Research Paper ■

Perceptions of Standards-based Electronic Prescribing Systems as Implemented in Outpatient Primary Care: A Physician Survey

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Abstract **Objective:** To compare the experiences of e-prescribing users and nonusers regarding prescription safety and workload and to assess the use of information from two e-prescribing standards (for medication history and formulary and benefit information), as they are implemented.

Design: Cross-sectional survey of physicians who either had installed or were awaiting installation of one of two commercial e-prescribing systems.

Measurements: Perceptions about medication history and formulary and benefit information among all respondents, and among e-prescribing users, experiences with system usability, job performance impact, and amount of e-prescribing.

Results: Of 395 eligible physicians, 228 (58%) completed the survey. E-prescribers (n = 139) were more likely than non-e-prescribers (n = 89) to perceive that they could identify clinically important drug–drug interactions (83 versus 67%, p = 0.004) but not that they could identify prescriptions from other providers (65 versus 60%, p = 0.49). They also perceived no significant difference in calls about drug coverage problems (76 versus 71% reported getting 10 or fewer such calls per week; p = 0.43). Most e-prescribers reported high satisfaction with their systems, but 17% had stopped using the system and another 46% said they sometimes reverted to handwriting for prescriptions that they could write electronically. The volume of e-prescribing was correlated with perceptions that it enhanced job performance, whereas quitting was associated with perceptions of poor usability.

Conclusions: E-prescribing users reported patient safety benefits but they did not perceive the enhanced benefits expected from using standardized medication history or formulary and benefit information. Additional work is needed for these standards to have the desired effects.

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Introduction

Ambulatory electronic prescribing (e-prescribing) is a form of health information technology that is expected to have immediate benefits, including improved quality and safety of prescribing,[1–4] more cost-effective medication options for patients,[4] and improvements in ambulatory care workflow.[5] Yet for e-prescribing systems to create these benefits, they need to go beyond simply authoring and storing prescriptions to incorporate more advanced decision-support features such as drug interaction alerts based on the patient's complete and current medication list and guidance in selecting medications that match the patient's drug benefits.[6–10] Because most patients in the United States receive their pharmaceutical care from a network of organizations including physician offices, retail pharmacies, prescription benefit management companies, and health plans, implementing advanced e-prescribing features requires the use of stan-

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dards for exchanging data among these separate organizations.[11–13]

Recognizing the importance of interoperable data exchange in e-prescribing, the Medicare Modernization Act of 2003 (the MMA) required the United States Department of Health and Human Services to conduct pilot studies of electronic prescribing standards and to issue rules requiring the use of standards found to be beneficial for electronic prescriptions to be covered by Medicare.[14,15] Two of the standards that required pilot testing, the *Medication History* (*RxH*) *transaction of the NCPDP SCRIPT standard*, and the *NCPDP Formulary* and *Benefit* (*F&B*) *Standard*, were already in use within some commercial e-prescribing systems and could be evaluated in the field. Based on industry experience and preliminary results of pilot testing, CMS issued rules that will require use of the *formulary* and *benefits*, and *medication history information* standards for e-prescribing programs under Medicare Part D.[16] However, the extent to which these standards, as implemented, actually deliver their intended benefits is not known.

E-prescribing standards, like any structural component of health care, should be assessed based on the extent to which they enable improvements in health care processes and outcomes.[17,18] System features that make use of the *RxH* and *F&B* standards could improve prescribers' workflow through the avoidance of telephone calls from pharmacies, pharmacy benefit managers (PBMs) or health plan administrators when prescriptions are not filled due to safety or coverage concerns. In the case of the medication history standard, benefits are expected from having a more complete and accurate medication list available for drug interaction alerts and reminders for important omitted medications.[6] While safety alerting was common among commercial e-prescribing systems, previous studies have found that systems rarely integrate data from external sources to support this alerting.[7,19] Similarly, obtaining standardized formulary and benefit information could help providers to minimize patients' out of pocket costs and to ensure better patient adherence.[6]

The barriers to e-prescribing adoption and use also require further study. Although e-prescribing systems have been widely available for several years, previous studies have found that only 11–24% of physicians have adopted e-prescribing in the outpatient setting[20-22] and e-prescribing only accounted for 2% of the roughly 1.5 billion prescriptions filled in the United States in 2007.[23] Even in settings where e-prescribing has been adopted, usage and effective integration into clinical workflow varies widely.[10,24] For e-prescribing to benefit patients, its rate of adoption will need to accelerate and, once adopted, such systems must be effectively integrated into clinical workflow.

We conducted a cross-sectional self-administered web-based survey to assess perceptions about *RxH* and *F&B* information (including its accuracy and usefulness), office workload, and prescribing safety and quality, among physicians who were enrolled in a program that sponsored e-prescribing adoption. The study assessed whether the standards worked to deliver the intended benefits and elucidated opportunities for improving the e-prescribing infrastructure. At the time of the survey, some physicians in the program had been using e-prescribing (for up to 2 yrs) and others were still awaiting e-prescribing installation. This offered the opportunity to compare perceptions among e-prescribing users and nonusers who had all volunteered to be relatively early adopters of these systems. The two e-prescribing systems involved (Caremark's iScribe® and Allscripts' TouchScript®) had implemented features making use of the *medication history* and the *formulary* and *benefit* standards. To assess satisfaction with e-prescribing and its specific features, we asked additional questions of e-prescribing users.

Background

The Medication History (RxH) Function of the NCPDP SCRIPT Standard

The Medication History (RxH) function of the NCPDP SCRIPT standard, v 8.1, is intended to give prescribers information about a patient's current and past medications by providing data from their past pharmacy claims. The function includes a request transaction (RXHREQ) that identifies a specific patient, and a response transaction (RXHRES) that returns the patient's past prescriptions. The request can optionally include a date range and the response returns prescriptions known by the responding entity, starting with the most recent in the specified range and extending to a limit number (which is implementation dependent), along with a flag indicating whether more history is available for the requested range. Drugs are identified in the transaction using the name and the national drug code (NDC) of the medication that was dispensed. However, NDCs often cannot be translated into an accurate drug identity—in one study, 27% of codes in the FDA's NDC Directory were erroneous and an additional 14,337 codes were identified as missing.[25] Without a reliable drug identifier, e-prescribing vendors find it difficult to accurately reconcile medication data from different sources and therefore few attempt to use RxH data for drug interaction alerting.[26]

At the time of our study, the only intermediary supplying medication history data was RxHub, and the source of medication history data was prescription drug claims that had been paid by one of the PBMs participating in RxHub. Patient identification depended on the successful completion of an Eligibility transaction (X12,270/271) with RxHub, which identifies the patient in RxHub's master patient index. Since the time of our study, RxHub has merged with SureScripts, which represented retail pharmacies, and medication history data are now increasingly available based on aggregated retail pharmacy sales, which can include over-the-counter, behind the counter and prescription medications.

The NCPDP Formulary and Benefit (F&B) Standard

The NCPDP Formulary and Benefit (F&B) Standard, v. 1.0, provides a basis for pharmacy benefit payers (including health plans and pharmacy benefit managers) to communicate formulary and benefit information to prescribers via point-of-care electronic prescribing systems. However, unlike the NCPDP SCRIPT transaction, the F&B standard does not provide data about individual patients. Rather, it provides information about the medication coverage provided by particular health plans for a more comprehensive list of medications. F&B data are downloaded by e-prescribing

system vendors in a "batch" fashion and this F&B file is then used to look up the patient's coverage, using the health plan identifier obtained from a successful Eligibility transaction. This approach is necessary to enable the display of coverage information for each medication in the pick-lists that prescribers use to make initial medication choices.

The F&B standard includes several separate files, representing different types of drug coverage information. The formulary status list provides information about which drugs are considered "on formulary." A coverage limitations file provides rules that may impact whether the patient's benefits will cover a drug being considered, for example, because of age or gender limits, step therapy requirements, or benefit-specific coverage exclusions. A copay file indicates the tier or amount of copayment that patients would be expected to pay out of pocket for specific, covered medications. The alternatives file represents specific alternative medications that the health plan would like to suggest when prescribers select specific medications. However, most PBMs only make use of the formulary status list, sometimes in combination with one additional file that represents the PBMs own emphasis on presenting coverage information to clinicians.[26] At the time of our survey, RxHub was the only formulary data aggregator distributing formulary data using the NCPDP F&B standard. Health plans must pay a fee to distribute their F&B data through RxHub and some choose not to participate.

Methods

Study Setting

Horizon Blue Cross Blue Shield of NJ (Horizon) launched an e-prescribing sponsorship program in late 2004, with plans to support the installation, training and ongoing use of e-prescribing for up to 1,000 prescribers. The e-prescribing systems made available were Caremark's iScribe®, Allscripts' TouchScript®, and InstantDx's OnCallData™, all of which were stand-alone e-prescribing systems without full electronic health record functionality. InstantDx users were not included in this study because few had completed installation at the time of the survey.

The iScribe and TouchScript systems differed somewhat in their implementation of the Medication History (RxH) and the Formulary and Benefit (F&B) standards. For Medication History, each system checked eligibility and then attempted to download RxH data nightly, for patients scheduled the next day. In iScribe, prescribers could review these data as a single, reverse-chronological listing by clicking a "Dispensed claims history" button that appeared at the bottom of the patient-summary screen. In TouchScript, RxH data could be reviewed for individual medications on a patient's medication list by clicking a "Fill history" button that became active when a medication with available history was selected. However, because of the unreliability of matching NDCs (described in the Background section, above),[26] neither system incorporated RxH data into the current medications used for drug interaction alerting. If the eligibility transaction failed, then no RxH data would be available and the relevant buttons were shown as inactive (gray) in each system. For F&B, each product displayed an indication of the patient's drug coverage for each medication name in e-prescribing pick lists. The iScribe system displayed a "P" to indicate "preferred" status and a "1", "2", or "3" to indicate the copay tier. It also, independently, displayed a "G" next to generic drugs, based on information from a commercial drug compendium. If no F&B information was available (e.g., if the patient's eligibility check failed) then iScribe only displayed the generic indicators. In contrast, the TouchScript system displayed a smiley face icon next to each medication in the prescriber's pick list to indicate its F&B status. A green smiley face indicated generic and on-formulary preferred drugs, a red frowning face indicated more expensive and nonformulary drugs, and a yellow neutral face indicated a middle tier or unavailable F&B status.

The Horizon e-prescribing program enrolled and installed e-prescribing systems for individual physicians rather than practices as a whole. Participants were required to be Horizon network providers and to have high-speed Internet access in their offices as well as a computerized practice management system capable of uploading patients' demographic information to the e-prescribing system. Once installed, prescribers could use the tool to write and transmit prescriptions for any patient, regardless of their insurance. The program covered the costs of hardware, software, installation, and training (estimated at US$4,200–US$6,400 per prescriber), and supported ongoing use of e-prescribing through quarterly honoraria of US$150 to US$500 per prescriber based primarily on the extent to which they actually used the systems.

Sampling and Subject Recruitment

Eligible physicians were sampled from among those enrolled in Horizon's e-prescribing sponsorship program as of Sept 2006. For the e-prescribing group, we randomly sampled 250 of the 602 physicians who had completed iScribe installation and 50 of the 70 physicians who had completed Allscripts installation. For the non-e-prescribing group, we randomly sampled 200 of 249 physicians who had enrolled in the Horizon e-prescribing program but were still awaiting the installation of an e-prescribing system. The no-e-prescribing group was delayed in receiving e-prescribing because they signed on to the program later. No installations took place during the survey period. These sample sizes were chosen to provide enough responses for assessing the performance of multi-item scales[27] within the limits dictated by the total populations available to sample. For each e-prescribing physician, Horizon provided data on their volume of e-prescribing use. Physicians were excluded if they were retired, deceased, were on leave during the survey period, or no longer in practice at the location of record with Horizon.

Recruitment for the survey began in October 2006, with a faxed letter from Horizon introducing the study and offering $100 for survey completion. Three days later RAND sent each physician an e-mail invitation containing a randomly assigned personal identification number to take the survey on the RAND survey Web site. We telephoned providers who had invalid, undeliverable or nonunique e-mail addresses to obtain unique and correct e-mail addresses where possible. Non-responders were sent weekly e-mail reminders. Six weeks after the start of the survey, we telephoned non-responders and new e-mail prompts were sent when requested. A final reminder was sent by express mail to non-responders during the final week of the field period.

Recruitment efforts were completed in Dec 2006. the RAND Institutional Review Board approved the study.

Survey Content

We developed a 35-item survey to assess prescribers' perceptions regarding various aspects of the prescribing process (See online Appendix, available at www.jamia.org). The survey asked all respondents about: (1) practice characteristics (e.g., solo v. group practice; tertiary medical center v. smaller physician office), and prescriber demographics (e.g., age, gender); (2) adequacy of available drug formulary and medication history information for users and nonusers of e-prescribing, including time prescribers spend dealing with drug coverage issues, information quality, office workload, and prescribing safety/quality and (3) computer-oriented attitudes and skills. Additional questions for e-prescribers asked about their general experiences with e-prescribing, the usability and performance of their e-prescribing system, and about the quality of formulary and benefit information and medication history information provided by the system. Some survey questions were adapted from existing survey instruments, including items from the Unified Theory of Acceptance and Use of Technology (UTAUT) framework.[28–33] Draft questionnaires were revised for clarity, uniformity of language and appropriateness of response categories by a survey research expert (MB) informed by pilot testing with 6 practicing physicians in Boston and LA.

Data Analysis

Data analysis included descriptive statistics for each survey item, χ^2 tests to compare the distribution of responses on categorical variables, Kruskal–Wallis equality-of-populations rank tests to compare the distribution of responses to Likert scale items between e-prescribers and non-e-prescribers, and Mantel Haenszel Stratified Analyses to study the association of key quality outcomes (e.g., identify potential drug–drug interactions, and prevent callbacks from pharmacies) with respect to e-prescribing status (e-prescribing user v. nonuser), broken-down by specialty/practice.

1. Composite scale scores: We created multi-item scale scores corresponding to key factors in the UTAUT.[33] All the items used a 5-point Likert-scale and we created scale scores by averaging each subject's responses across the items to create a score from 1 to 5 (minimum = 1; maximum = 5). For general ***computer attitudes*** we adapted the following items from an existing instrument[34]: "Computers generally increase the quality of my work", "Computers generally increase my efficiency at work", "I could be more effective at work if more things were computerized", "I feel comfortable working with computers", "Trying new technology is important to me", and "I embrace the use of computer technology in my work and personal life." The resulting *computer attitudes* scale had a Cronbach's alpha of 0.90.

For perceptions of the system's enhancement of job performance (the "performance expectancy" factor in the UTAUT framework[33]) we used 4 survey items: "E-prescribing made work easier for my staff"; "E-prescribing made my work easier"; "Using the e-prescribing system improved the quality of care I deliver", and "Using the e-prescribing system increased my productivity." The resulting system *performance* scale had a Cronbach's alpha of 0.92.

We assessed perceptions of the system's usability (the "effort expectancy" construct in UTAUT[33]) using the items: "The e-prescribing system was easy to use"; "Interacting with the system did not require a lot of mental effort"; and "I found it easy to get the system to do what I wanted it to do". The resulting system *usability* scale had a Cronbach's alpha of 0.85.

2. Regression analyses: We performed bivariate and multiple linear regression analyses to examine elements of the UTAUT model, such as prescribers' age, gender and computer attitudes scale (experience), as well as the perceived performance benefits and usability of the systems, on the volume of e-prescribing use. We used logistic regression modeling to examine the association of these factors with the decision to discontinue the use of e-prescribing.

3. Treatment of missing data: Missing responses per item never exceeded 2%. Missing values in all cases were imputed using the multiple-imputations-by-chained-equations (MICE) approach in Stata.[35]

Results

Survey Response and Prescriber Characteristics

Among the 500 sampled providers, a deliverable, unique e-mail address was not found for 89 (18%), leaving 411 who were actually invited by e-mail. Of these, 16 were ineligible because they were no longer in practice at their location of record. Of the 395 eligible respondents, 228 (58%) completed the survey. Response rates were similar for Allscripts versus iScribe enrollees (57 versus 58%; $p = 0.9$) and for e-prescribers versus non-e-prescribers (59 versus 56%; $p = 0.49$). All e-prescribers had started using the system at least four weeks before the survey (median duration of use = 10 mo; mean duration of use = 12 mo; SD = 11 mo).

Most respondents were in solo practice or single-specialty groups, and most were located in small physician offices (Table 1). A majority of respondents were from traditional primary care practices such as family medicine, general internal medicine and pediatrics (63%) but other specialties and subspecialties were well-represented. Respondents' mean age was 47 (SD = 10; range 27–82). Their attitudes towards computers were positive (Mean = 4.03; SD = 0.70). Approximately 20% of prescribers also used an electronic medical record in their practice. There were no statistically significant differences between e-prescribers and non-e-prescribers in age, composition of practice (e.g., solo practice v. multispecialty group practice), computer attitudes scale or electronic medical record use. The e-prescriber group had modestly lower proportions of hospital-based physicians, physicians in larger practices ($p = 0.002$), and nonprimary care specialists ($p = 0.049$).

Medication History Information

E-prescribers and non-e-prescribers did not differ significantly in the resources they found useful for finding out about patients' medication histories. Most prescribers reported that they find medication history information elicited by a nurse or office staff member to be useful "most of the time" or "always"; a minority reported that reviewing patients' actual medication bottles is useful "most of the time" or "always." Although each of the e-prescribing systems explicitly displayed medication history data as

Table 1 ■ Provider and Practice Characteristics

Characteristic	E-Prescribers (*N* = 139)	Non-E-Prescribers (*N* = 89)	P Value
Specialty			0.049
Family Medicine	30%	15%	
General internal medicine	27%	25%	
Pediatrics	13%	13%	
Internal medicine subspecialty	14%	19%	
Other*	17%	28%	
Age (mean)	47	49	0.09
Computer attitudes score (mean)†	4.00	4.09	0.32
Composition of practice			0.460
Solo practice	30%	35%	
Single-specialty group	58%	54%	
Multispecialty group	8%	10%	
Other	4%	1%	
Practice setting			0.002
Hospital tertiary care center	2%	13%	
Large ambulatory care center	4%	8%	
Small physician office	91%	74%	
Community clinic and other	4%	4%	
Practice uses electronic medical records	20%	22%	0.417

*Including Neurology, OB/GYN, pediatrics subspecialty, Physical medicine and rehabilitation, Psychiatry, and Surgery or surgical subspecialty.
†Higher scores imply greater positive attitude. Maximum score = 5.

being derived from claims, and many insurers, including Horizon, send medication claims histories by mail (e.g., to encourage generic use), very few respondents in either group identified the patient's insurance claims as being useful "most of the time" or "always" for obtaining medication history information (Table 2).

E-prescribers were more likely than non-e-prescribers to "agree" or "strongly agree" that the information they typically have available about the patient's medication history helps them to identify clinically important drug–drug interactions, and to prevent call backs from pharmacies for potential safety problems. The adjusted odds ratios for these comparisons in Mantel Haenszel stratified analyses were similar to the unadjusted odds ratios (for drug–drug interactions, unadjusted OR = 2.5, p = 0.04 v. adjusting for specialty AOR = 2.6, p = 0.002 and adjusting for practice size AOR = 2.6, p = 0.002; for preventing callbacks, unadjusted OR = 1.9, p = 0.02 v. adjusting for specialty AOR = 2.0, p = 0.01 and adjusting for practice size AOR = 1.8, p = 0.04), indicating that the imbalance in practice size and specialty between groups does not account for the differences observed. By contrast, we found no difference between e-prescribers and non-e-prescribers in perceptions of the benefits that depend specifically on external medication history information, such as identifying medications prescribed by other providers, and keeping track of medications patients have tried in the past. There was a trend toward e-prescribers perceiving that the available medication history information enables them to prescribe medications more safely overall (Table 2).

Among the 139 e-prescribers, only 37% reported being familiar with how to access the medication history information available in their system. Of those reporting familiarity with accessing medication history information, less than half reported positive experiences using the information (Fig 1), and only 16% reported using this function either "often" or "very often".

Formulary and Benefit Information

E-prescribers and non-e-prescribers reported similar rates of dealing with drug coverage problems. Most prescribers reported getting 10 or fewer calls about drug coverage problems in a typical week. Most also reported spending 15 minutes or less dealing with drug problems in a typical day (Table 2).

E-prescribers had mixed perceptions about the value of the drug coverage information they received. Many respondents (43%) perceived that formulary and benefit information is incomplete at least 20% of the time and a smaller proportion (14%) reported that this information is not correct at least 20% of the time. Moreover, e-prescribers split evenly about the statement that e-prescribing drug coverage information reduced the number of calls to their offices from pharmacies and patients regarding drug coverage problems (29% "agreed" or "strongly agreed", 41% were "neutral", and 30% "disagreed" or "strongly disagreed") (Fig 2). Perceptions were slightly more favorable toward the statements that e-prescribing drug coverage information helps in managing patients' costs (39% "agree" or "strongly agree," 37% "neutral," 24% "disagree" or "strongly disagree") and that they are satisfied with the drug coverage information overall (37% "agreed" or "strongly agreed", 38% were "neutral", and 25% "disagreed" or "strongly disagreed").

Use of e-Prescribing

Among e-prescribers, 37% reported using the system to write all of their prescriptions (except DEA Schedule II Medications, which were not available in e-prescribing), 46% reported using the system for some prescriptions, and 17% reported that they were no longer using the system for any prescriptions. Prior to quitting, the latter group of users had a mean e-prescribing volume of 51 prescriptions per month (SD = 87). Those who reported using the system to write some prescriptions had a mean e-prescribing volume of 119 prescriptions per month (SD = 116), and those who reported using the system to write all of their prescriptions had a mean e-prescribing volume of 178 prescriptions per month (SD = 158). Among those who had stopped or who used the system for only some prescriptions, the top reasons given for reverting to paper prescribing (rated "agree" or "strongly agree") were technical problems with network connectivity (87%), failure of prepopulating the e-prescribing system with patients' identifying information from the practice management system (83%), and time pressure when "too busy" (66%). Somewhat less-frequent reasons included pharmacies not reliably receiving and processing the prescriptions sent electronically (47%), the system taking too much of the prescriber's time (42%), and tending to use

Table 2 ■ Experiences of E-Prescribers versus Non-E-Prescribers with the Medication History Information and Formulary and Benefit Information Available to Them

	E-Prescriber (N = 139)	Non-E-Prescriber (N = 89)	P Value
The information I typically have available about the patient's medication history enables me to*			
Identify potential drug–drug interactions that are clinically important	83%	67%	0.004
Prevent callbacks from pharmacies for potential safety problems	68%	53%	0.02
Identify clinical situations where an alternative medicine may be less of a risk.	75%	65%	0.10
Identify medications prescribed by other providers that I did not realize the patient was taking†	65%	60%	0.49
Identify clinical conditions that I did not realize the patient had	63%	67%	0.57
Perform additional monitoring to prevent a possible complication	74%	72%	0.70
Keep track of medications patients have tried in the past†	74%	72%	0.70
Prescribe medications more safely, overall	83%	73%	0.07
When prescribing and need to find out about the patient's medication history, how often is each of the following information sources useful? ‡			
A listing of the patient's current medications, elicited by a nurse or office staff–person	64%	73%	0.16
The patient's actual medication bottles, brought in to the visit	22%	25%	0.67
A listing of medications based on claims that have been paid for by the patient's insurance	4%	4%	0.73
Receive 10 or fewer calls about drug coverage problems in a typical week	76%	71%	0.43
Spend 15 min or less dealing with drug coverage problems in a typical day	59%	56%	0.68

*Agree or Strongly Agree, %.
†Functions that are specifically enabled by external medication history information.
‡Always, or most of the time, %.

paper prescribing for acute conditions (e.g., antibiotics) that do not require refills (42%). We found no association between clinicians reverting to paper and practice setting or specialty.

Satisfaction and Predictors of e-Prescribing Use

Electronic prescribers reported positive experiences with their systems overall, with most reporting that they "agreed" or "strongly agreed" with the statements that the e-prescribing system is easy to use (79%), makes their work easier (53%), improves the quality of care they can deliver (62%), and does not require a lot of mental effort (62%). Somewhat fewer "agreed" or "strongly agreed" that e-prescribing had made work easier for their staff (49%), or that e-prescribing increased their productivity (40%). Overall, 66% "agreed" or "strongly agreed" that they were satisfied with their e-prescribing system and 68% would recommend it to others. On our composite rating scales, the mean "performance" scale score was 3.42 (maximum score = 5; SD = 1.01), and the mean "usability" scale score was 3.57 (maximum score = 5; SD = 0.96).

In multivariate regression analyses that included age, computer attitudes scale score, performance scale score and usability scale score as independent variables, we found that the *performance* scale score was independently associated with e-prescribing volume ($p < 0.01$); whereas the system *usability* scale score was independently associated with quitting use of the e-prescribing system ($p = 0.03$) (Table 3). These results remained substantially unchanged when the *computer attitudes* scale was eliminated from the regression models.

Discussion

In this study of two "stand alone" e-prescribing systems, we found that most e-prescribers report positive experiences with the systems, including having better information to reduce the chances of drug interactions, and to reduce the inefficiencies associated with pharmacy telephone calls for potential safety problems. Most e-prescribers also indicated that the e-prescribing system was relatively easy to use, made their work easier, and improved the quality of care they can deliver. However, despite these positive overall perceptions, many e-prescribers reverted to handwritten prescriptions at least occasionally. The reasons they endorsed for doing so included problems with network connectivity and practice management system interfaces, the presence of other technical and workflow-related issues such as external systems not reliably receiving and processing the prescriptions sent electronically, and the e-prescribing system taking too much of the prescriber's time. For a minority of physicians (17%), these difficulties resulted in their abandonment of e-prescribing altogether.

In accord with the UTAUT framework, we found that perceptions of enhanced job performance were associated with the extent of e-prescribing use, whereas perceptions that the system was easy to use were associated with lower odds of discontinuation among those who had started to use e-prescribing. In a separate, qualitative study conducted by our group among participants in the same program, we found that sites where implementation had been successful tended to have more moderate expectations about the performance of these systems, and a better appreciation of the challenges likely to be faced during implementation.[24] In addition, though all sites had equal access to technical support, some practices were more comfortable accessing this support to sustain e-prescribing efforts.[24] These findings add to previous studies that have also documented the importance of physician attitudes, system efficiency, and negative early experiences in shaping the adoption and use

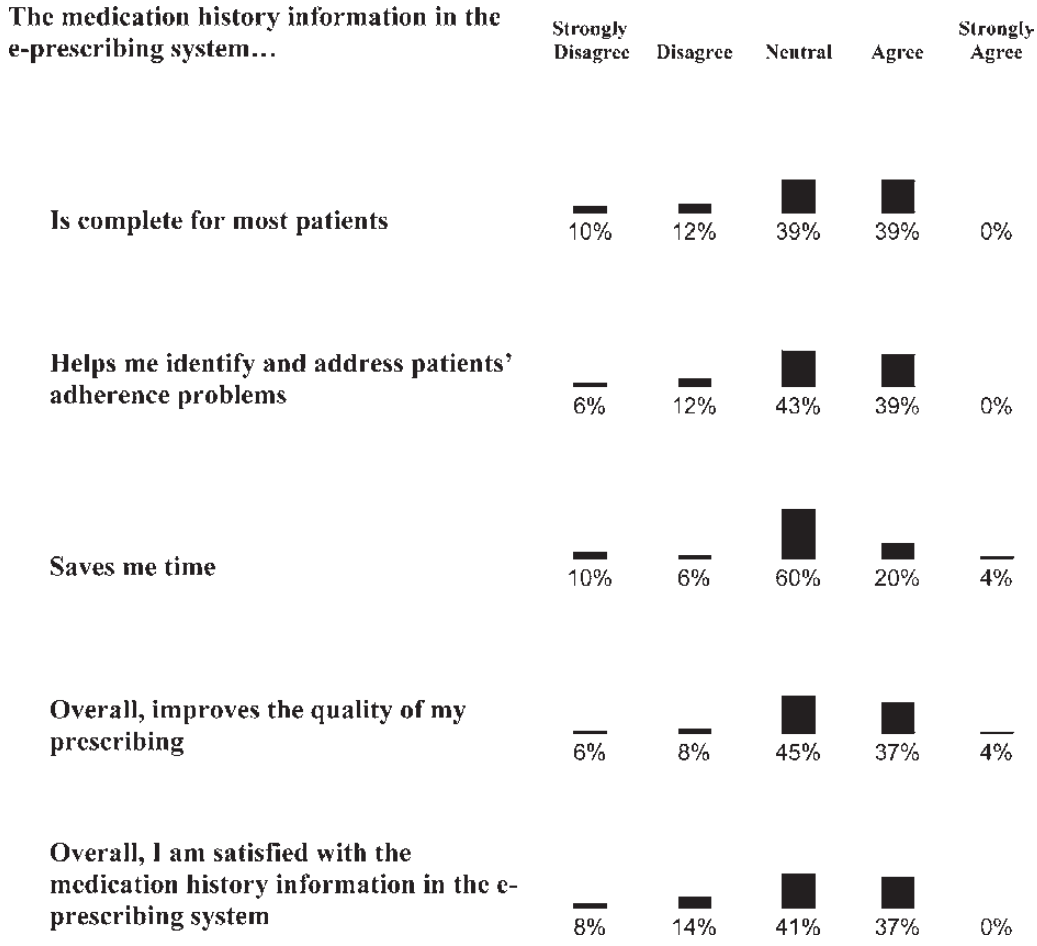

Figure 1. Experiences of E-prescribers Familiar with Medication History Information (n = 51).

of health information technology.[24,36,37] They also suggest the need for more resources to be devoted to training, systems support, and systems integration to help users overcome technical and workflow challenges.

The specific patient safety benefits that e-prescribers perceived were all available based on previous prescriptions from the same system; e-prescribers did not perceive the specific benefits that would require the use of external medication history (RxH) information. In a related study, we documented technical barriers to realizing benefits from RxH data, especially due to the lack of a universal drug identifier for accurate reconciliation across multiple sources.[26,38] Another barrier is the reliance on a successful Eligibility transaction to identify the patient and the nonparticipation of many health plans in RxHub, leading to the lack of available RxH data for their patients.[7] Due in part to these data challenges, e-prescribing system vendors had not truly integrated RxH information in e-prescribing workflows, requiring instead that users browse any available medication history data separately from medications they had prescribed. Our survey shows that many users were not familiar with this feature, and that those who were familiar with it had reservations about the value of information provided. However, the fact that no e-prescribers expressed strong satisfaction with the available medication history information would indicate that they perceive an unmet need. Thus, further work on each of these challenges—drug identifiers, completeness of data, and workflow integration—together might substantially advance the overall benefits of e-prescribing.

Similarly, e-prescribers did not perceive the benefits expected from having accurate F&B information. Up-to-date F&B information should help prescribers to select lower-cost alternatives that would reduce pharmacy call-backs to the prescriber's office. However, e-prescribers in our study did not perceive receiving fewer coverage-related pharmacy calls. This might be explained by our finding that F&B information was sometimes missing or wrong. These information quality problems, in turn, are likely due more to incompleteness in the data being published via RxHub than problems with the display of this information in the user interface. Furthermore, even patients whose insurers participate in RxHub can experience automatic look-up failures in which patients' formulary and benefit information is incorrectly matched.[26] Other studies have revealed similar gaps in F&B information.[7] Accurate formulary and benefit information is particularly important for Medicare Part D patients, who can experience high out of-pocket costs when they enter the coverage gap or when their coverage changes. Our findings highlight the need to improve the infrastructure and methods for exchanging formulary and benefit information among the organizations involved, including health plans, PBMs, and state Medicaid programs.

This study has several limitations. First, our sample came from physicians in one state, whose adoption and use of

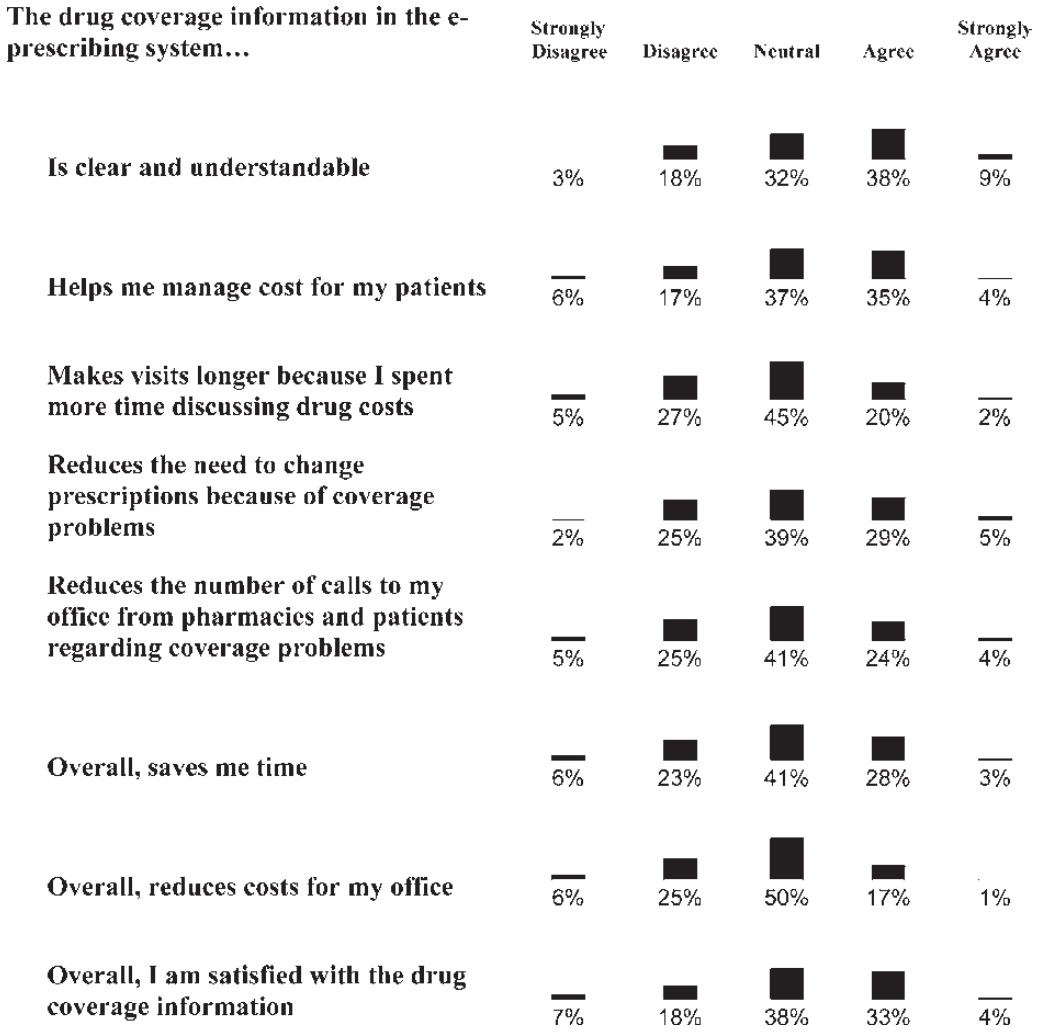

Figure 2. Experiences of E-Prescribers Regarding the Formulary and Benefit Information in the E-prescribing system (n = 139).

e-prescribing was subsidized. This incentive may mitigate the financial barriers experienced by providers in other settings.[39,40] Second, the infrastructure for e-prescribing varies regionally, as do other factors of the practice environment, such as payer mix and state policies. Third, both our e-prescribers and non-e-prescribers self-selected into the e-prescribing program and are therefore early adopters compared with the general physician population. Later adopters may be less prepared to undertake the changes needed for successful e-prescribing implementation. By contrast, late adopters may ultimately benefit more from these standards because early adopters may use other ways to seek out RxH and F&B information efficiently. Fourth, only two e-prescribing systems (Allscripts and iScribe) were used

Table 3 ■ Bivariate and Multivariate Regressions Predicting E-Prescribing Volume and Quitting Among E-Prescribers (n = 139)

	Outcome Measure			
	Monthly E-Prescribing Volume		Quit Using E-Prescribing	
Predictors	Bivariate Coefficient (CI)	Multivariate Coefficient (CI)	Bivariate OR (CI)	Multivariate OR (CI)
Performance scale§ (min = 1; max = 5)	49.37*** (27.30–71.45)	**46.52*** (12.06–+80.97)	0.295*** (0.17–0.52)	0.59 (0.26–1.33)
Usability scale§ (min = 1; max = 5)	41.27** (17.72–64.83)	7.84 (−26.80–+42.49)	0.31*** (0.18–0.53)	**0.42*** (0.19–0.90)
Computer attitudes score (min = 1; max = 5)	6.18 (−27.54–+39.90)	−15.53 (−49.19–+18.13)	0.45* (0.25–0.84)	0.65 (0.31–1.35)
Age (min = 27; max = 82)	1.32 (−1.08–+3.74)	0.81 (−1.50–+3.12)	0.96 (0.92–1.01)	0.94 (0.88–1.00)

OR = Odds Ratio; CI = 95% confidence interval. Associations that remained statistically significant in multivariate analyses are shown in bold text.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.
§Scores on the Performance scale and the Usability scale were correlated ($r^2 = 0.57$) but the results were not consistent with multicollinearity.

by our survey respondents and experiences with these systems may not be representative. However, these systems have among the largest e-prescribing customer bases and the users' experiences are similar to those reported in other studies.[7,41] Fifth, our survey represents perceptions elicited in the second half of 2006 and some of the technical problems with e-prescribing reported here may have since been resolved. Finally, generalizability is unknown, but a study of e-prescribing usage among physicians in Massachusetts also found that users often reverted to handwritten prescribing, with net usage rates below 30% of all prescriptions at 1 year after adoption.[41]

Conclusions

The Centers for Medicare and Medicaid Services will require use of the *formulary* and *benefits*, and *medication history information* standards for e-prescribing programs.[16] However, the overall findings of our study suggest that mandating the use of these standards is necessary but not sufficient for achieving the desired effects of e-prescribing. Additional work to improve the infrastructure in which these systems are used will be needed, and additional policy incentives may be required to facilitate and ensure effective communications between organizations involved in prescribing, supplying and paying for medications. Only when these systems communicate with each other in a timely, accurate, and patient-specific manner, will the full benefits of e-prescribing be realized.

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