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Medication safety messages for patients via the web portal: The MedCheck intervention

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ABSTRACT

Objective: Communication failures account for many adverse drug events (ADEs) in adult primary care. Improving patient–physician communication may improve medication safety. Accordingly, the goal of this study was to learn whether electronic medication safety messages directed to patients can improve communication about medications and identify ADEs.

Design: We studied adult patients enrolled in a patient Internet portal at three primary care practices affiliated with a teaching hospital. MedCheck, a medication safety application, sent patients a secure electronic message 10 days after they received a new or changed prescription. MedCheck asked if the patient had filled the prescription or experienced medication-related problems, and then forwarded the patient's response to their primary care physician.

Measurements: We selected a stratified random sample of 267 subjects from 1821 patients who received and opened a MedCheck message from April 2001 to June 2002. We reviewed subjects' medical records for three months following their first MedCheck message. We analyzed patient and clinician response rates and times, examined patient–clinician communication about medications, and identified ADEs.

Results: Patients opened 79% of MedCheck messages and responded to 12%; 77% responded within 1 day. Patients often identified problems filling their prescriptions (48%), problems with drug effectiveness (12%), and medication symptoms (10%). Clinicians responded to 68% of patients' messages; 93% answered within 1 week. Clinicians often supplied or requested information (19%), or made multiple recommendations (15%). Patients experienced 21 total ADEs; they reported 17 electronically.

Conclusion: Patients and physicians responded promptly to patient-directed electronic medication messages, identifying and addressing medication-related problems including ADEs.

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1. Introduction

Reducing adverse drug events (injuries due to medications, or "ADEs") in primary care depends on timely and effective patient–physician communication about medication-related symptoms [1]. One study suggested that nearly 8 million ADEs might be prevented or ameliorated if patients told their physicians about their medication-related symptoms in a timely way, and if physicians acted on patients' reports [2]. Intervening in this area might have even greater potential benefit for reducing ADEs than computerizing prescribing.

Given the salutary effect of electronic alerts for clinicians in preventing medication errors among inpatients [3], we hypothesized that electronic messages delivered automatically to patients via a patient Internet portal could (1) elicit patients' medication-related problems efficiently, (2) facilitate patient–physician communication about medication problems, and (3) identify ADEs. To test this concept, we created an automated portal-based application called MedCheck. In this report, we describe MedCheck and analyze its impact.

2. Methods

2.1. Site

We studied patients at three adult primary care sites: a hospital-based academic practice serving a socioeconomically diverse population, a suburban practice in a middle class community, and an urban clinic in a working class neighborhood. The practices included 52 part and full time physicians and served over 50,000 patients.

2.2. Intervention

The study practices used a common outpatient electronic medical record that included a prescription-writing feature with drug interaction and drug allergy alerts [4]. In September 2000, clinicians at the sites were given access to PatientSite, a secure, encrypted, and password-protected Web portal that offered patients an electronic messaging system, access to laboratory and radiology reports, and the ability to request managed care referrals, prescription refills, and appointments [5]. In April 2001, the organization deployed MedCheck, a drug safety application for use in PatientSite. MedCheck queried patients automatically 10 days after they received a new or changed prescription; discontinued drugs did not prompt a query.

The MedCheck message listed the patients' new or changed prescriptions and asked patients to select "No problems or questions" or "I have not filled or have had some problems." MedCheck triggered a traditional email message that was sent to the patient's email account indicating that he or she had received a PatientSite message and providing a link to the secure PatientSite Website, but there was no description of the content of the message.

Patients' responses were forwarded immediately to the primary care physician and to physician-designated staff. The hospital information systems department collected information about MedCheck in a secure database for quality improvement. Patient and clinician responses (if any) via PatientSite were archived as a permanent part of the patient's medical record.

2.3. Sample selection

We obtained a dataset with information about all 4979 MedCheck messages generated from April 1, 2001, through June 10, 2002 (the function was disabled with a new PatientSite release). Medical record numbers were unavailable for 367 messages, yielding 4612 usable MedCheck messages to 1821 unique patients. Of these, 1505 (82.6%) patients opened 3660 MedCheck messages (79.4% of the messages), and 316 (17.4%) patients responded to 423 (11.6%) of the messages.

We selected a stratified sample of patients who opened at least one MedCheck message for detailed chart review (see Fig. 1). We included all 316 patients who responded to at least one MedCheck message, and randomly sampled 100 patients from the remaining 1189 patients who opened but did not respond to any message. This yielded a preliminary chart review sample of 416 patients. We subsequently excluded 143 patients whose primary care was rendered at a site other than one of the three study practices and 6 patients who were not confirmed as PatientSite users. The final chart review sample included 267 patients.

2.4. Data abstraction

Nurse reviewers conducted a single, retrospective examination of the electronic record and PatientSite messages of subjects in the chart review sample. The review encompassed the period from the date of the prescription that triggered each patient's first ("index") MedCheck message until 3 months later. They abstracted demographic, administrative, and clinical information including clinicians' notes, problem and medication lists, and laboratory and radiology results. They characterized patients' reports of medication-related problems and recorded clinicians' responses. They also identified possible ADEs for subsequent physician review. To assess utilization, reviewers recorded the number of telephone contacts, PatientSite messages, office and emergency room visits, and hospital admissions.

2.5. Data coding and analysis

Two physician reviewers coded each candidate ADE independently, classifying their certainty that the incident occurred as reported, and the severity, extent of injury, preventability, class of medication, and type of complication [1,3]. Inter-rater reliability of pre-consensus judgments was excellent for type of event (kappa = 0.96), certainty (0.80), extent of injury (0.79), preventability (0.91), and type of complication (0.93). Percent agreement for judgments about severity of injury was excellent (95%), but kappa was low (−0.02) because of high consistency and low variability in reviewers' responses.

We compared the characteristics of patients who did ($n = 128$) and did not ($n = 139$) respond to the index MedCheck message using the Chi-square statistic and Student's t-test. Because we purposefully over-sampled MedCheck responders

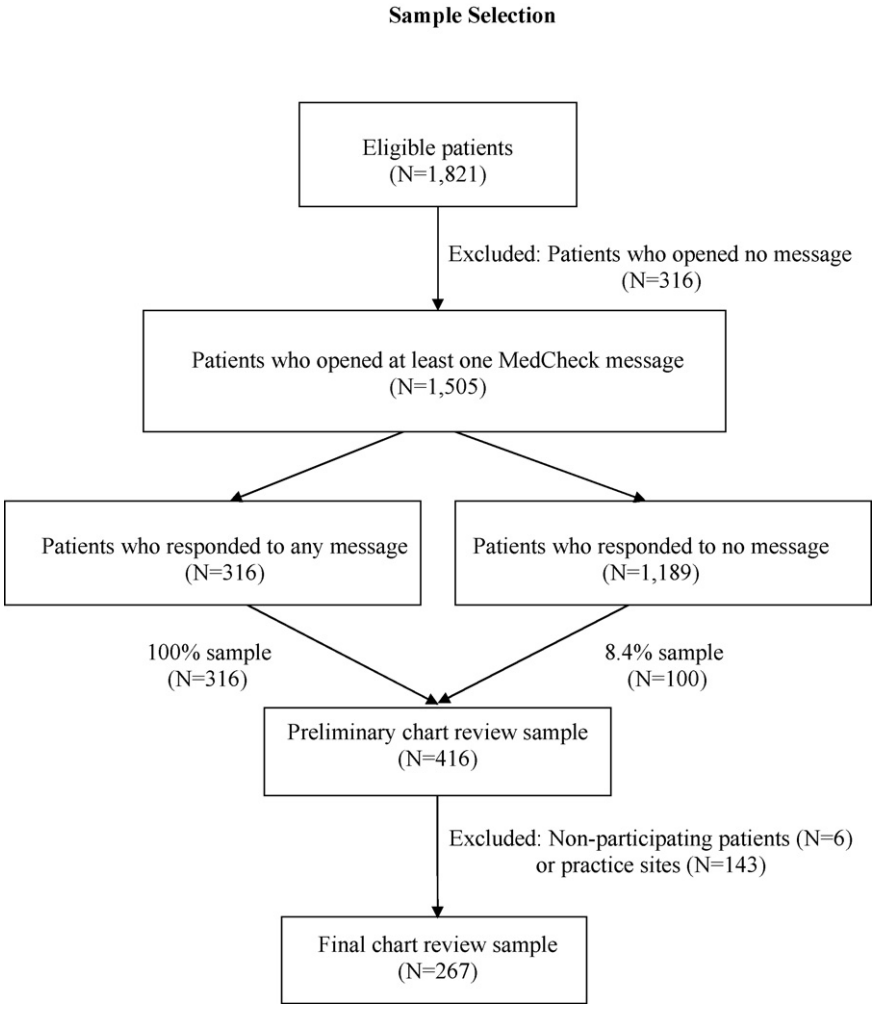

Fig. 1 – Sample selection.

as part of our study design, we used sampling weights to adjust these calculations for the stratified sample. We calculated the percent of messages that patients and clinicians opened and the response intervals, again using sampling weights to estimate accurately the behavior of patients and clinicians in the study practices. We classified the issues patients reported and clinicians' responses. We analyzed healthcare utilization of patients who responded to the index MedCheck message and those who did not. Finally, we analyzed the number and type of ADEs identified via MedCheck and on chart review.

Statistical analyses used Stata 7.0 (StataCorp, College Station, TX, USA). The hospital's institutional review board approved the study in advance.

3. Results

3.1. *Patient characteristics*

Consistent with previous surveys of Internet users [6–8], the mean age of subjects (Table 1) was 43 years (range, 15–98 years). Half were male and 19% were non-white. Most patients had either managed care or commercial indemnity insurance. Nevertheless, there was a significant burden of disease. Patients had an average of 6 medical problems each and 4 prescription drugs listed on their medication lists. Responders were older than non-responders, but these groups were otherwise similar.

3.2. *Opening and responding to MedCheck messages*

The 267 patients in the chart review sample received a total of 391 MedCheck messages. A single MedCheck message listed all the new or changed prescriptions ordered for a patient on a given date; the 267 index messages listed a total of 446 medications. Two-thirds of index messages were triggered by prescriptions written during an office visit, and primary care physicians wrote most prescriptions.

Table 2 shows that most patients opened the index MedCheck message within 1 day of its arrival. Among the 13% of patients who responded to the index message, 77% responded within 1 day of opening the message. Patients responded via PatientSite in all but three cases (one by telephone, two at office visits). Clinicians, in turn, responded to 68% of patients' messages. Three-quarters of clinicians responded to

Table 1 – Patient characteristics, by Response to Index MedCheck Message

	Did not respond to index message (%)	Responded to index message (%)	Total[a] (%)	P-value[b]
Age, mean (range), S.E.	42.5 (20–98), 1.3	48.3 (15–85), 2.6	43.4 (15–98), 1.2	0.045
Male sex	53	46	49	0.861
Nonwhite race	15	21	19	0.701
Insurance type				0.476
Commercial indemnity	19	26	20	
Managed care	67	70	67	
Medicare	8	3	7	
Free care	1	0	1	
Other/unknown	5	1	5	
Practice site				0.679
Hospital-based practice	43	39	42	
Suburban community practice	53	58	54	
Community health center	4	3	4	
No. of medical problems, mean (range), S.E.	6.3 (0–24), 0.4	6.9 (0–19), 0.8	6.4 (0–24), 0.4	0.540
No. of medication allergies, mean (range), S.E.	0.7 (0–36), 0.1	0.8 (0–9), 0.2	0.7 (0–36), 0.1	0.567
No. of prescription medications, mean (range), S.E.	4.4 (0–44), 0.5	4.2 (0–17), 0.3	4.4 (0–44), 0.4	0.710

[a] Figures are weighted to provide estimates for the entire group of patients who opened at least one MedCheck message, adjusting for the stratified sample.
[b] Chi-square for categorical variables, Student's *t*-test for continuous variables.

the patient message within 1 day, and 93% responded within 1 week. Eighty-one percent of respondents were physicians.

3.3. *Medication problems and clinician responses*

Table 3 shows the responses of patients who identified a medication-related problem in response to the index MedCheck message, and clinicians' responses to patients' messages. Patients reported delays or difficulty filling their prescriptions. They asked about the effectiveness of the drug; drug-related symptoms; and the dose, use, or name of a drug. Patients often raised multiple issues.

Clinicians, in turn, provided patients with information or asked for clarification in 19% of cases. Clinicians also changed the dose, frequency, or timing of a drug; provided an alternate medication; or renewed an existing prescription. Clinicians did not respond to 43% of patients' messages. However, many of these messages may not have required a response. Physicians were least likely to respond to patients who reported that they had not yet filled a prescription, and were most likely to respond to questions about a medication-related symptom, or about the use, dose, or name of a drug.

3.4. *Adverse drug events and resource utilization*

Reviewers confirmed 21 ADEs among 20 patients who received at least one of 446 medications identified in the index message. Adjusting for the sampling strategy, 5.0% of patients experienced an ADE involving one of the 446 medications. Seventeen of the 21 ADEs were reported via PatientSite by 128 patients who responded to the MedCheck message, and four ADEs were reported by 139 non-responders at an office visit ($p = 0.01$, Fisher's exact test).

Table 4 lists the index medication ADEs, their severity and preventability. There was one serious, preventable ADE, in which a patient failed to take prescribed phosphate supplements and had a dangerously low serum phosphate level. The remaining events were all judged to be significant ADEs (the lowest level of severity); examples included feeling "groggy" on cyclobenzaprine, nausea and bloating on metformin, dyspepsia and diarrhea on selective serotonin reuptake inhibitors, dizziness with atenolol, and constipation on narcotics.

Table 5 shows patients' utilization of selected health resources in the three months following the index message. There was no difference in the number of telephone calls, office or emergency room visits, or hospital admissions among patients who responded to the index MedCheck message compared to those who did not. Responders, however, exchanged more PatientSite messages with their clinicians than non-responders (8.8 versus 4.6, $p < 0.001$).

4. Discussion

We designed and implemented MedCheck, an application embedded in a patient Internet portal that generated automatic medication safety messages. We hypothesized that MedCheck would enhance clinical care by eliciting patients' medication symptoms efficiently, facilitating patient–physician communication about medications, and identifying ADEs. The application met each of these goals. Most patients with medication problems and difficulty filling their prescriptions reported within 1 day. Clinicians responded to two-thirds of patients' messages (most within 1 week) by asking questions, providing information, and generating new prescriptions. In addition, patients reported more ADEs electronically via MedCheck than by telephone or at office visits.

Table 2 – Patient and clinician use of patientsite to Open and Respond to the Index MedCheck Message

	Percentage[a]
Interval (days) between date MedCheck message was sent and opened, mean (range), S.E.	21.3 (0–410), 6.5
Percent of patients who opened the message within	
≤1 day	77
2–7 days	4
8–30 days	6
>30 days	13
Unable to determine	0
Percent of patients who responded to the MedCheck message among those who opened the message	13
Interval (days) between date message was opened and response sent, mean (range), S.E.	5.9 (0–500), 3.6
Of responders, percent of patients who responded to the message within	
≤1 day	77
2–7 days	3
8–30 days	8
>30 days	3
Unable to determine	9
Percent of clinicians who responded to a patient's message	68
Interval (days) between date patient's message was read and clinician's response sent, mean (range), S.E.	5.2 (0–305), 3.1
Percent of clinicians who responded to the patient's message within	
≤1 day	78
2–7 days	15
8–30 days	2
>30 days	5
Unable to determine	0
Responding clinician	
Primary care physician	80
Covering primary care physician	1
Clinical nurse	6
Other	13

[a] Figures are weighted to provide estimates for the entire group of patients who opened at least one MedCheck message, adjusting for the stratified sample.

In sum, MedCheck elicited patients' medication problems and symptoms and facilitated an electronic dialogue with their clinicians.

MedCheck messages differed from the electronic alerts and reminders that aid health professionals to comply with preventive health recommendations [9], address critical lab values [10,11], improve anticoagulation management [12], and prevent medication errors among inpatients [3,13]. The messages served instead as an extension and continuation of the clinical encounter, enabling clinicians to follow up automatically on a therapeutic intervention. For this type of application to be effective, patients must review their messages in a timely way, and then provide information for physicians to review and act upon.

Table 3 – Medication problems prompted by MedCheck Message and clinician responses

Clinician response	Patient medication problem							
	Unable or have not yet filled prescription *n* (%)	Question about drug effectiveness *n* (%)	Question about medication symptom *n* (%)	Question about drug dose, use, or name *n* (%)	Request to renew or change prescription *n* (%)	Questions about MedCheck message *n* (%)	Other issues *n* (%)	Total *n* (%)
Asked for or provided information	7 (10)	2 (11)	1 (7)	9 (64)	2 (18)	5 (100)	3 (20)	29 (19)
Renewal request completed	0 (0)	0 (0)	0 (0)	0 (0)	6 (55)	0 (0)	1 (7)	7 (5)
Changed dose, timing, frequency	0 (0)	1 (6)	1 (7)	2 (14)	0 (0)	0 (0)	0 (0)	4 (3)
Provided an alternate medication	2 (3)	1 (6)	0 (0)	0 (0)	1 (9)	0 (0)	0 (0)	4 (3)
Recommended an office visit	0 (0)	0 (0)	1 (7)	0 (0)	0 (0)	0 (0)	0 (0)	1 (1)
Multiple recommendations	5 (7)	7 (39)	7 (47)	3 (21)	0 (0)	0 (0)	0 (0)	22 (15)
Other responses	10 (14)	1 (6)	4 (27)	0 (0)	0 (0)	0 (0)	4 (27)	19 (13)
No response	49 (67)	6 (33)	1 (7)	0 (0)	2 (18)	0 (0)	7 (47)	65 (43)
Total *n* (row %)	73 (48)	18 (12)	15 (10)	14 (9)	11 (7)	5 (3)	15 (10)	151 (100)

Table 4 – Adverse drug events among index medications

Medication	Medication class	Patient report	Symptom Category	Extent	Severity	Preventability	How incident identified	Clinician response
Cyclobenzaprine 10 mg qhs, then tid prn	Antidepressant	Patient felt very groggy on Flexeril, difficult to get up the next day	CNS	≤1 day	Significant	No	PatientSite	Phone call 2 days later
Acetaminophen/codeine #3 1 pill qid prn pain	Narcotic	Patient with bothersome side effects—constipation, did not sleep well	Multiple	>1 day	Significant	No	PatientSite	No information
Atenolol 25 mg qd	Antihypertensive	Patient dizzy and lightheaded for a few days	Other	>1 day	Significant	No	PatientSite	Office visit 2 weeks later
Topiramate 25 mg bid	Antiseizure	Tachycardia and weight loss improved since dose decreased	Cardiovascular	>1 day	Significant	No	Office visit	No information
Levothyroxine 0.125 mg qd	Other	>1 month of abdomen pain, nausea, vomiting, diarrhea, postural dizziness, tachycardia. Weight loss 12 lbs, over 2 weeks	Multiple	>1 day	Significant	Probably	PatientSite	Taper
Budesonide nasal 32 mcg qd	Other	Patient with questions regarding severe symptoms of sneezing, nasal dryness	Respiratory	>1 day	Significant	No	PatientSite	Clinician advised patient to continue using saline and to stop the medication for a week
Metformin 500 mg tid with meals	Diabetes	Patient reports nausea, abdominal bloating on Glucophage tid with meals	GI	>1 day	Significant	No	PatientSite	No information
Chlorpheniramine/hydrocodone 1 tsp q12 h	Other	Patient slept too much, cut dose by 1/2, still slept too much. Patient switched to over the counter preparation	CNS	>1 day	Significant	No	PatientSite	No information
Atenolol 50 mg qd	Cardiovascular	Patient did not feel well on high dose of atenolol, had symptoms of lightheadness and uncomfortable feeling in chest when she took deep breath. Patient decreased dose by 1/2 on her own	Multiple	>1 day	Significant	No	PatientSite	No information
Trazodone 100 mg qhs	Antidepressant	Patient felt "snowed in", not sleeping, in a bad mood	CNS	>1 day	Significant	Probably	PatientSite	No information
Citolapram 40 mg qd	Antidepressant	Insomnia on nightly dose of citolapram, which patient is now taking in the morning	CNS	>1 day	Significant	No	PatientSite	No information
Potassium phosphate 250 mg qd	Electrolyte	Patient ran out/lost meds, so phosphate levels were low	Metabolic	Lab only	Serious	Definitely	Office visit	Physician renewed patient's medications and ordered blood work
Potassium chloride 20 meq 2 tabs qd	Electrolyte	Patient ran out/lost meds, and now has a low potassium level	Metabolic	Lab only	Significant	Definitely	Office visit	Physician renewed patient's medications and ordered blood work.
Atorvastatin 10 mg qd	Cardiovascular	Patient experiencing migratory aches, generalized fatigue, decreased alcohol tolerance, abdominal bloating	Multiple	>1 day	Significant	No	Office visit	Physician discontinued atorvastatin, discussed alternate approaches including titrating niacin
Nortriptyline 50 mg qd	Antidepressant	Medication did not help with sleep. Urinary symptoms occurred, severe dry mouth, hangover feeling, increased appetite	Multiple	>1 day	Significant	No	PatientSite	No information
Nifedipine 30 mg qd as directed	Cardiovascular	The medication did not seem to lessen heartburn/gurgling in the esophagus, and gave the patient massive headaches the first few days. He never gets headaches	Other	>1 day	Significant	Probably	PatientSite	No information
Sertraline 50 mg 1/2 tab qd	Antidepressant	Increased anxiety, irritability. GI side effects with sertraline at low dose	Multiple	>1 day	Significant	No	PatientSite	No information
Paroxetine 20 mg 1/2 tab qd	Antidepressant	Pressure in stomach, increased flatulence, constant heartburn, blood in stool	GI	>1 day	Significant	No	PatientSite	No information
Niacin 250 mg qd	Cardiovascular	Patient with itchy skin, sore/tender breasts	Other	>1 day	Significant	No	PatientSite	Physician told patient that niacin was probably causing the problems, suggested patient take aspirin 30 min before niacin dose
Guaifenesin 600 mg bid prn	Other	Patient with upper respiratory infection. Nurse prescribed chlorpheniramine/hydrocodone and guaifenesin to manage symptoms. Patient woke up with symptoms including headache, nausea, anorexia, dehydration	CNS	≤1 day	Significant	No	PatientSite	No information
Gabapentin tapering up dose	Antiseizure	Patient with severe foot pain, so primary care physician increased dose of Neurontin. The increased dose caused sexual side effects, decreased urination, testicular pain. Patient continued to have foot pain	Multiple	>1 day	Significant	No	PatientSite	Patient advised to continue taking gabapentin; clinician suggested other ways to address testicular pain, and provided support

Table 5 – Patient utilization of selected services within 3 months of index prescription

Utilization of selected services, mean (range), S.E.[a]	Did not respond to index message	Responded to index message	P-value[b]
Telephone calls	0.3 (0–6), 0.1	0.6 (0–8), 0.2	0.086
PatientSite messages	4.6 (0–40), 0.5	8.8 (0–50), 1.0	<0.001
No. of primary care physician appointments	0.9 (0–6), 0.1	1.2 (0–7), 0.1	0.004
No. of subspecialist physician appointments	1.0 (0–39), 0.2	1.0 (0–34), 0.3	0.949
No. of emergency department visits	0.0 (0–4), 0.0	0.0 (0–2), 0.0	0.508
No. of hospital admissions	0.0 (0–1), 0.0	0.0 (0–2), 0.0	0.841

[a] Figures are weighted to provide estimates for the entire group of patients who opened at least one MedCheck message, adjusting for the stratified sample.
[b] Student's t-test.

Automatic patient messaging may be useful in a variety of clinical settings. In oncology, for example, online monitoring of treatment and disease-related symptoms may allow early detection of adverse events and lead to timely intervention [14]. Automatic patient messages might also facilitate monitoring and management of post-surgical patients for infectious complications, of newborns, and of patients with chronic diseases such as asthma and diabetes. Clinicians might also use these messages to encourage tobacco cessation, healthy diet and exercise, and medication adherence. The utility of this approach will depend on the enthusiasm and e-literacy of patients and clinicians, the perceived value of the interventions, and the user-friendliness of the electronic systems [15,16]. Automatic clinical messages could become a core feature of the personal health record. However, these messages could also be annoying if overused.

Summary points

What was known before the study?

- Poor patient–physician communication accounts for many adverse drug events in ambulatory care.
- Patient Internet portals may enhance patient–physician communication.
- Portals may offer a means to improve patient–physician communication about medications, thus improving medication safety.

What has the research learned?

- Patients opened 79% of automatic medication safety ("MedCheck") messages sent via a secure patient Internet portal. 12% of these patients responded to the message, reporting a medication-related problem to their physician.
- Most patients with problems reported within 1 day of receiving the MedCheck message, and most physicians then responded within 1 week.
- Electronic messages delivered automatically to patients via a patient Internet portal elicited patients' medication-related problems, facilitated patient–physician communication about medication problems, and identified adverse drug events.

This study has several limitations. It used a single patient portal and studied subjects at only three primary care sites, so its generalizability requires further investigation. Clinicians who used PatientSite and their patients were self-selected early adopters of the technology, so their willingness and ability to use information technology may overestimate the enthusiasm and agility of later adopters. Although clinicians responded favorably toward MedCheck, we did not survey patients or clinicians systematically about their satisfaction with the application. We reviewed Web messages and electronic medical records to identify patient-reported medication symptoms and ADEs, but this approach underestimates the rate of these events, since ADEs in ambulatory care may be best elicited by interview [1]. Finally, our conclusions are limited by the use of a retrospective cohort design. A randomized, controlled trial is needed to assess its impact on clinical outcomes.

Nevertheless, this study offers evidence of patients' and clinicians' willingness to use electronic messaging to communicate about medication safety. The technology is potentially empowering for patients, offering unprecedented access to their health providers. Providers, in turn, receive timely and relevant clinical information that may enhance care and prevent medical injury.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.ijmedinf.2007.04.007.

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