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Contents

Original Paper

What Internet Services Would Patients Like From Hospitals During an Epidemic? Lessons From the SARS Outbreak in Toronto

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Abstract

Background: International health organizations and officials are bracing for a pandemic. Although the 2003 severe acute respiratory syndrome (SARS) outbreak in Toronto did not reach such a level, it created a unique opportunity to identify the optimal use of the Internet to promote communication with the public and to preserve health services during an epidemic.

Objective: The aim of the study was to explore patients' attitudes regarding the health services that might be provided through the Internet to supplement those traditionally available in the event of a future mass emergency situation.

Methods: We conducted "mask-to-mask" surveys of patients at three major teaching hospitals in Toronto during the second outbreak of SARS. Patients were surveyed at the hospital entrances and selected clinics. Descriptive statistics and logistic regression models were used for the analysis.

Results: In total, 1019 of 1130 patients responded to the survey (90% overall response rate). With respect to Internet use, 70% (711/1019) used the Internet by themselves and 57% (578/1019) with the help of a friend or family member. Of the Internet users, 68% (485/711) had already searched the World Wide Web for health information, and 75% (533/711) were interested in communicating with health professionals using the Internet as part of their ongoing care. Internet users expressed interest in using the Web for the following reasons: to learn about their health condition through patient education materials (84%), to obtain information about the status of their clinic appointments (83%), to send feedback to the hospital about how to improve its services (77%), to access screening tools to help determine if they were potentially affected by the infectious agent responsible for the outbreak (77%), to renew prescriptions (75%), to consult with their health professional about nonurgent matters (75%), and to access laboratory test results (75%). Regression results showed that younger age, higher education, and English as a first language were predictors of patients' interest in using Internet services in the event of an epidemic.

Conclusion: Most patients are willing and able to use the Internet as a means to maintain communication with the hospital during an outbreak of an infectious disease such as SARS. Hospitals should explore new ways to interact with the public, to provide relevant health information, and to ensure continuity of care when they are forced to restrict their services.

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KEYWORDS

Severe acute respiratory syndrome; communicable diseases, emerging; information services; Internet; public health; questionnaires

Introduction

International public health organizations and officials around the world are bracing for a pandemic [1-6]. Reports highlight that conditions for the global dissemination of avian flu [7-8] or influenza [9-10] are already emerging. It has been suggested that government officials may be underestimating the threat and that more aggressive allocation of resources is needed to minimize the potential devastation that a new pandemic could cause [5].

The 2003 severe acute respiratory syndrome (SARS) outbreak caused major disruption of hospital services in affected countries [11-15] and provided unique insights in terms of how to react to larger epidemics or full-blown pandemics (see also Textbox 1). Emergency containment and preventive measures required hospitals to cancel most clinics and operative procedures [16-18]. At the University Health Network (UHN) in Toronto, rigorous surveillance measures were instituted, and hospital access was restricted to single entrance points for staff and patients. Visits to the hospital were limited or prohibited. Working closely with public health authorities to maximize the impact of these measures, affected hospitals established Command Centres to prevent the spread of infection and provide information to staff and the public [19]. Whenever appropriate, hospital staff with no direct clinical responsibilities were encouraged to work remotely. Websites and Internet-based messaging systems were implemented to notify staff about policies and procedures instituted to contain the outbreak [20]. Telephone-based call centres made thousands of calls per day to alert patients about changes in clinic schedules and to provide nonurgent medical advice and prescription refills.

Although effective, telephone-based communication proved to be a resource-intensive solution that may not be sustainable in the event of a more widespread epidemic or external disaster. Considering that most Canadians have access to the Internet [21], it could be argued that the Internet may have the potential to facilitate information flow between hospitals and many of their patients during a crisis, complementing or replacing other means of communication. To our knowledge, no studies have explored patients' views with regard to the use of the Internet as a complementary or alternative form of communication during an epidemic. This study was designed to explore these views and the specific Internet-based services patients would like to have available in the event of a future outbreak.

Textbox 1. University Health Network–during and after SARS

- **Communication with staff and outpatients:** Shortly after the beginning of the SARS outbreak, the hospital enhanced its communication capability to ensure the flow of real-time information for public and staff. This process included mass voice mails from the Chief Executive Officer informing staff of the current status and expanding videoconferencing and Web mail services. Web mail traffic increased by 300% in the first days of the outbreak. Meanwhile, hits to the UHN website almost doubled from January to July 2003, from 273269 to 548108, respectively. Interestingly, website hits continued to increase throughout the year and never returned to pre-SARS figures. The corporate intranet was also made accessible over the Internet, enabling UHN to communicate with staff and ensure work continuity despite the environmental restrictions.
- **Communication support for inpatients:** UHN contracted the services of TLContact CarePages, enabling patients to send updates to family and friends over the Internet [22].
- **Remote access to UHN's electronic health record:** The electronic health record was made accessible to physicians over the Internet. Since then, physicians can consult patients' charts remotely. Through an application known as Patient Results Online (PRO), the hospital is providing its clinicians with real-time access to patient results. PRO also allows access to lab results stored in partner hospitals.
- **Electronic scheduling:** UHN developed an electronic scheduling application to reduce unnecessary patient travel, improve patient satisfaction, and reduce waiting lists. Implemented across all three UHN sites, this system allows electronic access to scheduling and contact information. In the event of a hospital closure, staff working offsite will be able to access schedules and contact patients, removing the need for intense telephone booking, rescheduling, and cancellations.
- **Infection control screening and surveillance:** UHN developed a SARS screening tool that is currently built into its registration screens. In the event of an outbreak, the surveillance software can be activated and the hospital can track where patients have been in the hospital and where they are headed.
- **Insight-alerting system software:** This software monitors patient information and alerts health care professionals about critical situations in real time. The software checks information as it is entered into the system and is supported by "rules" to detect potentially dangerous clinical situations. This will be beneficial during an outbreak as the system can detect a positive diagnosis of an infectious disease and alert health care providers by pager, email/Blackberry, the Web, or fax.

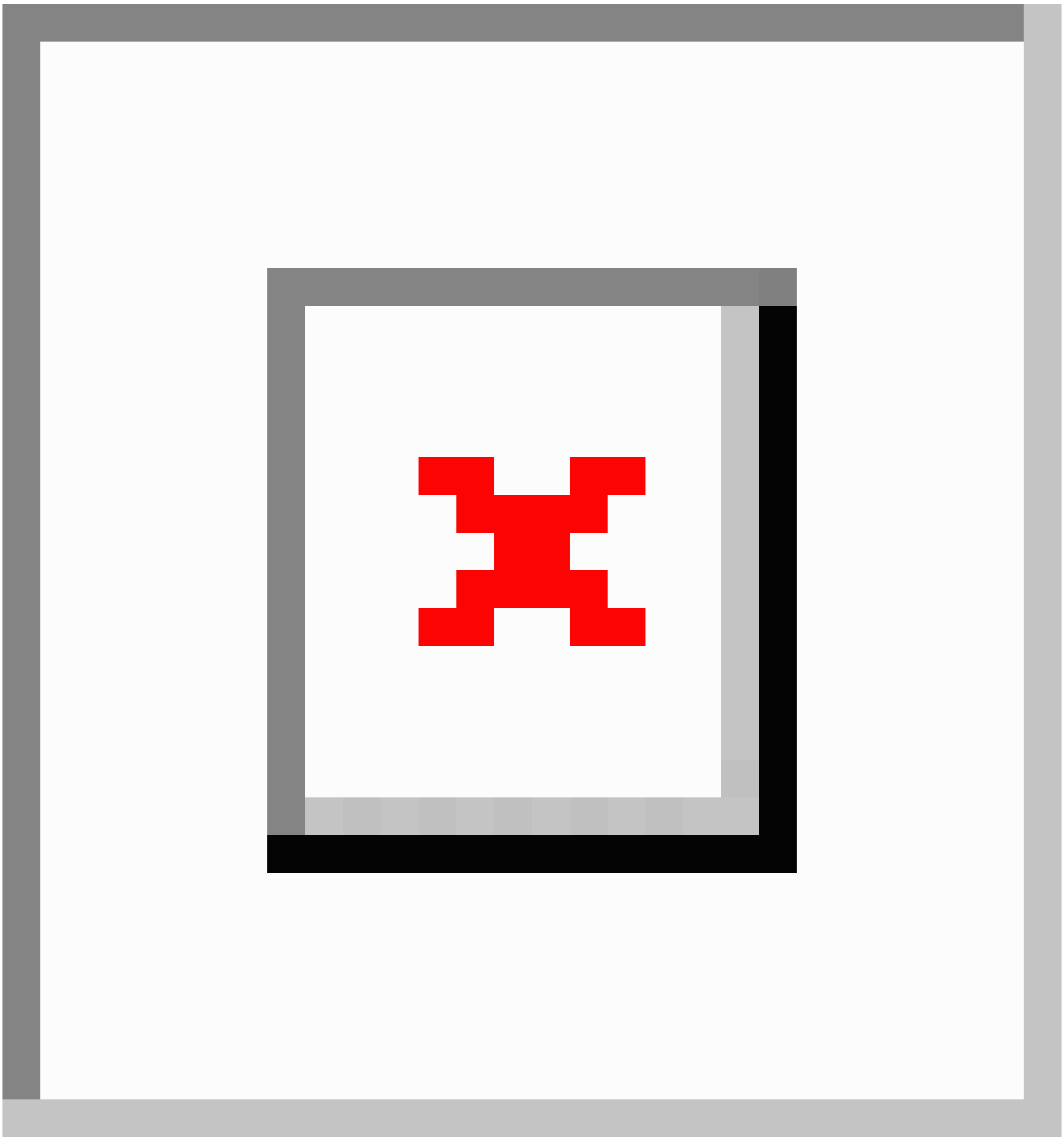
Methods

After obtaining permission from the UHN's Command Centre and approval from the institutional Research Ethics Board, we conducted a cross-sectional survey at the single access points of each of the hospitals comprising UHN (Toronto General Hospital, Toronto Western Hospital, and Princess Margaret Hospital) and six of the ambulatory clinics that remained open during July 2003.

Patient Survey

The survey was based on the core questions of the UHN e1000 study, a cross-sectional survey exploring the patterns of Internet use among patients and providers associated with the UHN. The e1000 survey [23] is a longitudinal study that has gathered cross-sectional data twice (January 2001 and April 2002) in seven ambulatory clinics. For this study, we continued assessing patients' patterns of Internet use for general and health-related purposes, adding questions regarding their opinions about services they would like to receive through the Internet in the event of hospital closure, clinic postponement, or procedure cancellation due to an outbreak. Respondents could also suggest other uses for the Internet in a health-related context. Additionally, the survey examined the influence of patients' demographics (ie, gender, age, level of education completed, first language, and country of birth) on awareness and use of the Internet in general and on seeking health-related information in particular. The Command Centre recommended that the survey should not take more than 3 minutes—much shorter than initially planned—in order to avoid congestion in the screening lineups by the entrance doors (Figure 1).

Figure 1. Screening during SARS at the University Health Network



To alleviate possible anxiety during the crisis, only 9 questions with categorical responses were asked, in addition to those capturing demographic information (Multimedia Appendix 1).

Study Logistics

The initial plan to survey all patients entering the hospital after being screened for SARS (approximately 1000 patients daily per hospital) proved to be unrealistic due to the cumbersome process of registration and screening that created additional challenges for those people approaching patients. For three days, we surveyed patients after they passed the entrance screening points, and we concluded that the clinics' waiting rooms would be a more appropriate venue for recruiting. Only adult ambulatory patients were approached. Ten trained multilingual interviewers conducted the surveys in English after obtaining verbal consent. The interviewers and patients were required to wear full protective gear, which meant "mask-to-mask" rather than face-to-face communication (Figure 2).

With no face recognition and to avoid re-approaching the same patients, interviewers used colored stickers on the masks of patients to identify those already invited to participate in the survey.

Data Protection

Contact information provided voluntarily by patients was stored in a secure database on the Centre for Global eHealth Innovation servers. Hard copies of the surveys were stored in locked cabinets and were accessible to researchers for analysis only at the Centre.

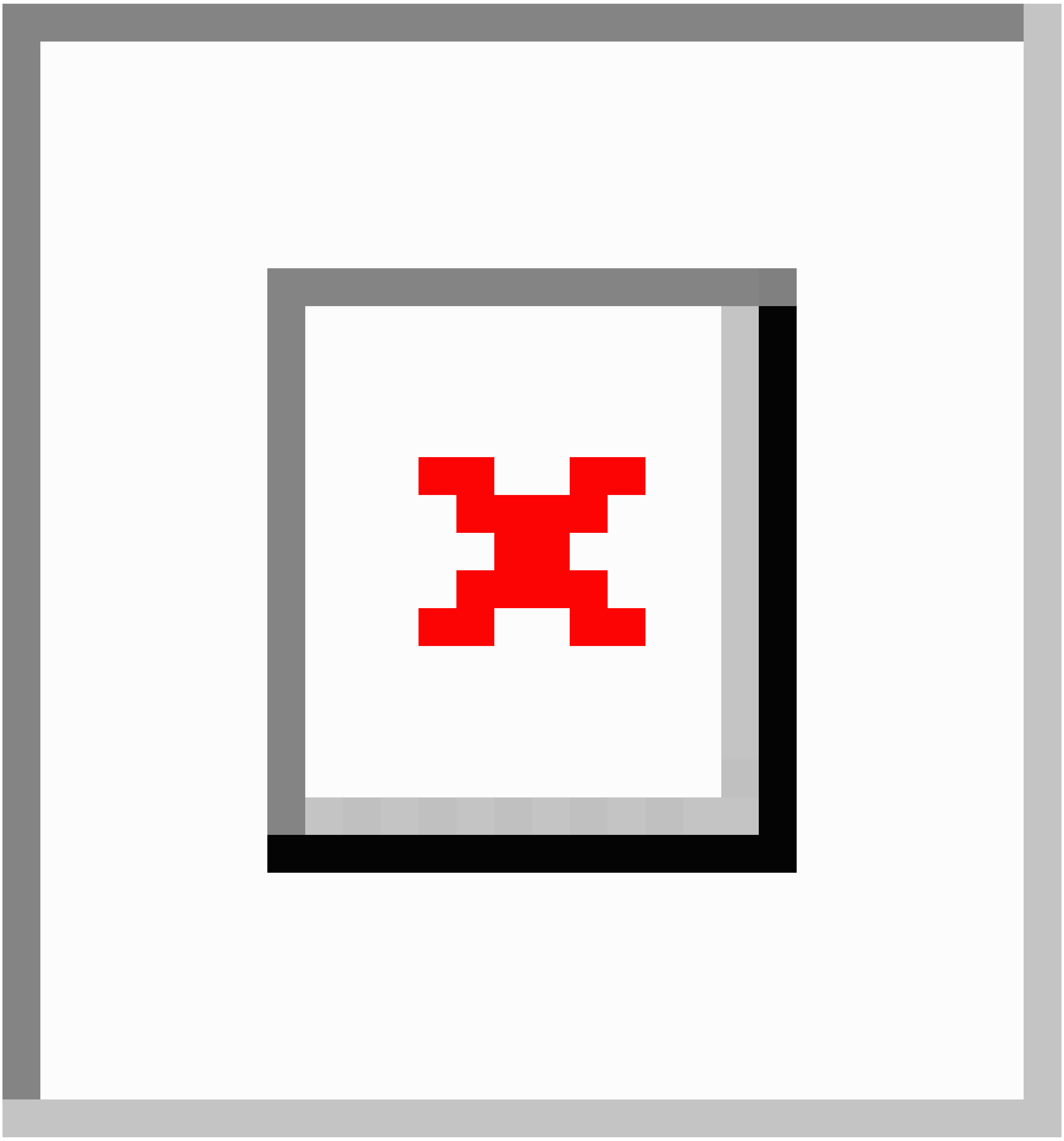
Statistical Analysis

Descriptive statistics were gathered for each of the answers. Multiple logistic regression analysis was used to assess the effect of the sociodemographic variables on patients' views of Internet usage for specific services in the event of a mass emergency. We used stepwise, forward, and backward methods with all variables to specify which ones stayed in the model. A cutoff *P* value of .2 was chosen for variable elimination. Then, we applied the enter method on those variables to force all variables into the equation. Results reported in the tables are based on the remaining variables only and include odd ratios (OR) and 95% confidence intervals. A *P* value less than .05 was considered statistically significant. The variables that did not stay in the model at first step are marked with "NS." All statistical analyses were conducted using the SAS System for Windows, release 8.02 (SAS Institute Inc, Cary, NC).

Quality

To ensure better reporting, we used the relevant items of the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) [24]. Although CHERRIES is designed for online surveys, we applied the relevant domains of the checklist to our survey.

Figure 2. Protective gear for staff and interviewers during the SARS outbreak at UHN



Results

A total of 1130 patients were approached, and 1019 chose to complete the survey, giving an overall participation rate of 90%. Refusal rate was initially higher at the entrances of the hospitals during the first three days of the survey (response rate 78%, 309/396 respondents approached) than later at the clinics that remained open (response rate 97%, 710/734 respondents approached). The most frequent reasons for declining were being late for a clinic appointment (50%), frustration and exhaustion due the long lineup to enter the hospital (20%), lack of interest (20%), and inability to speak English (10%).

Internet Use for Health Information and Interest in Communicating with Health Professionals

We found that 91% of patients were aware of the Internet (926/1019) and that 70% used the Internet (711/1019) by themselves and 57% (578/1019) with the help of a friend or family member. Of the Internet users, 68% (485/711) had already searched the World Wide Web for health information, and 75% (533/711) were interested in using the Internet to communicate with health professionals as part of their ongoing care.

Table 1 shows the demographic characteristics of all respondents, those with Internet access, and by survey location (entry point or clinic). Overall, there was a balanced gender representation of Internet users in our sample, with 44% (313/711) women and 45% (320/711) men. The majority of Internet users were in the 21 to 40 (32%, 224/711) and 41 to 60 (40%, 281/711) age categories. Almost half (42%, 300/711) of the Internet users had college or undergraduate education, 3 out of every 4 Internet users (558/711) spoke English as their first language, and 64% of them (453/711) were born in Canada. These demographic proportions are comparable for all users and for users at the entry doors or clinics.

There were no statistically significant differences between Internet users surveyed at entry doors and clinics with respect to age (P = .14), English as a first language (P = .90), or country of birth (P = .54). However, there were significant differences with respect to education (P < .001) and gender (P = .005). Regardless of the survey location, when all users were combined there was no significant gender difference.

Table 1. Demographic characteristics*

Variables	All Respondents (n = 1019)	Internet Users (n = 711)	Internet Users at Entry Doors (n = 197)	Internet Users at Clinics (n = 514)
Gender				
Male	44% (451/1019)	45% (320/711)	38% (74/197)	48% (246/514)
Female	42% (433/1019)	44% (313/711)	54% (106/197)	40% (207/514)
Age				
< 21	2% (21/1019)	3% (21/711)	1% (3/197)	3% (18/514)
21-40	24% (246/1019)	32% (224/711)	27% (53/197)	33% (171/514)
41-60	37% (378/1019)	40% (281/711)	44% (87/197)	38% (194/514)
> 60	24% (249/1019)	15% (108/711)	18% (35/197)	14% (73/514)
Education Completed				
Elementary	5% (49/1019)	1% (9/711)	1% (3/197)	1% (6/514)
High school	34% (346/1019)	29% (203/711)	19% (37/197)	32% (166/514)
College/Undergraduate	35% (354/1019)	42% (300/711)	48% (95/197)	40% (205/514)
Postgraduate	12% (124/1019)	17% (119/711)	23% (46/197)	14% (73/514)
First Language				
English	72% (734/1019)	78% (558/711)	78% (154/197)	79% (404/514)
Other	28% (285/1019)	22% (153/711)	22% (43/197)	21% (110/514)
Country of Origin				
Canada	57% (583/1019)	64% (453/711)	62% (122/197)	64% (331/514)
Other	43% (436/1019)	36% (258/711)	38% (75/197)	36% (183/514)

* Percentages may not add to 100% for each variable due to missing responses.

Internet Services During Mass Emergencies

In the event of a future outbreak, Internet users expressed interest in accessing the Internet to learn about their health condition through patient education materials (84%, 594/711), to obtain information about the status of their clinic appointment (83%, 590/711), to send feedback to the hospital about how to improve its services (77%, 549/711), to access screening tools to help determine if they were affected by the infectious agent responsible for the outbreak (77%, 544/711), to renew prescriptions (75%, 535/711), to consult with their health professional about nonurgent matters (75%, 536/711), and to obtain laboratory results (75%, 534/711). Respondents had the opportunity to suggest other uses for the Internet, and 10% (70/711) chose to do so. Their most frequent suggestion was the ability to communicate with family members, as visits were restricted. Others wanted to use the Internet to access their electronic health record, participate in virtual support groups, replace certain follow-up visits with online consultations, and find information on drug compatibility or clinical trials.

Statistically significant demographic predictors for interest in specific Internet services among Internet users are shown in Table 2.

Table 2. Logistic regression of demographic factors (independent variables: rows) predicting interest in specific Internet services (dependent variable: columns) among Internet users (n = 711)

	Odds Ratio (95% CI) (*P* value)							
	Communicate with health care professionals using Internet (Q5)	**Find out the status of clinic appointment (Q6a)**	**Request a prescription refill (Q6b)**	**Obtain lab results (Q6c)**	**Consult about non urgent matters (Q6d)**	**Learn through patient education program (Q6e)**	**Send feedback about improving services (Q6f)**	**Access screening tools (Q6g)**
Age								
< 40	1.98 (1.16–3.37) (*P* = .01)	2.37 (1.30–4.29) (*P* = .03)	2.12 (1.24–3.62) (*P* = .02)	1.98 (1.16–3.36) (*P* = .07)	1.96 (1.18–3.25) (*P* = .18)	2.27 (1.26–4.09) (*P* = .07)	2.51 (1.44–4.38) (*P* = .002)	2.05 (1.21–3.47) (*P* = .12)
41-60	1.38 (0.83–2.29) (*P* = .92)	1.93 (1.09–3.43) (*P* = .32)	1.76 (1.05–2.95) (*P* = .35)	1.84 (1.09–3.09) (*P* = .18)	2.23 (1.34–3.70) (*P* = .02)	2.18 (1.23–3.86) (*P* = .12)	1.61 (0.95–2.72) (*P* = .94)	2.21 (1.32–3.72) (*P* = .04)
> 60 (RC)	1	1	1	1	1	1	1	1
Education								
High school or less (RC)	1	1	1	1	1	1	1	1
College/ University	1.79 (1.20–2.65) (*P* = .003)	2.34 (1.48–3.69) (*P* < .001)	2.19 (1.48–3.24) (*P* < .001)	2.04 (1.38–3.02) (*P* <.001)	1.67 (1.13–2.48) (*P* = .01)	1.55 (0.98–2.46) (*P* = .06)	1.72 (1.13–2.61) (*P* = .01)	NS
English First Language								
No (RC)	1	1	1	1	1	1	1	1
Yes	1.87 (1.13–3.08) (*P* = .01)	2.45 (1.41–4.28) (*P* = .001)	2.13 (1.13–4.02) (*P* = .02)	2.73 (1.46–5.09) (*P* = .001)	1.36 (0.81–2.28) (*P* = .24)	1.38 (0.76–2.51) (*P* = .28)	1.96 (1.16–3.31) (*P* = .01)	NS
Gender								
Female (RC)	1	1	1	1	1	1	1	1
Male	0.75 (0.51–1.11) (*P* = .16)	NS	NS	NS	NS	NS	1.33 (0.87–2.01) (*P* = .18)	NS
Born in Canada								
No (RC)	1	1	1	1	1	1	1	1
Yes	NS	NS	0.58 (0.34–0.99) (*P* = .048)	0.54 (0.31–0.94) (*P* = .03)	NS	NS	NS	NS

RC = reference category
NS = nonsignificant factors (*P* values > .2)

Internet users (Table 2) younger than 40 years were significantly more likely to be interested in communicating with health professionals over the Internet, finding the status of their appointments, requesting prescription refills, and sending feedback to the hospital about improving services than those 41 to 60 years old. Interestingly, the odds for those aged 41 to 60 interested in consulting about nonurgent matters were significantly higher than for younger patients. All Internet users with college or university education were significantly more likely than participants with high school or elementary education to be interested in services provided through the Internet in case of a mass emergency, except for accessing screening tools or learning through patient education materials. Respondents with English as their first language were more likely to be interested in receiving services though the Internet in the event of a mass emergency. The likelihood of being interested in Internet services was not significant for gender.

The detailed results for the populations at the entry doors and at the clinics are provided in Multimedia Appendix 2. At the entry doors (Table 3 in Multimedia Appendix 2), the younger population was more likely than the older population to be interested in communicating with health professionals using the Internet or in sending feedback to the hospital. Patients between 41 and 60 years old were more likely to be interested in finding the status of a clinic appointment through the Internet than patients over 60 years. Although this trend was also detected among patients younger than 40, the result was not statistically significant. The odds of being interested in electronic communication and consulting about nonurgent matters were higher for college- and university-educated individuals than for those with lower levels of education. Men were slightly more interested than women in accessing test results over the Internet, and people born in Canada were more likely to be interested in requesting a prescription refill or obtaining a lab result than people born outside of Canada.

At the clinics (Table 4 in Multimedia Appendix 2), participants younger than 40 years were more likely than their older counterparts to be willing to send feedback to the hospital. Participants with undergraduate education were significantly more interested in finding the status of their clinic appointment, requesting a prescription refill, obtaining a laboratory result, and sending feedback to the hospital than people with high school or less. English speakers were more likely to be interested in all Internet services except for accessing patient education materials.

Overall, younger age, higher education, and English as a first language were predictors of interest in using Internet services in the event of a pandemic, with a few exceptions.

Discussion

Principal Results

Four people in Toronto died of SARS, while hundreds were infected around the world. However, the SARS outbreak pales in comparison to a full-blown pandemic. For instance, the bubonic plague killed more than 130 million people, while the Spanish flu pandemic of 1918 killed more than 30 million. In Philadelphia, the 1793 yellow fever outbreak took the lives of more than 4000 people. Today, research suggests that the world is due for a pandemic [1-6] of unprecedented proportions that could dramatically disrupt the activities of health organizations.

The 2003 SARS outbreak challenged the way in which health organizations deal with public health crises. Although the classic outbreak control measures (infection control, contact tracing, quarantine, etc) were used in order to overcome new obstacles, such as high volume of air travel, increased media attention, and generalized panic, alternative methods of communication and collaboration to overcome them were required.

Similar to what happened during the anthrax scare [25], the Internet provided a powerful way to offer information about the outbreak to patients and members of the public [26,27]. It also enabled data sharing and collaboration among health professionals and organizations around the world [28,29]. The Internet, however, may have not been used to its full potential as a means of communication between hospitals and the public during the SARS outbreak. Hospital communication with the public mostly relied on unidirectional mass media releases on the radio, television, newspapers, and Internet, except for an isolated case in which hotlines were used in a temperature-monitoring campaign [30]. Hospital staff relied on the telephone to communicate with health care providers who were quarantined in their homes. The hospital did not participate in activities to support quarantined members of the public, as this was done by public health officials.

Our results suggest that most patients are willing and able to use the Internet as a means to preserve and complement hospital information and communication services during an outbreak of an infectious disease such as SARS.

The results of this study are consistent with previously conducted surveys at UHN during non-SARS times. These results are related only to the proportion of patients using the Internet for general and health purposes. Earlier iterations indicate that 60% of respondents have used the Internet for general purposes and 69% for retrieving health information [23]. During SARS, the proportion of UHN patients using the Internet was higher (69%). This increase may be due to a combination of factors (timing of the survey, higher awareness and adoption, chance) and not necessarily due to the epidemic. Previous results showed that three of every four patients wanted to use email and websites as means of communication with health providers. This result is comparable with the one obtained during the SARS outbreak (75%). Consistent with previous results, patients more likely to be aware of and use the Internet were younger, more educated, and spoke English as their first language [23]. Unlike our previous surveys, the current one shows that older patients (> 60 years) were more likely to be interested in communicating about nonurgent matters with health professionals than their younger counterparts (41 to 60 years). This may be due to a combination of increased familiarity with the Internet over the previous two years in a population that faces chronic conditions and the realization that some face-to-face meetings may be replaced with online alternatives [26].

We conducted a systematic review of the literature looking for surveys of patients in relation to the type of services desired but did not find similar enough studies to justify a comparison with our SARS survey (data not shown).

There are many other potential uses for the Internet as a means of communication if hospitals and clinics were disabled by a new outbreak. Members of the public with Internet access who are quarantined may use it to get answers to nonurgent questions related to the infectious disease or to receive reassurance that they are managing their health properly [31]. Patients whose appointments are changed could receive customized information about their own care (eg, normal test results) or obtain prescription refills via simple text email messages. Family members of hospitalized patients, unable to visit their loved ones, may receive information about their loved ones' health status through patient-specific websites or blogs [22]. Teleconference booths could also be set up in the community so that hospitalized patients or individuals in isolation could continue to be in touch with their loved ones if the latter do not have easy access to the Internet.

Harnessing the power of the Internet in the event of a new outbreak, and particularly during a pandemic, will require changes at the hospital level that need to be gradually introduced during “new normal” times. At the very least, as part of the patients’ registration process, hospitals should collect data regarding patients’ choice for communication method (telephone, email, or both) in the event of an outbreak.

The SARS crisis underscored many opportunities for the use of Internet-mediated communication to extend the continuum of care outside of hospital walls, even under normal circumstances. Embracing the Internet as an integral part of clinical care, however, will require changes in legislation, funding structures, and flexible work patterns to enable health professionals to use it [32].

The findings of our survey highlight the need for timely, relevant, valid, feasible, and substantiated options to maintain communication lines with the public during crises that disable hospitals. We are aware that Internet access is not yet universal, but it certainly could be very valuable for the large subset of the population that uses it [33], while enabling more efficient allocation of resources to support those who require other communication modalities.

With the current increased risk of pandemics and bioterrorist attacks, it is essential to put in place the mechanisms necessary to use the Internet effectively and efficiently in order to reduce the impact of these crises on the health system and the public at large.

Limitations

The special circumstances under which these surveys were conducted presented several design, execution, and data analysis limitations.

Design Considerations

The sample chosen was one of convenience. Due to constraints inherent to the emergency, it was difficult to ensure that all individuals attending the hospital at any given date had the same probability of being selected. The difficulty of obtaining an up-to-date list of patients visiting the hospital limited our ability to establish an accurate denominator. Therefore, the likelihood of the sample being representative of the population attending the hospital during the second outbreak of SARS is unknown. To reduce the evident sampling bias, a number of random sampling techniques could have been used. Assuming that the population at selected clinics was captive and had patients with similar health conditions, cluster sampling may have been indicated.

Execution Considerations

At the hospital entry points, some interviewers noted that respondents were rushing and may have fallen into a rut (a “response set”), continuing to give the same response unthinkingly. This was particularly evident for question 6, which may have elicited repeated identical responses (ie, yes). In addition, the number of refusals at the single point entrances was higher than previously obtained at UHN [23]. To mitigate these considerations, the surveyors moved to the clinics that remained open, and they were encouraged to pause between asking questions.

Analysis Considerations

Comparisons of participants from the three participating hospitals and an assessment of users versus non-Internet users were outside the scope of this study. Furthermore, the patient’s health condition was not collected. For future studies, these elements will be considered.

Acknowledgments

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Authors' Contributions

CR and DL designed and carried out the study, led the analysis and interpretation of data, and drafted and revised the manuscript. HB provided statistical expertise and contributed to the analysis. MA and TC contributed to the concept of the study and revised the manuscript. AJ contributed to the concept and design of the study, interpreted the data, and revised the manuscript. All authors read and approved the final manuscript.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Study survey. [PDF file, 124 KB - jmir_v7i4e46_app1.pdf]

Multimedia Appendix 2

Additional tables (Tables 3 and 4) showing the results of the populations at the entry doors and clinics. [PDF file, 88 KB - jmir_v7i4e46_app2.pdf]

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Original Paper

An Internet-Based Patient-Provider Communication System: Randomized Controlled Trial

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Abstract

Background: Internet-based interactive websites for patient communication (patient portals) may improve communication between patients and their clinics and physicians.

Objective: The aim of the study was to assess the impact of a patient portal on patients' satisfaction with access to their clinic and clinical care. Another aim was to analyze the content and volume of email messages and telephone calls from patients to their clinic.

Methods: This was a randomized controlled trial with 606 patients from an academic internal medicine practice. The intervention "portal" group used a patient portal to send secure messages directly to their physicians and to request appointments, prescription refills, and referrals. The control group received usual care. We assessed patient satisfaction at the end of the 6-month trial period and compared the content of telephone and portal communications.

Results: Portal group patients reported improved communication with the clinic (portal: 77/174 [44%] "a little better" or "a lot better;" control: 18/146 [12%]; χ^2 = 38.8, *df* = 1, *P* < .001) and higher satisfaction with overall care (portal: 103/174 [59%] "very good" or "excellent;" control: 78/162 [48%]; χ^2 = 4.1, *df* = 1, *P* = .04). Portal group patients also reported higher satisfaction with each of the portal's services. Physicians received 1 portal message per day for every 250 portal patients. Total telephone call volume was not affected. Patients were more likely to send informational and psychosocial messages by portal than by phone. Of all surveyed patients, 162/341 (48%) were willing to pay for online correspondence with their physician. Of those willing to pay, the median amount cited was US $2 per message.

Conclusions: Portal group patients demonstrated increased satisfaction with communication and overall care. Patients in the portal group particularly valued the portal's convenience, reduced communication barriers, and direct physician responses. More online messages from patients contained informational and psychosocial content compared to telephone calls, which may enhance the patient-physician relationship.

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KEYWORDS

Ambulatory care; Internet; communication; patient satisfaction; randomized controlled trial

Introduction

The Institute of Medicine report "Crossing the Quality Chasm" [1] cites "the free flow of information" and "the patient as the source of control" as key features of patient-centered care. Information technology can play a vital role in meeting patient needs. Internet applications may be increasingly useful now that 73% of US adults have access to the Internet [2]. Previous studies have reported that 90% of patients with Internet access would like to communicate via email with their physician and that 56% indicate that it would influence their choice of doctor [3,4].

To meet this growing demand, some organizations have implemented Internet-based websites for communication between patients and their clinic and physician (patient portals) [4-10]. However, physicians have been hesitant about communicating online with patients, citing the potential for increased workload, increased medical liability, and risks to patient privacy [11-14].

Previous studies of Internet-based patient-provider communication include a randomized controlled trial [5] and several observational studies [4,6,11,12]. These studies established that online messaging between patients and physicians was an important medium of communication that was well accepted by patients yet used rarely by physicians. Although patient satisfaction with online messaging has been described, direct comparisons between online messaging and telephone call volume and content are lacking.

To better understand these issues, we conducted a randomized controlled trial while implementing a patient portal in an academic general internal medicine practice. This portal allowed patients to request appointments, prescription refills, and specialist referrals. It also allowed them to send secure electronic messages to their physician. We hypothesized that this portal would improve patient satisfaction with clinic operations. We were also interested in how the portal's messaging system was used and how the volume and content of that use differed from telephone calls. Finally, we assessed the utility of the patient portal by asking patients to place a monetary value on its services.

Methods

Setting

The study was conducted at an academic ambulatory internal medicine practice affiliated with the University of Colorado Hospital in Denver, CO. Fourteen physicians and staff in the practice were already using an electronic medical record (EMR) (Care Innovation, version 8.0, 3M Health Information Systems, Salt Lake City, UT), which included an electronic messaging system to document patients' incoming telephone calls. All 14 physicians participated in the study, answering messages from portal patients as well as controls. Clinic staff typed the content of incoming calls into the EMR. Staff nurses retrieved these messages electronically, called the patient, and documented their conversation or consulted the physician electronically prior to calling the patient. At baseline, physicians also communicated occasionally with patients using standard electronic mail (Outlook 2000, Microsoft Corporation, Redmond, WA). The volume of these email messages was small.

The study was approved by the Colorado Multiple Institutional Review Board.

Recruitment and Randomization

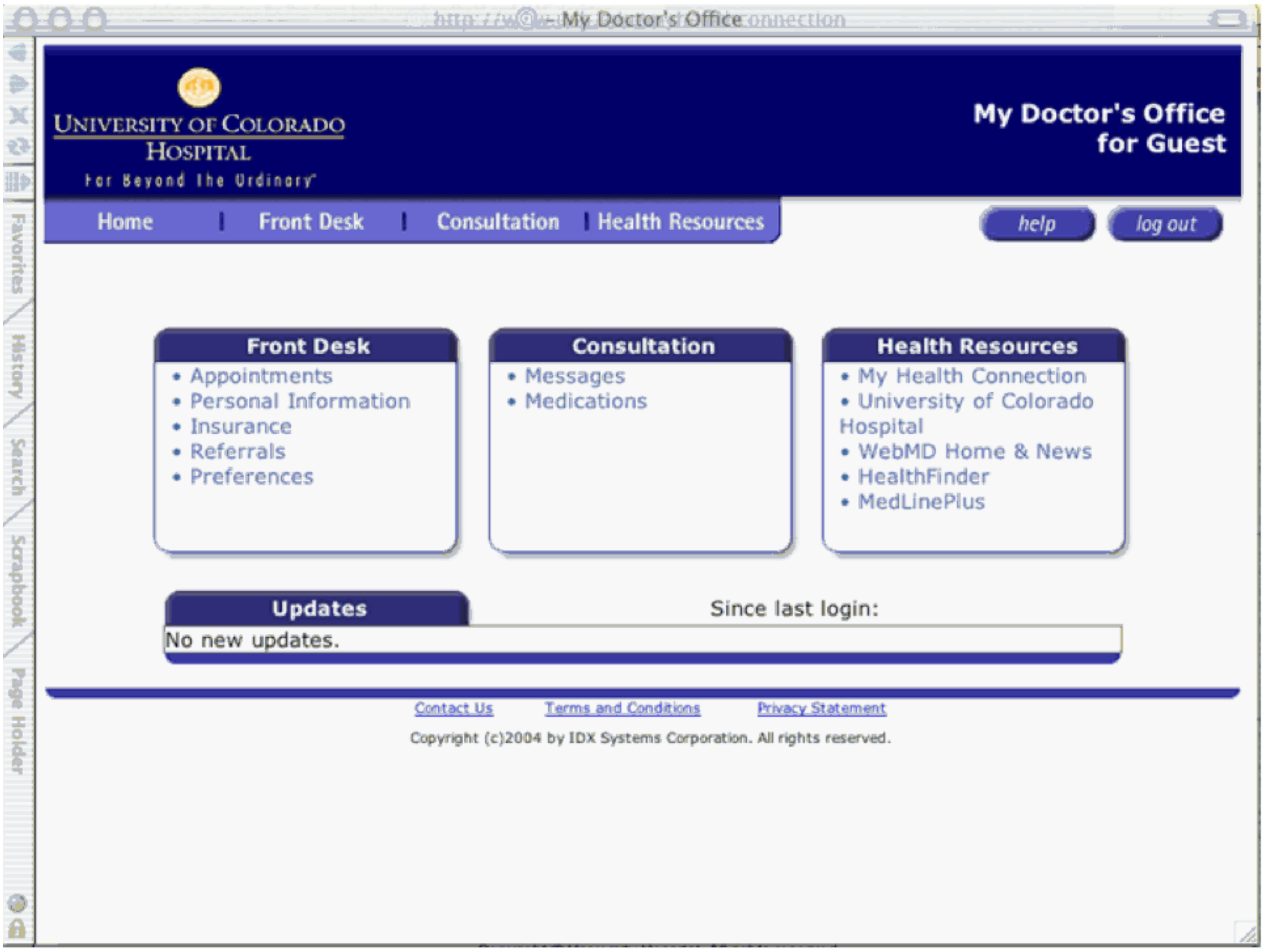
Patients were enrolled from August 2002 through February 2003. The study period began at the conclusion of enrollment and lasted 6 months from March 1, 2003 through August 31, 2003. Eligible patients were at least 18 years old, English speaking, and had experience using an Internet browser. Patients were recruited via descriptive brochures, a poster, and a research assistant in the practice waiting room and via additional brochures in the examination rooms. Two broadcast emails were sent to 6000 employees of the University of Colorado Health Science Center, many of whom were eligible patients. An article about the study was also distributed to 2000 employees in the hospital's newsletter. Patients were enrolled into the study after completing an online informed consent and initial survey.

Patients were consecutively assigned to intervention (access to the portal) or control (usual telephone care) groups by a research assistant according to a predetermined randomization scheme developed using SAS (SAS, version 8.2, SAS Institute Inc, Cary, NC), with equal numbers of portal and control participants in blocks of 10. Since patients in the portal group could send messages to physicians through the portal, physicians and clinic staff could not be blinded to the enrollment status of patients.

Portal and Control Groups

Portal group patients were instructed to register a username and password for the patient portal that the University of Colorado Hospital named "My Doctor's Office" (Patient Online, version 6.0, IDX Systems Corporation, Burlington, VT). See Figure 1 and Multimedia Appendix 1 for screenshots of the portal website. They could then send requests for appointments, prescription refills, and referrals to the clinic staff and send clinical messages to their physician. Portal group patients were warned in advance not to send urgent messages using the portal. A clinic staff member copied incoming portal messages to the existing telephone messaging system three times daily (excluding weekends or holidays). Clinical messages were sent directly to the physician, who could send an electronic response to the patient or forward the message with instructions to clinic nurses. For patients in the control group, access to the portal was delayed until end of study. Instead, the control group received access to a website providing general health advice. Both portal and control patients could contact the clinic by telephone at their discretion or for urgent messages. The incoming telephone call triage system (for both portal and control patients) via the EMR was unchanged.

Figure 1. Screenshot of My Doctor's Office portal



Broadcast emails were sent monthly during the study to patients in both groups. When these messages were returned due to an invalid email address, the research assistant attempted to retrieve correct contact information. Patients who could not be reached were disenrolled from the study. Also, portal group patients who had not registered their username and password were encouraged on five occasions via email to register.

Outcome Measures

Patient Satisfaction

The primary outcome measures were patient satisfaction with the following: communication, overall care by the clinic, administrative requests (appointments, prescriptions, referrals), and clinical messaging (by portal and by telephone) with their physician. Patients completed surveys before and after the 6-month trial period (Multimedia Appendices 2-4). The initial survey assessed demographics and baseline satisfaction with clinic services. The final survey assessed satisfaction with clinic services for all participants and the perceived utility of the patient portal in the portal group. Satisfaction was assessed on a 5-point scale (1 = poor, 2 = fair, 3 = good, 4 = very good, 5 = excellent), with an option for patients to indicate that they "never did this." Surveys were adapted by the investigators from prior instruments [4,6], pilot tested in a subset of nonstudy patients, and administered online. To maximize response rates, patients were contacted weekly by email for 4 weeks at the end of the 6-month trial period.

Qualitative Content Analysis of Administrative Requests and Clinical Messages

The patient portal tallied administrative requests and clinical messages. In all, 148/174 (85%) of portal patients and 142/166 (86%) of controls gave consent for investigators to review their medical record for the content of the clinical messages received via portal and telephone. The portal tracking system counted each incoming message separately, even if it was part of one clinical message exchange between patient and physician. During content review we only counted completed clinical message exchanges. We excluded clinical messages encompassing routine prescription refills, appointment requests, and referral requests from the content analysis.

We compared and categorized the content of clinical messages sent by patients in the portal and control groups. We adopted categories from a previous study [15] (request test information, request test action, request medication information, request medication action, miscellaneous) and added the following categories: urgent message, biomedical concern, psychosocial concern (eg, depression, anxiety, insomnia), FYI (for your information), home monitoring, and prevention. We identified message responses in which the physician elaborated on the advice given by the triage nurse and those in which the physician responded directly to the patient by a telephone call or portal messaging. Two of the investigators (CTL, LW) independently categorized message content according to this schema and met to resolve any interrater disparities.

Value to Patients

We asked patients whether they would pay for electronic correspondence with their doctor and, if so, to indicate a dollar value for this correspondence, per completed transaction. We calculated the median and mean dollar amounts provided by the patients who responded that they would pay for this correspondence.

Statistical Methods

SAS was used for all statistical calculations. All tests of statistical significance were 2-tailed, with alpha = .05. With an anticipated sample size of approximately 300 participants per group and a 50% survey response rate, the study was designed to have 80% power to detect a difference of 15% in the proportions of the portal group and control group who rated overall communications with the clinic as “a lot better.”

Data were examined to determine frequencies and normality of responses. Baseline characteristics and outcomes for both groups were assessed with Student *t*-tests or nonparametric Wilcoxon rank sum tests for count variables and chi-square tests for categorical variables or Fisher exact tests when appropriate. The nonparametric Kendall tau rank correlation was used to assess the correlation between categorical variables.

Results

The complete study data are included in Multimedia Appendix 5.

Participants

Demographic characteristics of the portal and control groups were comparable at the beginning of the study. Over 70% of the participants in both groups were college graduates and had a household income of at least US $45000 (Table 1). Proportionately, 96/305 (31%) of portal patients and 111/301 (37%) of controls registered using “uch.edu” or “uchsc.edu” email addresses and could be identified as employees of the University of Colorado Hospital or Health Sciences Center (χ^2 = 2.0, *df* = 1, *P* = .16). This was reflective of the general patient population at the study clinic.

Table 1. Baseline demographics

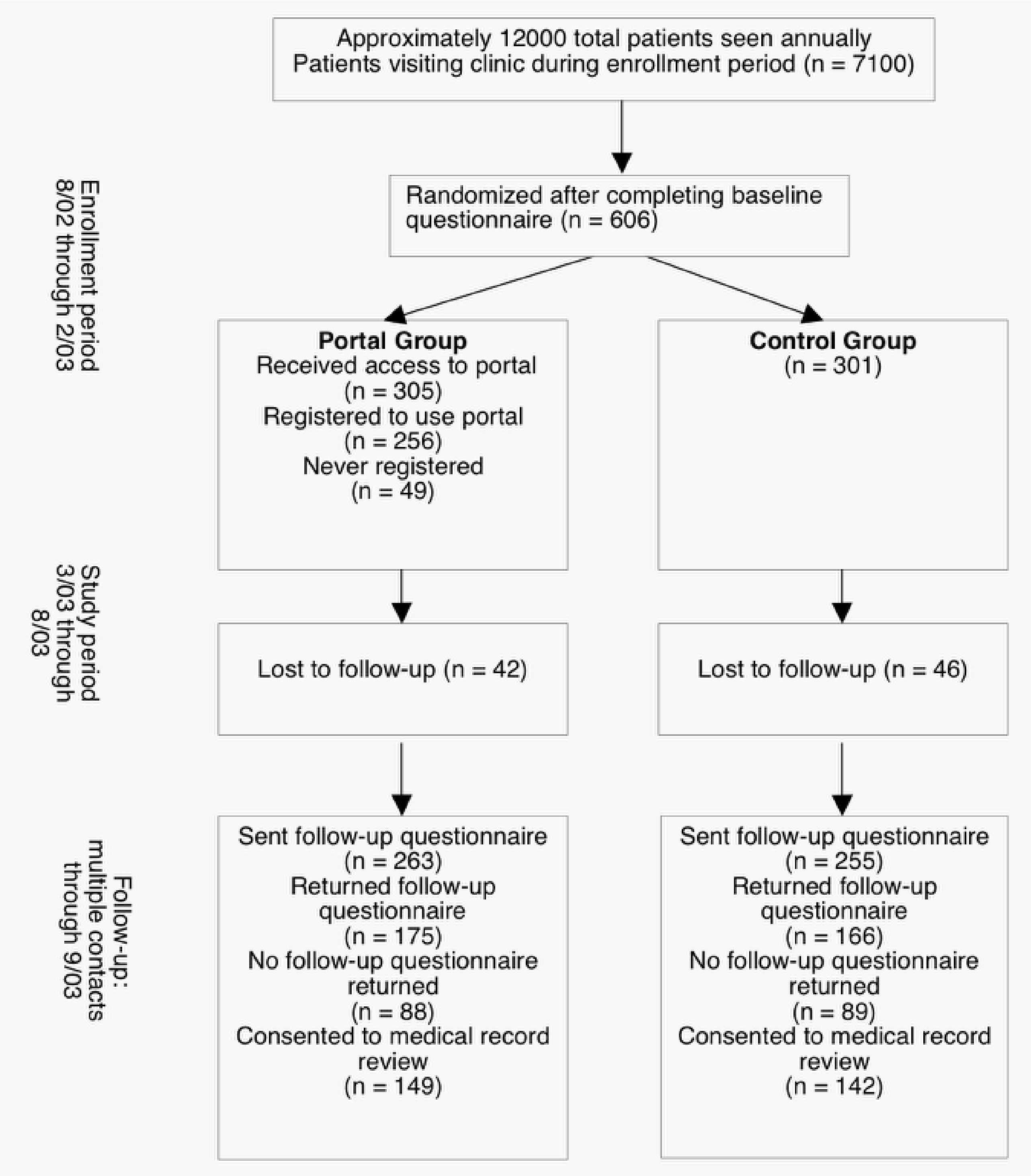
	Portal Group n = 305 Mean (SD) or No. (%)	Control Group n = 301 Mean (SD) or No. (%)	*t* or χ^2	*P* value
Mean age, years	52 (13)	50 (12)	-1.6	.12
Women	175 (57%)	176 (59%)	0.1	.75
College graduate and above	215 (75%)	224 (78%)	0.5	.46
Income ≥ US $45000/year	215 (76%)	221 (76%)	0.004	.95

Degrees of freedom = 585
Degrees of freedom = 1

In all, 606 patients completed a baseline questionnaire. Of the 305 patients who were allocated to the portal group, 256 (84%) obtained a user account for the patient portal, and 95 (31%) used the portal during the trial period (Figure 2).

A similar proportion of participants in the portal and control groups were lost to follow-up: 42 (14%) in the portal group and 46 (15%) in the control group. Of those who were sent the final survey, 175 (67%) of portal patients and 166 (65%) of controls responded. We compared overall satisfaction with care on the initial survey between participants who completed the study and those who did not (defined as those lost to follow-up plus those who never completed the final survey). Those who did not complete the study were less satisfied on the initial survey compared to those who did complete the study (completed study: 137/341 [40%] reported last interaction with clinic as “very good” or “excellent;” did not complete study: 84/265 [32%]; χ^2 = 7.3, *df* = 1, *P* = .007). However, of those who completed the study, there was no significant difference in initial satisfaction with last clinic interaction between the portal group and controls (portal group: 106/305 [35%] reported last interaction with clinic as “very good” or “excellent;” control group: 115/301 [38%]; χ^2 = 0.3, *df* = 1, *P* = .57).

Figure 2. Flow of participants throughout study period



Outcomes

Patient Satisfaction

At the end of the 6-month study, portal group patients were more likely to indicate that communication with the clinic had improved, and they were more likely to rate clinic services as “very good” or “excellent” compared to controls. Portal group patients were also more satisfied than controls with overall clinic services, and, for those portal group patients who used the administrative services, they were more satisfied with each of the services (appointments, refills, and referrals) and with clinical messaging (Table 2).

In subgroup analysis, portal group patients who never used the portal (portal group nonusers) were similar to controls. The only “overall service” in which portal group nonusers differed from controls was satisfaction with “current communication with the clinic compared with the beginning of the study.” The only “specific service” in which portal group nonusers differed from controls was in the subgroup of patients who scheduled appointments.

Table 2. Patient satisfaction at the end of 6-month study period

Question	Control n = 166 No. (%)	Portal Group Overall n = 175 No. (%)	Portal Group Nonuser n = 98 No. (%)	Portal Group Overall vs Control χ^2	Portal Group Overall vs Control *P* value	Portal Group Nonuser vs Control χ^2	Portal Group Nonuser vs Control *P* value
Compared with the beginning of the study, would you say that your communication with the clinic is… (a little better/a lot better)	18 (11%)	77 (44%)	29 (30%)	38.8	< .001	11.2	< .001
Overall, how would you rate the services you receive from the clinic? (very good/excellent)	78 (48%)	103 (59%)	49 (50%)	4.1	.04	0.1	.77
Based on your experiences using the phone or the portal to contact the clinic, please rate the services below:							
Communicating nonurgent messages to doctor and/or nurse (very good/excellent)	n = 137 43 (31%)	n = 141 77 (55%)	n = 76 32 (42%)	15.3	< .001	2.5	.12
Refilling prescription (very good/excellent)	n = 118 52 (44%)	n = 95 60 (63%)	n = 45 24 (53%)	7.7	.006	1.1	.29
Requesting referrals (very good/excellent)	n = 106 44 (42%)	n = 80 50 (63%)	n = 43 24 (56%)	8.0	.005	2.5	.11
Scheduling appointments (very good/excellent)	n = 154 47 (31%)	n = 131 71 (54%)	n = 70 31 (44%)	16.4	< .001	4.0	.045

Degrees of freedom = 1

Patient satisfaction with the portal was high: of the 114/175 (65%) who reported using the portal, 80 (70%) indicated that they were "satisfied" or "very satisfied" with portal services, 92 (81%) indicated that it saved them a telephone call to the clinic, and 37 (33%) indicated that it saved them a visit to the clinic during the 6-month trial.

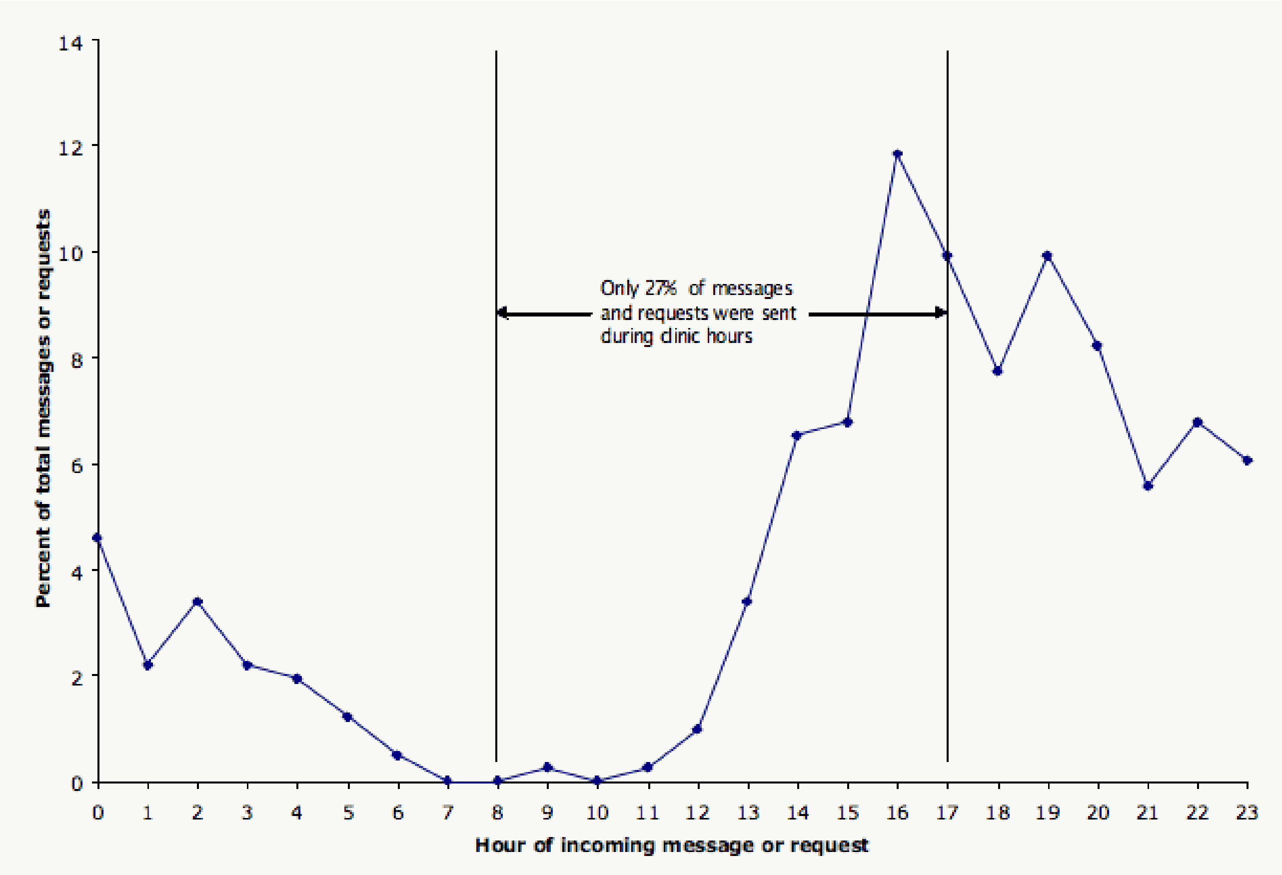
Of the entire portal group, 132/175 (75%) indicated they were "likely" or "very likely" to use the portal in the future, and 149 (85%) said they would prefer to use the portal over the telephone for nonurgent messages.

To determine whether frequent users of the portal were more satisfied with clinic services, we evaluated the association between the number of times patients logged on to the portal and their responses to questions about satisfaction. There were weak positive correlations between frequency of portal use and the following: satisfaction with portal services (r = 0.18, P = .02), improved communication with the clinic since baseline (r = 0.19, P = .01), and, for those who used it (n = 99), satisfaction with physician messaging (r = 0.17, P = .03).

Qualitative Content Analysis of Administrative Requests and Clinical Messaging

The 95 patients who actually used the portal sent a total of 175 administrative requests (88 appointments, 72 prescription refills, and 15 referrals) and 239 clinical messages. This translated to physicians receiving, on average, 1 clinical message per day for every 250 portal group patients enrolled. Monthly volumes were stable over the course of the study. Of these requests and messages, 27% were sent during clinic hours, and 73% were sent during nonclinic hours (Figure 3). Moreover, 52% were sent from 5 PM to midnight, 12% were sent from midnight to 8 AM, and 9% were sent on weekends or holidays. Although not explicitly measured, clinic staff spent about 8 hours daily answering telephones and about 5 minutes daily triaging and responding to portal requests and messages.

Figure 3. Incoming patient portal administrative requests and clinical messages by hour of the day (n = 414)



We compared the clinical messages of patients in both study groups who consented to a review of their medical record. Portal patients called 110 times and sent 76 portal messages. Control patients called 126 times. The median number of telephone calls per patient and total messages (telephone plus portal) per patient was 0 for both the portal and control groups. There was no significant difference in the number of telephone calls ($U = 1.1$, $P = .26$) or total number of contacts ($U = -1.1$, $P = .29$) between the portal and control groups. The mean number of telephone messages per patient was 0.36 (SD = 1.25) in the portal group and 0.42 (SD = 1.06) in the control group, and the mean number of total (telephone plus portal) messages per patient was 0.61 (SD = 1.79) in the portal group and 0.42 (SD = 1.06) in the control group (this is the same as the number of telephone calls since this is the only way this group contacted the clinic). In aggregate, clinical messages from portal patients and controls were similar in content (data not shown).

Within the portal group, we also compared the content of clinical messages sent by portal and by telephone (Table 3). Patients sent more FYI (for your information) and psychosocial messages via the portal. Only 2 portal messages were deemed urgent, and the receiving physicians did not consider these problematic.

Table 3. Content of clinical messages from portal group (comparing phone and portal messages)

Type of Message	Description of Message	Clinical Phone Messages n = 110	Clinical Portal Messages n = 76	χ^2	*P* value	Portal Clinical Message Examples
Urgent message	Patient expects same-day return call and describes acute symptoms or symptoms of infection, or patient calls twice in one day for the same reason	37 (34%)	2 (3%)	26.1	< .001	"I woke up 3:30 am with pain in left side, assumed it was a kidney stone. Took one Dilaudid 2 mg.... If it persists, more than 24 hours I will seek medical care unless you advise sooner."
Biomedical concern	Patient describes body symptoms such as fever, nausea, pain, headache, sore throat, dizziness	57 (52%)	32 (42%)	1.7	.19	"Several years ago I strained the lower left quadrant of my back. Periodically, I strain it and Advil usually reduces the swelling/pain. Last week, I strained it again, and I was hoping you could prescribe something that could help. Thanks."
Psychosocial concern	Patient describes symptoms such as stress, anxiety, depression	2 (2%)	7 (9%)	5.3	.02	"I saw you yesterday for a variety of issues but didn't mention that I am dealing with some heavy depression. I did start Prozac again.... I am having difficulty eating, and am crying a lot. This may also relate to the intestinal issues I am having... (gosh, I'd like to be sleeping at this 3:00 am hour)."
Request test information	Patient requests the results of tests or asks a question about results	12 (11%)	13 (17%)	1.5	.22	"I looked at my test results and I have a few questions. They were supposed to run a Hep C, and LFTs. I assume my Hep B antibody came back positive due to the fact that I was immunized. Please let me know if I need to get more blood drawn."
Request test action	Patient requests that a test be done (eg, blood test, urine culture, x-ray)	9 (8%)	5 (7%)	0.2	.68	"Anything else you think I should get done before I see you? Is it time to do a full blood work—hormones, cholesterol, etc?"
Medication question	Patient requests information about a medication	8 (7%)	1 (1%)	3.5	.08	"What's your opinion of fluoxetine and/or bupropion as antidepressants? They are reported to have virtually no side effects relative to the other meds used for depression."
Request medication action	Patient requests a change in medication dose or new medication	33 (30%)	16 (21%)	1.9	.17	"What I've been left with is a persistent cough...and very heavy sinus drainage, pretty much all day and all night.... I start rehearsals in a few weeks, and it's going to be very difficult for me to work unless I can get rid of this cough and sinus drainage. Can you think of any treatment that might help?"
FYI (for your information)	Patient provides new ideas or information to the physician not otherwise categorized	2 (2%)	14 (18%)	15.8	< .001	"Well, I think I might have solved my hive problem...bed bugs. I was away for a few days and did not have any new hives.... Last night I found some bugs in my bed. I have a pretty bad outbreak of hives again....
Home monitoring	Patient reports personal health data (eg, blood sugar, blood pressure, weight, exercise)	3 (3%)	4 (5%)	0.8	.45	"Here are some BP readings for the mornings of January. I started taking my diuretic on the third."

Type of Message	Description of Message	Clinical Phone Messages n = 110	Clinical Portal Messages n = 76	χ^2	*P* value	Portal Clinical Message Examples
Prevention	Patient requests screening tests or procedures such as colonoscopy or immunization	1 (1%)	4 (5%)	3.3	.16	"I do want to get a bone density test at some point but rib seems fine now and am not looking forward to any more tests."
Miscellaneous	Patient makes a request regarding a medical excuse, insurance issue, document, etc.	13 (12%)	14 (18%)	1.6	.21	"I was denied for Preferred Life Insurance recently—something I have had for over ten years—because of my recent medical problems."

Total percents exceed 100 as messages may contain topics in more than one category.
Degrees of freedom = 1

When physicians responded to clinical messages from the portal group, they were more likely to elaborate on the advice of the triage nurse when the message was received through the portal (physician input to portal message: 73/76 [96%]; physician input to phone message: 86/110 [78%]; $\chi^2 = 11.6$, $df = 1$, $P < .001$). They were also more likely to respond directly to the patient (physician direct response to portal message: 60/76 [79%]; physician direct response to phone message: 15/110 [14%]; $\chi^2 = 79.7$, $df = 1$, $P < .001$).

Value to Patients

In all, 162/341 (48%) of all survey respondents were willing to pay for electronic correspondence with their doctor. Of those willing to pay, the median amount reported per message was US $2, and the mean was $4.10.

Discussion

In this randomized controlled trial, patients with access to an Internet-based patient portal were more satisfied with their communication with the clinic and their overall care. These patients were also more satisfied with clinical messaging with their physicians and the process of requesting appointments, prescription refills, and referrals. Patients were more likely to send FYI and psychosocial messages via the portal than by telephone. The volume of incoming messages was minimal: 1 message daily for every 250 patients offered online access. Portal and control group clinical message volumes were not significantly different.

Why were portal patients more satisfied than controls? First, the portal was convenient: 81% believed that the portal saved them a telephone call, and 33% believed it saved them a visit to the clinic. The portal allowed patients to send messages at all hours; indeed, 73% of incoming messages were sent during nonclinic hours. Second, the portal reduced barriers to communication—portal patients were more likely to send FYI and psychosocial messages. Patients may hesitate to "bother the doctor" with FYI messages by phone, but they feel more comfortable sending a portal message. Patients may prefer sending psychosocial messages by portal because it affords privacy and distance, avoiding the aggravation of being on hold and having to speak to an intermediary. One patient even suggested to the physician that the portal was a more comfortable medium for psychosocial discussion than in-person visits. Third, patients may have appreciated that portal messages were more likely to receive direct responses from the physician, whereas telephone calls tended to be mediated by a triage nurse. Finally, the portal was efficient, providing quick message responses that likely exceeded patient expectations. A substantial majority of messages were answered the same day, even though the portal states that responses may take up to 2 business days. This is consistent with other studies that demonstrated improved patient satisfaction with shorter response time [11] and with meeting or exceeding patient expectations [16,17].

It is clear that patients increasingly desire and are satisfied with online messaging. Physicians are much less enamored with electronic communication, driven by fears of overwhelming volume, inappropriate messaging, and inadequate security [5,10,18,19]. The increasing publicity of patients demanding such service, the lack of demonstrated adverse effects, and the possibility of insurers reimbursing physicians for online communication may narrow this satisfaction gap [8,18,20].

In our sample, the total number of incoming messages from portal patients (portal plus phone) was not significantly different from the total number of incoming messages from controls. This implies that patients replace phone calls with electronic messages. Although Katz et al [5] showed that total message volume increases with patient access to online messaging, others have shown a replacement of phone calls with online messages [4,18,19]. Although not specifically measured, both physicians and staff noted that responding to electronic messages took less time than responding to telephone messages, even after discounting the frustration of "telephone tag." Others have corroborated this finding [18].

Portal patients called more times than they sent online messages. Why? Urgent calls were one third of the phone call volume. Subtracting urgent calls, portal patients were equally likely to call as they were to send an online message. Adopting a new communications medium may occur gradually, with patients not trusting the new system, forgetting how to access it, or not thinking to use it.

The clinical utility of incoming messages is beyond the scope of this study. It is not clear, for example, how FYI messages might have impacted care. At worst, one might imagine such messages "cluttering" the patient's medical record. At best, it might "close the loop" when patients inform their physician of the success or failure of a treatment. Although we demonstrated improvement of patient satisfaction, we are unable to state whether quality of care was affected.

Portal group patients who never used the system were similar to controls in their satisfaction with clinic services, except that they were more satisfied with “overall communication.” These patients may have felt that simply having the portal available if they needed it was advantageous.

Some organizations are charging patients for portal clinical messaging. Since 53% of study participants would not pay for portal messages, this could shift portal messages to “free” telephone calls, reduce FYI and psychosocial messages, and affect satisfaction. Notably, some insurers are beginning to reimburse physicians for online communications, which may partially address this concern [8].

Limitations

This study has several limitations. Control group patients who continued emailing their physician may have diluted the difference between groups. Our patients had relatively high incomes, educational status, and familiarity with the Internet, and one third were University of Colorado or Health Science Center employees, so these results may not be generalizable to an Internet-naive, less affluent sample. Because of the nature of the intervention (online messaging vs telephone calls), the physicians and staff could not be blinded to the process and may have paid more attention to online messages, influencing the results. The study was conducted for only 6 months; patient satisfaction could have increased (due to increased familiarity) or decreased (due to fading of initial enthusiasm) if the study was carried out over a longer period of time. We note that our final sample size (N = 95 actual users) was smaller than our desired size of 150. We reported that the portal group achieved higher satisfaction than controls for “overall care” ($P = .04$). A larger sample would have provided a more precise estimate of effect. Lastly, because of our recruitment method, we were unable to collect information from patients who were eligible for the study but declined to participate. Despite initial randomization of patients and comparable demographic characteristics in dropouts, those who dropped out of the portal and control groups may be different, biasing the results of the final survey.

Summary and Future Directions

This randomized controlled study adds to the literature by describing possible underlying reasons for patient satisfaction with online communication: convenience, reduced communication barriers, and direct physician responses. Another novel finding was that more online messages from patients contain FYI and psychosocial content compared to telephone calls. These findings may explain why patient access to an Internet-based patient portal was associated with greater patient satisfaction with communication and overall care.

A patient portal that supports online communication is a strong foundation on which to promote “care based on continuous healing relationships” [1] and encourage collaborative care. Further research is needed to evaluate more advanced portal services and their impact on patient satisfaction, empowerment, and medical outcomes. An advanced patient portal might include shared documentation by physicians and patients, patient access to test results and other aspects of their medical record, and shared decision support to patients and physicians for chronic care improvement.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Screenshots of My Doctor’s Office portal. [PPT file, 436 KB - jmir_v7i4e47_app1.ppt]

Multimedia Appendix 2

Baseline patient satisfaction questionnaire. [PDF file, 92 KB - jmir_v7i4e47_app2.pdf]

Multimedia Appendix 3

Final satisfaction questionnaire for subjects. [PDF file, 128 KB - jmir_v7i4e47_app3.pdf]

Multimedia Appendix 4

Final satisfaction questionnaire for controls. [PDF file, 124 KB - jmir_v7i4e47_app4.pdf]

Multimedia Appendix 5

Complete study data. [PDF file, 52 KB - jmir_v7i4e47_app5.pdf]

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Original Paper

Improving Physician Performance Through Internet-Based Interventions: Who Will Participate?

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Abstract

Background: The availability of Internet-based continuing medical education is rapidly increasing, but little is known about recruitment of physicians to these interventions.

Objective: The purpose of this study was to examine predictors of physician participation in an Internet intervention designed to increase screening of young women at risk for chlamydiosis.

Methods: Eligibility was based on administrative claims data, and eligible physicians received recruitment letters via fax and/or courier. Recruited offices had at least one physician who agreed to participate in the study by providing an email address. After one physician from an office was recruited, intensive recruitment of that office ceased. Email messages reminded individual physicians to participate by logging on to the Internet site.

Results: Of the eligible offices, 325 (33.2%) were recruited, from which 207 physicians (52.8%) participated. Recruited versus nonrecruited offices had more eligible patients (mean number of eligible patients per office: 44.1 vs 33.6; $P < .001$), more eligible physicians (mean number of eligible physicians per office: 6.2 vs 4.1; $P < .001$), and fewer doctors of osteopathy (mean percent of eligible physicians per office who were doctors of osteopathy: 20.5% vs 26.4%; $P = .02$). Multivariable analysis revealed that the odds of recruiting at least one physician from an office were greater if the office had more eligible patients and more eligible physicians. More participating versus nonparticipating physicians were female (mean percent of female recruited physicians: 39.1% vs 27.0%; $P = .01$); fewer participating physicians were doctors of osteopathy (mean percent of recruited physicians who were doctors of osteopathy: 15.5% vs 23.9%; $P = .04$) or international medical graduates (mean percent of recruited physicians who were international graduates: 12.3% vs 23.8%; $P = .003$). Multivariable analysis revealed that the odds of a physician participating were greater if the physician was older than 55 years (OR = 2.31; 95% CI = 1.09–4.93) and was from an office with a higher *Chlamydia* screening rate in the upper tertile (OR = 2.26; 95% CI = 1.23–4.16).

Conclusions: Physician participation in an Internet continuing medical education intervention varied significantly by physician and office characteristics.

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KEYWORDS

Physician recruitment; Chlamydia; chlamydiosis; Internet-based interventions; continuing medical education

Introduction

Many interventions, including guidelines and educational programs, have been designed to improve quality of medical care, but engaging physicians in these interventions can be challenging. Although traditional continuing medical education (CME) courses tend to have little impact on physician behavior, they remain a popular form of continuing education as physicians attempt to stay current with medical practice and meet mandated CME requirements for licensure and certification [1,2]. However, traditional CME courses can be difficult to accommodate into physicians' busy schedules [3]. These time constraints, as well as other factors, have led to the development of alternative methods, such as Internet-based CME—a form that is increasingly being used to reach physicians and which has the potential to reach large audiences.

Improving quality of care has historically been a major goal of CME activities. However, low rates of physician participation may bias results when such interventions are applied to change physician behavior in clinical settings [4]. When used as broad interventions to change behavior, even well-designed interventions may have limited impact as a result of low participation. Internet-based interventions hold the promise of increasing access to, and participation in, CME.

For Internet-based interventions to be effective they must reach their target audience. Understanding participation patterns and barriers to participation will help advance this important delivery mode of continuing education and improve quality.

We conducted a study to measure and improve *Chlamydia* screening rates among primary care physicians through a randomized controlled trial testing the use of an Internet-based, physician-targeted CME intervention that incorporated educational modules and provider audit and feedback. The purpose of this study was to identify potential physician and office characteristics that might predict physician participation in future Internet-based CME interventions.

Methods

We conducted a retrospective analysis of data generated from the randomized trial "An Internet Intervention to Promote *Chlamydia* Screening." Study recruitment proceeded in two phases: phase I focused on the primary care office, and phase II targeted individual physicians from recruited offices. In the analysis of phase I, we examined factors associated with office recruitment. In the analysis of phase II, we examined factors associated with physician participation.

This study was approved by the Institutional Review Boards of the University of Alabama at Birmingham and the managed care organization.

Overview of Parent Study

The parent study, funded by the Agency for Healthcare Research and Quality as part of the second Translating Research into Practice initiative, tested an Internet intervention for primary care physicians and was performed in collaboration with a large, national managed care organization. The intervention was designed to increase *Chlamydia* screening of at-risk, young women by primary care physicians.

A series of Internet CME modules focusing on chlamydiosis were developed for the intervention. The goal of the instructional design of the online program was to create a multifaceted and multiphase online physician intervention based on current evidence of what is effective in CME. Delivery was via an asynchronous mode: physicians could log on at any time to participate. Email announcements and reminders with direct course links were used to alert physicians to the introduction of the course as well as three updates. Four separate modules were introduced quarterly. Components of the modules included (1) interactive unfolding cases with branching pathways designed to provide remediation based on the physician's response to the case, (2) a quality improvement toolbox with resources to support office improvements in *Chlamydia screening*, (3) feedback to embedded questions so that participants could compare their responses to those of their peers, and (4) feedback of data on *Chlamydia* screening from the practice compared to peers within the overall group of practitioners. No online discussions were included. The intervention was designed and developed with Dreamweaver software (Dreamweaver MX, Macromedia, Inc., San Francisco, CA, USA) and used a SQL server database.

The Internet-based intervention for the control group was described to the participants as a CME course on women's health for primary care physicians. Four modules, one each quarter, were offered to participants, and physicians could log on at any time to participate. The modules focused on women's health issues unrelated to *Chlamydia* screening and included cardiovascular health and prevention of osteoporosis. The modules were text only and required participants to complete a post-test for CME credit. One category 1 CME credit was offered for each module. There was no mechanism for online discussions.

The intervention was designed for primary care physicians from internal medicine, family medicine/general practice, and pediatrics. Internists and pediatricians with a subspecialty board certification were not eligible. Physicians were randomized to an intervention or control group upon first logging on to the study Internet site. After one physician from a given office was randomized, all other physicians from the same office were assigned to the same study group.

Chlamydia screening rates, calculated by the managed care organization for each office, were based upon criteria from the Health Employers Data and Information Set (HEDIS) and provided the main outcomes for the parent study. The denominators for the rates were at-risk women identified from the 2001 HEDIS Technical Specifications applied to administrative data in the calendar year 2000. The HEDIS specifications were designed to identify women between the ages of 16 and 26 years who, based on health care services reflected in administrative data, were sexually active and therefore at risk for *Chlamydia* infections. HEDIS measures used pharmacy data (NDC codes) and claims/encounter data (ICD-9-CM and CPT-4 codes) to identify these health care services, which included pregnancy-related services, contraceptive prescriptions, screening for cervical cancer, and sexually transmitted diseases. The numerator was the number of women in the denominator who had claims data evidence of laboratory testing for *Chlamydia* during the baseline calendar year.

Recruitment and Enrollment

Phase I recruitment occurred at the office level. Each eligible primary care office had at least 20 patients aged 16 to 26 years who were at risk for chlamydiosis based on HEDIS criteria. In November 2001, all potentially eligible physicians (n = 4673) in eligible offices (n = 978) were faxed recruitment letters (Multimedia Appendix 1) inviting participation in the study. Recruitment letters were faxed twice. Initial nonresponders were then sent invitations by courier, but not if another physician from the same office had already been recruited. Letters described the project in general terms, as an Internet-based intervention to improve the care that physicians deliver to their female patients, but it did not indicate *Chlamydia* screening rates as the focus. Because the main purpose of phase I recruitment was to maximize the number of recruited offices, when at least one physician from an office agreed to participate, that office was labeled as "recruited" and no additional recruitment effort was made.

In phase II of recruitment, all physicians who provided their email address in phase I were invited to log on to the study Internet site. The intervention was initiated in February 2002 with an email broadcast to all recruited offices. Emails contained the website address, which connected directly with the module. Recruited physicians received email reminders (Multimedia Appendix 2) monthly and then weekly for a total of up to 33 reminders over a 45-week period until they logged on or asked to be dropped from the study. Only 2 physicians withdrew, asking not to receive additional emails. Emails for 18 physicians were returned because of invalid email addresses, and 3 email addresses did not belong to physicians. Intervention and control group physicians received email reminders according to the same protocol.

Data Sources

For all analyses, study variables were either (1) measured at the office level (patients/office and physicians/office), (2) measured at the patient level but available only at the office level (*Chlamydia* screening rates), or (3) measured at the physician level (physician age, gender, ethnicity, type of degree, country of graduation from medical school). Office characteristics were obtained from managed care organization administrative data. *Chlamydia* screening rates were calculated at the office level by the managed care organization based on HEDIS specifications. Other office characteristics were derived from managed care organization administrative data, and physician characteristics were derived from the American Medical Association's physician master file.

Analyses

The analysis for phase I examined factors associated with office recruitment (Tables 1 and 2) among all eligible offices (n = 978), and the analysis for phase II examined factors associated with physician participation (Tables 3 and 4) among all recruited physicians (n = 392). An office was labeled as recruited if at least one physician from that office was recruited. Physicians were defined as recruited if they provided an email address for subsequent contact. Participation was defined as having logged on to the study Internet site, regardless of how much of the material was completed. For phase I office-level analyses, the outcome was a dichotomous variable indicating whether the office had been recruited. For phase II physician-level analyses, the outcome was a dichotomous variable indicating whether the physician participated in the intervention. Independent variables included office and physician characteristics as described above.

Statistical significance was assessed using the chi-square statistic for categorical variables and the ANOVA for continuous variables for the bivariate analyses (Tables 1 and 3). Logistic regression was used for the phase I multivariable analysis (Table 2). For the phase II multivariable analysis, generalized estimation equations with a logit link accounted for the clustering of physicians within offices (Table 4). Because we were mainly interested in examining the independent contribution of covariates to either office recruitment or physician participation, we did not engage in covariate selection exercises to optimize the predictive power of the multivariable models. Instead, two models were constructed, each containing all important covariates.

Results

Of the 978 eligible offices, 325 (33.2%) were recruited by having at least one physician agree to participate. Overall, eligible offices had an average of 4.8 eligible primary care physicians and 39.1 female patients considered at risk for chlamydiosis. The average screening rate was 16.2%. Of the 392 recruited physicians, 207 (52.8%) participated in the intervention. Eligible physicians were, on average, 44.4 years old and represented 25 US states. About one third of the physicians were female (33.4%), and most were white (82.3%). Most physicians were in internal medicine (36.0%) or family practice (52.3%); fewer (11.7%) were in pediatrics. There was a significant representation of doctors of osteopathy (19.5%) and international medical graduates (17.8%).

Recruited versus nonrecruited offices had more eligible patients (mean number of eligible patients per office: 44.1 vs 33.6; $P < .001$) and physicians (mean number of eligible physicians per office: 6.2 vs 4.1; $P < .001$) (Table 1). Recruited offices also had more family practice physicians and fewer pediatricians, as well as fewer doctors of osteopathy. However, in the multivariable analyses, only the number of eligible patients and physicians remained significant independent predictors of office recruitment status (Table 2). The odds of an office being recruited were greater if the number of eligible patients was in the top 10% for all offices and the number of eligible physicians was in the top 10% for all offices.

Table 1. Characteristics of eligible primary care offices and eligible physicians from a large managed care organization, by office recruitment status

	Recruited (n = 325)	Not Recruited (n = 653)	*P* value
Office characteristics			
Eligible patients, mean	44.1	36.6	< .001
Chlamydia screening rate, mean*	16.3	16.2	.88
Eligible physicians, mean	6.2	4.1	< .001
Physician characteristics**			
Age, mean (years)	44.3	44.4	.90
Female physicians, mean (%)	33.7	33.7	.99
Ethnicity†			
White, mean (%)	81.7	79.6	.36
African American, mean (%)	4.5	6.7	.12
Asian, mean (%)	9.8	9.3	.76
Hispanic, mean (%)	3.9	4.4	.68
Specialty			
Internal medicine, mean (%)	36.4	34.2	.45
Family medicine/general practice, mean (%)	52.9	58.4	.08
Pediatrics, mean (%)	10.7	7.5	.07
Doctor of osteopathy, mean (%)	20.5	26.4	.02
International medical graduate, mean (%)	19.5	18.8	.75

Eligible offices had at least 1 eligible physician with at least 20 female patients who were candidates for *Chlamydia* screening according to the HEDIS Technical Specifications, 2000.
Recruited offices had at least 1 physician provide an email address for subsequent contact.

[*] *Chlamydia* screening rates were determined from HEDIS Technical Specifications, 2000.

[**] Physician characteristics were reported at office level as unweighted averages across all offices.

[†] This information was missing for 30.0% of the physicians in the sample.

Table 2. Multivariable logistic model for primary care office recruitment among all eligible primary care offices (n = 821; c statistic = 0.622)

	Odds Ratio	95% Confidence Interval	
No. eligible patients ≥ 90th percentile*	2.68	1.67	4.31
Chlamydia screening rate**			
Lower tertile	-	-	-
Middle tertile	1.09	0.77	1.56
Upper tertile	0.94	0.66	1.36
No. eligible physicians ≥ 90th percentile†	1.93	1.23	3.03
Physicians ‡			
Age, mean (years)	1.01	0.99	1.03
Female, mean (%)	0.83	0.51	1.36
Ethnicity			
White, mean (%)	-	-	-
African American, mean (%)	0.61	0.27	1.40
Asian, mean (%)	1.01	0.50	2.05
Hispanic, mean (%)	0.79	0.30	2.07
Specialty			
Internal medicine, mean (%)	-	-	-
Family medicine/general practice, mean (%)	1.12	0.78	1.62
Pediatrics, mean (%)	1.56	0.87	2.83
Doctor of osteopathy, mean (%)	1.04	0.63	1.71
International medical graduate, mean (%)	1.33	0.75	2.36

Recruited offices had at least 1 physician provide an email address for subsequent contact.
Eligible offices had at least 1 eligible physician with at least 20 female patients who were candidates for *Chlamydia* screening according to HEDIS Technical Specifications, 2000. The number is reduced due to missing data.

* Dichotomous variable indicating whether number of eligible patients in office was ≥ 90th percentile for number of eligible patients in all offices.

** *Chlamydia* screening rates were determined from HEDIS Technical Specifications, 2000.

† Dichotomous variable indicating whether number of eligible physicians in office was ≥ 90th percentile for number of eligible physicians in all offices.

‡ Physician characteristics were summarized at office level as unweighted averages across all offices. Odds represent one-unit increase.

Participating versus nonparticipating physicians were more likely to be female (mean percent of female recruited physicians: 39.1% vs 27.0%; *P* = .01) and less likely to be doctors of osteopathy (mean percent of recruited physicians who were doctors of osteopathy: 15.5% vs 23.9%; *P* = .04) or international medical school graduates ((mean percent of recruited physicians who were international graduates: 12.3% vs 23.8%; *P* = .003) (Table 3). From the multivariable analysis, being from an office with *Chlamydia* screening rates in the top tertile was associated with greater odds of participation. Also, physicians older than 55 years were more likely to participate (Table 4).

Table 3. Characteristics of 392 primary care recruited physicians from a large managed care organization, by physician participation status

	Participated (n = 207)	Did Not Participate (n = 185)	*P* value
Age, mean (years)	44.9	43.8	.22
Female, mean (%)	39.1	27.0	.01
Ethnicity *			
White, mean (%)	82.1	82.6	.91
African American, mean (%)	4.5	2.3	.29
Asian, mean (%)	9.5	10.6	.73
Hispanic, mean (%)	4.0	4.6	.80
Specialty			
Internal medicine, mean (%)	36.7	35.1	.75
Family medicine/general practice, mean (%)	53.6	50.8	.58
Pediatrics, mean (%)	9.7	14.1	.18
Doctor of osteopathy, mean (%)	15.5	23.9	.04
International medical graduate, mean (%)	12.3	23.8	.003

Recruited physicians provided their email address for subsequent contact.
Participating physicians logged on to the study Internet site.

* This information was missing for 30.0% of the physicians in the sample.

Table 4. Multivariable logistic model for primary care physician participation among all recruited physicians (n = 324)

	Odds Ratio	95% Confidence Interval	
Office characteristics			
No. eligible patients ≥ 90th percentile*	0.55	0.21	1.42
Chlamydia screening rate**			
Lower tertile	-	-	-
Middle tertile	1.29	0.73	2.31
Upper tertile	2.26	1.23	4.16
No. eligible physicians per office ≥ 90th percentile†	1.46	0.66	3.22
Physician characteristics			
Age > 55 years	2.31	1.09	4.93
Female, mean (%)	1.57	0.92	2.70
Ethnicity			
White, mean (%)	-	-	-
African American, mean (%)	1.82	0.43	7.71
Asian, mean (%)	0.85	0.35	2.02
Hispanic, mean (%)	1.22	0.43	3.45
Specialty			
Internal medicine, mean (%)	-	-	-
Family medicine/general practice, mean (%)	1.09	0.64	1.85
Pediatrics, mean (%)	0.46	0.20	1.03
Doctor of osteopathy, mean (%)	0.65	0.33	1.28
International medical graduate, mean (%)	0.57	0.28	1.16

Based on generalized estimation equations with logit link accounting for clustering of physicians within offices.
Recruited physicians provided their email address for subsequent contact. Participating physicians logged on to the study Internet site. The number is reduced due to missing data.

* Dichotomous variable indicating whether number of eligible patients for a given office was ≥ 90th percentile for number of eligible patients for all offices. Patient eligibility for *Chlamydia* screening was defined by HEDIS Technical Specifications, 2000.

** Offices classified according to *Chlamydia* screening rate tertiles. *Chlamydia* screening rates were determined from HEDIS Technical Specifications, 2000.

† Dichotomous variable indicating whether number of physicians in the office of primary care physician was ≥ 90th percentile for number of physicians in all offices. Eligible physicians had at least 20 eligible female patients.

Discussion

Our low-intensity recruitment methods, including fax and courier delivery and email reminders, allowed us to meet the recruitment goal of approximately 200 offices. Using these methods, we were able to recruit a geographically diverse sample of physicians who were not affiliated with our institution or research team. Our study is unique in that it provides a detailed description of predictors of physician recruitment and subsequent participation in an Internet-based intervention to improve care.

Recruiting Physicians for Office-Based Research

Many methods have been used to recruit physicians for office-based clinical research. The most intensive approach involves physician-to-physician contact, either by telephone or in person at the practice site. Initial contact by mail is commonly used, either alone or in conjunction with other methods. Less intensive approaches include contact by fax or email. Recruitment that combines several approaches will probably produce a higher participation rate, but the intervention team must determine if the higher participation rate justifies the added investment [5,6].

McBride et al compared three methods, based on point of contact, for recruiting community primary care physicians in a preventive services clinical trial: direct to primary care physicians, through the health maintenance organization to practice leaders, or direct to practice leaders [5]. All three methods involved an initial mailing, either from the university or the health maintenance organization, as well as follow-up phone calls and an informational on-site meeting with the practice. Outcomes included response rates, participation rates, and comparative costs of each method. Of the 86 eligible practices, 52 (60%) agreed to participate. Mailings to individual physicians were the least efficient means of recruiting, while targeting medical directors was the most efficient method in this trial.

While some physicians will enroll after only minimal efforts are expended to recruit them, others will require more intense recruitment efforts. Achieving large numbers of recruited subjects for minimal costs has obvious benefits, allowing more intensive and expensive efforts to be focused on those individuals that are more difficult to recruit. Having a staged approach to recruitment conserves valuable resources.

We met our recruitment goal of at least one physician from approximately 200 offices without using intensive recruitment methods. Therefore, we feel that this study underestimates the true percentage of physicians willing to engage in an Internet intervention. In addition, we did not ask participating physicians to recruit others from the same office, although such a strategy may prove useful for future studies.

Participation in projects targeting physicians may also be affected by physician characteristics. Shelton et al studied recruitment and retention of community primary care practices in a study to improve cancer screening and counseling [7]. Their initial decline rate was only 6%, but the refusal rate reached 30% by the time the intervention was implemented. Study participants were more often younger, located in rural areas, and family practitioners rather than internists.

Recruiting Physicians for CME Studies

Even though this was a research study, the physicians' viewed the study primarily as an opportunity to participate in a CME activity to improve care. Our intervention involved both an Internet-based CME component and physician feedback. While we could not find another study examining physician recruitment and participation in a similarly designed intervention, there are several studies of physician participation in traditional CME courses [3,8-12]. Factors which influence physician participation in traditional CME courses include licensure requirements and opportunities for review or general updates and for interaction with colleagues, especially in the context of professional societies [8,9]. Internet-based CME may be tailored to meet individual needs and be more interactive than traditional CME.

Goulet et al found that being older, having a rural practice, and having a solo practice were associated with less participation in group CME activities [10]. Distance to a CME activity may be more of an issue for rural physicians, while being in solo practice would significantly limit available time. Gerbert et al reported their experience with a study that used traditional CME to improve outpatient management of chronic obstructive pulmonary disease [11]. Of 2600 eligible physicians invited to participate, 277 (11%) declined. Of the 171 (7%) who expressed initial interest in participating, only 89 (3%) enrolled and only 63 (2%) actually participated. Board-certified physicians and family practitioners were more likely to participate.

In our study, we are able to distinguish recruitment and participation as distinct steps and to examine how these processes may be influenced by office and physician characteristics. Because our goal was to recruit the required number of offices and because we increased the intensity of our recruitment efforts for offices that did not initially respond, we cannot draw conclusions about the influence of practice type (group vs solo) on recruitment. Recruitment was more common from offices with more physicians, which is likely a direct effect of our recruitment strategy. Recruitment was also more common from offices that had a greater number of eligible female patients, probably reflecting the physician's perceived relevance for the CME program.

Different associations were found when physician-level participation after successful recruitment was examined. Practice composition based on physician gender, educational track, and international training was associated with physician participation only in the bivariate analyses. In the multivariable analysis, being an older physician and being in the highest *Chlamydia* screening group predicted participation. We did not expect older physicians to be more likely to participate in an Internet-based intervention. Older physicians are less likely to participate in group CME and more likely to obtain CME through independent reading and associated CME credits [10]. Participation in Internet-based CME may have a similar pattern in that it can be done at one's convenience and without time away from practice and family.

Barriers to participation in traditional CME include time away from practice and family, costs of travel, and lack of relevance of general topics to specific patient problems [3,12]. Theoretically, Internet-based CME overcomes some of these barriers in that it is available to any physician with Internet access, not being affected by geographic location. In addition, Internet-based CME can be accessed at any time, making it possible for busy physicians to participate without restricting patient appointments. Recent surveys have shown that virtually all physicians have access to the Internet at work or at home [13].

CME is increasingly more available via the Internet, making it much more accessible than traditional CME activities. In addition, use of Web-based technologies is expected to increase [8,14]. Understanding physician factors associated with participation will assist in designing future recruitment efforts as well as Internet-based interventions.

Limitations

Our study was limited to physicians with email access who met the specific inclusion criteria of being a member in a specified health maintenance organization–based provider network, practicing in one of the designated specialties (internal medicine, family practice, or pediatrics), and practicing in an office caring for a minimum number of at-risk women. Since we do not know the number of physicians with email, we do not know the true number of eligible physicians. Our recruitment methods were meant to be minimally intrusive, but we do not know who actually received the faxes and emails and made the decision of whether to participate. Because our study was not designed to maximally recruit physicians and determine response rates, we do not know what the response would have been to more intense recruitment efforts. Since we had a low rate of participation from international medical graduates, our results may not be generalized to this group. Special efforts may be needed in future projects in order to achieve greater participation from international medical graduates.

Conclusions

Recruiting physicians for participation in projects for practice improvement is a challenging process which requires multiple contact points and may require multiple modalities. Using a staged approach to recruitment saves valuable resources for recruiting those physicians who are more difficult to recruit.

In addition, recruitment does not equate with participation. Our initial contact was via mail from the managed care organization followed by contact from the study team via fax. However, many physicians received repeated emails before actually participating in the study. Fortunately, our study was designed to use email reminders as a means of contact following actual recruitment. Use of other methodologies could have resulted in unpredictably high costs for continued mailings, courier deliveries, or phone contacts.

Ideally, research studies should recruit a diverse population of participants that will represent the population from which the sample is drawn. However, multiple studies have shown that physician factors may play a role in participation in research studies. Understanding the role of these factors may help in the design of the recruitment process. While we found some physician and practice factors to be associated with participation, many were not. This suggests that our recruitment efforts resulted in a sample that was reasonably representative of the larger population.

Acknowledgments

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Recruitment letter. [PDF file, 204 KB - jmir_v7i4e48_app1.pdf]

Multimedia Appendix 2

Email reminder. [PDF file, 36 KB - jmir_v7i4e48_app2.pdf]

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Abbreviations

CME: continuing medical education
HEDIS: Health Employers Data and Information Set

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Original Paper

Bandwidth Constraints to Using Video and Other Rich Media in Behavior Change Websites

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Abstract

Background: Web-based behavior change interventions often include rich media (eg, video, audio, and large graphics). The rationale for using rich media includes the need to reach users who are not inclined or able to use text-based website content, encouragement of program engagement, and following the precedent set by news and sports websites.

Objectives: We describe the development of a bandwidth usage index, which seeks to provide a practical method to gauge the extent to which websites can successfully be used within different Internet access scenarios (eg, dial-up and broadband).

Methods: We conducted three studies to measure bandwidth consumption. In Study 1, we measured the bandwidth usage index for three video-rich websites (for smoking cessation, for caregivers, and for improving eldercare by family members). We then estimated the number of concurrent users that could be accommodated by each website under various Internet access scenarios. In Study 2, we sought to validate our estimated threshold number of concurrent users by testing the video-rich smoking cessation website with different numbers of concurrent users. In Study 3, we calculated the bandwidth usage index and threshold number of concurrent users for three versions of the smoking cessation website: the video-rich version (tested in Study 1), an audio-rich version, and a Web-enabled CD-ROM version in which all media-rich content was placed on a CD-ROM on the client computer.

Results: In Study 1, we found that the bandwidth usage index of the video-rich websites ranged from 144 Kbps to 93 Kbps. These results indicated that dial-up modem users would not achieve a “good user experience” with any of the three rich media websites. Results for Study 2 confirmed that usability was compromised when the estimated threshold number of concurrent users was exceeded. Results for Study 3 indicated that changing a website from video- to audio-rich content reduced the bandwidth requirement by almost 50%, but it remained too large to allow satisfactory use in dial-up modem scenarios. The Web-enabled CD-ROM reduced bandwidth requirements such that even a dial-up modem user could have a good user experience with the rich media content.

Conclusions: We conclude that the bandwidth usage index represents a practical tool that can help developers and researchers to measure the bandwidth requirements of their websites as well as to evaluate the feasibility of certain website designs in terms of specific use cases. These findings are discussed in terms of reaching different groups of users as well accommodating the intended number of concurrent users. We also discuss the promising option of using Web-enabled CD-ROMs to deliver rich media content to users with dial-up Internet access. We introduce a number of researchable themes for improving our ability to develop Web-based behavior change interventions that can better deliver what they promise.

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KEYWORDS

Health behavior; Internet; behavioral research; rich media; video; smoking cessation; bandwidth usage index

Introduction

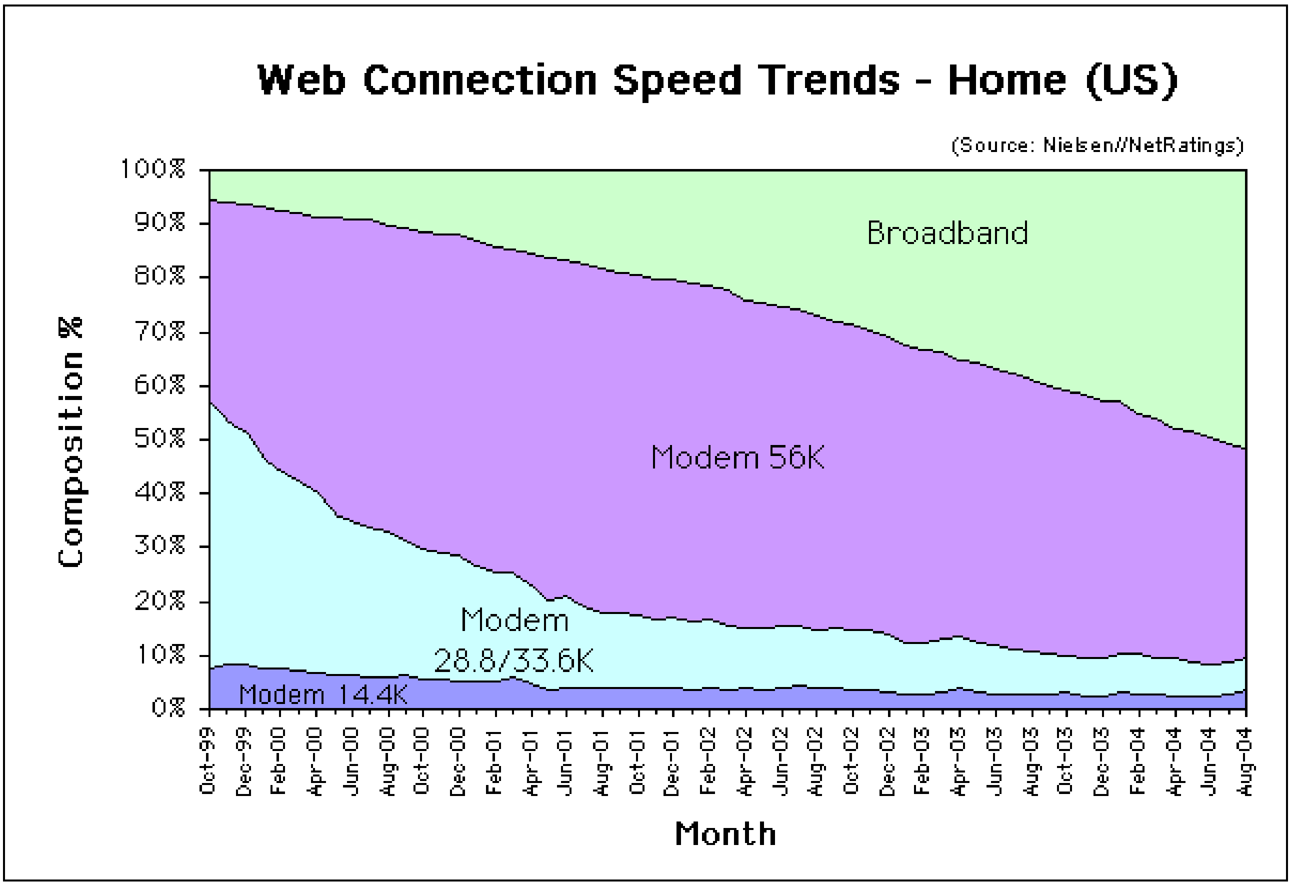
The Internet holds great promise as a delivery channel for programs designed to help people change their behaviors [1,2]. For example, a number of reports have described encouraging results for Web-based interventions for quitting smoking [3-7], managing diabetes [8], managing depression and stress [9,10], and increasing exercise and losing weight [11,12]. An early review of this burgeoning field concluded that Web-based interventions were relatively more helpful than non-Web controls across a broad range of behaviors and methodologies [13]. One of the more impressive features of Web-based behavior change programs is their ability to incorporate rich media components that use video and audio.

In this report we will review some of the forces that encourage the development of rich media websites, but we will also examine in considerable detail the factors that temper unbridled enthusiasm for this trend. We believe that any reasoned analysis of the use of rich media website content should also consider the possible barriers to its use. As a key part of our analysis, we will describe the development and testing of a practical index for gauging the amount of bandwidth that a Web-based program requires. We hope to highlight the ways that bandwidth constraints associated with rich media restrict both program reach as well as the number of concurrent end users who can successfully use a Web-based program. We also discuss ways that behavioral research can help elucidate how and when to use different website program ingredients, including, for example, the use of rich media. The remainder of this section describes the trends encouraging the use of rich media and introduces key technology issues that set the stage for the presentation of our investigation.

Trends and Assumptions That Encourage Use of Rich Media

Developing rich media is an expensive proposition [14]. Nonetheless, the use of rich media in Web-based programs has been encouraged by complementary technology trends: (1) the dramatic reduction in the cost and complexity of rich media recording and editing tools, (2) the fact that rich media is a defining characteristic of CD-ROM multimedia training [15-17], (3) the emergence of programming tools that reduce the complexity of delivering audio and video in websites, (4) the use of rich media content in a number of commercial websites (eg, sports, news, and entertainment sites) and company intranets [18], and (5) the growing number of households with *broadband* Internet access both in the United States [19] and the world [20]. Currently, more than 204 million people in the United States have home Internet access [19]. In August 2004, 51.4% of active Internet users connected from home using broadband connections. Among *narrowband* users, 39% use 56 Kbps modems, 6% use 28/33.3 Kbps modems, and 3.6% use 14.4 Kbps modems [19,21]. In summary, just under half of home users in the United States connect to the Internet at 56 Kbps or less (Figure 1).

Figure 1. Web connection speed trends in US homes (used with permission [21])



The emergence of rich media websites has also been encouraged by a number of assumptions made by behavior change program developers: (1) online video and audio presentations help reach the audience that is not able or inclined to interact with websites that use text-based content; (2) rich media may be more effective than text in conveying emotional content and subtle interpersonal communications [22]—issues that may be particularly pertinent to many behavior change programs; (3) by varying rich media components, Web-based programs can deliver tailored content that is more closely aligned with the racial, ethnic, and demographic characteristics of users (eg, varying the ethnicity or age of video models can affect acceptability and impact [23]); and (4) the entertainment value of rich media can help overcome problems of participant recruitment and program engagement that seem to afflict many Web-based programs. A recent study on cancer communication materials found that participants preferred multimedia which combined text, spoken audio, and animation compared with presentations that involved text only, audio only, or text and synchronized audio [24,25].

Technical Considerations

In this section we briefly introduce a number of technical considerations that affect website bandwidth constraints, including the size of rich media, ways to deliver rich media, calculating the extent of concurrent website usage, and typical bandwidth bottlenecks. Our discussion will only briefly touch upon the vast wealth of technological detail and resources associated with Internet content delivery/distribution. We encourage interested readers to explore this realm by first consulting the useful framework presented by Bush and his colleagues [26], followed by review of several excellent texts [27-29].

Web-Delivered Rich Media

Rich media content delivered over the Web typically undergoes a number of changes in order to reduce its absolute size (number of bits of data) while maintaining an acceptable level of clarity and attractiveness (fidelity to the original) [30-32]. The smaller the data size of a media file, the more rapidly it can be delivered over the Internet to the end user. One approach to reducing the data size of rich media involves scaling, that is, reducing the frame or image size, the frame rate, or the color resolution [27]. In addition to scaling, data size can be reduced by using very sophisticated technologies that compress (remove information that is perceptually redundant [27]) media content with varying degrees of fidelity and acceptability [28]. Video can be delivered using a *progressive download* process or via *streaming*. In our experience, progressive download provides better fidelity with fewer interruptions and fewer problems synchronizing video with audible speech (correctly timing speaker's lips and voice). Synchronization problems of this type are very distracting, and, as a result, they significantly degrade usability [33]. Finally, it is possible for websites to *preload* or *push* rich media to the end user before such content is selected for viewing [34], but this approach works best when the user has a broadband connection and when rich media selections are few in number or can be predicted reliably ahead of user selection (not typical of rich media behavior change websites). Corporate examples of preloading can be found in media content stored in cache on proxy servers [27].

Concurrent Users

Website usability is greatly affected by the number of users who access content at the same time. As a general rule, because of the asynchronous use pattern associated with most Web-based programs, the number of concurrent users is a small percentage of the total number of users eligible to access the program. However, given that websites can be made available to and thus accessed by an extremely large number of users, even a small percentage can yield a relatively large absolute number of concurrent users. As Salchner [35] has noted, concurrent user estimates can be derived by calculating the average number of user visits that occur each day and the average number of users per hour that a program can support (60 divided by the duration [in minutes] of a typical session or visit). Of course, visits are not evenly distributed across the hours of the day. And each user does not access the same program content (especially in Web-based programs with matrix information architecture components that enable users to choose how they access program content [2]). In summary, the number of concurrent users is critically important to website usability since it interacts with the available bandwidth (described next).

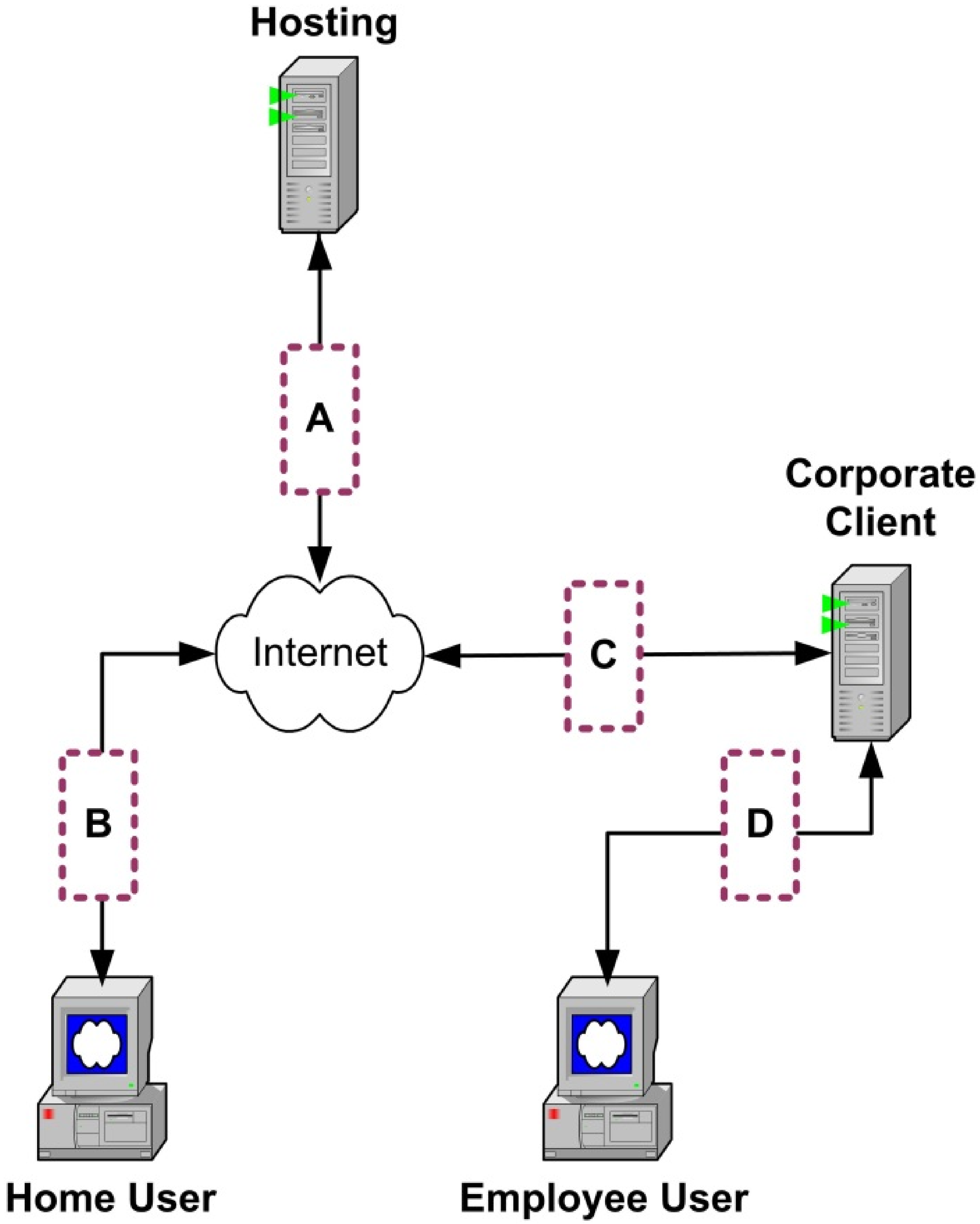
Bandwidth Bottlenecks

Most users and program developers are familiar with the term *bandwidth*, which is defined as "the amount of data that can be transferred through a digital connection in a given time period…[which is] usually measured in bits or bytes per second" [36]. The physical metaphor of a pipe is often invoked in an effort to describe the manner in which digital connections behave: larger pipes have greater bandwidth and they permit faster throughput of the digital data. As with the limits imposed by physical pipes, there are limitations on the amount of data that can be transmitted through any digital connection.

Bandwidth constraints have significant practical implications because, when exceeded, they can greatly increase end user frustration and seriously degrade interaction with a website. Consider, for example, that usability research confirms that users have extremely limited patience when waiting for a Web page to download [37]. The longer the wait, the less acceptable—and hence the less usable—the website. Jakob Nielsen, a noted Web usability expert, has recommended that response times of less than 0.1 second are needed for the user to feel that the system is being responsive (that the system has "heard" and "responded" to the user's request) and that any delay of greater than 1.0 second will interrupt the user's flow of thought [38].

There are at least four potential delivery bottlenecks that can interact in a cumulative fashion to impede the acceptable flow of content from the Internet to the end user [39]. The size/speed of the digital connection at various key points in the content delivery process has a very significant impact on bandwidth. Figure 2 depicts the key points where throughput bottlenecks can occur.

Figure 2. Potential bandwidth bottlenecks



Bottleneck A is defined as the capacity of the host to serve (deliver) the program content. Throughput can be undermined at this point if the program content is being served by an inefficient or overworked server. Fortunately, current servers are sufficiently robust that they become a throughput bottleneck only in scenarios when they are called upon to manage responses and generate logic to build and delivery dynamic Web pages for a very large number of concurrent users. Moreover, there are sophisticated hardware and software solutions for handling this type of demand. For example, major commercial Internet content providers typically use a server farm configuration in which one group of servers manages applications (program logic), other servers process database activities, and yet other servers manage the delivery of media assets (eg, graphics, audio, and video) [40]. However, when many concurrent users access video-rich content, the bottleneck is defined by the bandwidth constraints that cannot be resolved by improvements in server hardware configuration.

Bottleneck B describes the connection between the Internet and the home user. It is possible that the user's computer can be underpowered to manage Web-based programs with rich media. But a critically important factor at this point involves the "last mile" challenge [41,42] (ie, bandwidth limitations in delivering Internet content from the service provider to the home user). The limited bandwidth of dial-up modem users represents an obvious example of this bottleneck. So-called *broadband* connections enable home users to download significantly greater amounts of data per unit time from the Internet.

Bottleneck C describes the connection between the Internet and a company network. Many companies use T1 lines that provide all employees with "high speed" access to the Internet, email, and data sharing.

Bottleneck D describes the connection between a company network and the individual employee workstation.

Summary

Rich media is becoming a frequent ingredient of Web-based behavior change programs. As we have noted, there are forces that encourage this trend, as well as associated bandwidth requirements that need to be measured in order to inform the optimal planning, development, and delivery of Web-based programs that use rich media.

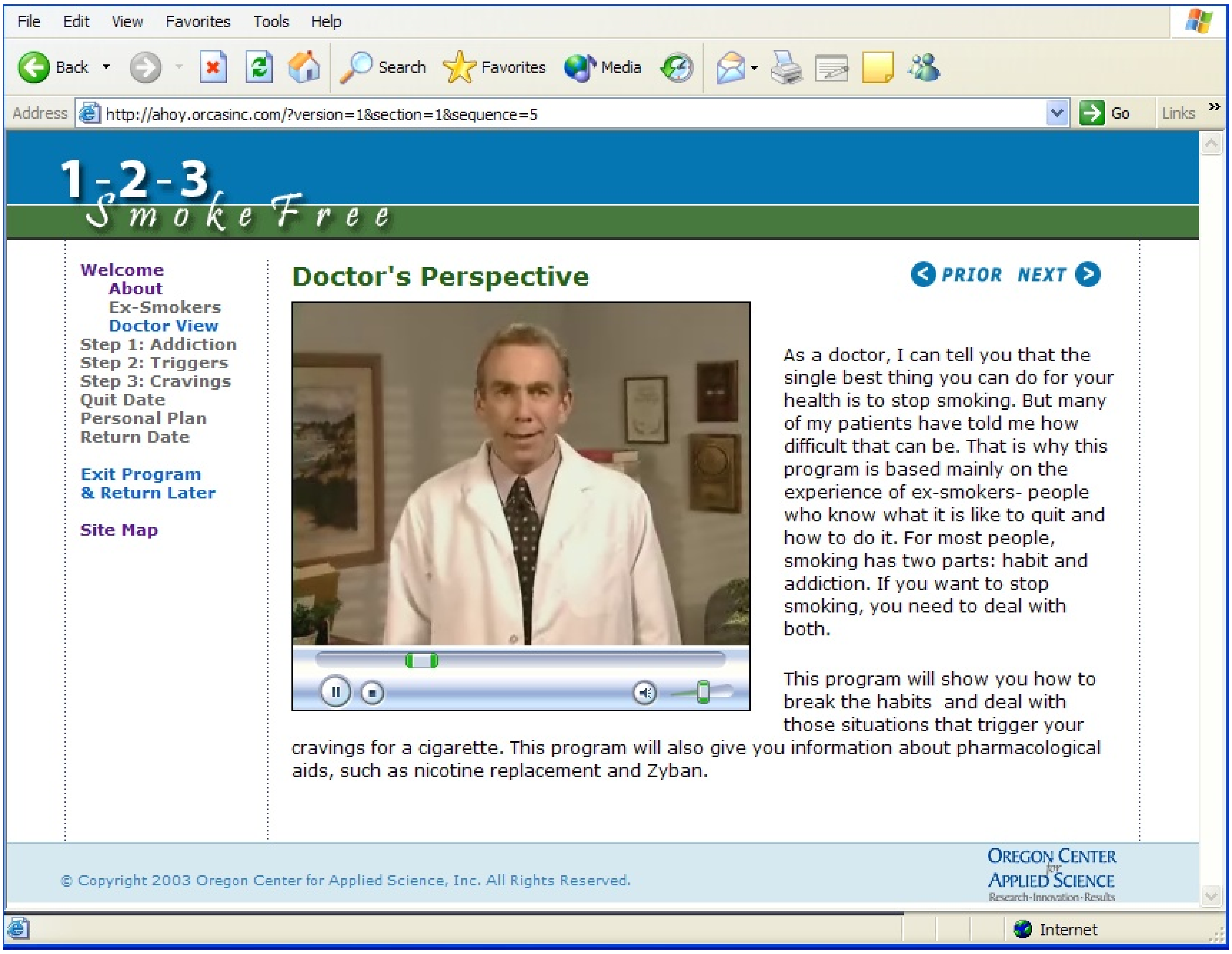
Methods

Study 1: Three Different Web Programs

We used a relatively simple methodology to calculate the bandwidth requirements of an Internet-based program. The resulting metric, which we have labeled the bandwidth usage index (BUI), can be used to define the minimum bandwidth requirements for any given program and can be used to estimate the number of concurrent users that can be accommodated (have a good user experience) under varying Internet access scenarios (eg, ranging from using a dial-up modem to using an internal network).

We determined the BUI for three different video-rich Web-based behavior change programs: (1) the 1-2-3 SmokeFree smoking cessation program [43] (Figure 3), (2) a program designed for caregivers, and (3) a program designed to improve eldercare by family members. Each of these programs was developed with NIH Small Business Innovation Research funding at the Oregon Center for Applied Science, each used a modularized, data-driven design that displayed content based upon the interaction of logic scripts (eg, PHP), SQL databases, and cascading style sheets, and each made extensive use of video and audio (rich media) components. In all tests, video was delivered using the progressive download method via a Windows Media Player object embedded in the Web page.

Figure 3. 1-2-3 SmokeFree Web page showing video and text components



Specifically, we measured the amount of data received by an end user (client computer) from a server (host computer) that delivered representative content from each of the three rich media Web-based programs. The 13-minute test followed a consistent protocol described generically in Table 1 and in more technical detail (with an example) in Multimedia Appendix 1. All tests were conducted in a 100 Mbps Ethernet network, which essentially eliminated any meaningful artifacts that would be associated with delays in network transmission (server response and bandwidth constraints).

Table 1. BUI measurement protocol

Step	BUI Measurement Task
1.	Clear the browser cache (from MS Internet Explorer 5.x, select "Tools," Internet Options," "General" tab, and click on "Delete Files" button).
2.	Access statistics for the network port that will be used by the test computer.
3.	Determine the noise level during a period of inactivity (see Multimedia Appendix 1).
4.	Reset the byte counters or settings for the port connected to the test computer.
5.	Launch and then use the Web-based behavior change program in a representative manner for the designated test period.
6.	Calculate the bytes received by the test computer at the end of the test period.
7.	Subtract the predicted noise from the bytes received calculation.
8.	Convert (as needed) into Kbps to obtain the BUI.

It is important to note that the end user in this test accessed a representative portion of the behavior change program content hosted on the server. We defined "representative portion" as a mixture of Web pages which included text, graphics, and rich media content (audio and video) used in a manner that simulated a typical use case. The index or gauge of data throughput was calculated as the total number of bits received by the client computer from the server divided by the duration of the test period to yield an average expressed in Kbps.

We used the BUI calculations to predict the number of concurrent users who could have a satisfactory experience using

Web-based behavior change programs under a number of different Internet access scenarios.

Study 2: BUI Validation Tests

In Study 2, we attempted to confirm the validity of our estimated threshold number of concurrent users for the three rich media behavior change websites we tested in Study 1. First, we used operating system tools to *throttle* a network computer (host) so that it would allow only 768 Kbps throughput (equivalent to the maximum throughput that would be experienced when using a DSL/cable to access the Internet). Next, we used that network computer to host the video-rich 1-2-3 SmokeFree Web-based smoking cessation program tested in Study 1. We stationed each of five end user participants (blind as to our earlier calculations and hypotheses) in separate offices where they could receive study instructions. Each end user participant used a separate workstation connected to the company intranet, and each was asked to clear the browser cache (Step 1 in Table 1). Finally, each participant was instructed at the same time via the intercom to launch and then use the Web-based behavior change program in a representative manner, which was described to them in terms of activities to perform and pages to visit (Step 5 in Table 1). At the end of the 5-minute test period, each participant was asked to rate the quality of their experience with the Web-based program using the binary label of “a good experience”—the program pages flow with little or no delay—or a “bad experience.”

Study 3: Varying BUI in Three Versions of the Same Web Program

We also tested the extent to which the bandwidth requirements of a single Web-based program might vary based upon the type of rich media it presents and its delivery format. More specifically, we created two new versions of the 1-2-3 SmokeFree Web-based smoking cessation program: (1) an “audio-rich” version in which program content had been adapted such that video content was replaced by audio-only content, and (2) a Web-enabled CD-ROM condition in which all media-rich content was placed on a CD-ROM that was located on the client computer. All program content and behavior was otherwise identical to that found in the video-rich version of the smoking cessation program tested in Study 1. We followed the test protocol described in Table 1 to obtain throughput measures (the BUI) for each of these new versions in order to determine how they compared to the video-rich version.

Results

Study 1: Three Different Web Programs

The BUI for three video-rich Web-based behavior change programs ranged from 144 Kbps for the smoking cessation website to 93 Kbps for the eldercare website (Table 2). By dividing the total amount of data that can be transmitted (based upon the type of Internet connection) by the BUI (the amount of data per second being transmitted by the program), we were able to estimate the number of concurrent users who could use the Web-based program content. It is important to note that we used the *idealized* throughput of various methods of accessing the Internet, ranging from the slowest 28.8 Kbps dial-up modem to an extremely fast 100-baseT corporate network [44,45], to calculate the estimated number of concurrent users who could be accommodated for each website. Many factors affect throughput availability (eg, network noise, competition from other applications or other users, and server and end user hardware and system configurations). Actual throughput is almost always less (never greater) than these idealized numbers. As a result, a more precise calculation of the maximum number of concurrent users would require the BUI (the focus of this report) and a representative measure of throughput availability.

In terms of Bottleneck A (Figure 2), Table 2 provides a useful guide for how many concurrent users an Internet host could accommodate. Internet service providers (ISPs) typically offer a range of services, including increasing levels of bandwidth at correspondingly higher costs. If the ISP offers Internet access equivalent to T1 bandwidth, then Table 2 shows that the ISP could host only 10 to 16 concurrent users of the rich media programs (eg, the smoking cessation program had 1544 Kbps/144 Kbps/user = 10 users [an integer]).

In terms of Bottleneck B describing end user access to the Internet, data displayed in Table 2 show that users with a dial-up modem (either 28.8 or 29 Kbps or 56 Kbps) would not be able to achieve a “good user experience” with any of the three rich media website programs. In order to use any of these programs, the end user would need to have at least a DSL/cable broadband connection.

In terms of Bottleneck C, Table 2 indicates that all Internet activity would be brought to a halt in a company with a single T1 access to the Internet if 17 or more of its employees were to concurrently access any of the rich media websites. Moreover, the same result would be obtained if only 11 employees were to concurrently access the smoking cessation program. Generally speaking, companies are loath to have mission-critical business activity interrupted in this manner.

Table 2. Estimated number of concurrent users accommodated by three behavior change Web-based programs, by type of Internet connection

Type of Internet Access and Related Maximum Download Throughput		Concurrent Users of Rich Media Web-Based Programs		
		Smoking cessation	Caregiver	Eldercare
Connection Type	Kbps	BUI = 144 Kbps	BUI = 95 Kbps	BUI = 93 Kbps
Dial-up	29	0	0	0
Dial-up	56	0	0	0
DSL/cable	384	2	4	4
DSL/cable	768	5	8	8
T1	1544	10	16	16
Home WIFI from cable modem	1972	13	20	21
Home cable modem	3000	20	31	32
T3	44736	310	470	481
Internal network (100-baseT)	100000	694	1052	1075

Finally, considering Bottleneck D, data presented in Table 2 underscore the fact that the remarkable speed of network connections means that this connection would rarely become a bandwidth bottleneck. This conclusion would seem to recommend that rich media programs should be placed on a company server or, alternatively, on a server that is connected inside the company firewall. However, few corporate IT departments wax enthusiastic about outside servers being connected to their networks, and there is also the challenge of outside organizations being able to maintain and update these servers within idiosyncratic IT environments. It is also important to note that Web-based programs are typically developed and then demonstrated using corporate networks that present few bandwidth constraints. Tests on corporate networks can lull the user/client/developer into the mistaken conclusion that the program will give a good user experience when it is delivered over the Internet.

Study 2: BUI Validation Tests

When 5 participants accessed the video-rich version of the smoking cessation program using a maximum download bandwidth of 768 Kbps, all users reported that they had a good experience with the program. The situation changed dramatically when 6 participants concurrently accessed the same program from within the same network environment—in this test case, all users reported that they had an unsatisfactory experience using the website, with reports of long delays in page loading, videos not playing, and so forth. These results confirmed the validity of the threshold numbers described in Table 2. Specifically, using the metrics in Table 2, it is possible to predict the number of concurrent users that will have a satisfactory experience. Exceeding that threshold number completely retrogrades the satisfactory experience for each concurrent user. The effect is not partial but, rather, it leads to a complete inability to access the program.

Study 3: Varying BUI in Three Versions of the Same Web Program

Results of the third study are presented in Table 3. Note that changing a program from video to audio reduced bandwidth requirements by almost 50% (from a BUI of 144 Kbps to 65.9 Kbps), but this bandwidth requirement was still too large to enable an end user to access this audio-rich Web-based content using a dial-up modem. In marked contrast, using the Web-enabled CD-ROM reduced bandwidth requirements dramatically (from a BUI of 144 Kbps to 2.1 Kbps), which would enable a user to easily access rich media content even from a dial-up modem. It is also important to note that even if a Web-enabled CD-ROM were to be used, the hardware and software constraints become increasingly salient when Internet access speeds increase (eg, T3 and faster), thereby enabling more concurrent users to access hosted content. Consider, for example, that Table 3 indicates that by using a T3 access to the Internet and a Web-enabled CD-ROM program format it might be possible to host more than 21000 concurrent users. In such circumstances, greater attention must be afforded to the number and type of server configurations (hardware and software) needed to generate logic, select content, and build dynamic Web pages.

Table 3. Estimated number of concurrent users accommodated by three variants of the same Web-based smoking cessation program, by type of Internet connection

Type of Internet Access and Related Maximum Download Throughput		Concurrent Users of Variants of a Web-Based Smoking Cessation Program		
		Video-Rich	Audio-Rich	Web-Enabled CD-ROM
Connection Type	Kbps	BUI = 144 Kbps	BUI = 65.9 Kbps	BUI = 2.1 Kbps
Dial-up	29	0	0	13
Dial-up	56	0	0	26
DSL/cable	384	2	5	182
DSL/cable	768	5	11	365
T1	1544	10	23	735
Home WIFI from cable modem	1972	13	29	939
Home cable modem*	3000	20	45	1428
T3	44736	311	678	21302
Internal network (100-baseT)	100000	694	1517	47619

* Faster cable modem download speeds up to three times this figure are emerging as providers ease bandwidth restrictions.

Discussion

In this report we have described a series of tests of the bandwidth usage index (BUI) that confirm the value of measuring the actual data throughput associated with delivering Web-based behavior change programs that have varying amounts of rich media. We believe that the BUI or other similar throughput measures can provide designers with important guidance about how much rich media to include in their Web-based programs depending upon the intended audience and the intended number of concurrent users.

Diffusion of Technology Changes

While technology changes at a very rapid rate, it is nonetheless also true that program designers need to take into careful consideration the significant delays associated with the diffusion of these changes to the large installed base of computer users. This challenge is confronted when considering end user software and hardware (eg, types and versions of operating systems, browsers, and browser plug-ins like Macromedia Flash and Adobe Acrobat; typical monitor sizes; and screen resolution settings). It is also highly relevant when considering types of Internet access which, in turn, affect the choice of program ingredients. These considerations may be even more salient when a Web-based intervention is targeted to groups that are not as far ahead as others on the adoption curve—as in the limited broadband penetration in rural [46] and different ethnic and racial communities [47]. Moreover, the adoption rate for broadband Internet access may slow down [21,48].

Tradeoffs to Delivering Digital Content

Delivering digital content is fraught with tradeoffs regarding costs, reach, and scalability. If a Web-based program uses rich media content, then the calculations we describe in this report indicate that the program will not be usable for approximately half of US Internet users who still use dial-up modems. Even if you target a website to users whose broadband Internet access provides them with more than sufficient bandwidth to receive rich media programming, the hosting of that rich media content to thousands of concurrent users has substantial costs associated with using content delivery network solutions (eg, Akamai [49] and Cisco Systems [40]). Commercial websites subsidize such outsourcing by selling paid Web page advertisements—a business model that may not be feasible or even appropriate for many behavior change websites.

Recommendations for Future Research

We recommend that reports of Web-based programs should routinely provide an indicator of bandwidth consumption, like the BUI, in order for readers to evaluate the manner in which such programs can be used. Of course, not all Web-based programs need to be designed for large audiences. But those programs that have widespread use as their goal need to be designed—and then fully tested—in a manner that ensures they can deliver the goods consistent with their intentions.

As we noted in our introduction, we believe that empirical research needs to examine the accuracy of widely held assumptions that video and audio automatically add value to Web-based programs [50,51]. Consider, for example, that intriguing research by Reeves and Nass [33] suggests that the value of the verisimilitude of video presentations may be overstated. Their studies suggest that video is not as critical an ingredient in the design of computer-based programs as is the tone of the communication that can be tailored to fit the user's expectations. Fogg [52] echoes this point in his discussion of the persuasive features of the computer as *social actor*. It is reasonable to expect that many users would not be well served by websites in which they become passive page turners while observing multiple "talking head" presentations [53]. Similarly, behavioral researchers have a very significant opportunity to explore and test how best to use the interactivity and tailoring possibilities of Web-based program delivery (eg, [54]).

Future research should consider developing *leanmedia* websites that use vector-based animated graphics to offer interactivity and graphical content without excessive bandwidth consumption. One vector graphics tool to consider in this regard is Macromedia Flash (for its vector graphics capabilities rather than its video capabilities). Flash uses a client-side browser plug-in that has a very large installed base: version 2.0 is on 98.3% of current computers, whereas the most recent version 7.0 is on 90.0% of current computers [55]. Alternatively, it is possible to use an open source structured vector graphics (SVG) tool rather than the proprietary Flash format, but currently only 13% of users have the SVG browser plug-in on their computers [55]. The acceptability of websites may be compromised when users are required to download and install new or updated versions of browser plug-ins, especially in scenarios in which the download is large and users have limited bandwidth, dial-up Internet access.

Researchers and developers of Web-based behavior change programs should consider using intelligent adaptive designs that “sniff out” user’s bandwidth transparently and then tailor program content according to the bandwidth characteristics of each user’s Internet connection. Using this approach would require program designers to consider how best to deliver equivalent content using different media—a topic with both technical and behavior change complexities that have received little empirical study to date.

Website designers should make greater use of Web-enabled CD-ROMs to deliver rich media to the very large base of Internet users who do not have broadband access. Programs of this type would still use centralized functions of a Web-based program (eg, logic, authentication, and data collection), but they would access rich media located on each user’s computer. In this scenario it should be noted that video and audio would not need to be as compressed as for Web delivery. As a result, rich media components could be longer and larger (eg, larger video image), and their enhanced quality could result in better acceptability and improved impact.

Plans to market a Web-based program need to consider the bandwidth demands that might accompany program recruitment announcements or delivery scenarios that encourage concurrent usage. Consider, for example, the possible stress on a smoking cessation website tied to an event that occurs on a single date (eg, the Great American Smokeout) or when an announcement is issued to all employees of a large corporate client. Similarly, consider the scenario in which scores of users are assembled in community computer centers or corporate training rooms to access rich media Web-based programs. Announcements via mass media, email as well as URL publishing, can generate large demand spikes. Resulting peaks of Internet traffic, especially when programs deliver rich media content, can compromise the functioning of any Web-based program.

Limitations and Strengths of Current Study

There are some noteworthy limitations to the design of the current study. The tests that validated the BUI threshold (number of concurrent users who would have a satisfactory user experience) were not exhaustive. More users could have been included to provide further confidence in the results we report. Nor was it possible for us to qualify the use of BUI by quantifying the peaks and valleys of available bandwidth in different real-world circumstances (eg, phone line degradation [particularly germane of dial-up and DSL users], geographically distributed users, times of day, server and end user hardware/software configurations). It is also important to acknowledge the subjective nature of the “satisfactory user experience” criterion we used. This measure was based upon individual user reactions when accessing program content in a realistic manner. We attempted to operationally define our use cases to be similar to what would typically be experienced by users of these programs.

Our investigation does, however, have a number of strengths. For example, we were able to measure the bandwidth use of a number of Web-based behavior change programs that contained rich media. In addition, we were able to test the impact on bandwidth use of three variations of one of these rich media behavior change programs, which enabled us to recommend the approach of using Web-enabled CD-ROM design to extend the reach of rich media Web programs to the largest possible audience of potential users. Finally, while the BUI is not a precise tool, it nonetheless describes a process that others can replicate in order to evaluate their own Web-based programs. We believe that important implications can be drawn from using the BUI to calculate estimates of the maximum number of concurrent users by Internet access type (Tables 2 and 3).

The Scalability of Behavior Change Websites

Because they attract relatively meager numbers of concurrent users, typical randomized controlled trials of Web-based programs provide an inadequate test of their ability to deliver content in a scalable manner. In some ways, it is as if the airworthiness of a modern airliner is tested with a light load of passengers and fuel in only ideal flying conditions without ever being tested with a full load in windy, stormy conditions. But website scalability is a typical rationale invoked in support of using the Internet as a delivery channel and in justifying the considerable development expenses. We believe it is essential to acknowledge that Web-based programs need to be designed to fit the goals for which they are intended and that their bandwidth requirements need to be considered, measured, and reported in order to gauge how well they will likely operate under their intended use case scenarios.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Calculation of BUI. [PDF file, 80 KB - jmir_v7i4e49_app1.pdf]

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Abbreviations

BUI: bandwidth usage index
Kbps: kilobits per second
NIH: National Institutes of Health
PHP: PHP hypertext preprocessor

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Letter

"Is Cybermedicine Killing You?" - Cochrane Collaboration Needs to Restore Confidence

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Related Article:

Comment on: Eysenbach G, Kummervold PE. "Is Cybermedicine Killing You?" - The Story of a Cochrane Disaster. J Med Internet Res. 2005;7(2) p. e21 http://www.jmir.org/2005/2/e21/

(J Med Internet Res 2005;7(4):e37) doi:10.2196/jmir.7.4.e37

I sat there agog reading your well-written, balanced, restrained, and devastating editorial on the "Cochrane disaster" [1]. I come away with the feeling that something is very wrong at Cochrane, and I'm extremely curious as to what it might be. Cochrane seems like such a good idea — so dignified, honorable, and professional — how could people get so sloppy and cavalier? If their false conclusions were of political value (defending a war, a contract, a questionable appointment) one would feel certain of having come across another outrageous conspiracy. But I can't imagine what cabal would substantially profit from finding that educating patients degrades their medical outcome. Was this just initial negligence, inattention, and then a sudden steamroller effect when a surprising finding reported by a bumbling research assistant seemed so novel and newsworthy that it attracted a misguided enthusiasm and loyalty that blinded all the participants to reality, with a perfunctory referee ritual proving inadequate to catch the errors?

I've been expressing skepticism about evidence-based medical practice at our departmental meetings but was gradually being won over by that approach, but now...whose evidence? Meta-analyzed by whom? I'm not competent to understand meta-analyses and sort of took them on faith. Fie on that.

I thought the editorial was very valuable and had some wise suggestions. I hope it will receive enough attention to lead to real changes in Cochrane procedures and in journals in general. One cannot assume that the chain of failures described in the editorial is unique. Certainly a diligent review of the Cochrane processes followed by appropriate candidly described fixes, perhaps as suggested by the editorial, are called for to restore confidence in what once seemed a reliable source of guidance for evidence-based clinical practice.

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Letter

"Is Cybermedicine Killing You?" - Peer Review and Evidence-Based Medicine

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Related Articles:

Comment on: Eysenbach G, Kummervold PE. "Is Cybermedicine Killing You?" - The Story of a Cochrane Disaster. J Med Internet Res. 2005;7(2) p. e21 http://www.jmir.org/2005/2/e21/

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Comment in: Eysenbach G. "Is Cybermedicine Killing You?" - Peer Review and Evidence-Based Medicine: Author's Reply. J Med Internet Res. 2005;7(2) p. e39 http://www.jmir.org/2005/2/e39/

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A recent JMIR article [1] and corresponding editorial [2] discuss an error in a review by a Cochrane Collaboration Group [3]. The articles accurately demonstrate that an error occurred, with the traditional approach to peer review failing.

A solution to this situation is necessary as similar errors could occur in the future. The Cochrane Collaboration attempts to achieve a higher standard than systematic review articles and meta-analysis articles published in other journals. The Cochrane Library claims it is "the *best* [italics added] single source of reliable evidence about the effects of health care" [4]. Striving for "the best" should include following best practices for peer review.

Rada [1] advocates extending the Cochrane Collaboration's current practice of open commentary to the prepublication phase. Articles could only be published once there has been extensive commenting by any interested individuals and a consensus has been achieved. Although a good suggestion, there are a few concerns. First, how much time would be necessary before a review period would be deemed appropriate and the article is published? Second, it often can be impossible to reach a consensus among all the reviewers, especially if there were a large number of individuals commenting on a particular topic.

Eysenbach and Kummervold [2] recommend making it a requirement to invite all primary authors quoted in the systematic review to comment on the review before publication. This suggestion has a lot of merit as this would guarantee that some of the peer reviewers are not only knowledgeable scientists, but also actual experts in the specific topic reviewed.

I suggest taking this a step further. The current Cochrane Collaboration policy is to have 4 peer reviewers for each manuscript [2]. My suggestion is that 2 peer reviewers should be specifically among those whose primary studies have been quoted. One should be from a positive outcome study and the other from a negative outcome study. This would give fair representation to each side on the topic being reviewed. The 2 other peer reviewers could be knowledgeable scientists who are not quoted in the review. These 2 other peer reviewers would be no different than the current standard for a typical journal article that usually has 2 peer reviewers.

Furthermore, each Cochrane review should state the level of the peer review on the title page. For example, a level "A" review would be a review with 4 peer reviews. There would be 1 reviewer from a positive outcome study quoted in the primary review, 1 reviewer from a negative outcome study quoted in the primary review, and 2 additional reviewers who have not been quoted in the review. A level "B1" review would have 4 peer reviews, similar to level "A," but would have only 1 peer reviewer from a primary positive outcome study review the manuscript. A level "B2" review would have 4 peer reviews, similar to level "A," but would have only 1 peer reviewer from a primary negative outcome study review the manuscript.

Finally, a level "C" review would have 4 peer reviews but would not have any peer reviewers whose studies were quoted in the primary review.

This approach for peer review may prevent future errors from occurring and maintain Cochrane Collaboration articles as the standard for systematic reviews.

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Letter

"Is Cybermedicine Killing You?" - Peer Review and Evidence-Based Medicine: Author's Reply

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Author's Response

Fogel's suggestion of a grading system according to the level of peer review (reminiscent of grading systems for "level of evidence" of primary studies) is interesting, but further study is required to determine to what degree the proposed ratings actually correlate with quality or peer review rigor. My suggestion [1] was to routinely invite all authors of the primary studies to comment on a draft of the systematic review. They actually do not have to peer review the entire paper in the sense of having to write a full referee report, they just should have access to the review before its actual publication to ensure that the authors did not make any major extraction errors (such as in the reported case) or misinterpret any of the original studies (as this would be most easily spotted by the authors of the primary studies). Because authors of systematic reviews often contact the authors of the primary studies anyway (to inquire about nonpublished data or ask other questions), this could be done relatively easily and routinely, in particular, if preprint servers are used, which in other disciplines are common but are underused in medicine.

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Letter

"Is Cybermedicine Killing You?" - A Response From the Authors of the Cochrane Review

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We wish to respond to the paper by Rada [1] and accompanying editorial by Eysenbach and Kummervold [2] in JMIR regarding our Cochrane systematic review on interactive health communication applications (IHCAs) for chronic disease. This systematic review was published in October 2004 in Issue 4 of The Cochrane Library, and we were notified of potential errors in the direction of change for clinical outcomes about 10 days after publication. We immediately reviewed our work and confirmed that errors had been made. We decided that our main responsibility was to limit the harm caused by these errors, by firstly, ensuring that all relevant stakeholders were informed as quickly as possible, and secondly, working toward correcting the errors in a transparent open fashion. Within 48 hours of the first notification, we had informed (a) the editors of the Cochrane Consumers and Communication Review Group, (b) the funders of the work, and (c) the University College London (UCL) press office. For technical reasons, it was not possible to immediately withdraw the review from The Cochrane Library website, so an alert was posted on the review, warning readers that there were errors in the direction of change for some of the behavioral and clinical outcomes and apologizing for the mistake. No one could access the review without seeing this alert. The review was withdrawn in Issue 1 of The Cochrane Library in 2005. We also made every effort to contact journalists who we knew to be writing articles about the original publication, but which had not yet been published. Since then we have continued to work closely with the editorial team of the Cochrane Consumers and Communication Review Group to revise the review. We are grateful for all the help and support we have received in this process.

We hope to be republishing the revised review shortly. The revision will address issues of the review's scope and the pooling of data that were raised by peer reviewers and also by Eysenbach and Kummervold. We have been greatly assisted by comments from external statistical reviewers from the Cochrane Group and from an internal independent statistical advisor, who have reviewed our methodology. We anticipate and welcome a lively and ongoing debate on these methodological issues.

In the meantime, we would like to correct three factual inaccuracies in Rada's paper. While Rada states that "the coauthors Nazareth and Tai [are] credited with doing the coding," we should clarify that Nazareth was not responsible for coding the data and is not credited with this in the review. Secondly, Rada writes that the "UCL...news bulletin...remained [on the website]." We should point out that the UCL press release, while still available on the UCL website, is clearly linked to the retraction and subsequent press release summarizing the errors and steps taken to rectify the errors. Thirdly, the UCL press release did define interactive health communication applications, although Rada said it did not.

We agree that the press coverage of the original report was not matched by coverage of the retraction, and we concur that this was unfortunate. However, the Cochrane Collaboration made two press releases advising all media outlets of the errors in October and December 2004.

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Letter

"Is Cybermedicine Killing You?" - A Response From the Authors of the Cochrane Review: Author's Reply (1)

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Author's Response

Murray et al's letter to the editor says that my paper [1] contains three factual inaccuracies. The first is that Nazareth was not responsible for coding the data and is not credited with this in the review. In fact, the list of contributions in the review did not explicitly use the term "coding," but it credits Tai with "designed analytical strategy, extracted and synthesised data...," and Nazareth with "designed review and analytical strategy, interpreted data..." from which I concluded that both Nazareth and Tai were jointly responsible for coding. I appreciate the clarification of Murray and colleagues. Secondly, my statement that the "UCL...news bulletin...remained there" was not meant to imply that it remained there devoid of a retraction statement. In fact, I did write that "the original press releases [are] now marked with 'retraction.'" Regarding the third issue, I acknowledge that this has been an oversight on my part. I apologize for interpreting incorrectly for item 1, communicating ambiguously for item 2, and being factually wrong for item 3.

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Letter

"Is Cybermedicine Killing You?" - A Response From the Authors of the Cochrane Review: Author's Reply (2)

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Related Articles:

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Author's Response

We thank Murray and colleagues for adding their view to the "series of unfortunate events" outlined in the editorial [1] and in Rada's paper [2]. The editorial accurately describes the swift response of the authors in retracting the review within 13 days — unfortunately, at this time the cat was already out of the bag, and the media coverage had been substantial. We still think that, in order to reach Murray's aim of "ensuring that all relevant stakeholders were informed as quickly as possible" [3], it may not have been enough to "contact journalists who we knew to be writing articles about the original publication, but which had not yet been published," but also to contact those journalists who had already published stories, asking them to print corrections. We realize that this is — psychologically and practically — a difficult thing to do; however, it would have been the only way to ensure that the press coverage of the retraction matched the original coverage, which Murray and colleagues agree would have been better. The inaccuracies regarding the press release in the Rada paper are this author's responsibility and did not occur in the editorial. In fact, the complete University College London press release was published as a Multimedia Appendix to the editorial, including the retraction notice. While it is true that the press release mentions an interactive health communication application definition (which the editorial does not dispute), it is also a fact that this appears toward the end of the press release and was picked up by few journalists because the "Internet" is emphasized in the first paragraphs of the press release. This may have contributed to the confusion about the scope of the review.

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Letter

"Is Cybermedicine Killing You?" - University College London (UCL) Media Strategy Explained

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Eysenbach and Kummervold [1] and Rada [2] criticize the handling of the Cochrane review retraction from a media perspective, and I wish to provide the following additional clarification of the actions of the UCL media relations office in this instance.

Had the withdrawal of the review been a permanent retraction with no further action to be taken by the authors or journal, the UCL media relations office would have issued a statement to this effect at the time via our media mailing lists.

Given that the review was withdrawn with a view to revision and republication at the earliest opportunity and not to permanent retraction, we decided to issue an updated press release once that process was complete. The release will both explain the error and provide the correct interpretation of the review, which will enable journalists to compare the original and revised papers and report on both the errors and the new, correct findings of the review. The release, anticipated later this year, will be sent to all journalists and websites which received the original October 2004 release.

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Letter

"Is Cybermedicine Killing You?" — University College London (UCL) Media Strategy Explained: Author's Reply

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Author's Response

The UCL media strategy as described in the letter of Fourniol has been understood by us and has been accurately described in our editorial [1]. In fact, it is exactly this strategy which has been criticized as insufficient (some may say even unethical). It would have been more in the public's interest to immediately and unambiguously disseminate the fact that these major errors and misinformation occurred (and their magnitude), rather than waiting many months for the revision to be published. The strategy of the UCL media office is akin to a car manufacturer not recalling a faulty vehicle immediately after errors become apparent, but waiting first for a new model to be developed before starting a campaign to exchange the flawed model.

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Letter

"Is Cybermedicine Killing You?" - Codes of Ethics for Journalists

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As a medical journalist, as well as a public health/media researcher, I was intrigued by your recent articles [1,2] on the Cochrane debacle. Specifically, I am writing to complement the information in your article regarding retractions. You highlight a central but tricky part of the media-research universe. One of the articles mentioned in the editorial by Eysenbach and Kummervold was written by the extremely respected Swedish medical writer Inger Atterstam and was published in the conservative Stockholm daily Svenska Dagbladet on October 18, 2004. There was, however, a retraction of this article published on December 9, 2004, headlined "Researchers Retract Overview."

Your thesis still stands of course. The retraction article was smaller and less prominently placed than the original. Indeed, as you point out, most media did not publish any retraction at all.

The policy implications are important, though controversial. They relate to the larger issue of to what extent laws, formal or informal guidelines, or rules of thumb — implemented with due regard for the freedom of the press — can ameliorate the quality of reporting in general, and health reporting in particular.

In Sweden, media are, in practice, bound by a Code of Ethics for Press, Radio, and Television within a system of self-regulation involving four stakeholders, stipulating that media should "be generous with corrections...where relevant and to publish these...in suitable form and without delay...in such a way that they may reach the receivers of the original information" [3]. While this of course does not guarantee that retractions are given equal column space or airtime as the original news story, as the JMIR editorial suggests, it does demand that a correction be published.

One item in the recently published "A Statement of Principles for Health Care Journalists" by the Association of Health Care Journalists (AHCJ) in the United States addresses a related situation. It reads: "Consider public interest the primary criterion when choosing which stories to report. Follow up on those stories that serve a wider public interest. In particular, follow-up stories on subsequent failures, negative findings, or other reversals of fortune for investigational drugs, devices, or procedures should receive coverage comparable to that given initial positive reports" [4].

The Cochrane eHealth case highlights just one of many media inadequacies. In the interests of improved and more responsible journalism, not least in the health field, and with due respect for freedom of the press, there is a strong case to be made for bringing stronger pressure to bear on the media. Media representatives need to be more self-reflective about how their institutions mal/function, media research must become more interdisciplinary, and the media need to be held more accountable by the community.

However, when respected researchers, scientific organizations, or agencies themselves disagree on an issue or — as in this case — make mistakes, it is a tall order to expect health journalists to be wiser. Fortunately, nevertheless, health reporters do, not infrequently, manage to "expose fact, fiction, and fraud" [5].

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