text box size in the prescriber and pharmacy systems and a mismatch in patient and/or prescriber details as weaknesses of electronic prescribing systems. Our results reveal these along with several additional opportunities for improvement to electronic prescribing technology. For example, we describe in detail communication issues between prescribers, pharmacy staff member and patients, which has not been well studied in the existing literature. Further, the delineation between unrealized potential and residual consequences associated with electronic prescribing has not been examined to date.

While studies have shown similar rates of workflow disruption between manual and electronic prescriptions, the electronic prescribing process provides opportunity to further reduce this workflow disruption. Based on the themes described above, we identified several strategies to improve the unintended consequences on pharmacy workflow associated with electronic prescribing, and improve its unrealized potential. These strategies can be grouped into technology-based interventions and health care provider-based interventions.

Examples of technology-based interventions include electronic end-to-end communication, forcing functions, prescription tracking and alerts. Electronic end-to-end communication could minimize the instances of hybrid manual entry, paper and electronic system use, and the associated opportunity for error. Further, the introduction of electronic communication channels from the pharmacy to the prescribers’ offices would allow for expedited requests for clarification and missing information. Finally, electronic transfers of prescriptions between pharmacies may streamline the current manual process.

Forcing functions can be designed to prevent omitted information including clinical information, patient insurance information, and provider DEA/NPI numbers. This could considerably improve workflow as reconciling this missing information is a time consuming and error prone process. Consideration should be given to including medication indication as a required data element on prescriptions. This would help to prevent and/or detect medication errors including wrong patient errors and dose errors, as well as facilitate collaboration between prescriber and pharmacist for medication reconciliation and patient education. Tracking systems for abandoned prescriptions would reduce redundant workflow associated with the current processes. Finally, automated, real-time updates on the status of prescriptions as well as patient alerts for prescriptions that are ready to be picked up could improve communication between the pharmacist and patient.

Health care provider-based interventions include financial incentives for pharmacies to participate in the use of electronic prescribing systems, which could be implemented in order to encourage meaningful use of these systems and to help offset the transaction fees that pharmacies incur to process electronic prescriptions. Although electronic prescribing has been promoted by the Medicare Improvements for Patients and Providers Act of 2008 (MIPPA) and the Health Information Technology for Economic and Clinical Health (HITECH) Act, these efforts focus mainly on increasing prescriber usage. Pharmacies can add valuable information to accelerate meaningful use such as maintaining current medication and allergy lists. Incorporating pharmacies into government-funded financial incentive programs for meaningful use may improve the meaningful use of electronic prescribing systems with end-to-end communication. For example, pharmacies that meet the criteria for meaningful use may receive a financial incentive that could offset their electronic prescription transaction costs.

This study has several limitations. First, our observations and interviews were conducted at a single retail pharmacy. While these results may be transferable to other independent pharmacies, large retail pharmacy chains may have additional considerations. Second, we did not conduct observations of the electronic prescribing process in prescribers’ offices. Thus, the results represent the perspectives of the pharmacy staff only. Third, we collected data until we were no longer gaining new information from successive observations or interviews. While this point of information saturation has been used extensively in the literature as a valid end point for data collection, it may be interpreted differently by various teams. Finally, while direct observation may impact the usual staff conduct within the pharmacy setting, studies have demonstrated little impact on behavior.

In conclusion, we used direct observations and key informant interviews to better understand the unrealized potential and residual consequences of electronic prescribing systems in an outpatient pharmacy. The vast majority of unintended consequences involved unrealized potential, and their impact can be minimized by the strategies described above. These data may be applied not only to improve staff perceptions of electronic prescribing systems but also to improve the design and/or selection of these systems in order to optimize communication and workflow within pharmacies while minimizing both cost and the potential for the introduction of new errors.

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REFERENCES
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