Impact of Electronic Prescribing on Medication Use in Ambulatory Care

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Objectives: To investigate differences before and after rollout of electronic prescribing (e-prescribing) in (1) patients' primary adherence to newly prescribed medications, (2) patients' understanding of how to use their medications, and (3) multiple pharmacy use.

Study Design: Postvisit interviews and follow-up phone calls were done with 344 patients at an academic general internal medicine clinic.

Methods: Patient interviews and follow-up phone calls were done (1) before e-prescribing, (2) 1 to 6 months after e-prescribing, and (3) 12 to 18 months after e-prescribing.

Results: Overall, rates of abandoned prescriptions were 6.9% before e-prescribing, 10.6% 1 to 6 months after e-prescribing, and 2.5% 12 to 18 months after e-prescribing ($P = .07$). There was a reduction in awareness of the indication for a newly prescribed medicine among patients after e-prescribing (95.4%, 97.9%, and 89.8%, respectively; $P = .03$). There was a decrease in patients' ability to demonstrate proper use of their new medicine after e-prescribing (69.0% before e-prescribing, 67.1% 1-6 months after e-prescribing, 51.9% 12 -18 months after e-prescribing; $P = .02$). There was an increasing trend in the percentage of patients using multiple pharmacies after e-prescribing was implemented.

Conclusions: We found both potential benefits and unexpected consequences as a result of the rollout of electronic prescribing. Adaptation to e-prescribing might be improved with outreach and education, including explicitly informing patients of the change during the first months of rollout. Tangible prescription information for reminder purposes only may also be beneficial.

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Between 2009 and 2011, there was a 72% increase in electronic prescribing (e-prescribing), from 191 million to 326 million e-prescribed orders.[1] From a quality and safety perspective, e-prescribing has been thought to have the potential to improve patient care by improving clinic efficiency, preventing medication errors, and even improving regimen adherence.[2-8] Yet to date there is limited evidence on the impact of e-prescribing on the patient experience in primary care, including adherence-related concerns.[9-11]

Despite the promise of e-prescribing to improve healthcare quality, a possible consequence could be primary nonadherence (ie, e-prescriptions would actually negatively impact the timely retrieval and purchase of a new prescription). The hypothesis follows that despite the expedited order from prescriber to pharmacy, e-prescribing removes the known tangible reminder to fill a prescription by eliminating the paper prescription. Additionally, it is plausible that the nature of physician-patient communication during a medical encounter on a newly prescribed medicine could change with greater efficiency, which may impact essential patient understanding of what a prescribed medicine is for (indication) and proper daily dosing. Beyond adherence concerns, the process of e-prescribing could lead to issues with medication reconciliation, as it requires patients to identify the pharmacy that they would like the order to be directed to; multiple pharmacies can be entered per patient (eg, pharmacy near work vs pharmacy closer to home). Multiple pharmacy use has been associated with lower compliance, higher risk of potentially dangerous or inappropriate drug combinations, and higher costs of pharmaceutical services.[12-14]

In 2009, our team was conducting baseline interviews as part of a clinical trial evaluating an electronic health record strategy to promote safe, appropriate medication use. Six months later, the clinic implemented e-prescribing for the first time, allowing for a natural experiment to take place. While it was not the original intention of the study, we identified a unique opportunity to leverage extensive data collection to explore several critical research questions. We were able to investigate differences before and up to 18 months after e-prescribing was implemented in the clinic in the following outcomes: (1) patients' primary adherence to newly prescribed medications as determined by rate of prescription abandonment (unfilled prescriptions) and delays in filling a prescription; (2) medication understanding

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as determined by patient understanding of a new prescription medication's indication and demonstrated proper use (number of pills per dose, times taken per day, total number of pills to be taken daily); and (3) multiple pharmacy use.

Take-Away Points

Postvisit interviews and follow-up phone calls among 344 patients (recruited from an academic general internal medicine clinic) were conducted to determine if and when patients picked up their new prescription and their understanding of it.

- Initially, rates of abandoned prescriptions increased after e-prescribing, but they later resolved to rates below baseline.
- There were decreases in patients' ability to demonstrate both proper use of and knowledge about their medication.
- There was an increasing trend of multiple pharmacy use after implementation of e-prescribing.
- These results suggest the need for improved outreach and education during e-prescribing rollout.

METHODS

We conducted a cross-sectional evaluation examining the impact of e-prescribing implementation within 1 primary care clinic, with 3 waves of patient interviews. Specifically, 1 baseline assessment was conducted during the 6 months prior to the implementation of e-prescribing (before e-prescribing), and 2 posttest assessments were performed, the first during the 6 months after implementation of e-prescribing (e-prescribing interval 1) and the second 12 to 18 months after implementation of e-prescribing (e-prescribing interval 2).

Sample

Adult patients (N = 344) receiving care at 1 academic general internal medicine ambulatory care clinic were recruited between September 2009 and March 2011. Three cohorts of patients were recruited: 144 patients before e-prescribing, 127 patients during the first 6 months after e-prescribing, and 73 patients 12 to 18 months after e-prescribing implementation. Individuals were eligible if they (1) were 18 years or older, (2) were established patients at the clinic, (3) had an appointment with their physician on the day of recruitment, and (4) received a new order for a prescription medication during their visit. Patients receiving only orders for refills (ie, no orders for a new prescription medication) were not eligible to participate, nor was anyone with a moderate to severe visual, hearing, or cognitive impairment as determined by clinical staff or the interviewer at the time of recruitment. If patients received both an order for a refill and an order for a new prescription, they were eligible to participate. Patients were also ineligible if they had participated in an earlier interview wave for this study. The Northwestern University Institutional Review Board approved the study prior to its initiation.

Procedure

Trained research interviewers working with clinic physicians and staff identified eligible patients upon their medical encounter at discharge. Specifically, clerical staff provided patients at check-in and discharge with a flyer that described the study in some detail as well as eligibility requirements. Staff directed interested patients to the available research staff who were waiting on site. Those who consented to participate then completed a brief, interviewer-assisted survey that included a literacy assessment. Interviewers notified patients they would receive a follow-up phone call with additional questions about their prescription, such as if and when they filled the medication and how they were taking it.

Measurement

Patients provided information regarding age, sex, marital status, race, education, income, type of insurance, number of medications currently prescribed, and number of comorbid conditions. Each patient also completed the Rapid Estimate of Adult Literacy in Medicine to assess literacy. The encounter discharge summary was reviewed to obtain the name, dose, and frequency information for the newly prescribed medication. Follow-up phone interviews occurred from as early as 6 days to as long as 2 weeks after the initial interview. During these follow-up phone interviews, appropriate medication knowledge (indication, side effects) and proper use (number of pills, number of times per day, time of day) were assessed. Additionally, patients were asked if they had filled their prescription, and if not, the reason for not obtaining the medication and the number of pharmacies used.

Statistical Analyses

Data were analyzed using SAS version 9.2 (SAS Institute Inc, Cary, North Carolina). Descriptive statistics were calculated for each variable. Chi-square tests were used to evaluate the association between sociodemographic characteristics and e-prescribing period according to the time point that patients were recruited into the study (before e-prescribing [n = 144], e-prescribing interval 1 [n = 123], or e-prescribing interval 2 [n = 73]). Differences in primary adherence and multiple pharmacy use were also examined using the χ^2 test, with significance set at $P < .05$. Differences

Table 1. Participant Characteristics, Stratified by Recruitment Period

Variable	Total, %	Before e-Prescribing (baseline), % (n = 144)	After e-Prescribing (1-6 months), % (n = 127)	After e-Prescribing (12-18 months), % (n = 73)	*P*
Age group, y					.13
<40	25.3	31.3	21.3	20.6	
40-49	19.2	15.3	24.4	17.8	
50-59	21.2	22.9	16.5	26.0	
≥60	34.3	30.6	37.8	35.6	
Female	77.9	86.8	70.1	74.0	.003
Race/ethnicity					.55
Black	40.7	37.5	44.9	39.7	
White	43.0	45.1	40.2	43.8	
Hispanic	5.2	6.9	2.4	6.9	
Other	11.1	10.4	12.6	9.6	
Education					.71
≤High school	16.3	16.0	18.1	13.7	
Some college	27.0	29.9	26.0	23.3	
≥College	56.7	54.2	55.9	63.0	
Limited literacy	22.1	17.4	29.1	19.2	.05
Health insurance					.09
Private	69.1	76.4	62.2	66.7	
Medicare	14.9	11.8	20.5	11.1	
Medicaid	8.8	6.9	10.2	9.7	
None/other	7.3	4.9	7.1	12.5	
Number of prescription drugs taken					.41
1-2	38.4	43.1	34.7	35.6	
3-4	25.0	25.7	23.6	26.0	
5-6	15.1	11.1	16.5	20.6	
≥7	21.5	20.1	25.2	17.8	
Number of chronic conditions					.12
0	23.0	29.9	16.5	20.6	
1	22.4	20.1	25.2	21.9	
2	24.1	25.7	24.4	20.6	
≥3	30.5	24.3	33.9	37.0	

e-Prescribing indicates electronic prescribing.

in medication knowledge (indication and proper use) by e-prescribing period were examined as an additional exploratory outcome.

RESULTS

Table 1 presents the sociodemographic characteristics of subjects stratified by e-prescribing period. A total of 428 new medications were prescribed among the 344 patients. Specifically, before e-prescribing, 144 patients were prescribed 187 new medications; during e-prescribing interval 1 (within 1-6 months of implementation), 127 patients were prescribed 160 new medications; and during e-prescribing interval 2 (12-18 months after implementation), 73 patients were prescribed 81 new medications. Patients were demographically representative of the rest of the ambulatory care clinic. There were some differences in demographic data between recruitment periods. More males were included after e-prescribing was

implemented (29.9% in e-prescribing interval 1 and 26.0% in e-prescribing interval 2 vs 13.2% before e-prescribing; P = .003). Patients recruited after implementation of e-prescribing were more likely to have limited literacy (P = .05). While not statistically significant, more patients in e-prescribing interval 2 had 3 or more chronic conditions compared with the 2 other time frames (37.0% e-prescribing interval 2, 33.9% e-prescribing interval 1, and 24.3% before e-prescribing; P = .12). More patients recruited before e-prescribing had private health insurance (76.4% before e-prescribing, 62.2% during e-prescribing interval 1, 66.7% during e-prescribing interval 2; P = . 09) and lower numbers of total prescription medications compared with patients recruited after the implementation of e-prescribing (P = .41).

Overall rates of primary nonadherence varied between recruitment periods (**Table 2**). Nonadherence rates as measured by abandoned prescriptions were 6.9% before e-prescribing, 10.6% during e-prescribing interval 1, and 2.5% during e-prescribing interval 2 (P = . 07). Patient-reported reasons for primary nonadherence included the medication being too expensive or a lack of prescription insurance coverage (20.7%), opting for an over-the-counter medication instead (17.3%), stating that they wanted to wait to see if they felt better (24.2%), and concerns about side effects (3.4%), as well as miscellaneous other concerns (34.4%) such as not liking samples given to them or not wanting to be on too many medications. Nonsignificant trends in delays in filling a prescription were also noted between periods, with 12.3% of patients delaying their time to fill a prescription before e-prescribing compared with 8.5% during e-prescribing interval 1 and 6.4% during e-prescribing interval 2 (P = .28).

Medications were classified into 5 categories: cardiovascular medications (20.1%), antibiotics (16.8%), analgesics/sedative hypnotics (14.5%), over-the-counter medications such as those for colds/allergies (12.2%), and "other" medications (36.4%). The other category included prescriptions that had too small a number to be included in a separate category (<5% of prescriptions). This category included antidepressants, hormones, anticonvulsants, and muscular-skeletal, antimalarial, gastrointestinal, diabetic, respiratory, triptan, eye and ear, and dermatology medications. There were minor differences in medication category by e-prescribing period, as there were slightly fewer over-the-counter medications prescribed and slightly more analgesic/sedative hypnotics in e-prescribing interval 2. Prescriptions were also classified as acute or chronic medications. There were no differences in acute versus chronic medications by e-prescribing period (36.4% were chronic medications before e-prescribing, 30.0% during e-prescribing interval 1, and 41.3% during e-prescribing interval 2; P = .19). No differences in adherence rates were found by medication type or by chronic versus acute.

An increasing but nonsignificant trend was noted in the percentage of patients using multiple pharmacies after e-prescribing was implemented (20.0% before e-prescribing, 26.5% during e-prescribing interval 1, and 30.1% during e-prescribing interval 2; P = . 23). Interestingly, among patients with adequate literacy skills, rates of prescription abandonment did not change from before e-prescribing to e-prescribing interval 1, but decreased approximately 50% by e-prescribing interval 2 (8.7% vs 8.9% vs 3.1%). Among patients with limited literacy skills, 0% of prescriptions were abandoned before e-prescribing, but 14.6% of prescriptions were abandoned during e-prescribing interval 1. The prescription abandonment rate returned to 0% during e-prescribing interval 2. No other trends were found by literacy or age group.

Exploratory analyses also involved determining patients' understanding of physician instructions, including knowledge of a medication's indication and proper dosing. Rates of proper medication understanding varied between recruitment periods (Table 2). There was a reduction in patients' awareness of the indication for a newly prescribed medicine after e-prescribing (95.4% before e-prescribing, 97.9% during e-prescribing interval 1, and 89.8% during e-prescribing interval 2; P = .03). More notable was the decrease in patients' ability to demonstrate proper use of their new medicine after e-prescribing (69.0% before e-prescribing, 67.1% during e-prescribing interval 1, and 51.9% during e-prescribing interval 2; P = . 02).

DISCUSSION

Our study sought to add to the currently limited available evidence around the implementation of e-prescribing and its potential to improve patient safety and outcome without compromising healthcare quality.[11] We documented an initial increase in abandoned prescriptions immediately following the implementation of e-prescribing. However, with time, these issues were resolved and even improved to rates lower than baseline. Other differences that were found between the before and after e-prescribing periods included slight increases in multipharmacy use and poorer patient understanding of a newly prescribed medication's indication and instructions for use. There a few possible explanations for these findings.

First, the immediate increase in abandoned prescriptions could reflect the process of adaptation to a significant change to primary care practice, for both providers and patients. In a prior study, one-third of patients surveyed were unaware of e-prescribing and 12% did not know a prescription had been sent.[15] Without an explicit orientation to the new process,

Table 2. Patient Medication Adherence, Understanding, and Multiple Pharmacy Use, Stratified by Recruitment Period

Outcome	Before e-Prescribing (baseline), % (n = 144)[a]	After e-Prescribing (1-6 months), % (n = 127)[a]	After e-Prescribing (12-18 months), % (n = 73)[a]	*P*
Primary adherence				
Unfilled prescription(s)	6.9	10.6	2.5	.07
More than 1-week delay in filling prescription	12.3	8.5	6.4	.28
Understanding of medication use				
Aware of indication	95.4	97.9	89.8	.03
Demonstrated proper use	69.0	67.1	51.9	.02
Multiple pharmacy use	20.0	26.5	30.1	.23

e-Prescribing indicates electronic prescribing.
[a]Each patient had a mean of 1.5 new medicines (standard deviation, 0.89).

patient confusion might be expected. A previous study examining pharmacy record data found that prescriptions delivered electronically were 1.64 times as likely to be abandoned compared with those that were not electronic (P = .001).[10] However, this is likely due to higher transmission rates, as it is difficult to accurately determine rates from handwritten prescriptions that often are never delivered to the pharmacy. In another investigation using more precise insurance claims information, e-prescriptions transmitted directly to the pharmacy were more likely to be purchased than those given directly to the patient.[9] There may be a learning curve after implementation of e-prescribing, and our single-site study ultimately demonstrated resolution of any problems with time.

Second, while there appear to be benefits to e-prescribing over time in terms of primary adherence, we also found unexpected consequences. The poorer knowledge demonstrated by patients of their prescription's indication for use and dosing instructions could be a spurious finding. Yet it might also suggest that this new automated prescribing process improved a physician's efficiency at the cost of some elements of spoken patient communication. Another possible explanation might be that patients relied on the tangible, handwritten prescription they previously received from their doctor to obtain the indication and instructions for use**.** From our data, we do not have the ability to answer this question with any certainty.

Third, though e-prescribing was associated with a slight increase in use of multiple pharmacies, this increase was not statistically significant. Compared with before e-prescribing, there was a 50% relative increase in multiple pharmacy use during e-prescribing interval 2. This would seem understandable, though, as e-prescribing allows and even encourages use of multiple pharmacies by entering as many pharmacies as are used by a patient into the electronic record system. That may be a potentially problematic health system trend, as patients increasingly have multiple prescribers and more complex medication regimens that will be dispersed further across practices and pharmacies that do not adequately communicate with one another.[11,16] Future studies might investigate use of multiple pharmacies as a risk for medication reconciliation and patient safety.

There are several limitations to this study. Results were based on patient self-report; therefore, rates of nonadherence were unrealistically low. There may have been social desirability bias in reporting adherence to new prescription medications. We did not have access to claims data that could have monitored primary adherence more objectively. In our study, new prescriptions were classified into types of medications prescribed and acute versus chronic. Primary adherence did not differ by either classification. This is surprising, as a previous study assessing 82,245 new e-prescriptions found that primary nonadherence was frequent for medications treating chronic conditions.[17] However, pharmacy claims data were leveraged, allowing adherence to be assessed more objectively.

Furthermore, selection bias may have occurred, as it is possible that patients willing to enroll in a research study could differ from those unwilling to participate. Patients consenting to participate were aware that they would be receiving follow-up phone calls regarding their medicines, so results presented may vastly underestimate rates of nonadherence. Additionally, results were based on a relatively small sample of patients. Only new prescriptions were assessed, so adherence measures for other medications taken were not quantified. Finally, this study was a natural experiment examining the implementation of e-prescribing at 1 clinic. Since this was not the original intention of the study, it was not adequately powered to detect these small differences in primary adherence or medication understanding in study outcomes, and we did not pursue multivariable modeling. Clearly, our findings are not meant to be generalizable but rather to help inform future investigations.

While we did not find that e-prescribing ultimately increased the number of unfilled or delayed new prescriptions, our findings have some specific implications. Adaptation to the new clinic protocol and subsequent patient behavior of filling a prescription with e-prescribing might be improved with explicit outreach and education. Physician orientation should include basic communication training to ensure proper discussions with patients about new prescriptions. If e-prescribing brings with it a higher rate of multiple pharmacy use, educational campaigns may be necessary to help patients carefully keep track of their prescription regimen or to encourage patients to consolidate their regimens to a single, known pharmacy. One last recommendation might be to consider how a clinical practice might better disseminate tangible prescription information—as part of the after-visit summary, through a patient Web portal, or as a stand-alone print prescription for reminder purposes only. As more practices adopt e-prescribing, we should continue to explore the many opportunities to improve medication use and adherence.

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