ELECTRONIC MEDICAL RECORDS

Uptake of Electronic Prescribing in Community-Based Practices

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BACKGROUND: Electronic prescribing (e-prescribing) has the potential to improve the safety and efficiency of medication use, but uptake of e-prescribing in community-based settings has been limited to date. In April 2004, 2 large insurers in Massachusetts began a program to fund e-prescribing systems for targeted clinicians and practices. We studied the adoption and uptake of e-prescribing by the targeted prescribers.

METHODS: We obtained data on all e-prescriptions written from April 2004 to March 2005. We tabulated the number of clinicians using the e-prescribing system and the number of prescriptions written. We also obtained claims data from the 2 insurance companies and calculated the proportion of each clinician's prescriptions that were written electronically. We developed multivariable models to estimate the impact of different clinician characteristics on the proportional rate of e-prescribing.

RESULTS: During the first 12 months of the e-prescribing program, 1,217 prescribers began using the e-prescribing system. In the final month of the study, over 55,000 e-prescriptions were written for patients covered by the 2 included insurance plans. The proportion of total reimbursed claims per clinician written electronically increased slowly during the study period and was still below 30% by the end of the study period. This number increased to 42% when we restricted the sample to medications normally used for acute indications. Multivariable models showed that younger clinicians, pediatricians, and prescribers in larger practices exhibited higher uptake rates as a proportion of total prescriptions.

CONCLUSIONS: Clinician use of e-prescribing increased steadily in the first 12 months of an initiative sponsoring e-prescribing systems. Uptake of e-prescribing was only partial, with younger clinicians and pediatricians more likely to use the system. Research to understand why prescribers vary in their use of e-prescribing and to develop techniques to encourage more wide-spread adoption will be an important priority for future studies.

KEY WORDS: health information technology; electronic prescribing; technology uptake.

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BACKGROUND

Electronic prescribing (e-prescribing) has been proposed as an important tool for improving the safety and efficiency of medication use. So far, the promise of e-prescribing has been realized largely in inpatient settings. Studies have demonstrated that hospital-based e-prescribing systems resulted in safer medication use,¹⁻⁴ more appropriate prescribing in the elderly,⁵ better prescribing of potentially dangerous medications,⁶ and reduced use of costlier versions of medications.⁷ One important limitation of prior research on e-prescribing is that the studies are based in a small number of large medical centers or integrated health care systems that are innovators in health information technology.⁸ E-prescribing systems at these centers benefit from the presence of faculty investigators and the availability of large technical support departments.

The bulk of prescribing, however, occurs in outpatient care, and most of these practice settings still use paper-based prescribing. For the potential of e-prescribing to be achieved, it must be adopted in community-based settings.^{9,10} A key concern for efforts to spread e-prescribing and health information technology generally has been barriers to adoption, such as the financial cost of acquiring new systems and the time required to learn how to e-prescribe.¹¹⁻¹⁴ Although many clinicians may eventually move to fully integrated electronic medical records systems that include e-prescribing components, at the present time the cost and complexity of acquiring and implementing such systems is prohibitive for many practices, especially smaller physician offices.^{11,12} Accordingly, more attention has focused on stand-alone e-prescribing systems, especially those including a hand-held device that prescribers can easily use in a busy office.^{15,16} Empiric data on the adoption and uptake of e-prescribing systems has been lacking to date. To fill this void, we studied clinician use of an e-prescribing system provided to a large sample of community-based practices.

METHODS

Intervention

In October 2003, Blue Cross Blue Shield of Massachusetts (BCBSMA), Tufts Health Plan (Tufts HP), and Zix Corporation (ZixCorp) formed the eRx Collaborative.¹⁷ Under the program, PocketScript™ software from ZixCorp was distributed to Massachusetts outpatient providers. E-prescribing was implemented as follows: The participating insurance companies

initially identified high-volume outpatient prescribers and offered access to the e-prescribing system, with costs paid by the insurance companies. Eligible providers included physicians, physician assistants, and nurse practitioners. Participants who chose to enroll in the program received a free wireless mobile device, access to a secure web portal, and licensing and wireless carrier service. Providers and office staff were offered multiple training options, including one-on-one sessions, remote training, or on-line training. The program was available to any high-volume prescriber; however, because many hospital-based clinicians were already using electronic medical records, the enrollees in the collaborative were overwhelmingly from community-based practices.

Clinicians began enrolling during the second quarter of 2004. The program subsequently expanded to include additional insurers and e-prescribing companies; however, for the purposes of this study, we focus exclusively on BCBSMA, Tufts HP, and ZixCorp. At the time of this study, most pharmacies did not have the capacity to receive prescriptions electronically, so the PocketScript system transmitted e-prescriptions to a central location from which a fax to the pharmacy would be generated; prescribers also had the option to print prescriptions to give to patients. During the prescribing process, PocketScript securely connects electronically to external databases to confirm patient eligibility information and to obtain formulary and medication history data. ZixCorp maintains records of all e-prescriptions centrally.

Sample and Data Sources

The sample for this study included all clinicians who wrote at least 1 e-prescription using the PocketScript system in Massachusetts during the first year of the eRx Collaborative, from April 1, 2004 through March 31, 2005. The data sources included the e-prescribing transactions, prescription claims from the 2 insurance plans, and provider characteristic files from the e-prescribing company and the 2 insurance plans.

The e-prescribing transaction data recorded all prescriptions issued by the e-prescribing system, regardless of whether the prescriptions were eventually filled or not. Included in these data were the prescribing clinician (encoded DEA number), encoded patient ID, the prescription date, drug name, dosage, form (pill, tablet, solution, etc.), and insurance plan. Pharmacy insurance claims included data on prescriptions that were filled and reimbursed (i.e., filled and picked up by the patient at the pharmacy) and, therefore, represent a subset of prescriptions written either electronically or by hand. These data contained encoded patient ID, prescription fill date, and insurance plan. Drugs were identified by the national drug code (NDC), which specifies the medication, dosage, form, package size, and manufacturer for each filled prescription. The provider files from the e-prescribing company and the insurance plans included specialty, age, gender, and practice size. One of the insurance plans did not assign specific provider IDs to nonphysician prescribers (i.e., nurse practitioners and physician assistants), meaning that prescriptions for those prescribers could not be identified in that plan's claims data. Each analysis described below was performed both with and without nonphysician prescribers, but because none of the results differed substantively, we present only the main results.

All identifiable individual characteristics were removed from the data before it was provided to the research teams. Crosswalks, using encrypted clinician identifiers, were created by ZixCorp and the insurance plans so that clinician records could be linked across the datasets while preserving confidentiality.

Measures of E-prescribing Uptake

We measured both an absolute count of e-prescriptions and a proportional uptake rate. For each prescriber, we identified the first date on which they wrote an e-prescription in the e-prescribing data and assigned this as their start date. We then tabulated the number of e-prescriptions written each month. This method yielded information on the absolute volume of e-prescriptions written. We also calculated a rate of e-prescribing as a proportion of total filled claims, calculated as the number of e-prescriptions divided by the total number of filled prescriptions in the claims data. Ideally this rate would be calculated as the number of electronic prescriptions divided by the total number of prescriptions written. However, the claims data did not include prescriptions written on paper that were never filled, which can lower the denominator for this rate. Conversely, the claims data included refills of previously written prescriptions, which can markedly increase the denominator for this rate. Accordingly, we regarded this rate as an approximation of the proportion of medications that were e-prescribed.

Analyses

We began by tabulating the characteristics of clinicians who used the e-prescribing system. Adoption and uptake of the e-prescribing system were measured by the number of prescribers enrolled and the number of e-prescriptions written in each calendar month. We then examined rates of e-prescribing use by month relative to when clinicians wrote their first e-prescription, regardless of calendar month. We categorized uptake volume and rates by the clinician characteristics available in our data.

To limit the impact of potential biases introduced by our proxy measure of proportional uptake rates, we reanalyzed the data using a subset of medications more likely to be prescribed for short-term relief of symptomatic conditions (antibiotics, pain medications, anti-emetics). We anticipated that, for this subset of medications, discrepancies between filled prescriptions and written prescriptions would be smaller because these medications are more likely to be filled by patients initially and would also be less likely to have refills (which would inflate the number of filled prescriptions relative to a written prescription).

To evaluate the relative impact of different clinician characteristics on the proportional uptake rate of e-prescribing, we developed regression models using generalized estimating equations. The e-prescribing rate was the dependent variable, and all measured prescriber characteristics were included in the model, in addition to the month relative to first use of the e-prescribing system. We assumed an autoregressive correlation structure to model repeated measures of e-prescribing use by month. A Poisson distribution with a log link was specified in the model to fit the data.

RESULTS

By March 31, 2005 (the end of the study period), the e-prescribing system had enrolled 2,055 prescribers and 1,496 had the system in place. However, over the 12-month study period, only a total of 1,217 clinicians (81%) had actually written 1 or more e-prescriptions using the PocketScript system. Table 1 shows the characteristics of providers who used the e-prescribing system during our study period and the month in which they first wrote prescriptions. Primary care specialties accounted for 70% of the sample, including 30% internists, 24% pediatricians, and 16% family practice. The 19% of clinicians in other specialties included gynecologists, cardiologists, and gastroenterologists (demographics were missing for about 11% of participants). More clinicians were male than female, and most prescribers were between 35 and 54 years of age. Participants were from a variety of practice sizes, with over 60% from practices of 8 clinicians or less. Of the total, 269 prescribers were nonphysicians.

We also obtained the characteristics of Massachusetts clinicians as a whole. During this study period, 45% were in primary care specialties, and 66% were male. These differences compared with e-prescribers were likely because of the fact that high-volume outpatient prescribers were recruited initially for the eRx Collaborative, skewing the populations toward primary care clinicians.

Table 1. Characteristics of Clinicians Using Electronic Prescribing System (Total=1,217)

Characteristic	Number (%)
Specialty	
Internal Medicine	366 (30.1)
Pediatrics	296 (24.3)
Family Practice	188 (15.5)
Other	230 (18.9)
Missing	137 (11.3)
Gender	
Male	595 (48.9)
Female	461 (37.9)
Missing	161 (13.2)
Age	
25–34	120 (9.9)
35–44	339 (27.9)
45–54	372 (30.6)
55–64	187 (15.4)
65+	31 (2.5)
Missing	168 (13.8)
Practice size	
1–3	348 (28.6)
4–8	398 (32.7)
9–15	205 (16.8)
16+	266 (21.9)
Month of first e-prescription	
April 2004	131 (10.8)
May 2004	47 (3.9)
June 2004	40 (3.3)
July 2004	71 (5.8)
August 2004	100 (8.2)
September 2004	265 (21.8)
October 2004	125 (10.3)
November 2004	86 (7.1)
December 2004	89 (7.3)
January 2005	84 (6.9)
February 2005	78 (6.4)
March 2005	101 (8.3)

Figure 1 displays the uptake of e-prescribing over the study year in terms of both clinicians using the e-prescribing program in that month and the absolute number of e-prescriptions written by month. Use of the e-prescribing system increased steadily during the study period, with over 55,000 e-prescriptions written in March 2005. Figure 2 shows that, on average, the proportional rate of e-prescribing also increased steadily. It was 15% in the first month of the clinicians' e-prescribing, increasing to an average of 26% by the 12th month. When the sample was limited to acute medications, the average first month e-prescribing rate was 25%, growing to 42% by the 12th month.

Figure 3 shows the increase in the proportional e-prescribing rate for acute medications over 12 months, subdivided by clinician characteristics; the trends were similar to those observed for all medications. The top section of Figure 3 lists the rates by age: The e-prescription rates were highest for the youngest prescribers, exceeding 60% for those under 35 by the end of the study period. Male and female clinicians had similar e-prescribing rates initially, with women showing higher rates of e-prescribing at the end of the study period. The next section of Figure 3 shows the result by practice size. Overall, larger practices had higher rates of e-prescribing, with increasing e-prescribing rates in both small and large practices over the study period. The bottom section of Figure 3 lists the rates by specialty. Pediatricians had the highest rates overall, with acute medication e-prescribing rates beginning at 45% and increasing to 57% by month 12; rates for internists increased from 18% to 32% over 12 months, and family practitioners doubled their e-prescribing rate from 22% to 47% over 12 months.

The results of multivariable models that control for the independent effects of each of these prescriber characteristics on e-prescribing rates over time are shown in Table 2. The models include the 1,056 e-prescribers for whom information on clinician characteristics was available. The left side of Table 2 shows the results for all prescriptions in the data set while the right side shows the same model with prescriptions limited to acute medications. Model output is presented as relative rates, compared to the index group in each category.

Clinician age had a significant independent relationship with e-prescribing. Relative to prescribers younger than 35, those aged 45–54 and 55 and over had a 29% lower e-prescription rate for all medications. The difference was greater when the analysis was restricted to acute medications only. Prescribers in the largest practices (16+) had a 36% higher e-prescribing rate than those in practices of 4–8 clinicians, although this finding was not statistically significant in the analysis restricted to acute medications. There was a trend toward more e-prescribing in 9–15 clinician practices. Pediatricians had significantly higher e-prescribing rates than internists, family practitioners, and other specialists both for all medications and acute medications only. When these other factors were controlled for, there was no difference in e-prescribing rates by clinician gender.

DISCUSSION

We evaluated the uptake of e-prescribing by a large sample of community-based clinicians who were provided with an e-prescribing system at no cost as part of the Massachusetts eRx Collaborative.¹⁷ We found that, over the first 12 months of

Figure 1. Number of clinicians using e-prescribing system and total volume of e-prescriptions, by calendar month, April 2004 through March 2005.

this program, over 1,200 prescribers became active users of the system, with continued growth in e-prescribing over the course of the year. Use of the electronic prescribing system varied by certain prescriber characteristics; most notably, pediatricians e-prescribed at a higher rate than clinicians in other specialties, younger clinicians e-prescribed more than older, and clinicians in very large practices e-prescribed at higher rates. Although unadjusted analyses suggested a difference in e-prescribing between men and women, this difference was not seen after controlling for other characteristics.

It has been estimated that e-prescribing systems, providing automated warnings and updated patient information at the time of prescribing, could reduce outpatient ADE by 25% per year.¹⁸ Anecdotal reports suggest that office-based e-prescribing systems can save 1 hour of nursing time and 30 minutes of clerical time per employee per day.¹⁵ Many programs have been initiated to encourage e-prescribing in community-based practices, but it is not known whether these efforts are succeeding. Our results provide the first such information from a large sample of community-based practices and, as such, provide important insights for future research and quality improvement efforts.

We found a slow and steady increase in e-prescribing over the 12 months of this study. This suggests that clinicians may have become somewhat more comfortable with e-prescribing as they continued using it; however, it did not appear that a large proportion of clinicians became exclusive—or even

majority—e-prescribers. This lack of full uptake may have multiple causes, such as problems with unusual doses or compounded medications, technical issues with the e-prescribing system, inability to access e-prescribing at all practice locations, or clinician preference for paper prescribing. Some medications, such as controlled substances, require a hard copy with actual prescriber signature and, thus, cannot be e-prescribed. Clinicians were recruited for the e-prescribing program via office practices but may have written nonelectronic prescriptions when practicing in the hospital or in offices other than their primary practice. Our study is unable to address the causes of incomplete adoption directly; studies including a qualitative component to evaluate how prescribers adopt and use e-prescribing systems are an important priority for future research.

Our analyses of clinician characteristics give some insight into predictors of e-prescribing uptake and may suggest where to target efforts to increase e-prescribing uptake in the future. We did find that e-prescribing rates were higher at the larger practices; it is possible that larger practices have more rapid access to on-site technology support. Prescribers in smaller practices did also increase their e-prescribing over the course of the study, but it is possible that such practices require additional support to adopt technology more fully. Older clinicians wrote e-prescriptions at a significantly lower rate than younger clinicians. Younger prescribers may be more comfortable with technology or may be less established in their

Figure 2. Proportion of prescriptions prescribed electronically by month since first use of e-prescribing system. The diamonds show e-prescribing proportion for all medications, and the triangles show the proportion for medications prescribed for acute indications.

Figure 3. Proportion of prescriptions prescribed electronically in the 1st and 12th months after the first use of e-prescribing system, by clinician characteristics. The grey bars shows the first month of e-prescribing use, and the blue bars show the twelfth month.

prescribing habits and more willing to adopt new systems; this also is a fruitful topic for additional study. Prior research on the diffusion of innovations has focused on the relative advantage of a new technology and its compatibility with the environment in which it is used as key factors influencing adoption.^{19,20} Future studies that compare different e-prescribing systems and include qualitative data on the impact of e-prescribing on medical office workflow could allow for the development of more sophisticated models explaining the uptake of e-prescribing.

We found that pediatricians wrote e-prescriptions at a higher rate than clinicians from other specialties. This result was especially striking when we limited the results to

medications written for acute indications. Because chronic medication use is less likely among children, it may be easier to detect the uptake of e-prescribing among pediatric patients, but we cannot exclude the possibility that distinctions between pediatricians and other specialists may be driving the differences that we observed. These analyses are limited by our inability to calculate a precise rate of e-prescribing, as noted in the methods section. Nevertheless, our approximation for the rate of e-prescribing does provide a better sense of adoption of this technology than has previously been available.

These results should be interpreted in light of several limitations of our study. We examined 1 e-prescribing system in 1 state, so our findings may not be generalizable to all medical settings. The collaboration between competing insurance companies to sponsor this program was unique, but several other states have e-prescribing programs that are sponsored by a single insurance company, which should yield a similar structure to the program described in this paper. Our analysis describes the first year of this program; anecdotal reports suggest that e-prescribing rates have continued to increase since then, and e-prescribing technology has improved significantly, with full electronic connectivity from e-prescribing systems to pharmacies replacing the generation of faxes. Additional studies will be required to evaluate the utilization of e-prescribing in subsequent years.

Enrollment in the e-prescribing system was voluntary, so it is possible that clinicians adopting the system in its first year are more accepting of new technology than the average prescriber would be. The system was provided to practices free of charge, so it is not clear whether this system would overcome the financial barriers to adoption of e-prescribing, especially by smaller practices. Even with the system provided at no cost to the practice, some prescribers never began e-prescribing during our study period. If insurers do not provide such systems to prescribers, it is possible that embedded advertising will be used to make systems affordable to practices, as occurs in other countries.²¹

Limitations in the structure of our data also need to be considered. The data were de-identified using stringent encryption protocols, which limited our ability to double check on

Table 2. Results of Multivariate Models: Impact of Clinician Characteristics on Relative Rate of E-Prescribing

All medications			Acute medications only	
Variable	Relative ERX rate	95% CI	Relative ERX rate	95% CI
Age				
25-34	Ref	—	Ref	—
35-44	0.917	[0.743-1.32]	0.860	[0.706-1.05]
45-54	0.711	[0.557-0.908]	0.622	[0.499-0.775]
55+	0.714	[0.541-0.944]	0.664	[0.510-0.863]
Practice size				
1	1.217	[0.935-1.59]	0.967	[0.743-1.26]
2-3	0.832	[0.610-1.14]	0.807	[0.602-1.08]
4-8	Ref	—	Ref	—
9-15	1.280	[0.932-1.76]	1.24	[1.02-1.49]
16+	1.362	[1.07-1.74]	1.17	[0.872-1.56]
Specialty				
Pediatrics	Ref	—	Ref	—
Internal medicine	0.619	[0.504-0.759]	0.450	[0.380-0.533]
Family practice	0.800	[0.638-1.00]	0.586	[0.468-0.733]
Other	0.424	[0.327-0.550]	0.389	[0.299-0.506]
Gender				
Male	Ref	—	Ref	—
Female	1.041	[0.880-1.23]	1.03	[0.879-1.22]

linkages across the plans. For 269 providers who were nurse practitioners and physician assistants, records could only be linked to 1 plan. However, these records accounted for relatively few prescriptions, and the results did not change when they were excluded. As noted above, our calculation of the rate of e-prescribing was problematic because of the presence of refills in the claims data, the imperfect identification of prescribing clinician in pharmacy claims, and our inability to account for patient compliance.

In conclusion, we found that, during the first year of deployment, over 1,200 community-based clinicians in Massachusetts used an e-prescribing system, with younger prescribers, pediatricians, and clinicians in larger practices more likely to e-prescribe. Although uptake of e-prescribing increased slowly over the study year, overall rates of use were low, even among clinicians who had been e-prescribing for several months. Our results provide the first large description of e-prescribing uptake in community-based settings and should stimulate studies of e-prescribing in other regions and further evaluation of the factors that drive e-prescribing adoption. These data will need to be used to develop future programs and interventions to encourage broader uptake of e-prescribing; without these, it will be difficult to realize the full potential benefits of this technology.

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