INNOVATIONS IN EDUCATION AND CLINICAL PRACTICE

Effect of a Triage-based E-mail System on Clinic Resource Use and Patient and Physician Satisfaction in Primary Care

A Randomized Controlled Trial

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OBJECTIVES: **E-mail communication between patients and their providers has diffused slowly in clinical practice. To address concerns about the use of this technology, we performed a randomized controlled trial of a triage-based e-mail system in primary care.**

DESIGN AND PATIENTS/PARTICIPANTS: **Physicians in 2 university-affiliated primary care centers were randomized to a triage-based e-mail system promoted to their patients. E-mails from patients of intervention physicians were routed to a central account and parsed to the appropriate staff for response. Control group physicians and their patients did not have access to the system. We collected information on patient e-mail use, phone calls, and visit distribution by physician over the 10 months and performed physician and patient surveys to examine attitudes about communication.**

RESULTS: **E-mail volume was greater for intervention versus control physicians (46 weekly e-mails per 100 scheduled visits vs 9 in the control group at the study midpoint; $P < .01$) but there were no between-group differences in phone volume (67 weekly phone calls per 100 scheduled visits vs 55 in the control group; $P = .45$) or rates of patient no-shows (5% in both groups; $P = .77$). Intervention physicians reported more favorable attitudes toward electronic communication than did control physicians but there were no differences in attitudes toward patient or staff communication in general. There were few between-group differences in patient attitudes toward electronic communication or communication in general.**

CONCLUSIONS: **E-mail generated through a triage-based system did not appear to substitute for phone communication or to reduce visit no-shows in a primary care setting. Physicians' attitudes toward electronic communication were improved, but physicians' and patients' attitudes toward general communication did not change. Growth of e-mail communication in primary care settings may not improve the efficiency of clinical care.**

KEY WORDS: **e-mail; utilization; primary care; on-line communication; patient-provider communication.**
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Proponents of e-mail and Web-based communication between patients and their providers advocate that these new modes of communication have enormous potential to alter the nature of communication and improve access to care in clinical delivery systems. The asynchronous aspect of on-line patient-provider communication may free patients and providers from the time and place constraints inherent in traditional modes of communication such as face-to-face visits or phone calls. The versatility of on-line communication can be harnessed to address patients' diverse information and service-related needs efficiently. Messaging tools can provide a "portal" by which patients can communicate directly with providers and staff about health problems or to receive information from the medical record such as test results. Additional tools can be used to facilitate receipt of medications, scheduling changes, or billing issues. Ultimately, a patient portal providing this array of functions could improve the efficiency and effectiveness of health care.[1–3]

However, there are many challenges and barriers to current use of on-line communication in the clinical setting. Though general use of e-mail and Web-based electronic communication has grown dramatically,[4] they have diffused very slowly in clinical practice.[5] Although there is increasing interest within clinical delivery systems in building Web-based communication tools for patients, most electronic communication between patients and their providers relies on e-mail, much of which is unsolicited and uncoordinated.

Several reasons explain slow diffusion. First, thus far payors have largely resisted reimbursing providers for this type of exchange. This lack of a reimbursement mechanism has delayed investments by medical organizations in on-line communication and has motivated discussions about its economic and clinical value. In particular, payors and providers are questioning whether on-line communication will substitute for clinic resources such as phone calls or

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visits, or whether it will be an "add on," increasing clinic workload and costs.[6] Second, providers have concerns about the appropriate use of e-mail communication in clinical practice and the potential hassle of responding to difficult or complex messages.[7,8] Although some physicians are encouraging selected patients to e-mail them directly, many physicians are resisting routine use of e-mail with patients because of these concerns. Third, there are enormous concerns among clinical practices and delivery systems about how to build e-mail or Web-based patient-provider portals and how to integrate them into existing operations and information systems.[9–11] Finally, although some patients appear to be willing to communicate by e-mail, many patients may be hesitant to send messages because of their uncertainty about whether messages will be answered in a timely fashion.[8]

To begin to address these concerns, we built a triage-based e-mail communication system and performed a randomized controlled trial of its use in an academic primary care setting. The study addressed several questions: Does a triage-based e-mail communication tool increase electronic communication between patients and providers? Does increased e-mail communication between patients and the clinic team substitute for phone calls or decrease patient no-shows to clinic? Does e-mail communication improve patient or provider perceptions of communication? We hypothesized that enhanced e-mail communication would reduce phone calls and no-show visits and improve communication between patients and their providers.

METHODS

The study was a randomized controlled trial in 2 large university-affiliated primary care clinics located in the Midwest from August 2000 through June 2001. Participants were 24 staff physicians and 74 resident physicians in internal medicine and family practice. Three staff physicians and 2 residents practicing during the study period declined to participate in the study. Staff physicians averaged 35 scheduled visits per week (range 12 to 50 visits), while resident physicians averaged 6 scheduled visits per week.

Physicians were randomized into 2 groups, intervention (N = 50) and control (N = 48). The patients of the intervention physicians were encouraged to use a new triage-based e-mail system—the Electronic Messaging and Information Link (E-MAIL)—to communicate with their physicians and clinic staff about scheduling, billing, health issues, prescription renewals, and referrals. All e-mails were automatically routed to a central resource account managed by a nurse "navigator" who routed messages within the account to appropriate staff. Physicians received copies of their messages but replied to only those requiring physician input, such as patient-specific health questions. Clinic staff entered the central account to receive and respond to messages not requiring physician input.

The e-mail system was promoted to patients of intervention physicians in several ways. Because there was no valid primary care patient roster, we promoted the system to patients who were likely to be those of intervention physicians. First, intervention physicians were encouraged to give their patients a card during clinic visits with a study-specific e-mail address on it and a description of the triage system and how to use it. Second, we mailed flyers to a random sample of 5,000 patients who had visited an intervention doctor in the prior 6 months of the study period or were scheduled to visit an intervention doctor during the study period. The flyers encouraged patients to e-mail their physician using the special e-mail addresses and educated patients about appropriate content, response times, and message handling by the clinics. Patients who used the e-mail system were asked to follow specific guidelines in e-mailing their physicians, including: 1) do not use e-mail for emergencies or for urgent messages; 2) do not use e-mail to communicate about sensitive topics, such as HIV; 3) use e-mail to communicate with your physician and health care team about the following: appointment scheduling, billing questions, health questions, prescription renewals, referrals, and test results; and 4) send separate e-mails for each type of request and include specific information (e.g., for referrals, include information about whether the referral was requested by a physician, previous visits, and preferred specialist). Additionally, all patients who used the e-mail system received automatic responses to each new e-mail message they sent, reinforcing the educational messages covered in the flyers. Finally, intervention physicians also were encouraged to forward patient e-mails from their personal e-mail accounts to the triage account and to encourage patients to use their study-specific addresses in future correspondence.

Control physicians and their patients did not have access to this account. However, independent of our study, patients of both intervention and control physicians could e-mail their physicians by using the physician's personal e-mail account available through physicians' personal cards (some of which had personal e-mail addresses on them) or by searching the medical center directory.

Data Collection

We collected information on e-mail and phone call volume and the visit distribution of all physicians in the study during 5 two-week periods spread evenly over the course of the study. We also performed patient and physician surveys at the conclusion of the study.

E-mail communication between patients and providers occurred directly through a physician's personal e-mail account or, in the case of physicians in the intervention arm of the study, through the e-mail triage system. Because personal e-mail accounts could not be monitored by study personnel, we measured e-mail volume based on physician recall of the number of e-mail messages

received directly from patients during the prior 2 weeks. Because approximately 20% of physicians did not report patient e-mail volume during various waves of data collection (mostly resident physicians equally divided between the intervention and control groups), we imputed these missing estimates to 0. We collected detailed information on the number of e-mails sent directly by patients to each intervention physician through the triage system. Information on phone call volume and type of call was collected periodically using staff phone logs. Information about the number and type of visits was obtained through the medical center information system. Visit types included arrived new visit, arrived return visit, and no-show, which indicated that a scheduled patient neither arrived nor canceled the visit.

We performed a physician survey at the conclusion of the study that assessed their use of e-mail with patients, attitudes toward the benefits of e-mail, how much they are bothered by different types of patient e-mail messages, and satisfaction with patient and staff communication. The self-administered survey took about 5 minutes to complete and was administered to physicians during clinic.

We also performed a patient survey at the conclusion of the study that assessed use of e-mail with physicians, perceived barriers and benefits of using e-mail with providers, preferred modes of communication for different health-related issues, general satisfaction with communication with physicians and staff, and demographic information. We selected a random sample of 900 patients (450 patients who had seen an intervention physician 1 or more times and a control physician no more than 1 time during the study period; and 450 patients who had seen a control doctor 1 or more times during the study period and an intervention physician no more than 1 time during the study period) to complete a mailed survey. The Dillman method was used to maximize response rates.[12] Survey data were entered and a 10% sample was checked for errors (which yielded only 2.5 errors per 1,000 entered variables).

Variables and Analysis

We created a number of physician-level variables for the utilization analysis. Because the volume of communication was highly correlated with the level of clinical activity of individual physicians (e.g., average number of scheduled visits per week) and the level of clinical activity varied markedly across physicians, we incorporated it into all utilization variables. We constructed 3 utilization variables: weekly patient e-mails per 100 scheduled visits (number of reported patient e-mails per week divided by average number of scheduled visits per week during the study period * 100); weekly phone calls per 100 scheduled visits (number of phone calls per week divided by average number of scheduled visits per week * 100); and "no-show rate" (number of patient no-shows per month per 100 scheduled visits).

Physician survey variables included: 1) an "e-mail benefits" scale, which indicates attitudes toward the benefits of using e-mail with patients, with higher scores indicating more favorable attitudes (7 items; $\alpha = 0.87$); item responses (5-point Likert scale from strongly disagree to strongly agree) were assigned scores of −2 to +2 and summed (range, −14 to 14); thus, higher scores indicated more perceived benefits; 2) an "e-mail bother" scale, indicating how bothered physicians were by different types of e-mail messaging from patients (8 items; $\alpha = 0.87$), with values assigned to the 3-point scale (not at all a problem to a big problem, values 1, 2, 3) and summed (range, 8 to 24); higher scores indicate more bother; and 3) a general communication scale indicating attitudes toward communication with patients and staff; higher scores indicate more favorable attitudes toward communication with patients and staff (8 items; $\alpha = 0.95$); item responses (5-point Likert scale from strongly disagree to strongly agree) were assigned scores of −2 to +2 and summed (range, −16 to 16).

We constructed a number of variables from the patient survey including: 1) an "e-mail barriers" scale, which was the sum of responses to 7 potential barriers to using e-mail; positive responses to the check list (7 items; $\alpha = 0.76$) were summed and compared across groups; 2) an "e-mail benefits" scale, which indicates attitudes toward the benefits of using e-mail with health care providers; higher scores indicate more favorable attitudes toward the benefits of e-mail communication (4 items; $\alpha = 0.84$); item responses (5-point Likert scale from strongly disagree to strongly agree) were assigned scores of −2 to +2 and summed; and 3) a general communication scale indicating attitudes toward communication involving physicians and staff, with higher scores indicating more favorable attitudes (7 items; $\alpha = 0.84$), which was based on a previously validated scale of communication in primary care[13]; item responses (5-point Likert scale from strongly disagree to strongly agree) were assigned scores of −2 to +2 and summed.

Bivariate comparisons between intervention and control groups were made using nonparametric statistics (Kruskal-Wallis, Fisher exact, or χ^2). We tested for between-study group differences in trends of the utilization of e-mail, phone, and visit volume over time using generalized estimating equations techniques appropriate for repeated measures analysis. We ran separate models for each utilization variable. For example, in 1 model, the dependent variable was phone volume and the independent variables included group (intervention vs control), the discrete time periods (1 through 5), and physician status (resident vs faculty physician). We ran this model using Poisson and binomial regression techniques for each of the utilization variables and tested for differences between trends using *z* tests. We tested for differences in physician and patient attitude scale scores using ordinary least-squares regression to control for other factors, such as physician type, (resident vs faculty physician) and adjusted standard errors for clinic clustering.

The study protocol and all materials were approved by the University of Michigan Institutional Review Board. The study sponsor was not involved with any aspect of study

Table 1. Baseline Characteristics of Physician Study Sample

Variable	Intervention (*N* = 50)	Control (*N* = 48)	*P* Value*
Age, y	44.9, 28.2†	42.2, 28.8	.34
Female, %	35.5	37.0	.47
Faculty, %	24.0	25.0	.63
Check e-mail daily, %	48.3	50.8	.48
Used e-mail with patients, %	73.0, 18.2†	70.0, 16.3	.29
Attitudes‡			
Fear of being overwhelmed with patient e-mail	51.6	47.5	.40
Don't mind if patients e-mail me	50.4	52.2	.44
E-mail is a good way for patients to reach me	57.4	61.3	.34

* *For differences between intervention and control groups.*
† *Faculty, residents.*
‡ *Percent who agreed or strongly agreed with item on a 5-point Likert scale.*

design, data collection, or analyses. Only the authors had access to the data in the study, and we accept full responsibility for the integrity of the data and the accuracy of the data analysis.

RESULTS

Baseline Characteristics of the Physician Sample

Prior to initiation of the intervention, a baseline survey[8] showed that intervention and control physician groups did not differ with regard to age, gender, position, or use of e-mail (Table 1). Additionally, there were no between-group differences in selected attitudes items about use of email with patients.

Resource Use

Table 2 shows e-mail volume, phone volume, and the rate of visit no-shows for discrete time periods during the course of the study period in the intervention and control group physicians. As expected, the trend of increased e-mail volume was significantly greater in the intervention versus control physician group ($P < .001$). E-mail volume (the average number of weekly e-mails reported in the prior 2 weeks per 100 average scheduled visits) rose for the study group during the course of the study to a peak of 49.8, and then decreased somewhat. Most of this volume occurred through the triage e-mail system. This corresponded to the intensity of patient promotion of the triage system, which peaked during the third data collection period. By contrast, e-mail volume did not increase significantly for the control group physicians. Differences in average e-mail use and trends over time between groups were highly significant (incident rate ratio [IRR] adjusted for physician type and clinic = 3.6; 95% confidence interval [95% CI], 2.1 to 6.2). However, there were no significant differences in trends between groups with regard to phone volume (adjusted IRR for differences in trends between intervention and control group = 1.2; 95% CI, 0.9 to 1.4) and visit no-show rates (adjusted IRR = 1.2; 95% CI, 0.9 to 1.6).

Table 2. E-mail, Phone and Visit No-show Rates by Group

Time	Study			Control		
Period*	E-mail†	Phone‡	No-shows§	E-mail	Phone	No-shows
1	9.0	59.2	10.2	6.4	60.1	10.2
2	23.7	61.2	11.4	7.4	55.2	10.0
3	49.8	67.0	12.4	9.0	55.5	12.0
4	29.0	70.5	11.6	8.0	58.9	9.7
5	27.0	75.2	12.2	10.4	70.0	11.5

* *Time period represents 2-week data collection periods every 2 months during the course of the study.*
† *Weekly patient e-mails per 100 average weekly scheduled visits.*
‡ *Weekly phone calls per 100 average weekly scheduled visits.*
§ *No-shows per 100 average scheduled visits.*

Physician Survey

The response rate to the survey was 90.8% ($n = 89$, 23 faculty physicians and 66 residents). Residents reported receiving on average 1.2 e-mails per week (range 0 to 5), while staff reported receiving an average 8.4 of e-mails per week (range 0 to 25). Intervention physicians reported receiving more weekly e-mails than did control physicians (2.1 vs 0.5 per week among residents, 12.3 vs 5.5 among staff physicians; $P < .001$).

Figure 1 shows perceived benefits of e-mail use with patients. Intervention physicians perceived greater benefits of e-mail than did control physicians across all items. For example, intervention physicians were more likely than control physicians to believe that e-mail was a good way to answer patients' non-urgent medical questions (81.8% vs 61.4% of control patients; $P = .06$), that e-mail was helpful for handling patients' administrative concerns (86.0% vs 58.0%; $P = .05$), and that they liked using e-mail with their patients (59.1% vs 35.5% of controls; $P = .11$). The mean scores for the e-mail benefits scale was 6.3 in the intervention group versus 3.1 in the control group ($P = .012$ controlling for physician type and clinic).

Figure 2 shows physicians' perceptions of how bothered they were by different types of e-mail. Intervention

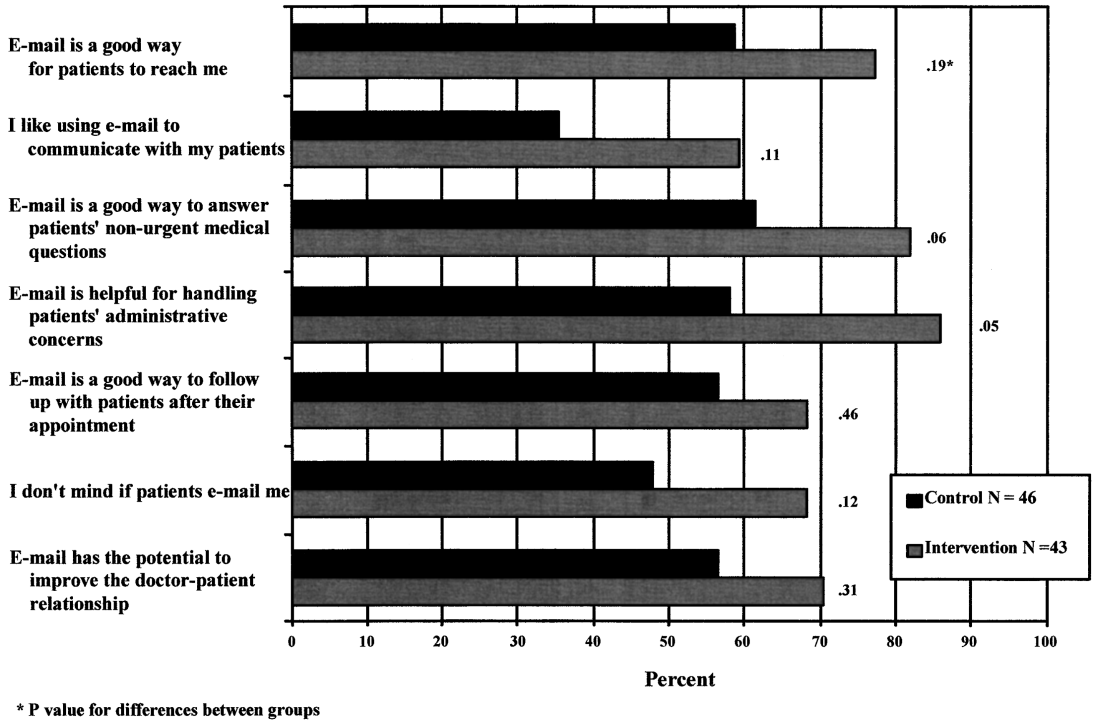

FIGURE 1. Physician perceptions of benefits of using e-mail with patients.

physicians were less bothered than control physicians across all items. More than half of control physicians felt that e-mails from patients they had never seen was a "big problem" (versus one quarter of intervention physicians; $P < .01$), while 28.6% of control physicians felt that e-mails from patients whom they had not seen for a long time were a big problem (versus only 7.1% of intervention physicians; $P < .01$). More than one quarter of the control physicians felt that e-mails that were too lengthy or had incomplete information were a big problem (versus 14.6% and 10.0% of intervention physicians, respectively). The mean scores for the e-mail bother scale were 15.3 in the control group versus 12.1 in the intervention group ($P = .03$, controlling for physician type and clinic).

Physician satisfaction with communication in general with patients and staff was similar among intervention and control physicians. More than three quarters of physicians were satisfied with their communication and relationship with patients, as well as communication with staff. However, many fewer physicians were satisfied with patient communication outside of clinic visits (44.7% for intervention versus 37.9% for control; $P = .25$). General communication scale scores did not differ between the 2 groups (mean score 7.6 for intervention versus 7.9 for control physicians; $P = .63$).

Patient Survey

The overall response rate to the mailed patient survey was 62.3% ($n = 561$ of 900). Administrative data from the medical center showed that compared to nonresponders, responders were older (51.0 vs 44.2; $P < .01$) and somewhat more likely to be female (58.2% vs 51.4%; $P = .03$). Nearly three quarters of patients reported having an e-mail account, and 60.0% reported using e-mail at least several times per week. Compared to those who did not use e-mail, e-mail users were younger (46.3 vs 67.1; $P < .01$), more likely to be female (62.1 vs 57.7%; $P = .04$), and more likely to be a college graduate (61.2% vs 21.6%; $P < .001$). Whites and Asian race groups were more likely to use e-mail (73.6% and 93.4%, respectively) than African Americans or others (42.9% and 50.3%, respectively; $P < .01$). Finally, e-mailers reported fewer physician visits in the prior 6 months than did non–e-mailers (mean 2.2 vs 3.0; $P < .01$). One third of respondents with e-mail access reported sending e-mail to their primary care provider in the prior 6 months (42.3% of intervention patients versus 26.6% of control patients; $P < .01$).

Figure 3 shows patients' perceived benefits and barriers to the use of e-mail with providers. There was little difference between patients of intervention and control physicians in perceived benefits of e-mail with providers. Many patients thought that e-mail was useful for dealing with non-urgent medical problems (70.3% vs 68.9% of controls) or a good way to follow up after an appointment (58.3% vs 55.7% of controls), but fewer thought it would improve their relationship with their providers (43.9% vs 43.0% of controls). With regard to barriers to e-mail communication, Figure 3 shows that many patients reported that they would rather talk to a

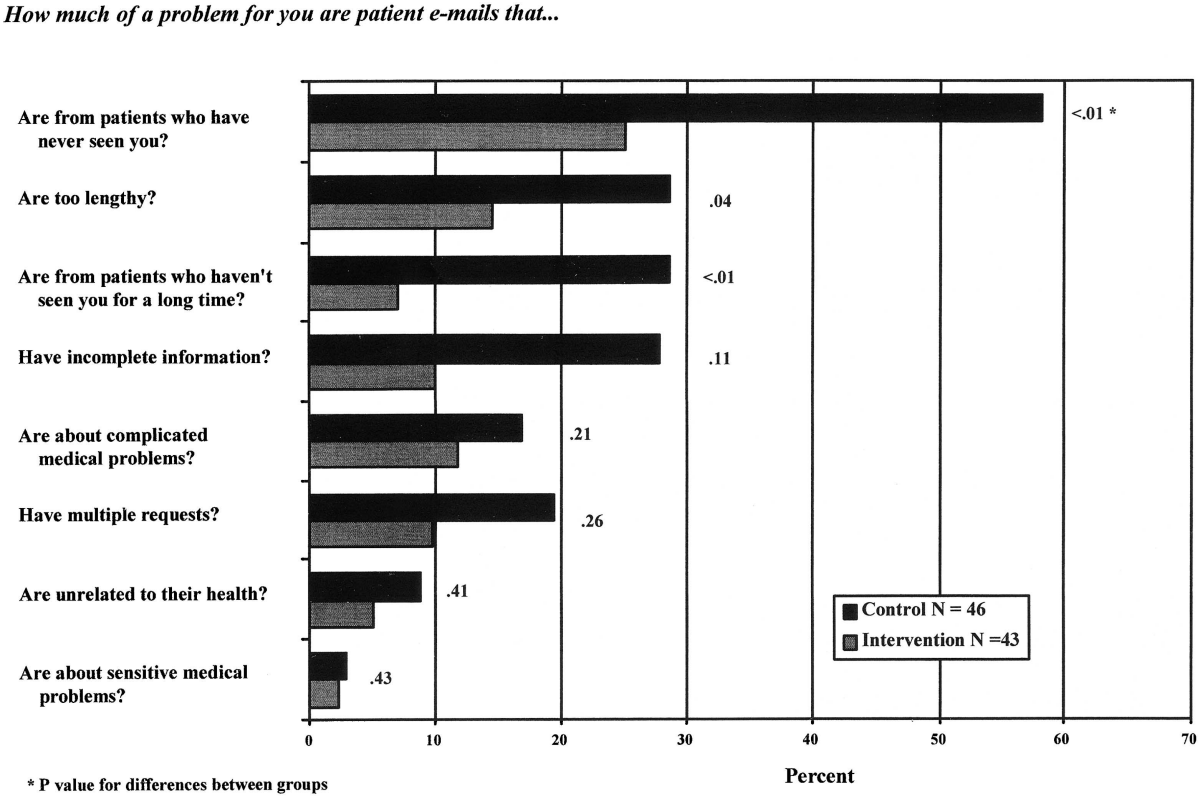

FIGURE 2. Physician perceptions of level of ``bother'' with different types of patient e-mail.

"real person" (53.8% vs 58.6% of controls). Some were concerned about the adequacy of e-mail communication, such as "takes too long to get a response" (43.9% vs 49.2% of controls) or e-mail being too impersonal (26.2% vs 32.6% of controls). Patients were more concerned about security in the clinic than security at home or in the office. Few patients viewed e-mail as a bother to their physicians. Attitudes appeared somewhat more favorable in the intervention versus control groups, but no individual items were statistically significant and scale scores did not differ significantly between groups.

Finally, there were no between-group differences in patients' attitudes toward general communication and relationships with providers. While many patients were satisfied with communication with providers and staff during clinic visits (76.3% vs 70.7% in the control group; $P = .31$) many fewer patients were satisfied with communication with staff and providers outside of clinic visits (47.6% vs 52.4% in the control group; $P = .29$). There was little difference between study groups in responses to questions about the quality of relationships with their providers. Patients gave high marks to their physicians regarding trust and affinity issues, and there were no significant differences between study groups. For example, 90.1% of respondents agreed that their provider uses good judgment and offers quality medical care, while 88.2% agreed that providers always treat them with respect.

Table 3 shows patients' preferences for different modes of communication for different health-related issues among patients who reported regular use of e-mail (at least several times per week). The interplay between patients' preferences clearly showed that face-to-face visits and phone-calling remain dominant preferred modes of communication for many health care issues, especially complex or sensitive issues. Patients appeared to endorse the use of e-mail for straightforward issues such as receipt of cholesterol test results or a normal Pap or prostate-specific antigen screening test. E-mail was a preferred way of dealing with questions regarding a sore throat or back pain, as 48.2% and 40.1% of patients endorsed e-mail compared to about one third who favored telephone and 22.0% and 34.0% favoring a visit for these 2 conditions, respectively. For the remaining issues, use of telephone or office visits were the preferred modes. Patients appeared to favor the phone for scheduling issues and for addressing side effects of medication. The results clearly show that preferences for an office visit were associated with the perceived seriousness of the issue. About two thirds of patients favored a visit for symptoms of prolonged sadness or anxiety, and more than half preferred a visit for issues such as breast or testicular pain, abnormal screening tests, and sensitive results, such as those related to sexually transmitted disease. There were no significant differences in responses between intervention and control group patients.

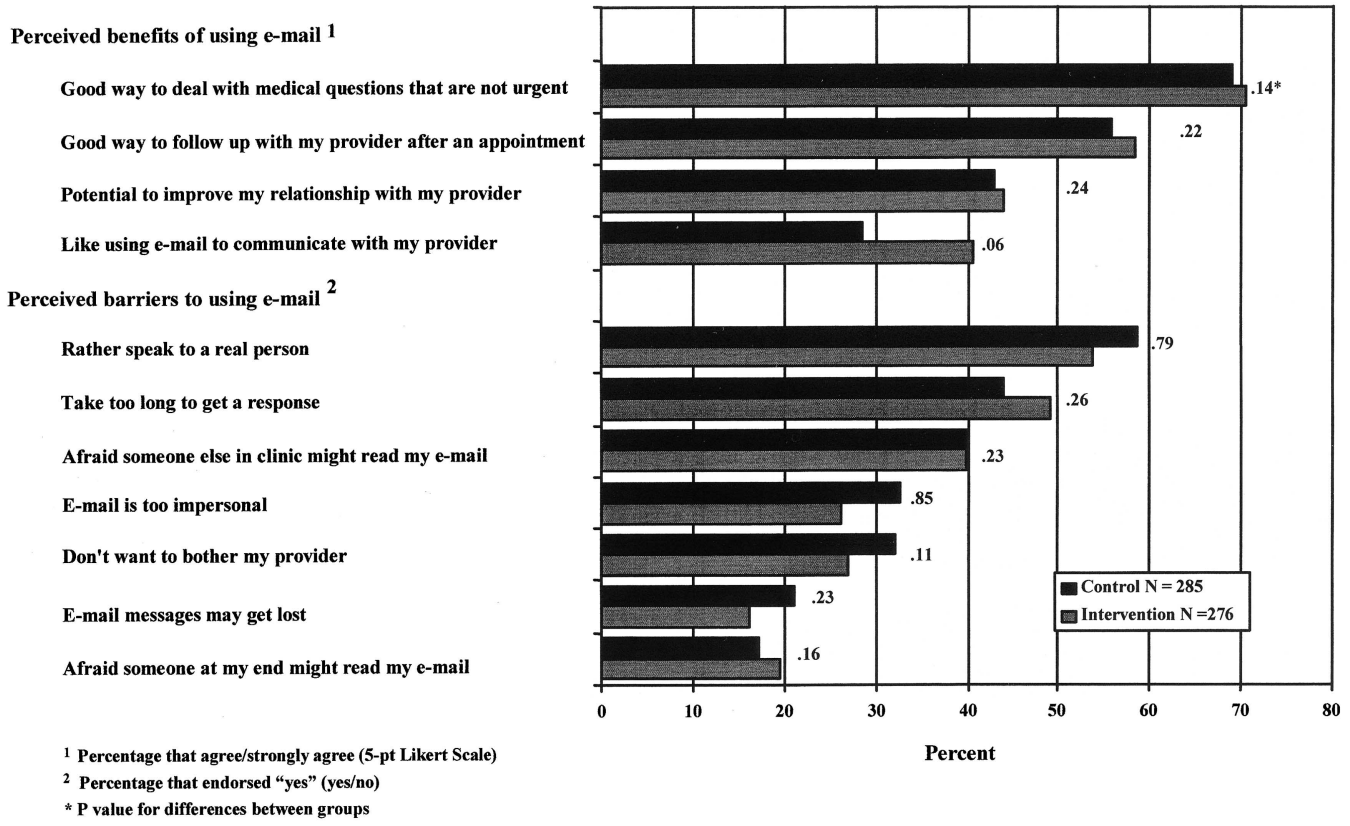

FIGURE 3. Patient benefits and barriers to e-mail use with providers.

Results from the survey data suggested a potential conflict between physicians and their patients with regard to the role of clinic staff in electronic communication. More than three quarters of physicians agreed that they were comfortable with clinic staff answering messages and nearly half felt that patient e-mails should be directed to clinic staff first. By contrast, only 31.7% of their patients felt comfortable with staff answering e-mails sent to their provider, and 52.3% felt that e-mails sent to the provider should be read only by him or her. Only about one third of providers and their patients agreed or strongly agreed that they had concerns about the security of e-mail.

Table 3. Patients* Preferences for Mode of Communication with Providers About Selected Issues

Issue†	E-mail	Telephone	Visit
Cholesterol results	70.0	32.5	11.5
Normal Pap or PSA test result	63.4	27.9	14.6
Prescription renewals	54.7	47.4	6.4
Questions re sore throat	48.2	38.8	22.0
Canceling a visit	43.4	65.4	0.0
Questions re back pain	40.1	31.7	34.0
Scheduling an appointment	38.8	68.8	3.1
Side effects of a new medication	32.3	60.2	17.5
Questions re breast /testicular pain	21.2	24.9	55.4
Abnormal Pap or PSA test result	17.6	26.8	58.4
Prolonged sadness or anxiety	17.4	20.7	64.3
STD test results	15.5	33.5	54.5

** For respondents who reported having regular access to e-mail (at least several times per week), N = 490.*
† Percent of patients who endorsed each mode of communication for each item. Percentages may not sum to 100% as patients could endorse more than one mode per item.
PSA, prostate-specific antigen.

DISCUSSION

In this study, we performed a randomized controlled trial of a triage-based e-mail system designed to enhance communication between patients and their physicians and staff. We found that a triage-based e-mail system promoted to patients did increase e-mail volume. At the peak of promotion, e-mail volume approached half that of phone volume for intervention physicians, while there was virtually no growth of e-mail use among control physicians. However, this surge among intervention physicians was not sustained, as e-mail volume diminished after the promotion to less than a third of phone volume. Importantly, e-mail volume did not appear to offset phone volume or visit no-show rates in the intervention group.

Our triage-based intervention appeared to improve physicians' perceptions of the role of e-mail in clinic communication. Intervention physicians perceived greater

benefits of e-mail use with patients and reported being less bothered by different types of e-mails, such as those from unknown patients or those containing inappropriate content. This is an important finding, because many physicians harbor negative attitudes toward e-mail with patients. A well-designed structured triage-based communication system may substantially lower physician resistance to use of these modes of communication. However, the intervention did not appear to affect physicians' attitudes toward general communication with patients and staff. This may reflect that fact that the dominant forms of communication remained phone calls and visits, especially for the most needful patients.

On the patient side, the intervention had a very modest effect on patient attitudes toward barriers and benefits of e-mail. It did somewhat decrease patients' concerns about the efficiency of this form of communication and improved affinity toward its use, but the effects were very modest. Similar to the physician results, the intervention did not affect patient attitudes toward communication in general. And again, patients were particularly dissatisfied with communication with providers between visits. Results from the patient survey regarding preferences for different modes of communication suggested that patients were more willing to use e-mail for less-complex, less-sensitive issues that would likely require a simple response. Telephone calls and visits remained highly preferred modes of communication, especially if the health matter appeared to require dialog or follow-up, or had sensitive or worrisome implications.

Limitations

Several aspects of the study merit comment. First, the setting was limited to university-affiliated primary care clinics and thus may not be generalizable to other settings, such as private practices or subspecialty clinics. Second, the study sample size may have limited power to detect intervention effects on phone volume and visit distributions. Post-hoc power calculations showed that the study had 80% power to detect a difference of 13 weekly phone calls per 100 scheduled visits (52 vs 65) and an absolute difference of 5% in no-show rates (7% vs 12%). Third, we imputed missing physician report of patient e-mail volume to 0 for each wave of data collection, which may have slightly underestimated e-mail volume equally in both study groups. Fourth, because we could not precisely identify patients of intervention and control physicians, we sampled patients on the basis of their visit histories. This may have introduced misclassification bias if some patients categorized as "intervention patients" were patients of control physicians and vice versa. This form of bias may have limited study power to detect differences between patient groups. Finally, promotion of the intervention within clinics may have caused "contamination" among patients of control physicians inducing e-mail use. However, this did not appear to occur, as e-mail use among study physicians remained very low throughout the study period.

Implications

Our findings have a number of implications relevant to patient care. First, we can expect that early diffusion of electronic communication into clinical practice will increase total communication volume on clinic systems. Our results suggest that early patient adopters represent a new group of communicators distinct from those who use the phone or frequently visit their physicians. These patients are younger, more educated, less sick and less likely to frequently use phone calls or visit their physicians.[8] Our analysis of the content of the patient e-mail generated in this trial showed that almost all messages were appropriate, relevant, and addressed the broad needs of patients in primary care settings (e.g., non-urgent medical issues, prescription renewals, scheduling, and billing questions).[14] This suggests that e-mail communication from these patients addressed an unmet need for relevant communication in primary care and, thus, provided an additional means of communication for patients who might not otherwise communicate with their physicians about such issues as new symptoms or resolution of old problems. While electronic communication is likely of value in this population, it does not appear that it will offset other clinic resources in the short run. As electronic communication becomes more robust, more tailored to patient needs, and more widely used among patients who are heavy users of other modes of communication such as phone calls and visits, this may change. However, innovations that improve the efficiency of phone systems or patient visit flow may also affect resource offsets.

Second, our results suggest that there is substantial resistance among patients and their providers to electronic communication. Many patients indicated concerns that e-mail would "not get the job done," and had concerns about delayed responses, lost messages, or the impersonal nature of this mode of communication. While these attitudes were somewhat more favorable among patients exposed to our intervention, the between-group differences were small. Many patient respondents in our trial still favored face-to-face visits and phone calls as modes of communication, especially and appropriately when health issues were sensitive or anxiety-provoking, or required complex dialog.

A key feature of our intervention was that e-mail was triaged by staff, but that physicians were "in the loop" on all communication and were able to respond to appropriate messages. Our results suggested that there may be a conflict in expectations between patients and their physicians with regard to the role played by clinic staff in electronic communication. Two thirds of patients reported being uncomfortable with clinic staff triaging incoming messages, while most physicians favored this arrangement. This suggests that patients may view e-mail as a more intimate direct communication to physicians and thus limit

e-mail use as a triage tool in the clinical setting. Managing expectations regarding who is online will be an important goal of on-line system deployment.

Our results and experiences with the E-MAIL system suggest that e-mail may be limited in meeting patient and provider needs because, compared to Web-based communication tools, it is insecure, unstructured, difficult to integrate into clinical delivery system databases, and difficult to document into medical records. Furthermore, e-mail may encourage unrealistic patient expectations regarding the intimacy of communication with physicians and obfuscate the important role played by staff in triaging and handling messages. Although e-mail appears to be growing in popularity among patients, they may sour on this form of EPPC over time when they more fully experience these limitations in the clinical setting.

Conclusions

Results of our study suggest a number of ways that electronic communication may be employed in clinical settings to improve communication and patient care. First, we need to build systems that have functions that are easy to use and are most salient to patients, such as medications use, scheduling, and test results–reporting.[15] Second, we need to educate patients and providers about the appropriate uses of on-line communication and the role played by staff in the delivery system. Third, we need to consider the critical operations issues related to the deployment of on-line communication strategies in clinical delivery systems. Our finding that e-mail appears to be an "add-on" should motivate delivery systems to allocate appropriate additional resources to manage an increase in total volume of communication, at least during the early phases of deployment. An early strategy to integrate data systems could dramatically reduce work burden. For example, building an electronic solution to documenting on-line communication in clinical data repositories could markedly reduce work related to paper-based documentation. Finally, we will need to target promotion of on-line communication to patients who are most vulnerable to delays in care and communication, such as older patients with chronic disease. More research will be required to help payors and providers address these issues as we deploy these new modes of communication in clinical practice.

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