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Editorial

SARS and Population Health Technology

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Abstract

The recent global outbreak of SARS (severe acute respiratory syndrome) provides an opportunity to study the use and impact of public health informatics and population health technology to detect and fight a global epidemic. Population health technology is the umbrella term for technology applications that have a population focus and the potential to improve public health. This includes the Internet, but also other technologies such as wireless devices, mobile phones, smart appliances, or smart homes. In the context of an outbreak or bioterrorism attack, such technologies may help to gather intelligence and detect diseases early, and communicate and exchange information electronically worldwide. Some of the technologies brought forward during the SARS epidemic may have been primarily motivated by marketing efforts, or were more directed towards reassuring people that "something is being done," ie, fighting an "epidemic of fear." To understand "fear epidemiology" is important because early warning systems monitoring data from a large number of people may not be able to discriminate between a biological epidemic and an epidemic of fear. The need for critical evaluation of all of these technologies is stressed.

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KEYWORDS

Severe acute respiratory syndrome; communicable diseases, emerging; epidemiology; Internet; public health; information dissemination, Internet; computer communication networks; bioterrorism

Introduction

Severe acute respiratory syndrome (SARS) hit the world on November 16, 2002, when the first cases of atypical pneumonia appeared in the Guangdong Province, south China. The disease quickly spread to Vietnam and Hong Kong, and from there made its way around the globe. The western hemisphere was not spared: about 37 people have died in Canada as of June 30, 2003, all in the Toronto area, and Canada remains the only region outside of Asia with deaths from SARS.

With SARS, countless media reports and company press releases promoting information and communication technology (ICT) solutions appeared (Textbox 1). Some technology firms attempted to turn lemons into lemonade by using the crisis to bring their ICT products and services into the media and to public attention. As the number of new SARS cases declines and the dust settles, it is time to ask critical questions, including which of these tools and technologies have proven useful or should be further developed and evaluated in order to be prepared for the next public health emergency.

Role of information technology during the SARS epidemic

The public health and infectious disease research community widely praised the role of ICT in early detection as well as in fostering global collaboration and information exchange during the SARS epidemic. On March 17, 2003, WHO called upon 11 laboratories in 9 countries to join a collaborative multi-center research project on SARS diagnosis. The network took advantage of e-mail and a secure WHO Web site to share outcomes of investigations of clinical samples, electron-microscope pictures of viruses, sequences of genetic material for virus identification and characterization, and postmortem tissues from SARS cases in real time [1]. Individual departments of affected hospitals also used Web sites and e-mail to rapidly disseminate clinical findings to health professionals [2]. "This is a form of early warning and communication that would not have been possible if the SARS Virus had appeared ten years ago," notes Dr. Kimball of the APEC Emerging Infections Network [3], and Julie Gerberding, director of the

US Centers for Disease Control and Prevention, writes in an editorial in the New England Journal of Medicine that "use of the Internet has sped information exchange and helped overcome the problems presented by asynchrony in the activities of investigators in many time zones" [4].

Journal editors celebrated themselves and the Internet for being able to publish articles about SARS at the speed of electrons [5]. However, the role of journals — even if with electronic preprint versions and fast track peer-review — dwarfs compared with the role of the Internet in information dissemination of SARS. As of June 30, 2003, PubMed lists 881 articles containing the search words ["severe acute respiratory syndrome" OR SARS]. In contrast, Google finds 358000 pages with the phrase "severe acute respiratory syndrome" (not counting non-English pages or pages which contain only the abbreviations SARS or SRAS for "syndrome respiratoire aigu sévère").

The World Health Organization (WHO) also praised the role of GPHIN (Global Public Health Intelligence Network) for early detection of SARS, claiming that "GPHIN provided some of the earliest alerts to the November outbreak in China" [6]. GPHIN is part of WHOs Global Outbreak Alert and Response Network [7]; it was developed and is operated by Health Canada's Centre for Emergency Preparedness and Response. It is essentially an Internet crawler specialized in detecting news articles indicating unusual events relevant to public health: GPHIN continually scans more than 400 international sources for news of any outbreaks of 31 communicable diseases, as well as articles about natural disasters and drug-resistant pathogens, rather than relying on "official" reports from government sources (which may be reluctant to report disease outbreaks to avoid economic disruptions). The approach is obviously insufficient when disease outbreaks occur in developing countries where little information finds its way into news media and the Internet, or in countries where the media a controlled by the government. GPHIN seems to be stretched to its limits (when the author requested access to the system the reply was "we have now reached our limit on the number of users that can have access to the system"). GPHIN is currently being upgraded to include more languages, including Chinese (which during the SARS crisis was not yet implemented).

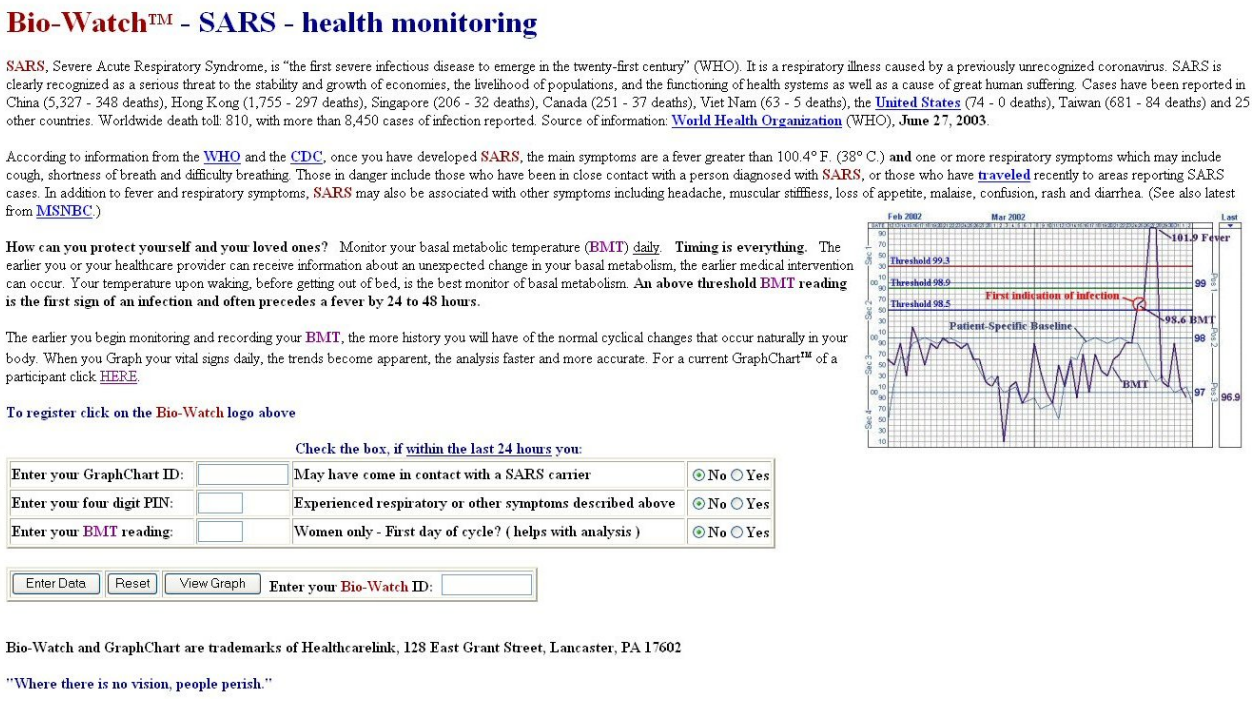
Population Health Technology

eHealth, consumer health informatics, and public health informatics are emerging fields that have a clear public health aspect, in that they include technologies that can be used to improve the health of entire populations, not just individuals. *Population health technology* is a recent umbrella term subsuming applications of technologies such as the Internet, wireless devices, mobile phones, smart appliances, or smart homes (domotics) that have a population focus and the potential to improve public health. In principle, all sorts of home-monitoring devices, from digital fever thermometers to asthma-monitoring devices, could be modified to function as early detection systems, ie, to transmit data — wirelessly or through the Internet — to central data-mining facilities, which may detect emerging patterns indicating disease outbreaks. Among the challenges of all of these systems are ethical and privacy concerns — it is a difficult balance between gathering data from thousands of people with being able to track down infected individuals on the one hand, and protecting the privacy of people on the other hand. Hospitals and pharmacies of tomorrow may also feed data into such central data-mining systems. In addition, there may be a role for detecting patterns of information and communication flows on the Internet. At the Centre for Global eHealth Innovation we have been experimenting with monitoring search requests people enter into search engines, to evaluate whether it is possible to detect increases or changes in health-related requests using automatic methods [8]. The sensitivity of such methods for detecting disease outbreaks or bioterrorism attacks remains to be evaluated — in our search term experiment it did not seem to be sensitive enough in the case of SARS.

Textbox 1. Examples for eHealth solutions offered during the SARS crisis

- Healthcarelink (http://www.healthcarelink.md) has developed a monitoring program that claims to detect severe acute respiratory syndrome before symptoms occur and which — by aggregating data from a large number of patients — also promises to detect bioterror outbreaks. Patients take their temperature daily in the morning and report the results by phone, fax, or Internet. The company publishes the graphs on the Internet for patients and physicians to review. The data, along with information on a person's travel history, can alert health workers to potential SARS patients and bioterrorist attacks (Figure 1). One of the open questions is, of course, how to motivate a large number of people to measure their temperature daily and to voluntarily enter this information into a Web form.
- A very similar approach is behind the idea of Swedish company MedDay (http://www.medday.com), which proposes that people enter symptoms into PDAs or smart phones, which would wirelessly transmit the information to a health or infectious-disease center, which could aggregate and monitor these data. The company claims that the system can be used as an early warning system for a nationwide outbreak of infectious diseases, chemical attack, or other disease. The company is surfing the bioterrorism wave as it simply rebranded its PharmaPoint software, originally developed for remote patient monitoring by physicians, into RegPoint, hoping that it will be used by governments to keep track of the health of populations. There are open questions about the sensitivity of the system to detect outbreaks against a "background noise" as well as about privacy issues.
- Sunday Communications, a Hong Kong mobile phone operator, launched a mobile phone service that promised to alert subscribers if they are near infected buildings. Those opting for the service had their phones tracked, and would be warned by SMS (short message service) whenever they strayed within a kilometer of a building where there had been instances of SARS infections. It is unknown whether this system prevented a single new SARS case (Figure 2).
- In Singapore, health officials tested electronic tracking systems that monitor the movements of every person who enters a public hospital. Staff and visitors wear credit card-sized RFID (radio frequency identification) tags around their neck to communicate their location to sensors hidden in the hospital ceilings, thereby enabling officials to track all encounters with other persons. Hospitals will save movement records for 20 days — twice the incubation period for SARS. If one person turns out to be infected, the database allows rapid identification of all encounters — health officials say it is 10 times faster than traditional methods of asking infected people whom they had contact with.

Figure 1. Healthcarelink



Bio-Watch™ - SARS - health monitoring

SARS, Severe Acute Respiratory Syndrome, is "the first severe infectious disease to emerge in the twenty-first century" (WHO). It is a respiratory illness caused by a previously unrecognized coronavirus. SARS is clearly recognized as a serious threat to the stability and growth of economies, the livelihood of populations, and the functioning of health systems as well as a cause of great human suffering. Cases have been reported in China (5,327 - 348 deaths), Hong Kong (1,755 - 297 deaths), Singapore (206 - 32 deaths), Canada (251 - 37 deaths), Viet Nam (63 - 5 deaths), the United States (74 - 0 deaths), Taiwan (681 - 84 deaths) and 25 other countries. Worldwide death toll: 810, with more than 8,450 cases of infection reported. Source of information: World Health Organization (WHO), **June 27, 2003**.

According to information from the WHO and the CDC, once you have developed SARS, the main symptoms are a fever greater than 100.4° F. (38° C.) **and** one or more respiratory symptoms which may include cough, shortness of breath and difficulty breathing. Those in danger include those who have been in close contact with a person diagnosed with SARS, or those who have traveled recently to areas reporting SARS cases. In addition to fever and respiratory symptoms, SARS may also be associated with other symptoms including headache, muscular stifffiess, loss of appetite, malaise, confusion, rash and diarrhea. (See also latest from MSNBC.)

How can you protect yourself and your loved ones? Monitor your basal metabolic temperature (BMT) daily. **Timing is everything.** The earlier you or your healthcare provider can receive information about an unexpected change in your basal metabolism, the earlier medical intervention can occur. Your temperature upon waking, before getting out of bed, is the best monitor of basal metabolism. **An above threshold BMT reading is the first sign of an infection and often precedes a fever by 24 to 48 hours.**

The earlier you begin monitoring and recording your BMT, the more history you will have of the normal cyclical changes that occur naturally in your body. When you Graph your vital signs daily, the trends become apparent, the analysis faster and more accurate. For a current GraphChart™ of a participant click HERE.

To register click on the Bio-Watch logo above

Check the box, if within the last 24 hours you:

Enter your GraphChart ID:		May have come in contact with a SARS carrier	◉ No ○ Yes
Enter your four digit PIN:		Experienced respiratory or other symptoms described above	◉ No ○ Yes
Enter your BMT reading:		Women only - First day of cycle? (helps with analysis)	◉ No ○ Yes

Enter Data | Reset | View Graph **Enter your Bio-Watch ID:**

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"Where there is no vision, people perish."

Figure 2. Advertisements of Sunday Communications in Hong Kong

Information Technology and the Epidemiology of Fear

In the last week of June, Ontario presented Ottawa with a breakdown of $945 million (Canadian) in SARS-related costs. Those include $395 million for hospitals and health-care institutions for extra staff expenses, protective gear, clinics, and isolation rooms. Another $330 million went to replace lost wages for quarantined health-care workers. Even more serious may be the consequences of the SARS-related "epidemic of fear" [9]. Millions of dollars were lost due to missed business — tourists and business travelers staying away from the hot spots. Worse, as in this particular incident hospitals were the hubs of the outbreaks, patients postponed or delayed important hospital visits. It is difficult to estimate how many patients have been harmed by avoiding hospitals — at least outside of China these may be more than those actually killed by the disease. Kelly MacDonald, a University of Toronto infectious-disease expert, estimates that four times as many Ontarians will die from lack of medical attention caused by the SARS outbreak as will die from the disease itself [10]. To understand the epidemiology of fear in the context of population health technology is important for at least two reasons.

First, some ICT applications that have been advocated sometimes played a role as a psychological "duct tape of the war against fear." Indeed, Bruce Hicks, group managing director of Sunday Communications, the operator that launched the mobile phone service that alerts subscribers when they are near

infected buildings (see above), was quoted as describing his service with these words: "With the dial of a few digits, subscribers can quickly get the peace of mind they need to go about their everyday lives." — speaking to the fact that it is not primarily the spread of SARS but the fear that is addressed by this service. Thermal-imaging scanners set up at airports to screen travelers for signs of SARS may have had a similar role: to assure people that "something is being done," and to prevent economic damages. In fact, there is limited evidence on the sensitivity and specificity of this technology to identify passengers with fever. Information and communication technology can also help to keep the health care system accessible in cases of disease (or fear) outbreaks. For example, Singapore General Hospital, introduced during the SARS crisis an online physiotherapy program allowing physical therapists to remotely monitor patients in their homes. Using a webcam, patients can communicate with their therapists, who can in turn show their patients new exercises and give them feedback on their progress [11].

The second reason why we need to understand the epidemiology of fear in the context of population health technology is that some technologies used as early warning system may not be able to discriminate between a true biological epidemic and an epidemic of fear. This is especially true for systems relying on users entering symptoms, systems designed to detect changes in patterns of health care utilization or other databases, or systems analyzing information and communication patterns on the Internet or in news media. Such early-warning systems may pick up changes in collective behavior triggered by a mere epidemic of fear. For example, thousands of New Yorkers buying duct tape did not indicate a bioterrorism attack, but a fear epidemic. Similarly, runs on doctors or pharmacies may either indicate mass hysteria (a highly-prevalent phenomenon in our society), or a bioterrorism attack (a far less prevalent event). The predictive value of such early warning systems is thus inherently low. False positive warnings lead to media reports, and lead to further changes in the public's behavior — a potentially-devastating positive-feedback loop.

Conclusions

The recent SARS outbreak provides an opportunity to analyze and study the use of population health technology, and to learn lessons for future public health emergencies, including acts of bioterrorism. Most importantly, it should be a stimulus to critically evaluate these technologies and to provide directions for further research and development. Population health technology clearly has a vast potential to increase our preparedness for the next public-health emergency, but it also raises many questions related to ethics, libertarian values, and privacy, and has the potential to fuel an epidemic of fear and collective mass hysteria.

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Viewpoint

Internet-based Patient Self-care: The Next Generation of Health Care Delivery

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Abstract

The United States health care system is an outdated model in need of fundamental change. As part of this change, the system must explore and take advantage of the potential benefits of the "e-revolution," a phenomenon that includes everyday use of the Internet by the general public. During 2002, an estimated 100 million Americans will have obtained information — including health information — from the Web as a basis for making decisions. The Internet is thus an influential force; and, as such, this medium could have a revolutionary role in retooling the trillion-dollar United States health care industry to improve patient self-management, patient satisfaction, and health outcomes. As a group, physicians use the Internet more than do many other sectors of the general adult population. However, physicians have not received sufficient information to convince them that they can provide higher-quality care by using the Internet; indeed, few studies have assessed the Internet's value for improving patients' medical self-management and health behavior, as well as their clinical outcomes and relationships with health care practitioners. New e-technology formats introduced to the growing consumer movement will drive the next generation of self-care by allowing patients to manage their own health conveniently and proficiently.

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KEYWORDS

Consumer participation; Internet; medical informatics; patient education; physician-patient relations; self care; technology; disease management; computers

Introduction

The landmark Institute of Medicine report, "Crossing the quality chasm: a new health care system for the 21st century" [1], depicts an outdated model of health care that hosts worsening chronic medical conditions, skyrocketing health care expenditures, and failure to effectively transform technical innovation into improved health outcomes. The Internet may have a revolutionary role in retooling the trillion-dollar health care industry in the United States.

Indeed, by introducing new e-technology formats to the growing consumer movement, the online revolution may become the engine driving the next generation of self-care, thereby allowing patients to manage their own health conveniently and proficiently. Although the Internet's power to positively affect care management seems an intuitive concept, the Internet's value for improving health outcomes must be examined and documented to provide a basis for further advancement.

The Online Revolution

Public use of the Internet as a health care tool has grown dramatically in the past few years, and this trend is expected to continue. During 2002, more than 100 million Americans will have searched online for information, including health information — an increase of 13 million from the previous year [2]. Obtaining information from the Web is often the basis for making health decisions and is thus an influential force. Of persons surveyed in 2000 by the Pew Internet & American Life Project, 41% said that the Internet affected their decisions about going to a doctor, treating an illness, or questioning their doctor [3].

This online phenomenon is occurring while a huge population segment, the postwar "baby boomers," is moving like a tsunami through the American health care system. Thanks to modern medicine, these adults will live longer than earlier generations ever could — and will flood the health care system with chronic ailments. Moreover, in addition to making health care decisions for themselves, this population is making such decisions for their elderly parents, many of whom have multiple chronic diseases. Baby boomers are demanding the same easy access to advanced health care technology as is currently available to them when they do their banking or plan a vacation. We have arrived at the era of the "impatient patient." Patients demand immediate, convenient access to a high level of personalized health care: they want it their way, and they want it now.

Effect of e-Technology on the Patient-Physician Relationship

Can the Internet empower patients? Can it enrich the patient-physician relationship? Breast cancer patients in an online education and support group had increased confidence in their physicians, as well as increased competence to deal with relevant, disease-related information. These patients were also more comfortable seeking information during a physician office visit and were more comfortable participating in their own care [4]. This study alone is minimal evidence to support changes in the patient-physician relationship and more research is needed.

A Harris Online poll found that patients who use the Internet to look for health information are more likely to ask more specific and informed questions of their doctors and to comply with prescribed treatment plans [5]. This was a survey and not a formal study. Further research is necessary to understand what effect the Internet age has on the patient-physician relationship. For example, are patients more compliant with prescribed therapy because they discussed it more with their physician or because they read it on the Web?

The "school of lay medicine" found on the Internet offers an important opportunity for patients to become actively engaged in their own care. During the pre-Internet era, medical information was published in medical textbooks and journals only, whereas patients can now gain access to citations of more than 12 million medical articles online [6]. Indeed, many patients are now helping to inform their physicians on the latest research and treatments.

Physicians Gerber and Eiser [7] postulate that the Internet age offers opportunities to improve the patient-physician relationship by sharing the burden of responsibility for knowledge. They also underline the necessity for research to identify the effects on the patient-physician relationship, as well as the effects on patient and physician satisfaction and on health outcomes.

The locus of power in health care also is shifting: instead of the doctor acting as sole manager of patient care (ie, "the captain of the ship"), a consumerist model has emerged in which patients and their doctors are partners in managing the patient's care [8]. On the other hand, there are many patients who do not wish to be the captain of the ship. Research needs to address how the Internet would affect these individuals.

Patient Self-management Using e-Monitoring

Several monitoring devices using the Internet have been developed to help patients manage their medical conditions at home. For example, diabetic patients can test their blood glucose level by using an e-device, which with the click of a computer mouse downloads the result to a health care practitioner. Patients with heart failure can step on an e-scale, which sends instantaneous alerts to health care professionals when the patient's weight exceeds the desired range. An e-shirt can be worn which transmits heart rate and respiratory rate over the Internet. A pill-sized camera can be swallowed which transmits pictures of the digestive tract over the Internet. Research is needed regarding health outcomes, cost effectiveness, as well as the long-term acceptance of these devices by patients.

The federal government has invested $28 million to evaluate home glucose monitoring via the Internet to homes of underserved rural and inner-city residents in New York State. The largest eHealth grant ever funded by the government, this study will serve as an important test case for the possibility of e-technology to improve health outcomes [9].

E-connecting to Others Who Have the Same Medical Condition

Online support groups exist for almost every disease and condition, and discussion topics within each disease category are limitless. For example, diabetic patients who enjoy scuba diving can learn from fellow diabetic scuba divers how to cope with diabetes 50 feet (15.2 meters) below the water's surface. But just as important as the information exchanged in these e-discussions is the emotional support they provide. For each e-patient seeking a listening "ear," dozens of other patients offer encouragement. In turn, these words of solace are read by hundreds (and sometimes thousands) of other patients who read Internet message boards. This support may be recorded for future reference of patients, clinicians, or health care planners.

Effect of e-Technology on Health Care Outcomes

Although online intervention may empower patients and may positively affect the patient-physician relationship, a realistic observation is that the Internet will be widely adopted as a part of usual care only if this venue improves patient self-management, betters patient satisfaction, and enhances health outcomes. To determine the success of Internet-based health care, rigorous outcome studies are needed.

A study by McKay et al [10] found that patients who participated in an online diabetes education and support group lowered their blood glucose levels more than controls did. Studies of online support groups for cystic fibrosis patients [11], amyotrophic lateral sclerosis (ALS) patients [12], and single mothers [13]

also showed that participants in these online support groups gained satisfaction and confidence in managing their medical condition.

There are limitations to the few studies that have been done. For example, the above study by McKay et al used a small sample, only had short-term follow-up, and there were no solid clinical-outcomes measures. Further research is needed utilizing larger samples over longer periods, controlled and randomized, in tandem with significant outcomes to support policy changes and buy-in efforts for implementation.

The Achilles' Heel of the Online Revolution

Until recently, the powerful phenomenon of online health care has been largely overlooked by the health care system. Most institutions funding medical research, health policymakers, and health care professionals have ignored both the "e-revolution" and the fact that it is consumer driven. Although the Internet has intuitive potential for improving patient-physician relationships and communication, patient self-management, and health outcomes, outcome research exists for only a few studies and cannot be applied widely because of the studies' limitations.

As a group, physicians themselves have constituted a major source of resistance to online health care. An article, "Why doctors hate the Net" [14], identified 3 specific concerns of physicians:

- E-mail from patients further burdens overflowing physician schedules
- During an already-crowded office visit schedule, e-savvy patients armed with printouts from the Internet waste precious time discussing information from unknown or otherwise-dubious sources
- Much health-related information posted on the Internet is unreliable.

More than a century ago, a similar backlash in health care accompanied introduction of another technology: the telephone. Soon after invention of the telephone by Alexander Graham Bell, much cultural opposition to it was generated by physicians who doubted that the telephone could add value to medical practice. These physicians complained that answering calls would diminish the time available for in-person interaction with patients. Other physicians questioned whether patients would be willing to use the new technology. Some physicians worried that the telephone might destroy the patient-physician relationship [15].

As they did with the telephone, however, physicians are becoming less resistant to using the Internet for delivering patient care. Recent estimates of Internet-equipped physicians vary, but these reports agree that physician adoption of the Internet is increasing noticeably [16], and most agree that physicians (a group sometimes thought technophobic) use the Internet more than do many other sectors of the general adult population [17]. However, physicians have not received information sufficient to convince them that the Internet can help them provide higher-quality care: although 55% of physicians surveyed use e-mail to communicate with professional colleagues, only 13% stated a willingness to send e-mail to patients [18]. In contrast to this finding, 90% of patients surveyed wished to communicate with their physicians by e-mail [19].

In their article "We got mail," Moyer et al [20] highlight issues such as inequity of e-mail access, workload, medical-legal concerns, as well as privacy and confidentiality. Research is necessary to address these issues. Does e-mail from patients really burden a physician's schedule? If so, will triaging by others help? What effect does e-communication have on the patient-physician relationship? Can e-mail reminders from a "virtual case manager" improve health outcomes? Can providers be held liable if an unauthorized third party accesses confidential medical information sent by e-mail? Is e-mail cost-effective?

Access Gaps

Another obstacle to widely implementing online forms of health intervention is the assumption that lack of necessary technology by many senior, minority, and lower-income patients will exclude them from this intervention. While access to the Internet is less common in these groups, studies show that the "digital divide" is narrowing.

From August 2000 through July 2001, the number of African Americans using the Internet grew nearly 20% [21]. The proportion of wired African Americans (43%), nonetheless, remains low in comparison with the average of online Americans (58%) [21]. Internet access among Hispanics in the United States increased by 25% from March 2000 through February 2001, indicating that more than half of that population is now online [22]. Like African Americans, however, Hispanics have less access to cyberspace than their Caucasian counterparts. In contrast, Asian Americans use the Internet more than other group: more than 75% of that population has access to the Internet [23].

Economics play a part in access. Studies show that lower-income people are less likely to be wired: 37% of those who are not wired have family incomes under $30000, whereas only 18% of those with Internet access have incomes under $30000 [24]. Poor reading skills add even more barriers to those economically disadvantaged for accessing the world of the Web.

The senior population has been slower than other age groups in embracing the Internet but this is changing. A Pew report [25] predicts that with many baby boomers approaching retirement age, seniors' use of the Internet will increase dramatically. The health care industry must be prepared to accommodate this growing segment of the population, many of whom will become homebound but will still need services, training, and reinforcement of medical self-management, as well as continued connection to clinicians and contact with other patients.

While eHealth technologies have the potential to reduce disparities in health care by promoting health and preventing disease, traditionally underserved groups who could benefit the most from eHealth initiatives, are the least likely to have access to such technologies. Although seniors and many minority

groups are the fastest-growing segments of new Internet users [22,23,25], we need to better understand access barriers. Furthermore, Eng et al [26] raise important points regarding access issues for those who cannot read at all, those who cannot read English, and those with disabilities.

Time to " `Byte' the Bullet"

The eHealth care train has not only left the station but is rapidly moving down the track carrying tens of millions of e-patients and many possibilities for transforming patient self-management, improving health outcomes, and enhancing the patient-clinician relationship. Because of substantial opposition to the online revolution, however, the "e-train" has so far evaded the transcontinental health care network.

Fundamental change is needed in our outmoded, Internet-averse system of health care, which still prevails in the United States. The United States health care system must embrace the e-revolution by exploring and taking advantage of the potential benefits of this revolution for improving quality of care. To pursue this goal, rigorous research must explore ways to use e-technology for improving patients' medical self-management, health-related behavior, health outcomes, and relationships with health care practitioners.

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Conflicts of Interest

None declared.

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Original Paper

Development and Evaluation of the Virtual Pathology Slide: A New Tool in Telepathology

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Abstract

Background: The Virtual Pathology Slide is an interactive microscope emulator that presents, via the Internet or CD-ROM, a complete 15.53 mm x 11.61 mm digitalized tissue section. The Virtual Pathology Slide mimics the use of a microscope in both the stepwise increase in magnification (from 16x up to 2000x) and in lateral motion in the X and Y Cartesian directions. This permits a pathologist to navigate to any area on a slide, at any magnification, similar to a conventional microscope.

Objective: The aim of this study was to assess the diagnostic accuracy and acceptability of the Virtual Pathology Slide.

Methods: Ten breast needle core biopsies were randomly selected and presented to 17 pathologists or trainee pathologists with at least 2 years experience in pathology practice. Participants were required to examine each case online and provide a diagnostic classification using online feedback forms. The recorded data permitted examination of interobserver variability and user satisfaction.

Results: Agreement between original glass-slide diagnosis and consensus diagnosis using the Virtual Pathology Slide was reached in 9 out of 10 slides. Percentage concordance for slides lay in the range of 35.3% to 100% with an average percentage concordance between slides of 66.5%. The average Kappa statistics for interobserver agreement was 0.75 while average percentage concordance amongst participants was 66.5%. Participants looked at an average of 22 fields of view while examining each slide. Confidence: 81.25% of the participants indicated confidence using the Virtual Pathology Slide to make a diagnostic decision, with 56.25% describing themselves as "reasonably confident," 18.75% as "confident," and 6.25% as "very confident." Ease of use: 68.75% reported the system as "easy" or "very easy" to use. Satisfaction: 87.5% of participants expressed satisfaction with image quality, with 43.75% describing the image quality as "adequate," 25% describing it as "good," and 18.75% describing the image quality as "excellent." Pathologists with a working bandwidth greater than 20 kilobits per second found the download speed of the Virtual Pathology Slide "adequate" or better.

Conclusions: Results from this study show that the Virtual Pathology Slide can be used to make a correct diagnostic decision, and that the system is a realistic alternative to dynamic telepathology.

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KEYWORDS

Telepathology; Internet; telemicroscopy; remote diagnosis; virtual slide; pathology; imaging

Introduction

Definition of Telepathology

Telepathology is the practice of diagnostic pathology by a remote pathologist utilizing images of tissue specimens transmitted over a telecommunications network [1,2]. Traditionally telepathology systems are defined as either dynamic or static. Dynamic systems allow a telepathologist to view images transmitted in real time from a remote robotic microscope that permits complete control of the field of view and magnification [3]. Static (or store-and-forward) telepathology involves the capture and storage of images followed by transmission over the Internet via e-mail attachment, file transfer protocol, or a Web page, or distribution via CD-ROM. Dynamic hybrids also exist, which incorporate aspects of both technologies [3].

Applications of Telepathology

The diversity in telepathology systems reflects growing technological expertise in this area and the increasing importance of telepathology in education, training, quality assurance, and teleconsultation [4- 9]. Numerous pathology archives abound on the Internet providing links to both educational and commercial telepathology websites. These offer access to either static or dynamic image delivery systems [7-19].

Limitations of Telepathology

Image quality and the ability to make diagnostic decisions from electronically-compressed images is a contentious issue [3,19-20]. In order for telepathology to be of clinical use, studies have attempted to access the diagnostic accuracy of store-and-forward telepathology, and have shown accuracy in the range of 77% to 100% [3,20- 28]. The diverse nature of this technology makes it difficult to draw comparisons between studies, or to form a consensus on a method of best practice. There is no universally-accepted standardization in hardware, software, image resolution, color-depth, or image compression and storage [3]. However, studies have shown that the use of images with as low a resolution as 1024 pixels x 768 pixels resolution x 24-bit color does not impair diagnostic performance [3,20,27-29]. To contend with such nonstandardization, guidelines have been formulated for the capture and treatment of diagnostic images and for the practice of telepathology [30- 31].

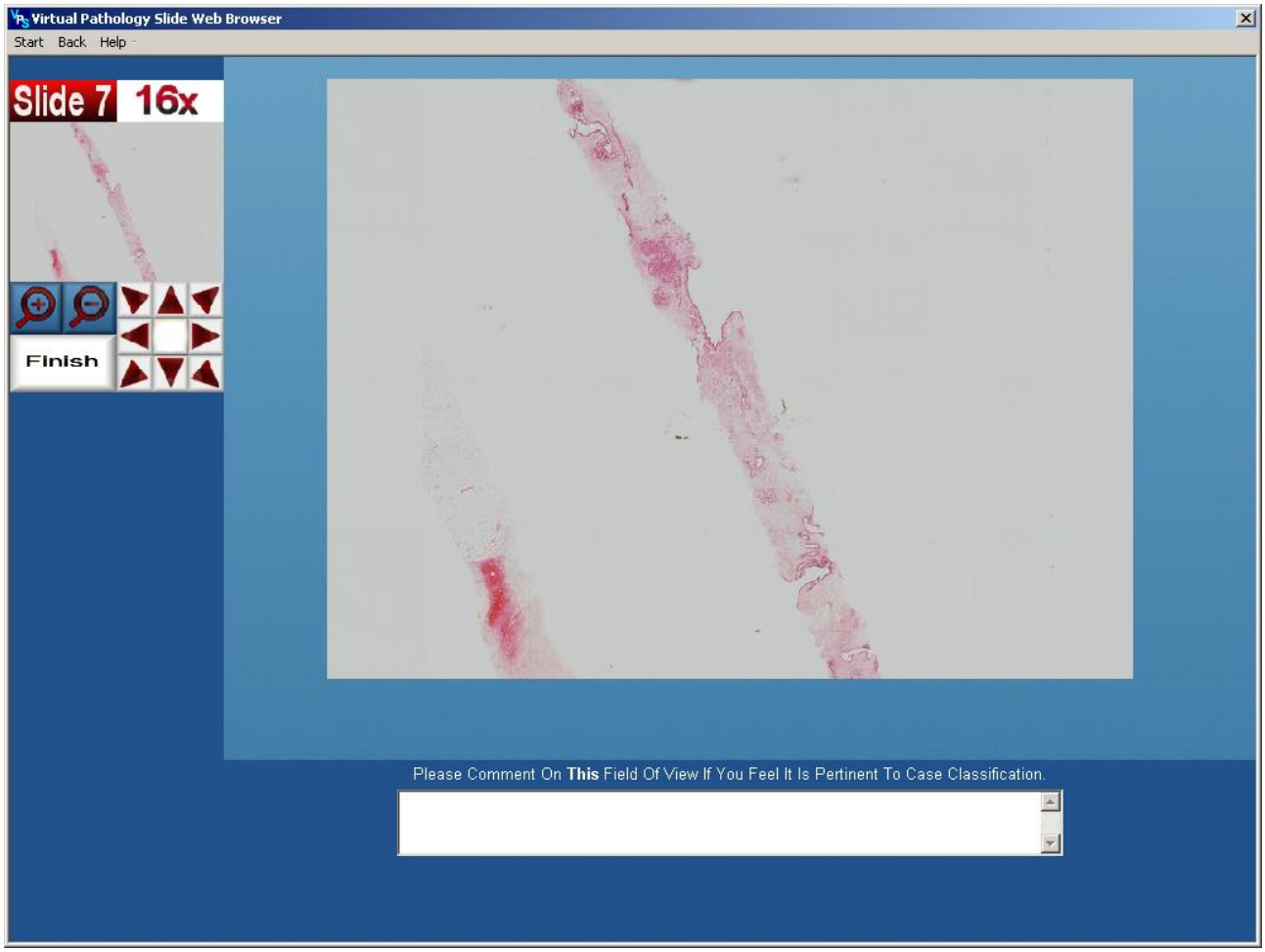
Recent improvements in Internet-browser technology have facilitated the development of interactive store-and-forward Web pages. These feature the ability to show the spatial relationship between individual images in low-power and high-power views. This technology is commonly visualized using a small image gallery constructed from one or two microscopic fields out of a possibility of thousands, displaying images of the same fields at higher magnifications [3,20,21]. Field selection and interpretation are thought to be the primary reasons specific to store-and-forward telepathology that account for its discordance with diagnosis in a conventional pathology setting [19- 20]. Studies involving multiple pathologists provide the most robust and accurate method of assessing a telepathology technique [20- 27]. However it is difficult to distinguish the performance of the technology from the skill of the pathologist and the degree of difficulty of the cases being presented [21]. Until recently, the development of a tool for routine diagnosis and teleconsultation was the driving goal for the evolution of telepathology systems. Initial expense, lack of broadband Internet connections, potential liabilities, and a lack of knowledge transfer from expert to potential user have all contributed to preventing the incorporation of telepathology into everyday practice [32- 35]. The emerging role of telepathology in the area of education and quality assurance is not encumbered by the same difficulties. It has been demonstrated that the application of telepathology in such roles has the advantage of lower cost, less logistical effort, and a positive response to its use by the end user [36- 39]. Coupled with the growing presence of ultra-fast slide scanners, this should ensure an increasing role for telepathology in this area [40- 42].

The Virtual Pathology Slide (VPS)

To overcome problems attributable to sampling bias and interpretation resulting from limited field selection, telepathologists must be able to navigate to any field of view, at magnifications comparable to that of a conventional microscope, using images of sufficient resolution to render a correct diagnosis [21,22,35]. To meet such criteria we have developed the Virtual Pathology slide (VPS) [43,44]. This is a microscope emulator that displays digitized representations of tissue slides, allowing inspection of numerous fields of view, over a wide range of magnifications. Similar applications, commonly referred to as Virtual Slides, have been developed by other commercial and academic bodies [16,18,20,34,35,40-42]. A screenshot of our VPS is shown in Figure 1; further screenshots are in Multimedia Appendix 1.

In an important new departure, the VPS can also record and quantify the diagnostic trace of a pathologist, as a discrete data set on a central server. This allows the decoupling of a pathologist's field selection from the technical functionality of the telepathology system. In this paper, we report on the development of this system, its acceptability among a group of evaluating pathologists, the level of diagnostic agreement among this group, and the potential future applications of the VPS in telepathology.

Figure 1. Screenshot of the Virtual Pathology Slide Web browser (for further screenshots, see Multimedia Appendix 1)



Methods

A comprehensive document detailing the scanning algorithm and system architecture of the VPS is in Multimedia Appendix 2.

Construction of the VPS

Development of VPS Imaging Workstation

To create VPS slides, an imaging workstation was developed in-house. An Olympus BX-40 microscope (Olympus, Melville, NY, USA) incorporating a 40x plan apochromat lens with a 0.95 numerical aperture was used. The microscope was fitted with a robotic stage (Prior Scientific Inc, Rockland, Mass, USA) and a JVC 3-CCD (3-chip charge-coupled device) video camera.

Development of VPS Slide Scanning Algorithm

Using Optimas 6.5 imaging software (Media Cybernetics, Inc, Silver Spring, Md, USA), an algorithm was written in ALI (Analytical Language for Images) to perform a raster scan of 15.53 mm x 11.61 mm (180 mm ^{2}) of tissue at 40x objective magnification. The VPS raster scan acquires 128 x 128 images in the X and Y Cartesian directions, one row at a time. Each acquired image represents 0.011 mm ^{2} at a resolution of 768 pixels by 574 pixels. Images were saved using a JPEG (Joint Photographic Experts Group) format at 10% compression, resulting in image-file sizes in the range of 100 to 150 KB (kilobytes). To build layers of lesser magnification, a second algorithm was developed, which tiles and resizes multiple images from the raster scan into composite images [16]. Images were subsequently uploaded onto the VPS Web server.

Development of VPS Web Interface

To view images via the Internet a graphical user interface was constructed [45]. This is a Web page powered by server-side scripting in PHP (PHP = Hypertext Preprocessor). The interface emulates the experience of using a conventional microscope by allowing a user to increase or decrease magnification or move laterally while examining a tissue section.

A customized browser was developed to control the user's access to the VPS during dedicated studies, to optimize the integrity of recorded data, and to provide a uniform experience for users who would otherwise experience subtle differences due to variation in currently-existing versions of Web browsers.

The VPS browser is a Microsoft Foundation Class (MFC) application written in Visual C++, which utilizes Internet Explorer file libraries to behave as a customized browser. The VPS customized browser opens up prescribed Web pages on the VPS server. The VPS browser is optimized for PC users with Microsoft Internet Explorer 5 or greater.

Development of VPS Database

When a user examines a VPS slide, data describing the user's interaction with the VPS is transmitted from the user's workstation to the VPS server and stored in an Oracle database. The VPS examination database is structured to contain the following data types:

System Configuration Data

This consists of data automatically recorded on the VPS server and includes parameters such as user's browser version, operating system, screen resolution, screen color depth, and IP (Internet Protocol) address.

User Tracking Data

This data records a user's "diagnostic pattern" as the user examines a slide. Information recorded includes image file name, image magnification, and the time spent viewing each image.

User-submitted Data

Diagnostic and descriptive data is submitted to the VPS server by participants, using HTML (Hypertext Markup Language) forms. Information recorded includes the report submitted by the user at the end of each slide examination and a final questionnaire. The observer also has the option to record or annotate every field of view examined.

VPS Deployment

The user has two choices on how he or she wishes to use the system. Users with high-speed Internet access can download the VPS browser from the VPS homepage and view images downloaded directly from the VPS server. To accommodate users with slow Internet connections, users may launch the VPS browser from a VPS CD and view images stored on the CD. However, an Internet connection is still required to record data on the VPS database, and to provide essential data for statistical analysis and playback facilities.

Validation of the VPS

Slide Selection

Ten needle core biopsies were obtained from the Department of Pathology, Mater Misericordiae Hospital, Dublin, Ireland. The slides were randomly selected by a pathologist (P.A.D.) with a special interest in breast pathology. The slides represented a range of diagnostic classifications. Two of the slides are presented in Figure 2. All 10 slides can be viewed in Multimedia Appendix 3.

Participants

Fifty-four pathologists with at least 2 years experience in pathology practice registered for the study. Of the 54 pathologists, 17 examined all 10 slides and 8 initiated the study but did not complete it. Of the 17 participants who completed the study, 8 were members of the European Working Group of Breast Screening Pathology. Of the 17 participants who examined all 10 slides, 13 subsequently completed a questionnaire on user perception of the VPS. Of the 8 participants that initiated the study but did not complete it, 3 completed the questionnaire.

Examination Procedure

Upon launching the VPS browser, participants were prompted to log in using the username and password they received at registration. This made them identifiable to the system. On successful log-in, the VPS needle core examination guidelines [46] were displayed.

After stating they read the guidelines, users were permitted to browse the slides available for examination and select one from a slide gallery. The slide gallery displayed a thumbnail image of each slide and indicated the patient's age and sex, and a brief case description.

Upon selecting a slide for examination, participants were presented with the VPS user interface. While examining a slide, participants could if desired annotate the fields of view using the text area provided. Upon completing a slide examination, participants submitted an online report that provided a diagnostic classification for the case, using an adaptation of the Core Biopsy Reporting Guidelines for Non-operative Diagnostic Procedures and Reporting in Breast Cancer screening [47] as used by the British National Co-ordinating Committee for Breast Screening Pathology. Users were requested to classify the slides as one of the following:

B1: Unsatisfactory/normal tissue only.

B2: Benign.

B3: Benign but of uncertain malignant potential.

B4: Suspicious of malignancy.

B5: Malignant.

For slides categorized as B5, participants were required to subclassify their decision as malignant, in-situ, or invasive. Upon making a classification, participants were returned to the slide gallery from which another slide could be selected for examination.

Utilization of this data allowed the following to be determined:

- Percentage concordance for a user, calculated as the number of slides (expressed as a percentage) for which the user's diagnosis is in agreement with the consensus VPS diagnosis.
- Percentage concordance of a slide, calculated as the percentage of users who concur as to the correct diagnosis of a slide.
- Cohen's Kappa [48- 49], a measure of agreement between observers taking into account agreement that could occur by chance. Kappa values range from 0 to 1 with a score greater than 0.7 indicating "substantial agreement."

Participants who completed examination of the 10 slides were subsequently requested to complete an online questionnaire describing their experience using the VPS. Participants were asked to give a subjective evaluation of diagnostic confidence in using the VPS, reasons for uncertainty, an evaluation of image quality, and perceived download speed.

Figure 2. Two examples of the 10 breast needle core biopsies presented to 17 pathologists or trainee pathologists using the VPS (for all 10 images, see Multimedia Appendix 3)

Results

User Performance Using the VPS

Table 1 shows strong diagnostic agreement between original glass-slide diagnosis and the most-common diagnosis offered by users of the VPS, with agreement being reached in 9 out of the 10 slides. Disagreement by 1 diagnostic degree occurred with slide 8 (glass slide diagnosis was B3; most- common VPS diagnosis was B4). The diagnostic classification of slide 8 had the lowest level of agreement between participants at 38.5%. The second most popular choice for slide 8 was split between B3 and B2, 6 participants (35.3% of users) classified it as B4 while 4 participants (23.5% of users) classified it as B3 and 4 participants (23.5% of users) classified it as B2). Participants with the 4 highest Kappa scores (23.5% of users) classified slide 8 as B4.

Table 1. Comparison of glass slide needle core surgical biopsy diagnosis and most-common Virtual Pathology Slide (VPS) diagnosis, in order of level of agreement (concordance) for each slide

	Virtual Pathology Slide									
	S6	**S2**	**S3**	**S4**	**S7**	**S9**	**S10**	**S1**	**S5**	**S8**
Diagnosis Glass	B5	B5	B5	B2	B2	B2	B2	B5	B5	B3
Diagnosis VPS	B5	B5	B5	B2	B2	B2	B2	B5	B5	B4
Concordance, %	100	94.1	82.4	76.5	64.7	58.8	52.9	52.9	47.1	35.3
Fields of view*	243	208	464	410	463	309	591	431	487	299

A more-detailed analysis of the diagnostic classifications made by participants is described in Table 2. The average percentage concordance between participants on all cases was 66.5%. Of the 17 participants, 14 attained a percentage concordance of between 90% and 60%.

Table 2. For each participant: years of experience in pathology practice, diagnostic classification of slides, level of agreement with each other (% concordance and Kappa index), and number of fields of view examined

ID *	EXP †	Virtual Pathology Slide										Concordance,% ‡	Kappa §	Fields of View
		S6	S2	S3	S4	S7	S9	S10	S1	S5	S8			
5	5	B5	B5	B5	B2	B2	B2	B2	B4	B5	B4	90	0.97	321
62	5	B5	B5	B5	B2	B2	B3	B2	B5	B4	B4	80	0.94	326
35	5	B5	B5	B5	B2	B2	B1	B1	B4	B5	B4	70	0.94	122
10	5	B5	B5	B5	B2	B3	B3	B2	B5	B4	B4	70	0.91	157
39	5	B5	B5	B5	B1	B3	B3	B2	B5	B5	B5	60	0.90	343
55	5	B5	B5	B5	B2	B2	B2	B2	B5	B3	B3	80	0.87	289
87	5	B5	B5	B5	B1	B2	B2	B2	B3	B5	B3	70	0.86	130
18	3	B5	B5	B4	B1	B3	B2	B1	B5	B4	B3	40	0.86	252
68	5	B5	B5	B5	B2	B3	B2	B2	B5	B4	B2	70	0.85	228
65	5	B5	B5	B5	B2	B2	B3	B1	B3	B4	B4	60	0.80	234
22	5	B5	B5	B5	B2	B2	B2	B5	B5	B5	B5	80	0.75	204
41	5	B5	B5	B5	B1	B2	B2	B2	B2	B4	B4	70	0.75	216
7	5	B5	B5	B5	B2	B2	B2	B1	B4	B2	B3	60	0.73	121
1	5	B5	B5	B4	B2	B4	B2	B2	B5	B5	B1	70	0.67	223
75	5	B5	B5	B5	B2	B2	B2	B5	B4	B5	B2	70	0.65	120
36	3	B5	B5	B2	B2	B3	B3	B4	B5	B2	B2	40	0.26	201
6	5	B5	B2	B5	B2	B2	B4	B5	B3	B5	B2	50	0.23	418
Average												66.5	0.76	23

* ID = identification number of participant.

† EXP = years of experience in pathology practice.

‡ Concordance = number of slides (expressed as a percentage) for which the user's diagnosis is in agreement with the consensus Virtual Pathology Slide diagnosis.

§ Kappa = Cohen's Kappa, a measure of agreement between observers, taking into account agreement that could occur by chance. Kappa greater than 0.7 indicates "substantial agreement."

The average Kappa value achieved by participants was 0.76. Participants 36 and 6 achieved a Kappa of 0.26 and 0.23 respectively indicating "fair agreement" [31- 32] with other participants while the remaining 15 participants achieved a Kappa of between 0.97 and 0.65.

The average percentage concordance for slides was 66.5% with a minimum concordance of 35.3% for slide 8 and a maximum concordance of 100% for slide 6. The percentage concordance for slide 5 was 47%. For all remaining slides there was greater than 50% agreement between participants.

The average number of fields of view examined by each participant was 23 per slide. Participant number 5, who achieved the highest Kappa, examined 321 views, while participant number 6, who had the lowest Kappa, examined 418 fields of view.

The highest number of number of fields of view examined for a particular slide was 118 by participant number 6 while examining slide 10. This slide had a percentage concordance between participants of 52.9%. The lowest number of views examined while examining a slide was 3; this was by participant 10 who achieved a Kappa score of 0.91 and agreed with the group consensus for slide 2. Diagnosis for slide 2 had a percentage concurrence amongst participants of 94%.

The average time taken for participants to examine a slide was recorded as 6 minutes 11 seconds. The maximum time taken to examine a slide was recorded as 12 minutes 49 seconds by participant number 36 with an average bandwidth of 20 kilobits per second while examining slide 7. The minimum examination time was recorded as 43 seconds by participant number 1 with an average bandwidth of 64 kilobits per second while examining slide 2.

User Perception of the VPS

Participants were asked to assess their own computer competency and the frequency with which they use a telepathology system. Participants described themselves as "advanced" (18.75%), "competent" (18.75%), or "adequately competent" (62.5%) with computers, while 44% of participants indicated they had never used a telepathology system prior to the study.

Figure 3. Ease of use of the Virtual Pathology Slide (VPS). Yrs = years of pathology experience. Percentages = percentage of 16 participants for that rating

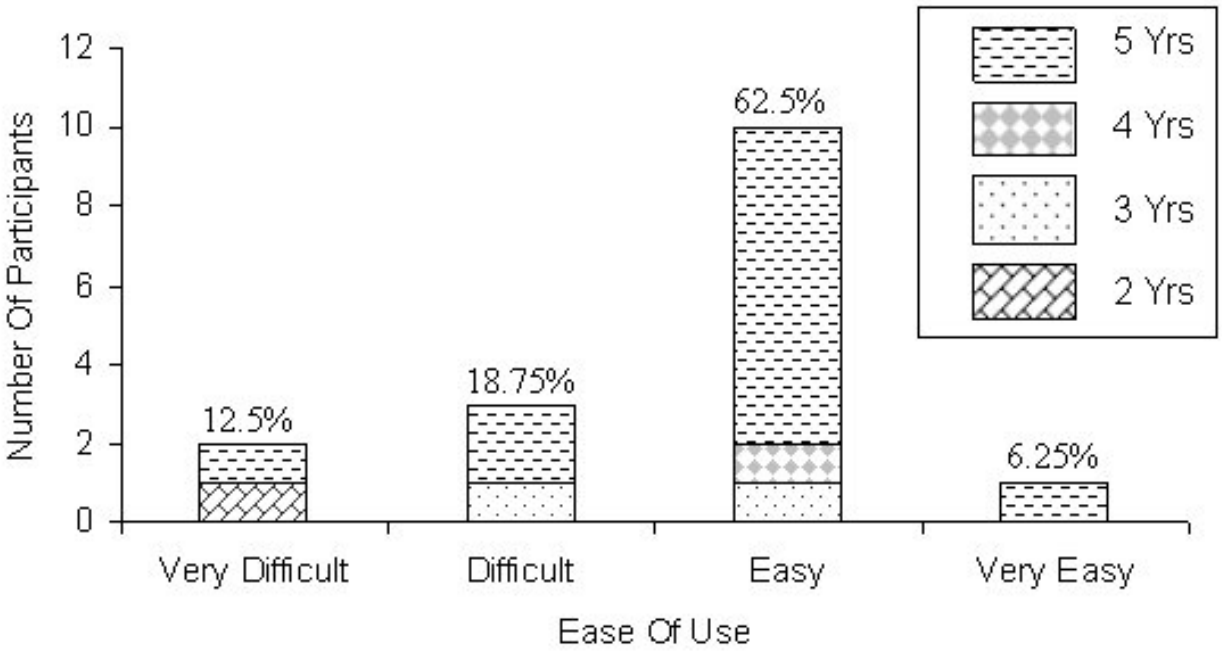


Figure 4. Degree of confidence in using the Virtual Pathology Slide (VPS) to make a diagnostic decision. Yrs = years of pathology experience. Percentages = percentage of 16 participants for that rating

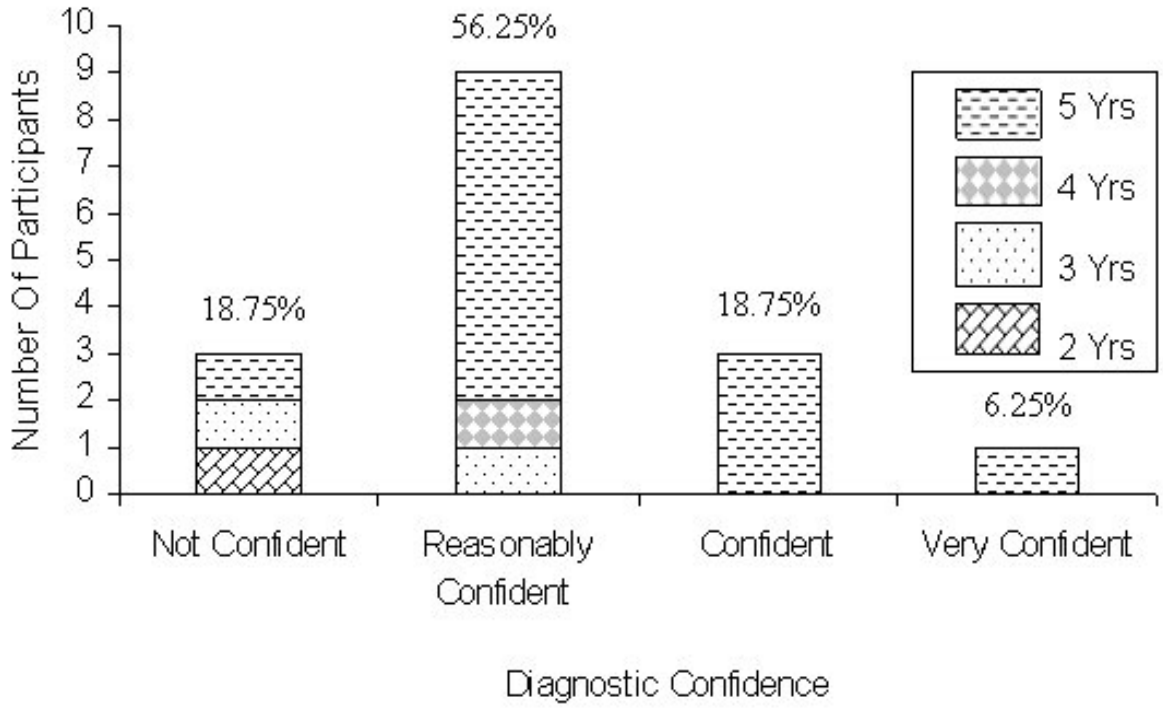
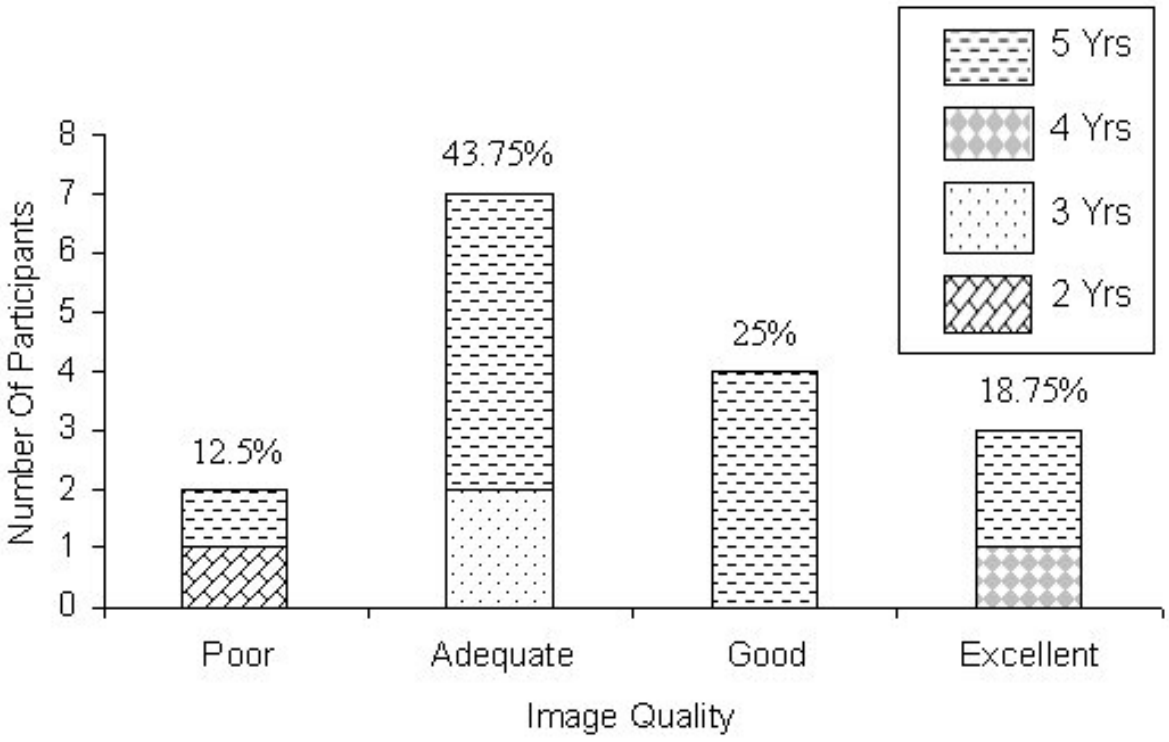


Figure 3 illustrates that 68.75% of participants rated the VPS "easy" (62.5%) to use or "very easy" to use (6.25%). Participants were requested to rate their degree of confidence in making a diagnostic decision using the VPS.

Figure 4 illustrates that 80.25% of participants expressed confidence in using the VPS with 56.25% indicating they were "reasonably confident," while 18.75% were "confident," and 6.25% were "very confident" in making a diagnosis.

Figure 5 illustrates that 87.5% of participants expressed satisfaction with the image quality with 43.75% indicating the quality as "adequate," 25% as "good," and 18.75% of participants indicating the image quality as "excellent."

Figure 5. Perceived image quality of the Virtual Pathology Slide (VPS). Yrs = years of pathology experience. Percentages = percentage of 16 participants for that rating



Discussion

The VPS system is a realistic alternative to dynamic telepathology, in terms of its ability to mimic a conventional microscope, its accessibility via the Internet, and its simplicity of operation. Of the 17 participants, 15 achieved a Kappa of between 0.97 and 0.65 and 14 attained a percentage concordance of between 90% and 60%. This demonstrates "substantial" agreement between users when using the VPS [31- 32]. The calculation of Kappa was weighted to reflect the degree of variation of a participant's diagnostic decision from the most popular choice. For example, participant 18 achieved a high Kappa of 0.86 despite being in agreement with other participants for 4 out of the 10 slides. This is because for each of the other 6 slides, participant 18 was inconsistent with the popular choice by one degree. Participant 36 achieved the same percentage concordance as participant 18 but only achieved a Kappa of 0.26. This is because the diagnostic categories selected by participant 36 deviated to a greater degree from the popular choice than those selected by participant 18 [48- 49].

Participant 36 and participant 6 attained the lowest Kappa scores of 0.26 and 0.23 respectively. This reduced the overall average Kappa value considerably. Confidence in using the VPS was described as "reasonably confident" by participant 36, who had 3 years experience in pathology and examined 201 fields of view while examining the entire set of slides. Further analysis of the images viewed is necessary to elucidate reasons for the diagnostic decisions made by participant 36; however, inexperience with breast pathology coupled with insufficient examination of the slides may have contributed to poor performance. Use of telpathology was described as "infrequently" by participant 6 who was "confident" in making a diagnostic classification using the VPS and described the use of the VPS as "easy." However, participant 6 attributed some diagnostic uncertainty to "problems with assessing significance of small subtle lesions without having the whole slide to look at." Participant 6 examined 418 fields of view, the highest number examined by any participant.

The average percentage concordance for the entire set of slides was 66.5%. Full agreement between participants was achieved for slide 6, which demonstrates that full agreement can be achieved using the VPS.

The average number of views examined by participants while examining the entire set of slides was 230. The percentage concordance for a particular slide decreases as the average number of fields examined for that slide increases. For example, the average number of fields examined for slide 6 (100% concordance amongst participants) was 14.3, while the average number of fields examined for slide 10 (52.9% concordance amongst participants) was 34.8. Conversely, participants with a high Kappa score tend to view a greater number of fields of view than participants with a low Kappa score, suggesting that the greater the amount of tissue viewed by a pathologist, the more likely they are to make a correct diagnosis.

Slide 8 had the lowest level of concordance at 35.3%. This reduced the average percentage concordance for the set of slides by 3.46%. Table 2 shows there is a broad distribution of diagnostic categorization for slide 8 by participants. As shown in Table 1, for slide 8 the number of fields of view examined by participants is low (299) given the apparent complexity of the case. It is apparent that users are rapidly coming to a conclusion that usually does not concur with the original glass slide diagnosis. Further study of the examination traces from this slide will be required to evaluate the reasons for the diagnostic spread.

Participants with 3 years or less experience did not have access to broadband Internet connection and recorded bandwidth speeds of less than 15 kilobits per second. These participants expressed least satisfaction with the VPS in terms of ease of use, image quality, and diagnostic confidence. All 3 participants, who indicated they were "not confident," attributed difficulty in using the VPS to poor download speed, with comments such as "Poor download speed was extremely slow and made the viewing experience disjointed and basically unworkable." Of these 3 participants, 2 had a working bandwidth of 12.6 kilobits per second and 31.5 kilobits per second respectively. A bandwidth could not be determined for the third, however the third did offer such comments as "too long to download images" and "problem was on my end, slow connection." High-speed broadband Internet connectivity is still unavailable to many pathologists. This is a major limiting factor for acceptability of Web-driven telepathology due to the time taken to download large image files over the Internet [2,4,39]. We have attempted to overcome this with the development and deployment of a CD-ROM VPS system to selected participants. This facilitates rapid retrieval of images from a CD while data pertaining to the examination is transmitted and stored on the VPS web server.

Participants were asked to comment on improvements to the VPS that they would like implemented. A number of participants suggested they would like additional magnification ranges. For example, "Navigation within the slide was disjointed and it was difficult to maintain perspective whilst moving from field to field. The range of magnifications was too limited, especially in the intermediate magnification range."

There are a growing number of interactive pathology sites available via the Internet [7- 19]. The diversity in their principle of operation, their application in telepathology, and their degree of sophistication promises an encouraging future in telepathology. The contribution of the VPS to the field of telepathology is notable in that it records the diagnostic pathway of a pathologists slide examination. We now have the diagnostic traces of 17 pathologists examining 10 cases. We intend to utilize this data to elucidate the cognitive and decision-making process of pathologists as they render a diagnosis when using a microscope. This will provide valuable insight into interobserver variability and the subjective process of microscopic diagnosis.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Screenshots of the Virtual Pathology Web browser.

[PowerPoint file, 525 KB - jmir_v5i2e11_app1.ppt]

Multimedia Appendix 2

Technical Documentation.

[PDF file, 552KB - jmir_v5i2e11_app2.pdf]

Multimedia Appendix 3

Ten breast needle core biopsies presented to 17 pathologists or trainee pathologists using the VPS.

[PowerPoint file, 76 KB - jmir_v5i2e11_app3.ppt]

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Abbreviations

VPS: Virtual Pathology Slide

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Original Paper

Collaborative e-Learning Using Streaming Video and Asynchronous Discussion Boards to Teach the Cognitive Foundation of Medical Interviewing: A Case Study

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Abstract

Background: Advances in electronic technology have created opportunities for new instructional designs of medical curricula.

Objective: We created and evaluated a 4-week online elective course for medical students to teach the cognitive basis for interviewing skills.

Methods: Ten students, from 2 medical schools, studied online modules on interviewing concepts and viewed videos illustrating the concepts. They then participated in asynchronous discussion groups designed to reinforce course concepts, stimulate reflective learning, and promote peer learning.

Results: In qualitative evaluations, learners reported improvements in self-awareness; increased understanding of interviewing concepts; and benefits of online learning vs face to face learning. Participants reported high levels of satisfaction with online learning and with achievement of course objectives. Self-reported knowledge scores increased significantly from pre-course completion to post-course completion.

Conclusions: Online education has significant potential to augment curriculum on the medical interview, particularly among students trained in community settings geographically distant from their academic medical center.

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KEYWORDS

Education, distance; medical history taking; education, medical; online systems; students, medical; communication; physician-patient relations; clinical competence; Internet; World Wide Web

Introduction

A number of organizations [1- 3] have identified deficiencies in physician communication-skills training. Strengthening instruction in communication skills is a priority national objective for US medical schools [4]. Learning effective communication requires a cognitive foundation of interviewing theories and concepts [4]. A curriculum on communication concepts and strategies should provide understanding of fundamental skills and processes, and will establish a sound foundation for learning skills [4]. Such knowledge objectives have typically been best taught in years one and two of the curriculum [4]. Decentralization [5], a growing emphasis on adult learning principles, and use of distance education requires new thinking about curricular design and delivery. This paper

reports our experiences with a new online method for teaching communication concepts to medical students.

Materials and Methods

The instructional design we use for online courses [6] has the learner follow a deliberate sequence of educational activities (Figure 1). Guided by the SEGUE (Set the Stage, Elicit Information, Give Information, Understand the Patient's Perspective, End the Encounter) framework of communication tasks [4], over 4 weeks in an online elective course we consecutively addressed questioning techniques, affect and nonverbal cues, eliciting the cardinal features of a symptom, and stages and transitions.

Figure 1. Sequence of educational activities

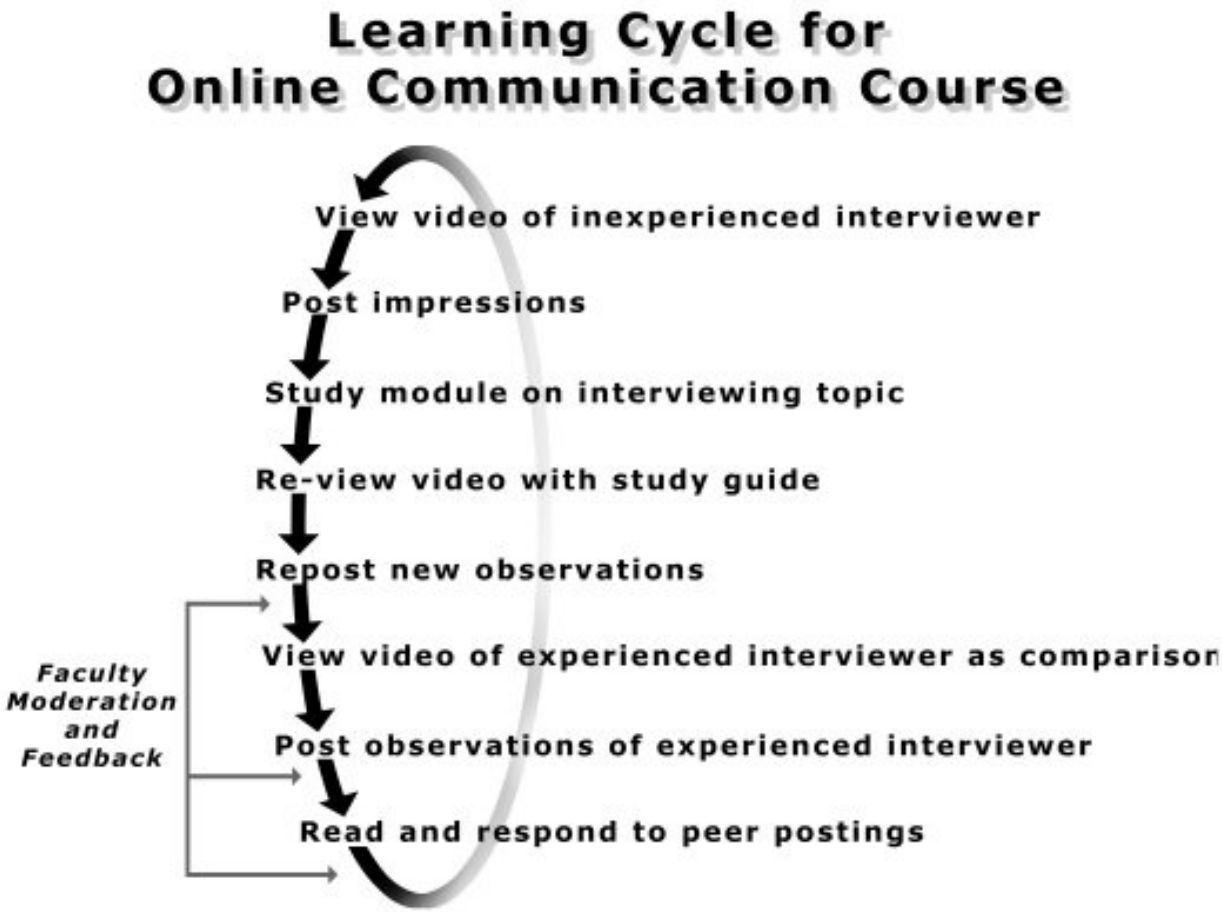
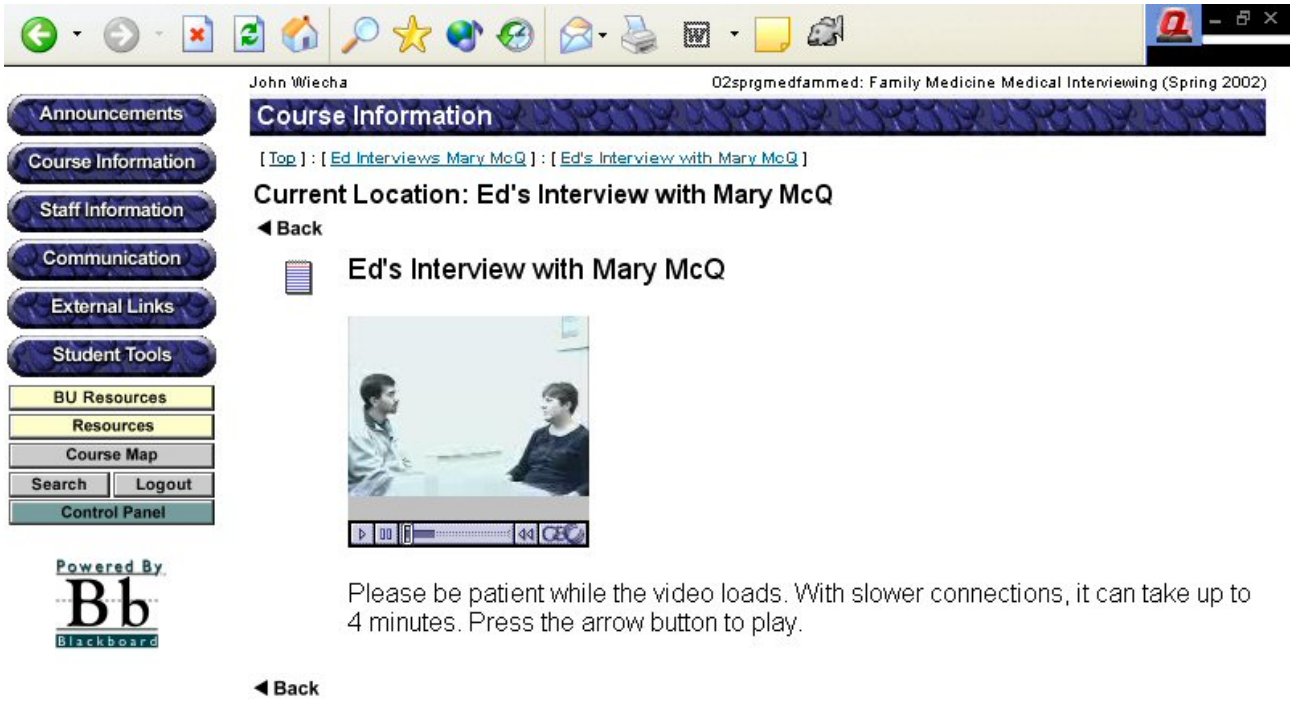


Figure 2. Videos on the Blackboard e-learning site showing inexperienced and experienced interviews with patients



Blackboard, a web-based learning system [7] was used to organize course material and activities (Multimedia Appendix 1). Two videos, delivered online through the Blackboard courseware and produced with GeoSystems compression software, illustrated the concepts presented each week in the Web-based text modules (Figure 2). The videos were between 15 and 20 minutes in length. The first video demonstrated inexperienced interviewing by showing a first-year student interviewing a woman (Mary) with a depressed affect and dyspepsia. The second video was of a family physician interviewing a young man (Ed) with the same symptoms, and demonstrated a more-experienced interviewer. Each video was streamed through the course Web site.

Students received access to a moderated, asynchronous discussion board and were required to post their impressions and observations each week. If necessary (that is, if they lagged in posting), they were reminded by the moderator. Using established principles [8- 9] (including probing participants for deeper reflection, challenging assertions by contrasting differing viewpoints and observations, and summarizing concepts and conclusions included in the postings to provide closure to each week's discussion), trained faculty moderated the discussion groups. Discourse should be a component of courses teaching communication concepts [4]. At the course midpoint (ie, after 2 weeks) and at course end, students also received written feedback on their participation and performance by personal e-mail from one of the authors (PJ).

Evaluation Instruments and Processes

Qualitative assessments included one-to-one in-person interviews using open-ended questions, analysis of student course postings, and a face-to-face focus group with all 10 students, done by a facilitator previously unknown to the students. Interviews and focus groups were recorded and transcribed, and analyzed for emerging themes by one investigator (RG).

Eleven formative evaluation questions (Table 1) were presented 1 week after the course using a Web-based questionnaire. Each question was scored on a 7-point Likert scale.

Students also completed pre-course and post-course Web-based questionnaires with 21 items (Multimedia Appendix 2 and Multimedia Appendix 3), each scored on a scale from 1 (no understanding) to 10 (complete understanding), grouped into 4 categories (shown in Table 2) corresponding to the major course objectives. Before/after scores were compared using a paired t test.

We calculated for each student a mean score on the baseline knowledge items. This score was linearly correlated with the number of interviews each student reported having completed to date (r= 0.9412, P< .001), providing support for the construct validity of the self-reported knowledge measures (Figure 3).

Table 1. Student evaluation of the process of learning online

	Agreement (n = 9)	
	Mean*(Maximum = 7.0)	Agree Strongly n (%)
The faculty interview was effective in demonstrating principles of interviewing	6.4	7 (77.8)
The student interview was effective in demonstrating principles of interviewing	5.1	3 (33.3)
I valued interacting with faculty online via the threaded discussions groups	6.3	6 (66.7)
I valued interacting with other students online via the threaded discussion groups	6.2	5 (55.6)
I received feedback on my questions and concerns from BU faculty during the course	6.1	4 (44.4)
During this course I learned from other students	5.7	1 (11.1)
I had adequate time in my schedule to complete the assignments in the online course	6.1	6 (66.7)
The online course was easy to use	6.3	7 (77.8)
I enjoyed the online course	5.9	3 (33.3)
I would recommend that other students take this course	6.1	5 (55.6)
I would be interested in other online courses in medical school	6.1	5 (55.6)

* Scaled as: 1= Disagree Strongly, 2= Disagree Moderately, 3= Disagree Slightly, 4=Neutral, 5= Agree Slightly, 6= Agree Moderately, 7= Agree Strongly.

Table 2. Level of understanding of interviewing concepts*

Question Group	Pre-course	Post-course	Mean Gain	*P* Value #
Structure of the interview(6 items)	6.2	8.7	2.5	0.003
with the patient(6 items)Relationship with the patient(6 items)	6.5	8.4	1.9	0.002
Assessing affect(3 items)	6.6	8.6	2.0	0.001
Collecting data(6 items)	5.6	8.5	2.9	0.002

* Each question group consists of 5 or 6 questions, each scored on a scale from 1(no understanding) to 10 (complete understanding). Presented are the mean scores of the students in each question group.

Using paired t test

Figure 3. Interviewing experience vs. baseline interviewing knowledge

The course was offered to students between their first and second year at 2 medical schools to benefit from the inter-institutional learning facilitated by Web-based distance education. Our enrollment target of 10 students was reached with 7 students from Boston University and 3 from the University of Massachusetts. Two working groups of 5 students were created, in our experience an ideal size for online course discussions [6,10].

Results

Of the 10 students who started the course, one student dropped out of the course due to schedule conflicts, while 9 students completed the course and evaluations. Students made an average of 14 written postings during the 4-week course.

A qualitative analysis of the postings from course assignments consistently provided evidence of concept acquisition. A representative posting:

> *I realized that I never truly noticed any of Mary's or Ed's affect or non-verbal cues when I previously viewed the interview. However, when I watched the interview for a second time, I noticed many interactions that I had not before.*

Major themes to emerge from the focus group are presented in Textbox 1.

Textbox 1. Major Themes

Theme 1: Theoretical understanding and self-awareness.

Student: "I really do think I have a more organized picture in my head of what I want to do the next time I sit down."

Theme 2: Benefits compared to face-to-face interaction.

Student 1: "You're forced to think through a good response and good interpretation . . . "

Student 2: "I think it's great. I never thought that I would, I'm very computer illiterate, I never thought that I would choose to do something online as opposed to just on paper or in class, but it was so convenient and so like relaxing you know? I took away a ton from it too. I mean I really feel like I did."

Student 3: "You're so much more likely to learn if you're doing it when you're ready for it."

Student 4: "I felt like there were some things that I was really able to take my time with and understand."

Also apparent from the group was a desire for variation in interviews to analyze (Theme 3) and opportunities to apply the concepts to real patients (Theme 4).

Open-ended comments on the course evaluation form supported these themes, and provided more detail about advantages of online learning in this course over more conventional methods. Two students provided representative viewpoints:

Student 1: ". . . interacting with students in the on-line format allowed for well thought-out, comprehensive responses and much more insightful comments than sometimes heard in a classroom. I attribute this to the time one has to sit and think through a response, choose the words carefully, and elaborate uninterrupted. There's less pressure on-line, so you can piece together your thoughts with less stress and greater sincerity."

Student 2: "The strengths are the high level of participation and interaction and conversation (more so than in any other course so far.)"

Quantitative Results

Students rated all aspects of the course highly (Table 1) and knowledge scores increased significantly ($P< .01$) at the end of the course (Table 2). As can be expected, students who reported the least baseline knowledge reported the greatest increase in understanding of course concepts ($r= 0.79$, $P= .015$) (Figure 4).

Figure 4. Gain in knowledge, by baseline knowledge

Figure 5. Correlation between words posted to course discussion group and gain in knowledge

Also, gain correlated with the number of words posted to the course discussion group ($r= 0.72$, $P=.02$), suggesting that greater educational effort was correlated with greater self-reported gain in knowledge (Figure 5).

Discussion

The students completing this course participated at a high level and rated it highly on learning process and achievement of course goals. Our data suggests that it increased student understanding of basic concepts underlying effective clinical communication. The course's acceptance was in large part due to its congruence with principles of adult learning [11] such as self pacing, reflective learning, and collaborative learning from peers [11]. Participants noted a number of advantages of online learning. Although there are only rare examples in the literature of online courses on communication skills for medical professionals or students [12], this study does add to the growing literature in medicine and in fields outside of medicine [13- 15], suggesting the effectiveness of Internet-based distance education. However, more-rigorous evaluations with control groups and a larger number of participants are required to establish which factors and participant characteristics are determinants of effective learning. Medical-education studies generally show that Internet-based instruction is at least as effective as conventional methods [16- 18] and in some cases superior [19- 21]. However, a recent meta-analysis of Web-based learning in medical education did not find this method superior to conventional methods, but did acknowledge that studies are needed that better compare instructional *methods* rather than comparing instructional *media*, as has been the focus of many studies to date, rendering conclusions about the relative merits of online vs face-to-face methods difficult to make [22]. A carefully-designed, carefully-taught, and carefully-evaluated online course may effect better learning outcomes than face to face instruction [23]. Based on the limitations of research to date, it is clear that further work is needed to assess the impact and acceptance of small group online education, and the role of faculty or other moderators in online medical education courses [19,24- 26]. The acceptance of this method in a broader, unselected student population will be of interest. Evidence suggests that most learners will ultimately be successful online learners [27]. We also note that self report of learning is less reliable than direct measurement of knowledge acquisition. However, there was consistency of findings from the mixed-method approach used to evaluate this course. Given the favorable results from this elective, we plan to integrate elements of this online course into the preclinical-years' communication-skills curricula for use by all first-year students.

Jordan Cohen, the President of the Association of American Medical Colleges (AAMC), in a speech once exhorted medical educators to seize "the potential of the technological revolution to transform the way students learn" [28]. In response, we have developed a new method of introducing the cognitive basis for communication using electronic technology. It should also be applicable to other content areas and is likely to prove particularly useful as medical education becomes increasingly decentralized.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Course Material

[PPT File, 1.2MB - jmir_v5i2e13_app1.ppt]

Multimedia Appendix 2

Interviewing Pre Survey Questionnaire

[HTML, 90KB - jmir_v5i2e13_app2.html]

Multimedia Appendix 3

Interviewing Post Survey Questionnaire

[HTML, 122KB - jmir_v5i2e13_app3.html]

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Original Paper

Doctors Who Are Using E-mail With Their Patients: a Qualitative Exploration

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Abstract

Background: Despite the potential for rapid, asynchronous, documentable communication, the use of e-mail for physician-patient communication has not been widely adopted.

Objective: To survey physicians currently using e-mail with their patients daily to understand their experiences.

Methods: In-depth phone interviews of 45 physicians currently using e-mail with patients were audio taped and transcribed verbatim. Two investigators independently qualitatively coded comments. Differences were adjudicated by group consensus.

Results: Almost all of the 642 comments from these physicians who currently use e-mail with patients daily could be grouped into 1 of 4 broad domains: (1) e-mail access and content, (2) effects of e-mail on the doctor-patient relationship, (3) managing clinical issues by e-mail, and (4) integrating e-mail into office processes. The most consistent theme was that e-mail communication enhances chronic-disease management. Many physicians also reported improved continuity of care and increased flexibility in responding to nonurgent issues. Integration of e-mail into daily workflow, such as utilization of office personnel, appears to be a significant area of concern for many of the physicians. For other issues, such as content, efficiency of e-mail, and confidentiality, there were diverging experiences and opinions. Physicians appear to be selective in choosing which patients they will communicate with via e-mail, but the criteria for selection is unclear.

Conclusions: These physician respondents did perceive benefits to e-mail with a select group of patients. Several areas, such as identifying clinical situations where e-mail communication is effective, incorporating e-mail into office flow, and being reimbursed for online medical care/communication, need to be addressed before this mode of communication diffuses into most practices.

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KEYWORDS

Electronic mail; Internet; physician-patient relations; communication

Introduction

Effective patient-provider communication is essential to comprehensive, quality health care [1,2]. Improving physician-patient communication is increasingly recognized as an important health care issue [3]. As outlined in the Institute of Medicine (IOM) report, "Crossing the Quality Chasm," 1 of the 5 key areas in the way information technology could contribute to an improved health care delivery system includes enhanced patient and clinician communication [4]. The Institute of Medicine indicated "the health care system should be responsive at all times . . . and that access to care should be provided over the Internet, by phone . . . in addition to face-to-face visits" and that "a 2-minute email communication could meet many patients' needs more responsively and at a lower cost."

E-mail is a rapidly-growing communication medium, particularly as time limitations on the part of both providers and patients increase. Technically-minded, electronically-equipped, health care consumers have accelerated the demand for e-mail access to their providers [5]. Although more than 100 million Americans now use the Internet (and many access health information), few doctors communicate with their patients through e-mail [6,7]. Despite its potential to improve both the quality and efficiency of health services delivery [8], the use of e-mail communication has not been widely adopted by many clinicians. There is still a wide gap between patients' desire for e-mail communication with their healthcare providers and providers' acceptance of this electronic patient-centered communication [6,9]. Yet other data indicate that physicians are more optimistic than patients about the potential for e-mail use, particularly as it impacts the doctor-patient relationship [10]. Concerns regarding additional time demands that e-mail communication may impose [10,11] and trouble finding time to connect to the Internet are reported by many clinicians [12]. Also, due to the asynchronous nature of electronic communication, e-mail may not be an effective medium for some patient-physician interactions [13].

There are several unanswered questions regarding this method of communication that must be answered before widespread use can be expected. How does this new technology impact the patient-physician relationship? For what problems can e-mail be used most effectively? How do physicians respond to patients' desire for electronic communication? How do they integrate this new technology into their practice? There is little research that documents how clinicians who use e-mail daily view and use e-mail communication, or documents its impact on medical practice. Some of these questions may not be fully answered until the diffusion of this technology becomes widespread. To begin to understand and generate hypotheses regarding the potential benefits and limitations of e-mail communication with patients, we explored the experiences of physicians who are currently frequent users of e-mail communication in their clinical practice. By identifying early adopters of this innovation in physician-patient communication and using methods akin to appreciative inquiry (which attempts to look at systems to find out what is currently working, and thus what is, potentially, the future ideal) we hoped to better understand how and why electronic mail is currently being used in "real-world" practices, and to perceive how the technology may be successfully used in the future.

Methods

Sample

We identified a sample of "Internet savvy" physicians frequently using e-mail with patients through the national convenience sample of members of Physicians' Online [14], an Internet-based professional information and communication portal limited to physicians currently practicing in the United States. Respondents to an Internet-based questionnaire designed to identify *frequent users*, defined as physicians who "receive one or more e-mails from patients in a typical day," were included [15]. Of these physicians, 204 indicated daily use of e-mail and 88 expressed interest in completing an in-depth phone interview.

Conduct of Interviews

We sent an e-mail to these 88 physicians describing our study and asking them to participate in a 10 to15 minute in-depth phone interview. Nonresponders were sent up to 4 separate reminder e-mails and those who provided phone-contact information were contacted by phone. One researcher, who was blinded to physician responses in the earlier questionnaire on e-mail use and had little familiarity with e-mail communication in health care, conducted the interviews.

The interview was designed to explore the physicians' experiences and thoughts regarding e-mail through a series of open-ended questions. A general outline of topics and questions was designed by the researchers to provide a platform for participants to generate thoughts about e-mail communication. Example questions/cues included: (1) What made you start using e-mail with your patients?, (2) Can you give me examples of how e-mail affected quality of care provided, including examples of both increased and/or decreased quality of care?, (3) Tell me about problems you've encountered using e-mail. The interviewer could ask additional questions if comments or questions by the interviewee generated new ideas. The interviews were conducted from November 2000 through April 2001. A $50 honorarium was provided to the physicians for participating. We obtained verbal consent from each physician, and audio taped all interviews, which were then transcribed verbatim.

Data Analysis

Two authors independently identified distinct comments from the transcripts and together with a third author, who has expertise in qualitative methodology, reviewed comments and developed domains and subdomains. Repeated or reworded comments of the same thought by the same participant were counted only once. Any disagreement on whether a particular segment represented a unique thought or concept was adjudicated. Domains and subdomains were agreed upon by consensus. Taxonomy of all comments was then sent to the remaining authors to be reviewed for relevance and consistency. All discrepancies were resolved by consensus.

Results

Among the 88 physicians contacted, 52 responded. However, 7 of these were unable to participate in phone interviews during the time interval of the study. There was no response from 36 physicians despite 4 or more e-mail attempts and, if phone contact information, was provided, phone messages. We completed 45 interviews. The demographic characteristics of the participating physicians are provided in Table 1. There were no statistically-significant differences in age, gender, race, and subspecialty between the participants and the nonresponders, or by positive or negative attitudes on the earlier survey.

Table 1. Demographic characteristics of physicians interviewed (n = 45)

Characteristic	Percent
Age (years)	
<<35	9
35-55	73
Over 55	18
Gender	
Male	82
Female	18
Specialty	
Generalists (general internal medicine, family practice, general pediatrics, general psych, preventive medicine)	64
Specialists (internal medicine, pediatrics)	20
Surgery	7
Emergency room	2
Obstetrics/Gynecology	7
Number of daily email exchanges	
1-5	87
6-10	9
11-15	2
>>15	2
Would recommend doctor-patient e-mail communication to a colleague	
Yes	84
No	16

Almost all of the 642 comments could be grouped into 1 of 4 broad domains: (1) e-mail access and content, (2) effects of e-mail on the doctor-patient relationship, (3) managing clinical issues by e-mail, and (4) integrating e-mail into office processes. The full taxonomy is represented in Table 2. Twenty-six comments could not be classified into one of the domains. A prominent and consistent subdomain, use of e-mail for chronic-disease management, which was identified as a major finding, is summarized in Box 1. Details and examples of specific categories within the taxonomy are described below.

Textbox 1. Representative comments from the prominent and consistent subdomain of e-mail use for chronic disease management

I had a guy who wrote to me specifically about his dose of Ritalin and informed me how he was doing. I wrote him back and told him what to do about adjusting his dose.

Usually, I use it with patients that have an established condition that we are managing together and I want to spare them the time and expense of an office visit for something I don't really need to do an office visit for. These are my sugars what should I do? My asthma is kicking up should I increase my steroids?

For diabetic patients with sliding scales, they can send me email with their sugar levels and they will change their treatment according to what I recommend.

Patients sending in their home blood pressures, glucose monitors, ordering tests, making sure their tests get ordered before their visit, sending information back and forth to get stuff done.

Patients sending in their home blood pressures, glucose monitors, ordering tests, making sure their tests get ordered before their visit, sending information back and forth to get stuff done

Table 2. Taxonomy of comments

I. E-MAIL ACCESS AND CONTENT
E-MAIL AS AN ALTERNATIVE OPTION FOR PATIENTS
E-MAIL IMPROVES ACCESSIBILITY
Direct access to provider
Increases access to patients and providers away from office setting
ISSUES ADDRESSED VIA E-MAIL
Sensitive issues
Emergencies
Inappropriate
General information
Limitations
II. E-MAIL AND THE DOCTOR-PATIENT RELATIONSHIP
CONCERN REGARDING CONFIDENTIALITY
IMPACT OF E-MAIL ON TRUST/RAPPORT
III. MANAGING CLINICAL ISSUES BY E-MAIL
USE OF E-MAIL FOR CHRONIC DISEASE MANAGEMENT
USE OF E-MAIL FOR PATIENT EDUCATION
USE OF E-MAIL FOR RX REQUESTS
USE OF E-MAIL TO IMPROVE CONTINUITY OF PATIENT CARE
Previsit information
Followup
IV. INTEGRATING E-MAIL INTO OFFICE PROCESSES
GETTING STARTED USING E-MAIL WITH PATIENTS
Acceptance by physicians and patients
Promotion and initiation of e-mail use with patients
Selection of patients
POLICIES ON HOW TO USE E-MAIL
General
Medicolegal
Reimbursement
E-MAIL AND VOLUME OF PATIENT CARE
Ability to address more issues
Concern regarding overuse of e-mail by patients
IMPACT OF E-MAIL ON PRACTICE EFFICIENCY
Increased convenience and flexibility for patients and physicians
Managing time demands of physicians and patients
Volume insufficient to notice significant change in practice
INCORPORATING E-MAIL INTO DAILY OFFICE WORKFLOW
Documentation
Technical problems - information technology related
Use of office personnel
Responding to e-mail in timely manner

E-mail Access and Content

Many physicians considered e-mail as an alternative communication tool for patients and providers, primarily as a result of difficulties experienced with the phone system. These physicians believed that e-mail saves time spent on tracking patients down via the phone and allows more opportunity for patients to communicate with them during the busy workday and after hours. For example:

> *If they [patients] have a simple question that is not urgent then they don't have to wait on the phone, for example "Can I take my meds at bedtime with milk?"*

The comments reflected a belief that e-mail increases physician's accessibility to patients, both by providing a direct route to the physician and by allowing continuous communication when patients are traveling. Some believed that direct access to the physician is a benefit to the patients. A few stated that this could become a potential burden for the physician if there is no triage system with nurses or other office personnel. Others expressed concern about e-mails not reaching them at all or in an untimely manner. For example:

> *Sometimes [the nurses] filter questions [received by phone] appropriately but sometimes they don't. With e-mail, when patients mail me a concern I get it.*
>
> *I had a patient e-mail me with questions about whether he needed a tetanus shot [after an acute event] and I got the message [several days later]*

There were mixed opinions regarding the potential scope of topics covered by e-mail. Most felt that e-mail provided a somewhat-anonymous medium through which many patients could discuss "sensitive" topics that they may not have otherwise discussed. Patient surrogates, ie, family members or caretakers, have also used e-mail to introduce issues the patient had been reluctant to discuss with the physician. However, some physicians stated that there are some inherent limitations to using e-mail for communicating complex issues and that using e-mail cannot be done as casually as talking on the phone or in person.

There was also divergence on the issues of urgencies or emergencies. A few physicians gave examples of when e-mail actually helped in these situations and thought that e-mail could and should be used for emergencies. However, the majority believed e-mail should be utilized for nonemergency matters. Almost all the physicians felt that e-mail is a great medium for exchange of general information, such as scheduling and general clinical questions. When confronted with difficult, vague, or inappropriate questions, physicians generally asked the patients to call the office. Physicians in favor of e-mail told us:

> *There are some patients who are unable to communicate verbally but who are able to put information on paper or who have become accustomed to chat rooms. With those people, I have been able to communicate much more effectively. I had one patient who e-mailed me that she had another issue to discuss with me but she hadn't brought it up earlier because she was too embarrassed to do so in front of the medical student.*
>
> *Wives e-mail and tell me that their husbands are coming in and they are not going to say this but they are passing blood, etc.*

Those with concerns reported:

> *The only thing that I am scared of honestly is when patients e-mail me with problems like "shortness of breath" or with 20 questions which they feel like I should be able to answer right away.*
>
> *For me, e-mail or phone — I limit it. I use it only for getting some information. I don't even like using the phone for long communication, I ask the patient to come in.*
>
> *There is a difference between seeing someone in the office and seeing them via e-mail with nothing but a name.*

E-mail and the Doctor-Patient Relationship

These physicians seemed to have mixed views regarding confidentiality and e-mail. Some physicians were not concerned about confidentiality as long as the patients were "comfortable" using e-mail, while others were concerned and did not include personal information in e-mails. An example of these concerns is:

> *The biggest snafu that I committed was with a patient's husband, who was having an affair, I breeched patient confidentiality, by sending information to one spouse who I thought was then giving it to the other spouse.*

There was concern, among these physicians, of potential loss of trust and a negative impact on the doctor-patient relationship. When there is a loss of trust, it is difficult and takes a long time to regain. At the same time, physicians told us that e-mail communication has a positive effect on the doctor-patient relationship by increasing rapport and keeping lines of communication open. For example:

> *I look at e-mail as a fabulous way to establish a rapport with my patients.*
>
> *With e-mail we are able to keep the lines of communication open.*
>
> *Patients feel more of a one to one relationship*

Managing Clinical Issues by E-mail

Chronic disease management is one area of consistent agreement for our respondents. These physicians felt that e-mail is a very effective way of managing patients whom they know well. Many cited examples of using e-mail to manage conditions, such as diabetes, hypertension, psoriasis, and even congestive heart failure.

Many of these physicians also felt that there is great potential for exchange of educational information via e-mail, and, therefore, subsequent improvement in clinical management. They felt that e-mail is a useful educational tool. A representative comment is:

> *I have had a few patients [who] you don't have time in the office to give them specific details about their*

disease. I have compiled a list of articles or Internet sites, and I can e-mail those lists to them. It is not complete yet, it has to be categorized and organized more. But the patients love it.

One very-specific use for e-mail, stated by most physicians, is for prescription refills. There were comments, primarily from physicians who do not currently prescribe medications online, concerning the appropriateness of this, the medicolegal concerns, and the difficulty of doing this online. A few physicians who currently provide refills online also expressed these concerns. A separate site designed to deal specifically with medications was suggested as a helpful alternative. Physicians told us that they have realized that e-mail can be very effective for this aspect of patient care. For example:

A few patients have got hold of my e-mail address and have started to send me information about prescription renewal or questions. At first, I thought it was an intrusion but I realized what a time saver it was. So yes, I now use it for my regular practice as well; it has helped efficiency.

Most physicians' comments seem to reflect the idea that e-mail can improve the continuity of patient care if used for previsit information gathering and followup, particularly with test results and scheduling of tests previsit; this is primarily useful for patients with chronic diseases and for those with whom they had an ongoing relationship. Some stated that receiving preliminary information — such as basic past medical history, allergies to medications, and current medications and doses — prior to the visit saves time during the visit and allows more time to be spent on management. Physicians also felt that e-mail allows patients to communicate with them after leaving the office, particularly for clarification or asking questions they forgot during the visit.

Integrating E-mail Into Office Processes

There were numerous concerns regarding the technical and day-to-day aspects of actually integrating e-mail communication into daily practice. Comments ranged from the general acceptance of e-mail by patients and providers to broad policy issues and technical implementation into the daily schedule. For the most part, physicians seemed to accept e-mail and felt that it is going to increase in the future. Most physicians felt that their patients who use e-mail love it. There was some ambivalence though, particularly regarding how and for what purposes it should be used. One comment described e-mail as a "double edged sword." There was also some concern regarding the potential substitution of e-mail for visits. For example:

A policy needs to be in place regarding expectations about response time, what can be asked, the types of things that would be appropriate or inappropriate, and how my e-mail would be handled if I were to go out of town.

Selection of patients for e-mail communication appears to be an issue with which physicians are grappling. Physicians appear to be selective in choosing patients whom they will communicate with via e-mail, but it is not clear, other than patient access to the Internet, what criteria they use. For example:

I have chosen my patients impromptu, people who I think can handle the task [of using e-mail].

There are a few patients who I do not know well, and e-mail in those instances, is logistically more difficult. I only give it to selected patients. I kind of pick the ones that I know won't abuse it.

Promoting and initiating e-mail with patients was also an area of confusion for these physicians. While some physicians were offering the use of e-mail to their patients, a number of physicians commented that patients initially approached them with the idea of using e-mail. A few had advertised the use of e-mail on their Web pages and business cards. There were reservations regarding getting inundated with e-mail, with current methods of advertisement, and these concerns deterred some physicians from putting their e-mail on the business card. On the other hand, there was a fear of disenfranchising patients if they did not offer e-mail.

With regard to general and medicolegal issues, the responses indicated that physicians do not have formal policies in place regarding how e-mail should be used with patients. Those who did have formal policies in place generally had a consent sheet or had their patients sign a waiver; a few physicians followed American Medical Association (AMA) guidelines [16]. Many had informal dialogue with their patients and a general implicit acceptance and belief that their patients understood that e-mail would be used in specific ways, such as for nonemergency use. Many indicated that a formal policy would be important and useful to having e-mail run smoothly, particularly addressing such issues as response time and appropriate content, including updates on progress and general medical questions.

Physicians felt that they should be reimbursed for e-mail exchanges, but were skeptical that this would happen in the near future, as they had difficulty getting reimbursed for phone consultations. Again, opinions varied. Some of the physicians did not seem to be too concerned regarding reimbursement, while others feared that this is a potential deterrent to widespread use of e-mail. The following comments are a few examples:

If no one is going to pay you for the time, it is not cost effective to use e-mail.

Unless reimbursement changes, e-mail consultation won't work.

For physicians time is money.

There were diverging comments on the impact of e-mail on volume of patient care. Some physicians reported that they were able to address more issues and take care of more patients since some of the preliminary, noncritical topics were handled by e-mail. Others reported concerns that e-mail can be redundant, overused by patients, time-consuming, and can potentially overburden physicians as e-mail use increases. This is an anticipated fear.

There were also conflicting opinions and experiences regarding the impact of e-mail on efficiency. Some stated that e-mail was more convenient, offered more flexibility and saved time. Others felt that e-mail could become an added burden, particularly if the physician is solely responsible for handing the e-mails. Most physicians felt that e-mail is more convenient and increases the

flexibility of both physicians and patients in terms of addressing medical questions. The ability to communicate via e-mail outside office hours and on their schedule is viewed as an important benefit. Some examples included:

> *E-mail is so much more efficient, you end up knowing the patients so well by the time they come for followup, that you can ask more direct questions about what has been going on with their lives, why their blood pressure is consistently up, etc.*
>
> *No matter what you do there is always limited time in the office. With e-mail the patients are unlimited with their time. They can ask me questions that they forgot to ask while they were in the office.*
>
> *It is more work for the physicians. On the other hand, I can answer e-mails when I am at home, when I am eating, or whenever.*

There did not appear to be a clear method of documentation. Some respondents felt that documentation by e-mail was much better and easier than by phone; others, who were struggling with how to do this efficiently and incorporate it into office flow, felt that documentation was worse with e-mail. For example:

> *There is much better documentation. I write my response, copy it, and put it in the medical records. In terms of efficiency, it is a wash because it takes me as much time to write an e-mail as to make a phone call.*
>
> *Things are not documented as well as when patients use the phone. We have a formal system of phone calls, but not for e-mails.*

Physicians were concerned about the technical aspects of using e-mail — particularly with servers malfunctioning and systems failing, inadvertently leading to missed e-mails. This appeared to be more of an anticipated concern than one frequently experienced.

Finally, there was a wide spectrum of opinions and experiences in reference to use of office personnel and colleagues using e-mail to communicate with patients. Most physicians had not fully broached the subject with their staff. Many who did felt that their staff was not prepared or interested in using e-mail. The few who had incorporated office personnel into e-mail communication met with success. Most physicians seemed to be responsible for accessing their own e-mail, even when out of town, although some respondents told us about colleagues accessing their e-mail.

Discussion

We attempted to search for what is currently working in electronic patient-centered communication, and through that, to identify "what might be" in the future. We talked with 45 physicians who were frequently using e-mail with patients and found that most opinions regarding electronic patient-physician communication were positive. These physicians did see a benefit to using e-mail in specific situations with specific patients. Physicians reported better and more-consistent communication with patients who have chronic diseases and require frequent, small changes in management. Respondents noted several other benefits including continuity of communication with patients (particularly patients who travel), ability to respond to nonurgent issues on their own time, avoidance of phone tag with patients, and improved efficiency in certain scenarios. Drug-refill requests and dissemination of educational information, including links to reliable Internet sources, were also cited as examples of the effective use of e-mail with patients.

Despite the positive experiences, e-mail communication is not yet widespread in clinical care. We heard about a number of barriers that may be influencing this, such as uncertainty of involving office staff, potential of increased demand on physician time (particularly with overuse of e-mail by patients), difficulty incorporating e-mail into daily office work flow, generating timely responses, inappropriate or urgent content in the messages, confidentiality issues, and lack of reimbursement for this service. In previous research by Moyer et al, almost half of a sample of physicians at 2 university-based primary care clinics indicated concerns about being overwhelmed by patients' e-mails and felt that e-mail with patients would add to their workload if they used it in their clinical practice [10]. The only controlled trial implementing e-mail communication between physicians and patients revealed no significant reduction in volume of phone communication; thus supporting these physicians' concern [17]. Although most physicians did not express concern about confidentiality, those who did were very concerned. Current guidelines for physician-patient e-mail and medicolegal reports identify the potential risks to confidentiality and the importance of establishing policies for integration of technology into practice [18]. Despite existence of guidelines [16,18], physicians, for the most part, do not have established formal policies or guidelines that they use with patients regarding e-mail communication. Those who do have formal polices in place appear to have fewer concerns about content and overall use.

The respondents anticipated other problems with e-mail communication, such as reimbursement problems, logistic and technical problems (such as failing servers, lost e-mails), and medicolegal consequences of e-mail used for urgent issues, but had not frequently experienced them. The physicians in this study appeared quite concerned about the "nuts and bolts" of integrating the technology into the workflow of their clinical practice. Technology for secure communication between physician and patient has not been widely integrated with the medical record system or other office systems for scheduling or triage. Future development in this area may increase e-mail adoption. Expert opinions from prior literature have highlighted additional limitations of e-mail physician-patient communication [13]. Specifically, the asynchronous nature of the communication may not be amenable to complex diagnostic issues.

An important aspect of e-mail communication involves how physicians select patients for whom they will start e-mail communication. Criteria used to select patients for e-mail communication, such as a patient's "ability to handle it" (verbatim comment from one of the physicians), were not well defined or objective, and do not depend only on access to the

Internet. Whether selection depends on the length of the doctor-patient relationship, the nature of the medical issue, educational achievement of the patient, or other factors is not clear and requires further research. E-mail communication may lead to greater, not less, inequality in access to care for certain patient groups.

Our study is limited by a relatively-small sample size. The sample was recruited from an online physician organization and is probably more Internet savvy than most physicians. However, these physicians represent several specialties and were from a wide geographic region. Because the use of electronic patient-centered communication is largely unstudied, we feel that the qualitative nature of this study has particular strengths. Our results included 642 comments from physicians across the United States who are frequent users of this technology and reflected a wide range of opinions. Many outcomes, including the selection of specific patients, the lack of concerns related to confidentiality, and the large number of anticipated but unrealized technical problems, were not perceived as potential major themes prior to collecting these data. We believe these qualitative methods have provided useful pilot data for future studies of the feasibility of dissemination and potential impact of this technology.

These physician respondents did perceive benefits to e-mail with a select group of patients. Through this study we identified several areas of future research. These include: developing criteria for selecting patients to use e-mail; increasing dissemination of formal guidelines regarding e-mail use; improving incorporation into office flow; use of office personnel to manage e-mail; clarifying medicolegal consequences; and mechanisms for reimbursing online medical care/communication.

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Conflicts of Interest

None declared.

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Original Paper

The Evolution of Web-based Medical Information on Sore Throat: a Longitudinal Study

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Abstract

Background: The content of a page can change and is likely to change over time; this is one of the useful qualities of the Web, but also a dangerous one.

Objective: To monitor the evolution of Web page contents on sore throat over a 3 year period.

Methods: Two medical doctors independently evaluated 34 Web pages on sore throat. Pages were found using a metasearch engine. The evaluation factors were: the adherence of medical contents to a gold standard (American Academy of Pediatrics recommendations) composed of 5 subfactors (epidemiological, clinical, complications, diagnosis, and therapy); the completeness of the contents in terms of considered/missed factors of the gold standard; references to medical literature; and a specified last update of the page. During the observation period these sites were revisited twice, after 28 and 39 months, to examine any changes therein since the first visit.

Results: The degree of adherence to the gold standard did not significantly change. Variations (both positive and negative) were recorded solely with regard to the update and references factors as well as with regard to the availability of the pages over time (18% disappeared during the observation period).

Conclusions: In 3 years medical contents have not changed significantly and despite the contemporary epochal Internet revolution (in terms of, eg, technology, graphics, and access) and the increase in the number of sites dealing with the issue of sore throat, there has been no corresponding qualitative increase in the contents of the pages monitored.

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KEYWORDS

World Wide Web; Internet; evolution; sore throat; quality of contents; quality control; longitudinal studies

Introduction

The Internet is a relatively-recent phenomenon and its evolution and use by nonprofessionals have developed especially in the last 5 years. The usefulness of medical cyberspace continues to grow and links, search engines, and the presentation of information as well as users' Web-surfing skills all seem to be steadily improving. The use of the Internet is also rapidly increasing in Italian households. Our previous study carried out on a population of parents in 1999 showed that approximately 19% of an unselected sample of parents used the Internet to acquire medical information [1]. The ability to obtain medical information quickly, cheaply, and in the home represents an important development for better-informed participation in the care of children. From the point of view of pediatricians the dissemination of correct medical information to parents is an essential aspect of childcare. In our evaluation we did not consider such factors as usability and aesthetics. These areas, which are most certainly of interest in parents' consideration of a good Web page, are discussed in another study now in

progress. Despite growing interest in evaluating health information on the Web, professional users say information quality is a problem [2- 6]. Eysenbach [7], in a recent systematic review [7] on what he called "infodemiology" [8] studies, i.e. studies where investigators evaluated the quality of health information on the web, reported that the greater part of studies (70%) concluded that quality is poor on the Web, while only 9% gave a positive statement.

The content of a page can change and is likely to change over time; this is one of the useful qualities of the Web, but also a dangerous one. Although many attempts have been made to assess, control, and assure the quality of Web-based medical information [9- 11], there is no single standard strategy for evaluating Web pages available to nonprofessional users such as parents. The Web is truly an international press and is essentially unregulated [12]. Although the cited authors provide relevant results, their analysis is on the status of the quality and not on its evolution over time. Since the Internet is continuously changing, our evaluation during a 3-year period could be an additional element for investigating this phenomenon. A contribution in this direction is offered by the study of Pandolfini et al [13] who replaced their study of 1997 [4] and reevaluated the quality of the same sites included in that study, as well as that of a more-recent sample of pages, using the same methodology. Li et al [14] conducted a prospective systematic review of Web sites related to back pain, using 5 search engines, during a 2-year period. In our study we carried out an evaluation of the content of medical Web sites directed to parents and we repeated the study of the same Web pages after a 24 and a 39 month period respectively.

Methods

On August 12 1998 we searched the World Wide Web for the first time using Metacrawler, a metasearch system that in 1998 combined 6 different search engines (Alta Vista, Excite, Infoseek, Lycos, Webcrawler, and Yahoo). Because of the differences among the search engines (eg, Infoseek is a random-search tool and Alta Vista ranks the requested references in order of relevance) a metasearcher combines such different approaches in a unique "independent" collection that could be linked to the way in which parents — who have variable experience, culture, and computer ability — perform the search.

We used the English words: *sore throat* and *pharyngitis* and the corresponding Italian translations: *mal di gola* and *faringite*(ie, the medical condition and its symptom, because the parents frequently use the same words for their research) without Boolean operators, as Metacrawler did not use them in the search; the results displayed 97 Web sites. As occurs in all Internet searches, some inappropriate documents appeared. We excluded all pages in which the words of our search appeared in a nonmedical context; ie, we excluded all pages created by commercial ventures and corporate sites sustained by advertising and sales of commercial products (eg, candies, oral spray, and herbal tea) as well as pages related to veterinary purposes. After the exclusion of the inappropriate sources, 34 Web sites were included in the study. These Web sites were all created by health care authorities (eg, American Medical Association and American Academy of Pediatrics), hospitals (eg, Children's Hospital of Iowa and St. James Hospital), departments of public health (eg, Hawaii, Illinois, and Bethesda), research foundations (eg, MayoClinic), or other lay health care organizations (eg, WellnessWeb, MedicineNet, HealthyNet). The list of evaluated sites is in Table 1.

To evaluate the quality of each Web site, we considered the adherence to some of the criteria suggested in literature available in 1998 on this topic: suitability of the medical contents, scientific citations, and date of creation and/or of the last update. We compared the medical contents of all these Web sites with the recommendations of the Committee on Infectious Diseases of the American Academy of Pediatrics [15], whose guidelines did not change between then and the last edition published in 2000 [16].

Textbox 1. Score Criteria

Adherence

The median score of the present factors was used as the global evaluation of *adherence*. Since our gold standard consists of 5 factors (epidemiological, clinical, complications, diagnosis, and therapy), each factor was evaluated according to the following scale: 1 (low, in case of errors or no adherence); 2 (medium-low adherence); 3 (medium adherence); 4 (medium-high adherence); and 5 (full adherence).

Completeness

Completeness was determined according to the number of considered/missed factors of the gold standard: 1 (the worst, in case of 1 factor), 2 (bad, 2 factors), 3 (medium, 3 factors), 4 (good, 4 factors), 5 (the best, all factors).

References

References: 1 if the page listed some pertinent references about its contents.

Update

Update: 1 if the page contained the date of creation (or its last update).

According to these criteria, the quality of the Web pages was independently evaluated by 2 medical doctors (VC, a senior pediatrician, and PSB, a resident) to validate the medical information for parents. Each doctor evaluated every Web site individually without knowing the site's address or author. When the 2 authors disagreed, to ensure the reliability of the rating they talked about the disagreement until they reached a common value.

On December 12, 2000 and on November 12, 2001 all 34 sites included in the study were revisited to see if the pages still existed or if they had been substituted with new pages. All pages

were reevaluated with the same methodology, comparing the content with copies of the original pages. The missing pages were manually searched in the Web (by means of Altavista, Google, and other search engines) starting from the address and/or the contents of the previously-evaluated pages. The results were analyzed through Wilcoxon's paired signed rank test and the McNemar test.

Table 1. Sites evaluated and their respective homepage URL

Organization	Homepage URL
Abersychan Surgery	http://www.abersychan.demon.co.uk/
American Academy of Pediatrics	http://www.aap.org/
American Medical Association	http://www.ama-assn.org/
Association of State and Territorial Directors of Health Promotion and Public Health Education (ASTDHPPHE)	http://www.astdhpphe.org/
Baltimore County Public Schools	http://www.bcps.org/
Beijing Scene Publishing	http://www.beijingscene.com/
National Center for Emergency Medicine Informatics	http://www.ncemi.org/
Children's Medical Center of Dallas	http://www.childrens.com/
ComWeb	http://espaceweb.qc.ca/
Darthmouth-Hitchcock	http://www.healthimprov.org/
Drugbase	http://www.drugbase.co.za/
Eastern Wyoming College	http://ewcweb.ewc.whecn.edu/
http://www.fcr.re.it/	http://www.saninforma.it/
Group Health Cooperative	http://www.ghc.org/web/
Hawaii Department of Health	http://mano.icsd.hawaii.gov/doh/
HealthWorld Online	http://www.healthy.net/
HealthAnswers,Inc	http://www.healthanswers.com/
Housecall Medical Resources, Inc.	http://www.housecall.com/
linois Department of Public Health	http://www.idph.state.il.us/
Kenyon College	http://www.kenyon.edu/
MayoClinic.com	http://www.mayoclinic.com/
MedicineNet, Inc.	http://www.medicinenet.com/
Medscape Portals, Inc.	http://www.medscape.com/
National Institute of Allergy and Infectious Diseases	http://www.niaid.nih.gov/
Nightime Pediatrics Clinics, Inc.	http://www.nightimepeds.com/
Seton Hall University	http://studentaffairs.shu.edu/
St. James's Hospital	http://www.stjames.ie/
The Nemours Foundation	http://www.kidshealth.org/
University of Iowa	http://www.medicine.uiowa.edu/
University of Colorado at Boulder	http://www.colorado.edu/
University of Iowa Health Care	http://www.uihealthcare.com/
University of Missouri-Rolla	http://www.umr.edu/
University of Rochester	http://www.rochester.edu/
WellnessWeb	http://www.wellnessweb.com/

Results

During the observation period, 6 (18%) of the 34 pages monitored disappeared between August 1998 and November 2001; 3 pages were no longer available after 28 months with the remaining ones no longer active by 39 months. Table 2 summarizes the results of our survey for 1998, 2000, and 2001

and shows for each variable (adherence, completeness, update, and references) the number of Web sites for each score.

Table 2. Comparison of scores for 1998, 2000, and 2001

Score Criteriaand Score	Number of Web Sites		
	Year		
	1998	2000	2001
Adherence			
1	3	3	2
2	1	1	1
3	5	4	4
4	5	5	3
5	20	18	18
Completeness			
1	0	0	0
2	4	4	4
3	6	4	3
4	8	6	6
5	16	17	15
References			
0	29	27	24
1	5	4	4
Update			
0	22	19	16
1	12	12	12
Number of sites evaluated	34	31	28

Because only 1 Web site showed a large degree of variation in terms of adherence and completeness to the gold standard, no statistical analyses were performed. Most variations relate exclusively to update and references; to evaluate their evolution, we made the Wilcoxon's paired signed rank test and the McNemar test for the pairs of years 1998-2000 and 1998-2001. The differences were not significant ($P > .05$) for update and references for either pair of years. The pair 2000-2001 was not considered because there were not differences between respective values, the only difference was in the number of available sites.

Discussion

If it is true that the Internet is continuously developing as regards the quantity of information available and the number of sites online, it seems that the same cannot be said for the quality of the information provided. This leads one to have doubts as to the effective greater dynamism of Web publications compared to publications printed on paper. Only 3 sites in our sample modified the pages relative to sore throat during the observation period and in 2 cases the changes did not have any significant impact on quality. With the exception of 1 site, the medical contents of the reevaluated sites remained similar to the initial version; apart from the foregoing, improvements were recorded only in aesthetics (2 sites) and a request for HON certification (1 site).

Of the 5 gold standard factors, the least common one is *complication*(about 60% of the sites) whereas *clinical* is in all sites. The factor that adheres least of all to the gold standard is *therapy*(72%). Overall average adherence is 81%. Only 12.5% of the sites give any indication of references. Only 33% of the sites specify the date of creation or of the last update. In our opinion it is very important for the reader to know the date the page was written; a recent date would imply possibly-better information, especially for the sites with a bad evaluation. In addition, some authors [7- 18,9] included the date of creation or update of the page among the items to consider when you want to evaluate health-related Web sites. In particular Abbott [17] included the update under the category of "content." Although this article was published after the beginning of our study, its conclusions reinforced our considerations. The low number of sites that dedicate space to complications is probably because these sites are addressed to more "impressionable" nonprofessionals (often parents) whose anxiety for their children's health dictates that it is better that matters like this are discussed personally and directly with a pediatrician. Of greater concern is the poor quality of therapeutic advice, since dealing with the issue inadequately means there is a risk of people treating themselves erroneously.

In the observation period the relevant changes were restricted to *update*(15 sites) and *references*(6 sites). An unexpected result was that the number of improved sites was the same as the number of those that became worse; hence the overall average result was the same as before. This leads one to wonder if such a trend is limited to the pages on sore throat or whether it is also applicable to other contexts.

It was not always trivial to find a missing page through the initial address or via a simple path starting from the home page. The Web administrator often made a major change in the location of the page in the site. In some cases there were no direct links to reach the new location; instead, the new page was only accessible by using a search engine In 1 case, the Web site on which the page was published ceased to exist.

Our research was limited in terms of the observation period, the number of monitored sites and the unique medical issue considered. The idea of conducting a broader and more-systematic analysis of the evolution over time of the pediatric information available to parents via a suitable "Internet observatory" is an important challenge. Unfortunately, the huge number of sites and issues to be monitored require a correspondingly huge amount of resources; nevertheless there is the need to continuously improve the efforts to provide the final user such services.

Conflicts of Interest

None declared.

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Original Paper

Use of the World Wide Web to Implement Clinical Practice Guidelines: A Feasibility Study

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Abstract

Background: Important efforts have been invested in the past few years in the development of quality clinical guidelines. However, the means for the effective dissemination of guidelines to practicing physicians have not been determined. Several studies have examined the possibilities offered by the World Wide Web (the Web), but studies examining the implementation of clinical guidelines in actual practice are clearly lacking.

Objective: This study assessed the potential of the Web to implement clinical practice guidelines in actual clinical settings. It also documents the obstacles perceived by the physicians in their use of guidelines on the Internet to determine the role that the Web can play in the implementation of guidelines in practice.

Methods: Two guidelines were developed using a standardized panel method and made available via the Web. One concerned indications for low-back surgery and the other dealt with indications for upper and lower digestive endoscopies. To identify obstacles to their use in clinical practice, 20 physicians were asked to consult the guidelines during consultations with patients. Answers were collected using 3 different questionnaires.

Results: Questionnaires were completed for consultations involving 213 patients. Less than 50% of the physicians have direct access to the Internet in their examination room. For 75%, the use of the guidelines was easy and the time required to consult them acceptable (3.4 minutes on average, or 12% of the time spent with the patient). The fear that use of such guidelines might interfere with the physician-patient relationship was mentioned as a reason for not consulting the guidelines for 27 consultations. Taking into account their experience with the Web, 75% of the physicians considered that the Web has a great or very-great potential for the dissemination of guidelines and 78% indicated that they would use such guidelines if they became generally available for clinical questions that concerned them. Only 3 physicians had consulted guidelines on the Web prior to this study.

Conclusions: The acceptance of use of clinical practice guidelines via the Web is high. The main limits to further use of such Web-based guidelines seem to be the lack of a computer connection in the physician's office or examining room and the fear that use of such guidelines might interfere with the physician-patient relationship. Though most participants appreciate the considerable potential of the Web for disseminating guidelines, only a small handful regularly use guidelines available on the Web. There are still numerous obstacles to the regular use of guidelines in clinical practice, some related to the physicians, others to the guidelines themselves.

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KEYWORDS

Practice guidelines; Internet; decision support systems, clinical; appropriateness of care; quality of health care; back pain; laminectomy; endoscopy

Introduction

This study assessed the potential of the World Wide Web to implement clinical practice guidelines in real clinical settings. It highlights the obstacles perceived by the physicians in their use of guidelines on the Internet.

Dissemination of Guidelines Alone is Not Enough, it Needs to be Combined With an Implementation Strategy

Clinical practice guidelines are defined as systematically-developed statements to assist patient and practitioner in decisions about appropriate health care for specific clinical circumstances [1]. Clinical practice guidelines are intended to increase the quality of patient care by reducing variations in practice and to control costs through more-efficient use of health care resources [1]. But formulating guidelines is easier than making them work [2]. More than 50 systematic reviews on strategies and approaches for implementing guidelines in clinical practice have been undertaken in the last decade [3]. The results are, however, not straightforward. Strategies effective in one study were not effective in others. Even when a strategy was effective, it was often not clear what had caused the change [4]. A combination of different activities in a well-designed implementation plan is usually the most-effective approach [5,6]. Evidence-based medicine should be complemented by evidence-based implementation [5].

The benefits of the Internet in Health Care Will Depend on its Ability to Provide Efficient and Effective Ways to Access and Use the Knowledge That We Need, When We Need It, and In the Right Format

A growing number of papers in the medical literature present information systems in general and on the World Wide Web in particular as a promising media to implement guidelines [7,8,9,10]. In spite of these enthusiastic opinions, proofs of the effectiveness of the Internet to implement guidelines are still lacking [11,12,13]. Several studies based their conclusions more on hopes than on strong evidence [14,15]. The more-interesting studies [16] have aimed at testing clinical guidelines that could be delivered over the Internet. Those authors conclude that when tested in clinical scenarios compliance of the physicians is better with electronic guidelines than with paper guidelines.

The aim of our study was to go one step further in assessing the potential of the Web to implement clinical practice guidelines in the physician's office in real clinical settings. The importance of validating the effectiveness of guidelines via the Web in clinical situations has been emphasized by several authors [17,18,12].

Some obstacles can be expected in terms of the difficulty of changing physician habits [19,20,21] and the perceived intrusion of the computer into the doctor-patient relation [22]. However, it is precisely because such resistance exists that studies to address ways to overcome that resistance are important. Before a strategy to implement change is selected the obstacles to change have to be identified.

Methods

Guidelines

The guidelines used in this study were developed using a standardized panel method (RAND) [23,24]. The proposed guidelines are designed to provide guidance for the individual patient and feedback to the physician, both of which are elements that have been identified as favorably impacting the successful implementation of clinical guidelines [25,26,27]. They consist of explicit criteria for the evaluation of the appropriateness of medical procedures, which combine a detailed review of the literature with systematically-developed collective-expert opinion. The concept of appropriateness refers to the relative weight of the benefits and harms of a medical or surgical intervention. An appropriate procedure is one in which "the expected health benefit exceeds the negative consequences by a sufficiently wide margin that the procedure is worth doing, exclusive of cost" [24]. The rationale behind the method is that randomized clinical trials, the gold standard for evidence-based medicine, often are not available or cannot provide evidence at a level of detail sufficient to apply to the wide range of patients seen in everyday clinical practice. The RAND method combines the best available scientific evidence with the collective judgment of experts to yield an assessment of the appropriateness of performing a procedure at the level of patient-specific symptoms, medical history, and test results.

The guidelines studied in this paper concerned the indications for low-back surgery (laminectomy) and upper and lower digestive endoscopy. They were then transcribed into HTML (Hyper Text Mark-up Language) and made available on the Web.

See Multimedia Appendix 1: PowerPoint presentation of laminectomy guideline (3 minutes).

Participating Physicians

An invitation to participate in this study was sent to 98 physicians in private practice in the French-speaking part of Switzerland. They were chosen because of expressed interest in this feasibility study and because they were believed to have patients concerned about the subject of the 2 guidelines. They were informed that an inclusion criterion was an Internet connection. The general practitioners were asked to test both guidelines, the neurosurgeons and rheumatologists the low-back surgery guidelines (laminectomy) [28], and the gastroenterologists the endoscopy guidelines [29].

Survey

The participating physicians first reported on their use of the Internet and about their computer equipment. Then, each participating physician was requested to use the electronic

guidelines in the evaluation of all eligible patients during a period of 3 weeks, or a maximum of 20 patients. Any patient presenting with upper or lower gastrointestinal symptoms or with low-back pain or sciatica was eligible for inclusion in the study. For each eligible patient, the physician was asked to report on whether he/she consulted the Web guidelines, reasons for nonconsultation, length of consultation (total patient and online access to guidelines), difficulties in accessing or understanding the Web guidelines, appropriateness of the procedure, whether the procedure was proposed to the patient, and whether the patient would undergo the procedure.

At the end of this testing phase, the physician was asked about the acceptability of the Web site and ways to render it more accessible, acceptable, and user friendly. Questions centered on obstacles to use, functions which were particularly helpful or not used, functions that could be added, ease of use, usefulness, perceived potential (with improvement), and whether the use of the guidelines disturbed the physician in his/her work routine or in his/her relationship with his/her patient.

Results

Of the 98 physicians, 33 manifested interest in participation. Of those 33, 20 (14 general practitioners, 1 gastroenterologist, 1 neurosurgeon, and 4 rheumatologists) consulted the guidelines for at least 1 patient. The main reasons for nonparticipation were lack of time and/or the unavailability of an Internet connection at the time of the study. The guidelines were consulted for 213 patients.

Computer Equipment and Previous Experience With the Web

The response rate was 98% for the general items dealing with use of the Web and computer equipment. All 20 physicians had experience navigating on the Internet; 18 stated doing so at least once a week. The majority (13) indicated accessing both medical and non-medical sites, but only 3 were aware of guidelines available on the Web. None were aware of the National Guideline Clearinghouse Web site [30].

Though it would seem to be a requisite condition for our study, only 9 participants actually had a computer in their office, 5 have one in their secretariat, and 1 in another room in the practice. Concerning Internet connections, 8 physicians used an analog modem at 56 Kb/sec, 8 a digital modem (ISDN - Integrated Services Digital Network), and 4 a more-rapid connection.

See Appendix 2: questions and summary of responses for questionnaire "Computer equipment and previous experience with the Web (extract)."

Use of the Guidelines Web Sites

For the whole set of questions, the average rate of response was 85%. The physicians consulted the back-surgery guidelines 104 times and the endoscopy guidelines 80 times. The main reasons for not consulting the guidelines were fear of disturbing the physician-patient relationship (n = 27) and that the situation was so clear that reference to guidelines was not necessary (n = 22).

In 87% of the cases, the computer was already turned on when the physician intended to consult the guidelines and in 94% of the cases the Internet connection was established without difficulty.

In 96% of the cases the physician was able to readily reply to the questions on the guidelines site. On average, the total length of the consultation was 27 minutes, including an average of 3.4 minutes consulting the guidelines site online (12% of total consultation time, range 3% to 33%).

According to the guidelines, the procedure was appropriate in 32% of the cases, uncertain in 14%, and inappropriate in 54%. In 90% of the cases the physician was in agreement with the treatment approach proposed by the guidelines.

See Appendix 3: questions and summary of responses for questionnaire "Use of guidelines sites."

Evaluation of Guidelines

The response rate for the questionnaire concerning the general evaluation of the use of the two sites was 92%. Among the 20 physicians who had used both sites, 7 preferred the endoscopy site, qualifying it as more useful; 3 preferred the back-surgery site, qualifying it as faster. Almost all participants considered access to both sites as easy.

Nineteen felt the access time for both sites was acceptable.

Fifteen felt that the use of such guidelines as a decision tool was easy or very easy.

All felt that the use of the guidelines had little or no effect on their relationship with the patient. Fourteen stated that the use of the guidelines did not significantly disturb their working routine. Fourteen felt that such guidelines are of little or no use for determining the appropriateness of guidelines for medical procedures.

Taking into account their experience with the Web, 75% of the physicians considered that the Web has a great or very-great potential for the dissemination of guidelines and 78% indicated that they would use such guidelines if they became generally available for clinical questions that concerned them.

See Appendix 4: questions and summary of responses for questionnaire "Evaluation of guidelines."

Discussion

Since the aim of this project was more to test the physicians' acceptance of implementing guidelines via the World Wide Web than to test the validity of the guidelines, the evaluation covered the aspects of content, form, and functioning of the Web guidelines, and acceptance by the physician. This evaluation included elements that have been identified as important in the implementation of guidelines in general [26,31]. The question of whether the guidelines led to the appropriate decision - an important question in its own right - has been and is being addressed in other studies and is not the object of this study.

To appreciate the role of the Web in the dissemination of guidelines and highlight the obstacles perceived by the physicians, several results should be emphasized:

- In spite of a highly-selected group of participants who were no doubt better equipped than the average physician in private practice, only a minority of physicians has a computer in their consultation room. Concerning the fear of disturbing the physician-patient relation, the answers are ambiguous. On the one hand, to justify the nonutilization of the guidelines for certain eligible consultations, the participants evoked fear of disturbing the relationship, and yet on the other hand, in the general evaluation at the end of the study, all participants indicated that the consultation of the guidelines involved little or no interference with that relationship.
- The user friendliness of the 2 guidelines sites was not an obstacle as the participants felt they were easy to use and that access time was acceptable. Seventy-five percent of the participants considered that the Web has great or very-great potential for the dissemination and use of guidelines.

Acceptability by the physician of implementing guidelines via the Web thus appears very high. These results allow us to conclude with confidence that the Web will be an essential tool for future guidelines-implementation strategies.

Previous studies on the possibilities of using the Web for the implementation of guidelines have shown that physician compliance is better with electronic guidelines than with paper guidelines [16]. The importance of this study in relation to previous ones is thus related to the fact that we actually tested the guidelines in clinical situations and not merely through scenarios. Our results are thus of interest in pinpointing the obstacles encountered by physicians in their daily practice.

Our study does have several limitations. Most important among these is the lack of representativity of the participants. Being a feasibility study, we chose to limit participation to physicians interested in the use of the Web in their practice and having access to a computer in their place of work. Thus, although we cannot extend our results to all physicians in Switzerland, we can reasonably consider them as representing the best-possible scenario for the implementation of guidelines via the Web, at the present time. A further limitation, also related to the nature of the study, is that we can say nothing about the appropriateness of the decisions taken by the physicians after consulting the guidelines. To have sufficient data, we asked participants to consult the guidelines even if there was no clear need to do so. This fact - consulting guidelines even if it may clearly not lead to needed information - may have affected the results.

The Ready Availability of Guidelines on the Web is a Necessary, but Not Sufficient, Step Toward Integrating Guidelines Into Clinical Practice

The fairly-high acceptability of the Web-based guidelines needs to be tempered by the following observations:

- Only a minority of physicians have used guidelines on the Web.
- A majority of participants felt that the 2 guidelines were of little or no use in actual practice.

One of the puzzling yet important results of our study is the discrepancy between the statement that the participants wish to use the Web for guidelines and the fact that they rarely do so. The fact that the participants did not generally have ready access to a computer connected to the Internet cannot, in our opinion, explain this limited use of Web-based guidelines.

To be Effective, Information Systems Must be Easy to Access and Use, and Must Provide Rapid Access to Appropriate Information [28]

Several hypotheses can be advanced that require further study and verifications:

- The physicians may have insufficient knowledge and awareness of medical Internet sites and not know where to find high-quality guidelines [32,8].
- The guidelines currently proposed via the Web may not correspond to the actual needs of physicians, either because of the content or because the presentations do not match up with the expectations of physicians. The transfer of paper-based guidelines to Web-based guidelines is not straightforward [13]. Guidelines need to meet certain standards and live up to certain criteria that ensure homogeneity in content and presentation [13]. The National Guideline Clearinghouse site is a step in this direction [30].
- Improved integration of guidelines into the clinical process may also facilitate use. In this vein, the integration of guidelines into computerized medical records will certainly be a fertile field of investigation [10,7]. For ready and rapid access to guidelines, a further approach that needs to be pursued, tested, and evaluated is the availability of guidelines in palm-held computing devices [33].

Training, Standardization and Integration

In conclusion, this study demonstrated that, among motivated and fairly well-equipped physicians, the acceptability of using clinical practice guidelines via the Web is high. The main limitations to such use appear to be the absence of access to the Web at the site of consultation and perhaps the fear of the physician that consulting such guidelines will disturb the physician-patient relation. There are however numerous obstacles to overcome related to the physician or the guidelines before Web-based guidelines will become part of the everyday practice of medicine.

Future interventional studies should examine whether improved knowledge of medical Internet sites and improved skills in using those sites can increase and improve the use of Web-based clinical practice guidelines.

A minimum of standardization of Web-based guidelines might facilitate their use, and it will probably be necessary to develop and implement standardization for the quality and presentation of Web-based guidelines along the lines of what has been undertaken by the National Guideline Clearinghouse and the AGREE (Appraisal of Guidelines Research & Evaluation) collaboration [34].

Finally, it will be necessary to pursue research to better integrate the use of guidelines - in particular Web-based guidelines - into daily clinical practice.

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Conflicts of Interest

None declared.

Multimedia Appendix 1

Screenshots of www.epage.ch (European Panel on the Appropiateness of Gastrointestinal Endoscopy) [PPT File, 388K - jmir_v5i2e12_app1.ppt]

Multimedia Appendix 2

Computer Equipment and Previous Experience With the Web (extract) [HTML File, 2.5K - jmir_v5i2e12_app2.html]

Multimedia Appendix 3

Use of the Guidelines Sites (extract) [HTML File, 2.9K - jmir_v5i2e12_app3.html]

Multimedia Appendix 4

Evaluation of Guidelines (extract) [HTML File, 9.5K - jmir_v5i2e12_app4.html]

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