

Clinicians' Assessments of Electronic Medication Safety Alerts in Ambulatory Care

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Background: While electronic prescribing (e-prescribing) systems with drug interaction and allergy alerts promise to improve medication safety in ambulatory care, clinicians often override these safety features. We undertook a study of respondents' satisfaction with e-prescribing systems, their perceptions of alerts, and their perceptions of behavior changes resulting from alerts.

Methods: Random sample survey of 300 Massachusetts ambulatory care clinicians who used a commercial e-prescribing system.

Results: A total of 184 respondents completed the survey (61%). Respondents indicated that e-prescribing improved the quality of care delivered (78%), prevented medical errors (83%), and enhanced patient satisfaction (71%) and clinician efficiency (75%). In addition, 35% of prescribers said that electronic alerts caused them to modify a potentially dangerous prescription in the last

30 days. They suggested that alerts also led to other changes in clinical care: counseling patients about potential reactions (49% of respondents), looking up information in medical references (44%), and changing the way a patient was monitored (33%). Altogether, 63% of clinicians reported taking action other than discontinuing or modifying an alerted prescription in the previous month in response to alerts. Despite these benefits, fewer than half of respondents were satisfied with drug interaction and allergy alerts (47%). Problems included alerts triggered by discontinued medications (58%), alerts that failed to account for appropriate drug combinations (46%), and excessive volume of alerts (37%).

Conclusion: Although clinicians were critical of the quality of e-prescribing alerts, alerts may lead to clinically significant modifications in patient management not readily apparent based on "acceptance" rates.

Arch Intern Med. 2009;169(17):1627-1632

DESPITE GROWING ENTHUSIASM for electronic prescribing (e-prescribing),¹⁻³ relatively little is known about the benefits of this technology in ambulatory care. Studies have shown that e-prescribing with decision support can increase ordering of appropriate laboratory tests⁴ and decrease the use of potentially risky medications by vulnerable patients.⁵⁻⁷

However, e-prescribing without advanced decision support did not prevent adverse drug events (ADEs) in a study of 4 Boston primary care practices.⁸ Indeed, several studies have documented high rates of "overridden" alerts and widespread dissatisfaction among prescribers with alerts that are perceived to be irrelevant, trivial, disruptive, or redundant.⁹⁻¹⁹ Creating e-prescribing systems for ambulatory care that present clinically meaningful alerts may avoid alert fatigue, minimize interruptions in care, and potentially reduce

medication errors and ADEs.²⁰⁻²² Accordingly, we sought to guide the development of effective e-prescribing in community-based practices by studying Massachusetts clinicians' perceptions of e-prescribing and their experiences with medication safety alerts.

METHODS

E-PRESCRIBING SYSTEM

We studied a commercial e-prescribing system (PocketScript; ZixCorp, Dallas, Texas) used by 3244 Massachusetts clinicians in 2006. The multifaceted application is a desktop and handheld system that uses drug allergy and interaction alerts provided by the Cerner Multum (Denver, Colorado) drug reference database.²³

QUESTIONNAIRE

We developed a written survey to assess clinicians' judgments about the value of e-prescribing, including drug allergy and interaction alerts. We conducted three 2-hour

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Table 1. Respondent Characteristics

Characteristic	Number Result ^a
Total respondents	184 (100) ^b
Men	91 (52)
Women	85 (48)
Data missing, No.	8
Race/ethnicity	
White	159 (90)
Nonwhite	17 (10)
Data missing, No.	8
Primary language	
English	166 (94)
Other	10 (6)
Data missing, No.	8
Profession	
Physician	138 (78)
Nurse practitioner	33 (18)
Physician assistant	3 (2)
Clinical nurse	3 (2)
Data missing, No.	7
Specialty	
Internal medicine	50 (28)
Pediatrics	51 (28)
Family practice	29 (16)
Medical subspecialty	20 (11)
Surgical subspecialty	3 (2)
Obstetrics-gynecology	3 (2)
Psychiatry	9 (5)
Other	14 (8)
Data missing, No.	5
Type of practice	
Hospital-based teaching	16 (9)
Hospital-based nonteaching	3 (2)
Community-based office	106 (59)
Community health center	11 (6)
Multispecialty group	26 (15)
Other	17 (9)
Data missing, No.	5
Practice duration, mean (SD) (range), y	22 (10) (2-46)
Direct care time per week, mean (SD) (range), h	38 (12) (12-80)
Comfort with computers and electronic technology	
Very comfortable	92 (52)
Comfortable	56 (32)
Somewhat comfortable	24 (14)
Not at all comfortable	5 (3)
Data missing, No.	7
E-prescribing experience, mean (SD) (range), y	3.4 (1.1) (1.0-8.0)
Prescriptions written per week, mean	
≤50	48 (27)
51-100	67 (37)
101-150	40 (22)
>150	26 (14)
Data missing, No.	3
Prescriptions written electronically, mean (SD) (range), % ^c	90 (18) (0-100)

^aUnless otherwise indicated, data are reported as number (percentage) of respondents; percentages may not total 100% owing to rounding, and the total number of respondents analyzed differs for each question.

^bOverall total is 184, but number of respondents with item-level missing data differs for each question.

^cInclusion criteria included 100 or more electronic prescriptions per month between January 1, 2006, and June 30, 2006. Respondents who reported writing 0% of prescriptions electronically either had recall bias or no longer wrote electronic prescriptions by the time of the survey in December 2007.

focus groups with 25 Massachusetts PocketScript users and conducted cognitive testing of the draft instrument. The final instrument was a 42-question written survey that asked clinicians about their adoption of and satisfaction

with e-prescribing and the effect of these systems on the safety, efficiency, and cost of care. The instrument was formatted for pencil and paper as well as Web-based administration (Datstat, Seattle, Washington).

SUBJECT SELECTION AND SURVEY ADMINISTRATION

We obtained a list of names and addresses of all 687 Massachusetts clinicians who wrote at least 100 prescriptions per month between January 1, 2006, and June 30, 2006, using PocketScript. We mailed the written survey and cover letter to a random sample of 300 subjects in December 2007, indicating that the study was being conducted by academic researchers with funding from Blue Cross Blue Shield of Massachusetts. Respondents were assured that their responses and identities would be kept confidential and not shared with the sponsor. We sent a follow-up mailing to nonresponders, and an investigator made up to 3 follow-up telephone calls. We included a \$20 gift card incentive in the initial mailing and offered an additional \$10 check to those who completed the survey online.

DATA ANALYSIS

We tabulated responses and performed descriptive analyses using Stata software, version 9.0 (StataCorp, College Station, Texas) and Wincross software, version 8.0 (Analytical Group, Scottsdale, Arizona). The focus group sessions, final survey content, and data analyses were entirely the responsibility of the academically based investigators. The study was approved in advance by the institutional review board of the Dana-Farber Harvard Cancer Center.

RESULTS

RESPONDENT CHARACTERISTICS

A total of 184 of 300 clinicians completed the survey (61%).²⁴ Respondent characteristics are summarized in **Table 1**. Most respondents were white, English-speaking, full-time primary care physicians who practiced in community-based offices or health centers. On average, respondents had used e-prescribing for the past 3.4 years.

ADOPTION AND PERCEPTIONS OF E-PRESCRIBING

The survey presented clinicians with 15 reasons to adopt e-prescribing and asked them to select a response for each reason from a 4-point Likert scale (ranging from

very important to not important at all). Respondents endorsed a number of these factors (**Figure 1**), as well as the perception that e-prescribing would improve the quality of care delivered (78%), prevent medical errors (83%), and enhance patient satisfaction (71%) and clinician efficiency (75%).

Respondents gave mixed reviews to various features of the electronic prescribing system (**Figure 2**). The most favorable ratings (based on a 4-point Likert scale) were for ease of renewing prescriptions, ease of initial prescription writing, visual layout, built-in drug references, and speed of transmission of prescriptions to the pharmacy. Respondents were generally critical of the system's ability to facilitate prescriptions for medical supplies and equipment (70% of respondents rated this characteristic fair or poor) and to track drug allergy information (48%, fair or poor). Nevertheless, the vast majority of respondents were satisfied or very satisfied with e-prescribing overall (89%).

PERCEPTIONS OF MEDICATION SAFETY ALERTS

In contrast to the high level of overall satisfaction with e-prescribing, only 47% of clinicians were satisfied or very satisfied with medication safety alerts. As summarized in **Table 2**, respondents evaluated potential problems with alerts by selecting from a 4-point Likert scale (ranging from a big problem to not a problem). Participants agreed that alerts were triggered by discontinued medications (58%); alerts of different severities appeared similar (50%); and alerts often failed to account for appropriate combination use of drugs (46%). Thirty-seven percent of respondents complained of an excessive volume of alerts; indeed, clinicians estimated that about 1 in 4 electronic prescriptions generated an alert (data not shown).

EFFECT OF DRUG ALLERGY AND INTERACTION ALERTS

Respondents were asked to estimate the number of alerts in the last 6 months that caused them to change their behavior. Seventy-eight percent of respondents indi-

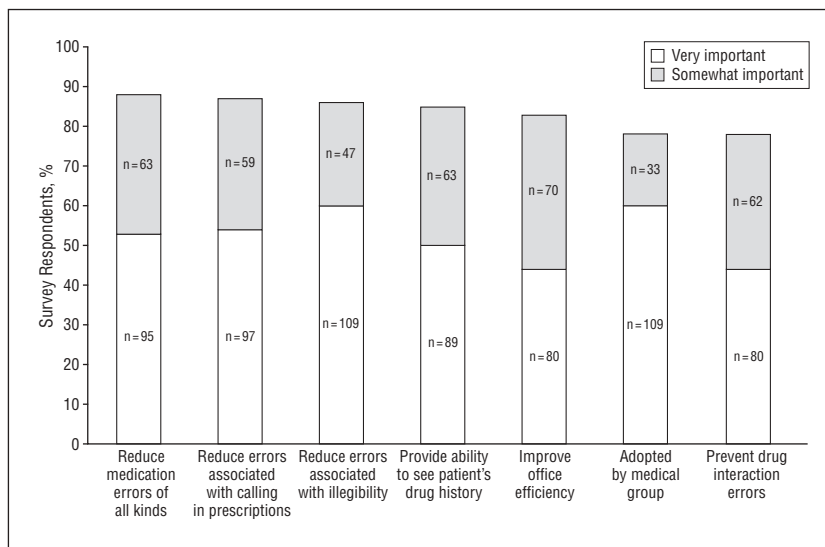


Figure 1. Responses to the survey question "Think back to the time when you began to use electronic prescribing. How important were each of the following reasons in your decision to begin using electronic prescribing?" Clinicians were presented with 15 reasons that emerged in focus group discussions and were asked to select from a 4-point Likert scale ranging from very important to not important at all, or to select not applicable. Respondents endorsed a number of factors as influential in their decisions to adopt electronic prescribing, including a desire to reduce medication errors, to prevent errors associated with illegible prescriptions, and to improve the efficiency of their office practices.

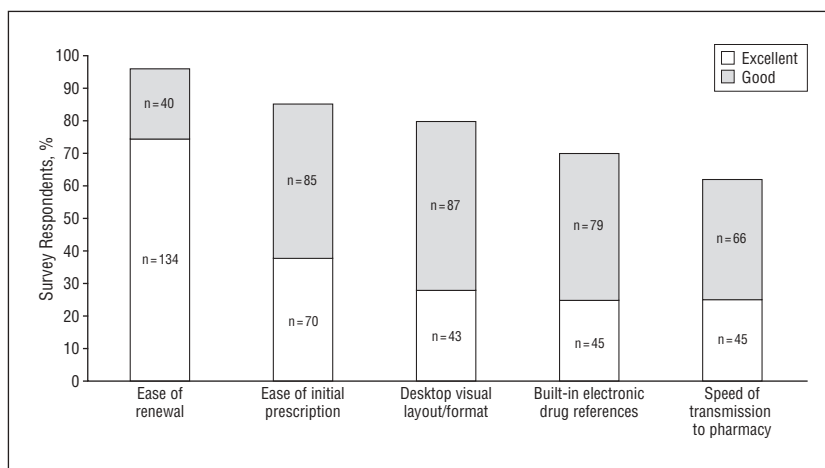


Figure 2. Responses to the survey question "How would you rate the following features of the electronic prescribing system that you use?" Clinicians were presented with 10 features of the electronic prescribing system and asked to select from a 4-point Likert scale ranging from excellent to poor. Respondents rated highly a number of features. Most clinicians reported that the technology made renewing existing prescriptions particularly easy.

cated that at least 1 alert had done so (**Table 3** and **Table 4**). Clinicians were also presented with 9 behaviors that emerged in focus group discussions as potential reactions to electronic alerts and were asked to identify the frequency with which they did each in the previous month. Thirty-five percent and 36%, respectively, reported that an alert caused them to modify a prescription for an alerted drug or to write a prescription for a different drug often or sometimes. In addition, almost two-thirds of respondents indicated that,

in the last month, an alert caused them to take action other than change an alerted prescription (63%). As shown in **Figure 3**, respondents said that an alert led them to counsel a patient about potential reactions or interactions (49%), to look something up in a drug or medical reference (44%), and to change the way they monitored a patient (33%).

Collectively, respondents perceived that medication safety alerts and their resultant behavior changes prevented medication errors and

Table 2. Problems Associated With Drug Allergy or Interaction Alerts^a

Problem	Respondents, No. (N=184) ^b	Big Problem	Problem	Small Problem	Not a Problem
Alerts are triggered by medications that the patient no longer takes	162	41 (25)	54 (33)	31 (19)	36 (22)
Severe, moderate, and mild interaction alerts all look the same on the computer screen	154	27 (18)	49 (32)	28 (18)	50 (32)
Alerts fail to account for appropriate use of combination drug therapy	156	27 (17)	46 (29)	44 (28)	39 (24)
There are too many alerts	161	24 (15)	35 (22)	34 (21)	68 (42)
The frequency of alerts causes me to disregard potentially valuable alerts	159	24 (15)	34 (21)	34 (21)	67 (42)
The interaction is so familiar that the alert provides little added value	159	22 (14)	43 (27)	43 (27)	51 (32)
Alerts that are classified as "severe" are no more dangerous for patients than moderate and mild interactions	156	20 (13)	32 (21)	47 (30)	57 (37)
Alerts are not clinically relevant	160	21 (13)	26 (16)	41 (26)	72 (45)
Alerts identify extremely rare complications	158	16 (10)	43 (27)	52 (33)	47 (30)
Alerts are not based on persuasive scientific evidence	161	12 (7)	33 (20)	44 (27)	72 (45)
Alerts offer recommendations that are contrary to guidelines or recommendations	159	7 (4)	27 (17)	49 (31)	76 (48)
Text of alert message is difficult to understand	158	6 (4)	12 (8)	35 (22)	105 (66)

^aUnless otherwise indicated, data are reported as number (percentage) of respondents; percentages may not total 100% owing to rounding.

^bOverall total is 184, but number of respondents with item-level missing data differs for each question.

Table 3. Perceived Specific Behavioral Effects of Drug Interaction and Allergy Alerts^a

Question and Answers	Respondents, No. (N=184) ^b	Often	Sometimes	Rarely	Never
In the last 30 days, how often has a drug allergy or interaction alert caused you to do any of the following?					
Counsel a patient about potential drug reactions or interactions	176	15 (9)	72 (41)	49 (28)	40 (23)
Look something up in a drug or medical reference	175	13 (7)	64 (37)	51 (29)	47 (27)
Write a new prescription for a different drug	174	9 (5)	54 (31)	60 (35)	51 (29)
Modify a prescription for an alerted drug	176	8 (5)	53 (30)	64 (36)	51 (29)
Change the way you monitor a patient	174	4 (2)	53 (31)	58 (33)	59 (34)
Discuss the case with a colleague	175	3 (2)	36 (21)	61 (35)	75 (43)
Check additional laboratory tests	174	3 (2)	31 (18)	65 (37)	75 (43)
Check a physical examination finding	173	3 (2)	23 (13)	52 (30)	95 (55)
Decide to prescribe no drug in place of the alerted drug	174	3 (2)	20 (12)	73 (42)	78 (45)

^aUnless otherwise indicated, data are reported as number (percentage) of respondents; percentages may not total 100% owing to rounding.

^bOverall total is 184, but number of respondents with item-level missing data differs for each question.

Table 4. Perceived Impact of Drug Interaction and Allergy Alerts^a

Questions and Answers	Respondents, No. (%) (N=184) ^b
In the last 6 months, what is your best estimate of the number of alerts that caused you to change your behavior by modifying a prescription, counseling a patient, checking a laboratory test, etc?	178 (100)
0	40 (22)
1-2	51 (29)
3-5	40 (22)
6-10	30 (17)
11-20	12 (7)
>20	5 (3)
Since using your current electronic prescribing system, about how many times in an average month have you received an alert that may have prevented any error or injury in your practice?	173 (100)
0	74 (43)
1	46 (27)
2-5	45 (26)
6-10	6 (3)
>10	2 (1)
To the best of your knowledge, has a medication alert ever prevented a potentially serious error or injury to a patient in your practice?	176 (100)
Yes	38 (22)
No	92 (52)
Don't know	46 (26)

^aData are reported as number (percentage) of respondents; percentages may not total 100% owing to rounding.

^bOverall total is 184, but number of respondents with item-level missing data differs for each question.

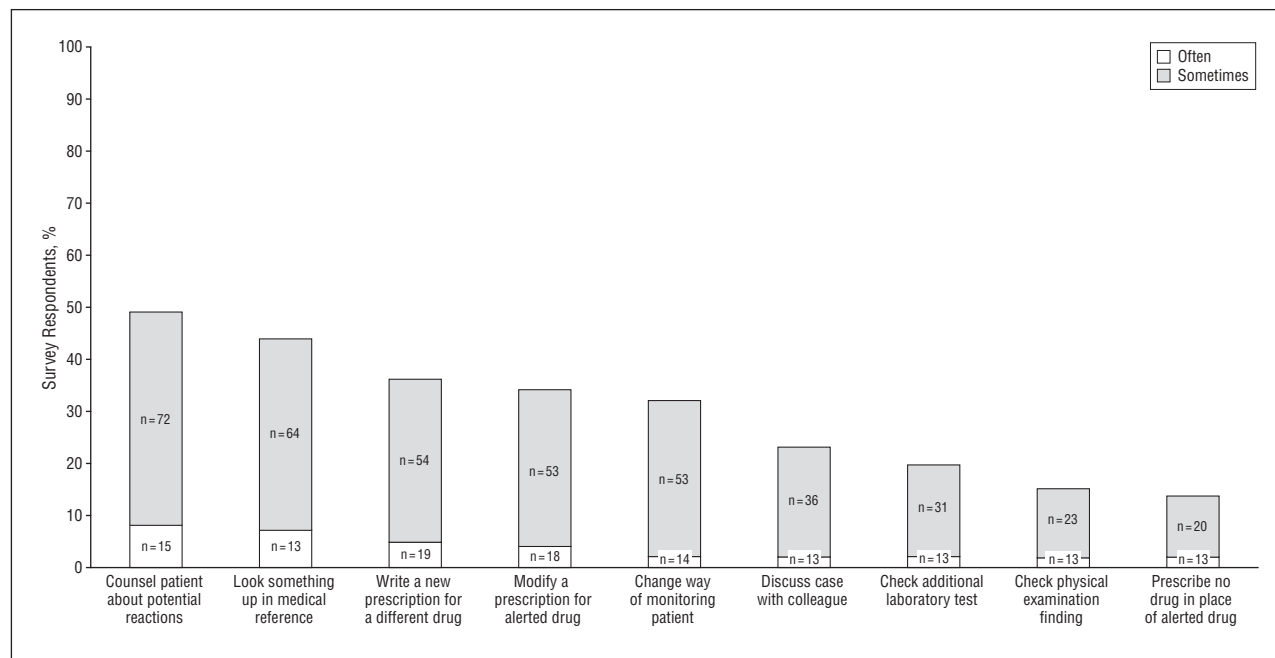


Figure 3. Responses to the survey question "In the last 30 days, how often has a drug allergy or interaction alert caused you to do any of the following?" Clinicians were presented with 9 behaviors that emerged in focus group discussions as potential reactions to electronic alerts and asked to select from a 4-point Likert scale ranging from often to never. Respondents endorsed the idea that medication safety alerts not only caused prescribers to alter or cancel prescriptions, but also resulted in actions that were not immediately evident based on alert acceptance rates.

ADEs. Fifty-seven percent reported that an alert might have prevented at least 1 error or injury (of any severity) in the average month. Moreover, 22% responded affirmatively when asked whether a medication alert had ever prevented potentially serious errors or injuries in their practices.

COMMENT

Our study of Massachusetts clinicians found that most established e-prescribers were highly satisfied with e-prescribing in general. In contrast, many clinicians perceived alerts to be a nuisance, often triggered by discontinued drugs retained on the medication list or the appropriate use of drug combinations. While alerts generated by outdated medications may indicate a problem with clinician workflow or inadequate medication reconciliation, they may also signal the need for features that automatically retire outdated prescriptions. Clinicians nevertheless acknowledged that medication safety alerts performed important functions; over half of clinicians agreed that alerts prevented errors or injuries in their practices each month.

Predictably, drug safety alerts caused prescribers to modify potentially dangerous prescriptions. However, a novel finding of this study is that alerts also prompted prescribers to take other actions to improve the quality of care, including counseling patients about potential reactions, looking up information in a medical reference, changing the way a patient was monitored, or discussing a case with a colleague. In short, alerts may affect clinical care in ways that are not apparent based on the low rate of accepted alerts (ie, those that result in a change of prescription).

This study has several limitations. First, it may be subject to a nonresponse bias: respondents might have been motivated to participate if they were particularly supportive or critical of e-prescribing or the study sponsor. Second, we surveyed users of a single e-prescribing system and drug interaction database, which may affect the generalizability of our findings. However, e-prescribing systems share many common features: Cerner Multum, which maintains the medication safety alerts for the PocketScript system, is one of a limited number of commercial drug interaction databases used through-

out North America. Third, our findings may not be generalizable to clinicians from other geographic areas. Finally, the opinions and behaviors of our established e-prescribers may differ from those of less committed users. In fact, early adopters included a mix of technophile clinicians and more conventional clinicians brought along by practice leaders who elected to adopt e-prescribing. Therefore, the opinions of these clinicians may anticipate the perceptions of future users as e-prescribing becomes more widespread.

In conclusion, many Massachusetts ambulatory care e-prescribers were dissatisfied with drug allergy and interaction alerts but reported that alerts prevented serious medication errors in their practices. Efforts to identify and reduce the number of low-yield alerts may lighten the burden on busy clinicians while enabling medication alerts to provide the patient safety benefits for which they were designed.^{8,10-12,19,25} In addition, high-alert override rates may belie changes in clinician behavior that enhance care in ways that are not measured routinely. Future research should assess the indirect benefits associated with alerts that affect clini-

cian behavior without necessarily aborting a prescription attempt.

Accepted for Publication: May 27, 2009.

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Financial Disclosure: Ms Cyrulik is employed by Blue Cross Blue Shield of Massachusetts, which provided grant support for this study. She was involved in the project as a member of the study team but had no access to the identity of study participants or primary data sources. Dr Sands was formerly an employee of ZixCorp, the manufacturer of the e-prescribing system used in this study, but left the company prior to the initiation of this study.

Funding/Support: This research was supported by a grant from Blue Cross Blue Shield of Massachusetts.

Role of the Sponsor: Blue Cross Blue Shield of Massachusetts was not involved in the design or conduct of the study, data collection, or data analysis. The company did not prepare or approve the final manuscript.

Additional Contributions: Christopher Yu, MPH, Angus MacDonald, and Geoff Bibby, BC, of ZixCorp provided the e-prescription and alert data; Jessica Fefferman, MPH, of Blue Cross Blue Shield of Massachusetts assisted in conceptualizing the project. No compensation was provided for this assistance.

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