INTRODUCTION

Innovative tools such as the Internet, personal digital assistants, tablet computers, cell phones, and other technologies are a growing arsenal in the effort to prevent and control HIV and other sexually transmitted infections (STIs). As the price of technology decreases, some of these tools have become more ubiquitous even in resource-constrained settings, and their uses are just beginning to be explored in depth. In this chapter, we review the opportunities and challenges of using information and communication technologies (ICT) for HIV/STI surveillance, diagnosis, partner notification, prevention, clinical management, and provider training, in both resource-rich and resource-constrained settings.

To do this, we conducted a literature review of English-, Spanish-, and Portuguese-language publications and conference proceedings in databases such as MEDLINE (from 1966 to April 2007), the Cochrane Library Database (up to Issue 1, 2007), LILACS (the Latin American and Caribbean Health Science Literature Database; from 1982 to April 2007), as well as the Google search engine. Additional articles were identified from references extracted from relevant articles, reviews, and from experts in the field.

SURVEILLANCE

As the diversity of HIV/STI epidemics around the world becomes more apparent, existing HIV/STI surveillance systems must be able to flexibly capture data to describe emerging infections or to explain changes over time in mature epidemics. Surveillance systems vary from simple systems that collect data from a single source, to electronic systems that receive data from many sources in multiple formats, to complex surveys. For ongoing systematic reporting, public health agencies increasingly rely on automated electronic laboratory reports of notifiable diseases and Internet-based confidential morbidity reporting from physicians. Other efforts, dubbed “second-generation surveillance systems,” collect data among sentinel populations most at risk of becoming newly infected with HIV/STIs, e.g., populations with high levels of risk behavior or young people at the start of their sexual lives.

HIV/STI surveillance often extends beyond case-based reporting to the monitoring of sexual-risk behavior at the population level. Such behavioral surveillance and associated research capture risk factor data, often including sensitive and stigmatized behaviors. This is best done in a way to minimize social desirability, reporting, and other biases. Data collection methods that reduce the need for face-to-face acknowledgment of these behaviors, or that ensure anonymity, provide an important means of reducing these biases. This may be facilitated by use of computer-assisted self-interviews (CASIs). CASIs with audio, video, or telephone enhancements have been used to assess general risks, patient histories, and a variety of health data, such as psychiatric and other clinical and public health data. In particular, using CASI, HIV/STI risks have been surveyed by researchers among populations including blood donors, university students, adolescents, injection drug users, and women at risk of seroconversion, and HIV-seropositive individuals. CASI studies conducted in STI clinics have shown enhanced reporting of some sensitive or stigmatized behaviors, as compared with face-to-face forms of data collection, though not for all behaviors or equally by sex of the respondents. Advantages of CASI-collected data include lower levels of missing data and of data entry errors as well as reduced costs.

In a systematic review of audio computer-assisted self interviews (ACASIs) for assessment of drug use and sexual behavior conducted in 2004, it was found that out of 24 reviewed papers, only 3 described research implemented outside the United States. In the time since that review, the literature on use of ACASI in resource-constrained settings...
has grown, showing evidence of usefulness in countries such as Brazil, Vietnam, Thailand, India, Kenya, Zimbabwe, and South Africa, among others. The NIMH Collaborative HIV/STI Prevention Trial conducted a feasibility study of ACASI in convenience samples in China, India, Peru, Russia, and Zimbabwe. The results suggested a high-comfort level among participants. The authors reported that despite variable computer experience and literacy, feasibility study participants reported ease in completing ACASI, and preferred a computer to an interviewer for answering sensitive questions, or had no preference.

In clinical practice or research, the use of ACASI in conjunction with electronic health records could ultimately provide high-quality surveillance data linking risk behaviors to HIV/STI prevalence and may also have some advantages in terms of systems efficiency. For example, a touch-screen ACASI blood donor interview system developed for blood banks in the United States was found in one study to increase donor time by 4 minutes but reduced staff time by 5 minutes; the system also generates automated generation of required reports to the health department. Use of an ACASI HIV counseling and testing tool by staff of a community-based mobile HIV testing organization in Seattle resulted in the agency doubling the number of HIV tests offered, with the same staffing level; the automated generation of required reports to the health department also shortened the billing and payment cycle. For busy clinicians, ACASI sexual histories could be a practical tool for identifying persons at increased risk for infection. ACASI interviews done prior to the clinical encounter (e.g., while counseling messages to the patient’s specific situation. These have been conducted at a population level from centralized call centers, as well as through use of personal digital assistants (PDAs) in venues where higher risk populations may congregate, such as at Gay Pride events. Mobile phone and interactive computer interviewing have been used to measure HIV-related risk behaviors, e.g., in a survey of 2416 adult men returning to Hong Kong from Shenzhen in mainland China during April 1997, who were intercepted at the exit of the checkpoint by systematic sampling.

Cell phones also have been used to collect data and report sentinel events such as medication side effects. Cell-PREVEN Fig. 108-1 is an interactive computer system using cell phones for real-time collection and transmission of adverse events related to metronidazole administration among female sex workers (FSW) in Peru. Curioso et al. developed Cell-PREVEN as an application for cell phones in Spanish, based on a system from Voxiva Inc. Cell phones were used successfully as a method of data reporting for tracking adverse events attributable to medicine given to FSW in three communities. Information was stored in an online database, where it could be immediately accessed worldwide and exported over a secure Internet connection. E-mail and text messages sent to mobile devices alerted key personnel to selected symptoms. Both health-care interviewers and FSW were satisfied with cell phones as a method of data collection, and the system led to much earlier and more complete reports of adverse effects.

Other software applications are being developed so that cell phones and PDAs can be used to transfer disease surveillance data, including for HIV infection, via a General Packet Radio Service connection or Short Message Service data channel into a central database, and to allow health workers to order medication, send alerts, and download treatment guidelines.

Handheld CASI is emerging for data collection and intervention delivery due to advantages such as portability, lower cost compared to laptops, and energy efficiency, which could make handheld computers (e.g., PDAs, cell and “smart” phones) ideal for collecting data in the community. Data collection using handheld computers has been shown to be a faster and more accurate method for transferring data than paper-based methods, including scantron forms. A 2004 conference on the use of handhelds in Africa concluded that PDAs were cheaper than paper-based health data collection due to reduced data management costs. One study conducted among adolescents in South Africa to ascertain sexual risk, compared PDA to paper data collection and found reporting was equivalent by modality, but that the PDA format collected more complete data. Data entry via a pen-based PDA may reduce technology anxiety compared to other forms of computer-aided data collection.
Satellite (http://pda.healthnet.org/) are using the cell phone network in Uganda to transfer data to a central site. Local health-care workers collect data on Palm Pilots and then connect to a local, battery-powered server called a “Wide Ray Jack.” This server allows data to be sent to and from a central database via a cell phone modem. In Peru, the PREVEN project conducted a cross-sectional field study in 20 cities with an open-source application for PDAs to collect sexual behavior data. The data collected with the PDA application, called PDA-PREVEN, showed very close agreement between paper and PDA responses. The project suggested that PDAs are a feasible alternative to paper forms for field data collection in a developing country.50

Computerized data collection for documenting risk behaviors may increase the reliability of sensitive data6 as well as provide other advantages such as eliminating interviewer bias, ensuring that appropriate questions are asked of respondents, fewer missing data, and reduced data entry costs as compared to paper methods. Resource-constrained countries especially need data collection approaches that are reliable, inexpensive, readily available, and do not require extensive technological expertise to implement or use.6 Cell-phone-based systems may best fit these requirements.

DIAGNOSIS AND PARTNER NOTIFICATION

Timely HIV/STI diagnosis and partner notification are important actions to initiate treatment and reduce further transmission in the population. Knowledge of an HIV-seropositive status is an important motivator for changing sexual risk practices and seeking medical care.32, 53 Additionally, with the current initiatives to provide universal access to antiretroviral therapy in developing countries, participants diagnosed with HIV will benefit from early entry into the health-care system.54

To increase HIV/STI diagnosis and improve partner notification, a variety of informatics tools that include the Internet and cell phones are being used. Use of these tools is appealing when they provide anonymity and convenience for the participants. In this section, we will review new technology approaches for HIV/STI testing and partner notification.

STI SCREENING

For several years, innovative World Wide Web sites to increase STI screening through on-site or self-collected specimens have been created in developed country settings. Some of these Web sites are www.inspot.org, www.STItest.org, and www.iwantthekit.org. InSPOT (see Fig. 108-2), an acronym for Internet Notification Service for Partners or Tricks, started on October 2004 in the city of San Francisco.57 Although mainly used for partner notification, this Web site also offers information regarding HIV/STI prevention, on-site diagnosis and treatment, as well as locations of STI clinics in the U.S. cities of San Francisco, Chicago, Los Angeles, Philadelphia, and Portland, in the states of California, Colorado, Massachusetts, Indiana as well as the country of Romania (www.inspot.org).

STIest.org is a Web site of the San Francisco City Clinic that provides on-site testing, treatment, and information about a variety of STIs. An interesting component of this Web site is the opportunity for participants to create their laboratory requisition slip and receive their syphilis test online (www.STIest.org). During the first year of launching this program, 218 tests were performed and six patients were diagnosed and treated for a new syphilis infection.67

Another Web site used for STI screening is www.iwantthekit.org (Fig. 108-3). This Web site provides an educational Internet-based program to encourage women older than 13 years to request, use, and send back to the laboratory home-sampling kits for self-collection of specimens for Chlamydia trachomatis testing. After 1 week, the participants can call to the program and by using their kit’s unique ID number and a private password can obtain their results. If the result is positive, the participant is referred to the nearest clinic to receive free treatment. During 7 months, 10% (41/400) of participants were found to be Chlamydia positive and 95.1% received treatment. There was good acceptability of this method: 89.5% of women preferred self-collection and 94% rated collection as easy or very easy. Compared to the community kit pick-up approach, this online program has shown better results: 97.2% of kits were requested by e-mail and 87.5% of kits returned for testing were e-mail requested.72

The Internet has been used to advertise kits that involve self-collection of specimens for HIV and STI at home that later are sent to the laboratory for analysis. Frank et al. in 1997 demonstrated that anonymous HIV-1 home specimen collection (HSC) kits with pretest and post-test telephone counseling provided a safe and effective alternative to conventional venous blood HIV-1 antibody testing.73 Further studies have shown that HSC kits increase HIV testing among persons not previously tested, 60% of all users and 49% of those who tested HIV positive using the kit had never been tested before. Additionally, this way of testing is an acceptable option in the United States for persons with less access such as ethnic minorities or bisexuals.19

Only one HSC kit for HIV, The Home Access HIV-1 Test System manufactured by Home Access Health Corporation, has been approved by the U.S. Food and Drug Administration.60 This kit may be purchased over-the-counter or on the Internet. The blood samples are taken at home by finger prick, and the dried blood spots are mailed to a laboratory for testing using an anonymous personal identification number (PIN). The pretest, and posttest counseling and the results are received through a toll-free telephone number using the PIN.74
Evaluation of HIV self-testing is now being studied in the United States; this way of testing requires consumers to collect the sample, run the test, and interpret the results. Although as of mid-2007, there were no FDA cleared home-use test kits, the existence of rapid HIV testing and HSC make its future implementation feasible. Additional research about the acceptability of the test in high-risk populations, feasibility to perform and interpret self-tests correctly, its impact on confirmatory testing, and on risk behaviors still need to be addressed.

**PARTNER NOTIFICATION: VIA THE INTERNET, VIA E-MAIL, WHAT ELSE IS COMING?**

Partner notification—the process by which sex partners of index cases with HIV/STI are informed of their exposure and the need to receive medical evaluation—traditionally has utilized telephone, mail, or personal contact. Recently, technologies such as cell phones, Internet, email and text messaging have been adopted.

In the first study addressing the use of the Internet for online partner notification, participants of an Internet chat room were notified via e-mail messages about a syphilis cluster and encouraged to seek medical evaluation. As a result, 42% of named partners were notified and tested. Further studies have analyzed different methods to improve partner response rates; some of the recommendations include the involvement of the index patient on the notification, conditional referral of the index patient where he/she is given a distinct time period to notify partners before the provider contacts them, inclusion of personalized messages that reference a specific health matter, the availability of health educators on chat rooms, and the provision of information on STI-testing sites, STIs, and partner referral on Web sites frequently visited by MSM.

The InSPOT Web site was created to allow newly diagnosed patients with an STI/HIV infection the ability to inform anonymously or confidentially their partners through an electronic postcard that they might have been exposed to an STI or HIV. In 2005, this Web site had over 93,000 visitors and approximately 16,000 e-cards were sent to 26,000 recipients; 77% of these e-cards were sent anonymously, 14% notified about Chlamydia, 17% about gonorrhea, and 15% about syphilis.
Other forms of partner notification such as text messaging have been published. A case report of a partner receiving a text message with the diagnosis of trichomoniasis resulted in a timely treatment of this disease.67

Future directions for partner notification may involve a text or e-mail message from the health provider’s mobile phone or computer to the partner(s) of the index case. The e-mail or text message could have a Web site address specific to each infection that could provide patients with additional information about the disease. In order to protect confidentiality, the Web site could be designed with mechanisms that ensure each page automatically expires when the user moves to another page or alternatively, the partner could be given instructions on how to erase the history of the visit when logging out. A user ID and password could be given to the partner to enter the site; this would not only protect privacy but also could provide an accurate number of contacts visiting the Web site, which can be useful for program evaluation purposes.63

While there are multiple benefits to the use of technology for partner notification, it nevertheless also has some risks. Internet and cell phone notification are not always confidential, e-mails can be read by others, mobile phones may be used by more than one person, e-mails and phones can change, and phones can be lost.63 For these reasons and within the context of each public health effort, it is important to balance the risks and benefits of the use of these technologies before deciding their implementation.

**PREVENTION**

Effective prevention begins with a foundation of awareness and knowledge about HIV and STIs. One recent effort to promote awareness and increase knowledge and access to education about HIV and STIs using a cell phone short message service is SexTextSF in San Francisco (www.sextextsf.org).68 This cell phone-based sexual health promotion service was based on a similar service developed by the Brook Charity in the UK. In the San Francisco example, the health department promotes in target communities, the text message “SEXINFO” and the call in number. Users access the discrete service via their text messaging program on their cell phone to reach a variety of topics in sexual health including the following: “What to do about a broken condom?” “If they think they are pregnant?” “Where to go for STI or HIV testing?” The evaluation of that project demonstrated that about 10% of the target population had used the service and use of the service could be associated with increased access to sexual health clinical services.69

Brief counseling interventions can reduce incident STIs,70 yet not all settings have trained staff counselors or sufficient
The use of the Internet to seek sex partners has been widely reported in developed and developing countries. In some regards, at-risk populations such as men who have sex with men are leading the way in self-directed use of ICT, e.g., using the Internet to seek sex partners, or health information. Offline sex that occurs following online solicitation may result in a disproportionately large risk of HIV and STI transmission.

Individuals who seek sex partners through the Internet may report a higher level of sexual risk behaviors such as higher number of partners, more anal sex, and more sexual exposure to partners known to be HIV positive compared to those who do not use the Internet to find sex partners. Studies of patients at STI clinics found also that among this core group, the Internet has been a common venue for meeting and having sex with partners. In San Francisco, MSM with early syphilis infections reported the Internet to be the most common place to meet sex partners, followed by bars, bathhouses, and sex clubs. Having sexual intercourse with partners met online has also been directly linked to syphilis epidemics and HIV transmission. Klausner et al. in 2000 reported a syphilis outbreak among gay men linked to online chat rooms in San Francisco, and Tashima et al. in 2003 reported two cases of acute HIV infection acquired through meeting persons over the Internet.

The Internet does provide an environment where individuals may have open and anonymous discussions about their serostatus, preferences for certain sexual practices and condom use. Carballo-Diez and colleagues in 2006 found that both HIV-negative and HIV-positive MSM were more likely to engage in sexual negotiation and serostatus disclosure on the Internet than in person and that those who negotiated on the Internet were more likely to use condoms for anal intercourse.

Among MSM, certain sexual harm reduction practices such as serosorting, strategic positioning, and withdrawal before ejaculation have been described. Serosorting is a process by which individuals discuss their HIV status with potential partners and modify their sexual behavior based on the partner’s serostatus. Strategic positioning is a process by which individuals choose certain sexual positions to decrease the risk of transmitting or getting HIV, for example, they may choose to be the receptive instead of the insertive partner if the partner’s serostatus is HIV positive.

### EDUCATING PATIENTS WITH INFORMATION TECHNOLOGIES

The Internet constitutes an important source of information in health care. Patients can search for information about their diagnosis, seek out health care providers, explore treatment options, and share opinions about their disease. The existence of chat rooms that allow real-time communication, forums, and discussion groups where participants can post messages about a specific topic and Web logs where they can comment, post news, or simply talk about their personal lives have changed the way patients interact with each other and has increased enormously the amount of information each participant shares and receives.

Practical criteria to evaluate Web sites are provided by the PILOT mnemonic, developed by Price, to remind people what they should look for a trustworthy medical Web site:
- Purpose: If the site has a mission statement, read it. If not, read the home page and analyze the site’s purpose. Does it inform and educate? Or is designed to persuade, sell, outrage, or entertain?
- Information: Truly useful medical Web sites offer valuable information and emphasize facts rather than opinion and testimonials. If the site is selling anything, ask yourself if that influences the content.

In some regards, at-risk populations such as men who have sex with men are leading the way in self-directed use of ICT, e.g., using the Internet to seek sex partners, or health information. Offline sex that occurs following online solicitation may result in a disproportionately large risk of HIV and STI transmission. Individuals who seek sex partners through the Internet may report a higher level of sexual risk behaviors such as higher number of partners, more anal sex, and more sexual exposure to partners known to be HIV positive compared to those who do not use the Internet to find sex partners. Studies of patients at STI clinics found also that among this core group, the Internet has been a common venue for meeting and having sex with partners. In San Francisco, MSM with early syphilis infections reported the Internet as the most common place to meet sex partners, followed by bars, bathhouses, and sex clubs. Having sexual intercourse with partners met online has also been directly linked to syphilis epidemics and HIV transmission. Klausner et al. in 2000 reported a syphilis outbreak among gay men linked to online chat rooms in San Francisco, and Tashima et al. in 2003 reported two cases of acute HIV infection acquired through meeting persons over the Internet.
• Links: The best sites want to inform you and are happy to recommend additional Web sites to further enhance your knowledge in that topic or related topics. The best sites provide links that are rated or reviewed.

• Originator: Who is responsible for the information? Best bets for sound medical information are medical societies, consumer-advocacy groups, well-known hospitals, and government and university-sponsored sites.

• Timeliness: Medical information is only useful if it is current. Look for sites that update frequently.

The PILOT method has been used by Kalichman et al. to teach HIV-seropositive patients some useful skills for critically evaluating and using health information.11

The use of the Internet to provide patient education can be useful to target high-risk populations in developed and developing countries. Bull et al. found in a US study that MSM and persons with a history of STI testing were likely to endorse HIV/STI prevention through chat rooms, e-mails, and Web sites.49 Traut et al. in 2005 found that among Peruvian HIV-positive persons, who used the Internet to meet sex partners 87.5% also sought information related to HIV, compared to 72.1% of such persons not seeking partners.50

Health departments, community-based organizations, and others have long used ICT to reach persons with information about HIV testing, HIV/STI prevention, and advocacy. Rai et al. reported the “Chandigarh AIDS hotline,” a computerized telecounseling service in Chandigarh, India, for AIDS prevention and AIDS awareness. It is a 24 hour computerized interactive voice response service, which is accessible on a four-digit number (1097) by telephone.51 Confidentiality and anonymity of the caller are the hallmarks of this service. The HIV/AIDS hotline is a toll-free service that provides information and counseling on HIV/AIDS related issues in English, Hindi (national language), and Punjabi (regional language).

Web-based health information and education may provide new ways to provide better access to difficult-to-reach populations, cities, and regions. Consider, for example, the great popularity and cheap cost of Internet cafes or “cabinas publicas” in Peru.46 The unique popularity and low cost of Internet cafes in a growing number of countries open new possibilities to developing future web-based systems to show that effective information management can be possible in poor communities with no modern infrastructure but widespread use of internet cafes.

CLINICAL MANAGEMENT

Electronic Health Records (EHRs)

Electronic health records are evolving rapidly and are influencing clinical practice69.88 particularly in chronic disease management. The EHR can provide data that are essential for implementing continuous quality improvement not only at the individual patient level, but also at the clinic or health system level. This will be useful not only for the chronic viral STIs, but will likely also prove essential for optimizing acute care management as well, for example, in management of bacterial STIs.65 Clinicians need to monitor HIV patient status carefully and frequently, and intervene with various therapies. Effective health-care delivery requires innovative methods of disseminating medical knowledge and informing the physician about how to provide and monitor high-quality care. Physicians need easy access to patients’ information, simplified reporting, guidelines that improve the quality of care, and methods to facilitate adherence to guidelines. Computer-based patients’ records can provide a useful tool for such efforts.14

Since 1989, the U.S. Department of Veterans Affairs has maintained a national HIV registry and contains longitudinal data and detailed resource utilization and clinical information. The registry contains data that are electronically extracted from Veteran Affairs’ computerized comprehensive clinical and administrative databases, called “Veterans Integrated Health Systems Technology and Architecture.”101 In France, NADIS 2000 is an electronic health record program for patients with HIV infection and hepatitis that has been in use in centers of Infectious Diseases in France since November 2000. The tool permitted real-time use by the physicians in outpatient and day-care units and was easily handled by all the practitioners. The developers note that its use was facilitated by having clearly defined the system principles before its application, an intuitive interface simulating a consultation, and providing functions that benefit the physician users (graphical visualization of biological variables, printing of prescriptions and letters).102

In the United States, the National Institute of Allergy and Infectious Diseases funds the “Center for AIDS Research Network of Integrated Clinical Systems (CNICS)”; a system of EHRs in use across seven HIV clinics. This extensive infrastructure will support basic, translational, and multidisciplinary research, allowing longitudinal tracking of patient outcomes and clinical specimens across sites.

AMPATH, the Academic Model for Prevention and Treatment of HIV/AIDS, is a collaboration of Moi University and the Moi Teaching and Referral Hospital in Eldoret, Kenya and the Indiana University School of Medicine. It was the first organization to offer comprehensive ambulatory HIV/AIDS care in Kenya, enrolling its first patient in November 2001 and by mid-2007 was caring for nearly 45,000 HIV-positive individuals. The AMPATH medical record system (AMRIS) is sub-Saharan Africa’s first EHR system for the comprehensive management of the clinical care of patients infected with HIV. It was based on an initial “Mosoriot medical record system.”103,104 This system,
composed of both paper-based and electronic records, has been found by Sika and colleagues to lead to uniformity in data collection and to facilitate the retrieval of patient data for clinical care and research. The AMRS was explicitly designed to use simple technology, in order to aid in the maintenance and sustainability of the system in resource-constrained environments; the tool is now in use in several countries in eastern Africa and elsewhere. A Wiki (collaborative development) site for the openMRS system is available at http://openmrs.org/wiki/OpenMRS; see Fig. 108-4.

Web-based electronic medical record systems have shown that effective information management is possible in other poor communities without extensive modern infrastructure. In Peru, Fraser et al. described a web-based medical record system to support the management of multidrug resistant tuberculosis. Web-based analyses have been developed to track drug sensitivity test results, patterns of sputum smear, and culture results and time to conversion from positive to negative cultures. Fraser et al. also described the “HIV-EMR,” a prototype electronic medical record system to support treatment of HIV and tuberculosis in remote and impoverished areas in Haiti. This electronic medical record allows physicians to order medicines and laboratory tests, and provides alerts based on clinical status and test results. Partners in health have also used web-based EHRs in Rwanda to support anti-retroviral rollout. Recently, Curioso et al. developed a web-based electronic report system for STI for the PREVEN project in Peru. Interviewers entered their data directly into a single database as they progress through the reports, thereby saving time and costs over having the data entry done after data are collected. The system collects new participants and generates alert reports defined by the number of missed treatments that must be provided by the health-care interviewers. The system has the capability of searching so the interviewers can check past laboratory results and medications. The system allows real-time access of the database (only available for the team leaders) via the web.

**FIGURE 108-4.** Example of HIV electronic health record “OpenMRS” architecture.

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**DECISION SUPPORT SYSTEMS**

The potential for computerization to improve clinical care has been appreciated for some time. Advances in electronic medical record capabilities enable clinical reminders to inform providers when recommended actions are “due” for a patient. Computerized clinical reminders have been advocated as a strategy to improve adherence with established clinical guidelines. With clinical reminders, the software rather than the human initiates the human–machine interaction. Clinical reminders take advantage of preexisting electronic patient information to alert the provider when an action is recommended. In addition, clinical reminders are “real-time” decision aids in that they prompt providers to consider guideline-based advice when a patient record, and ideally the patient, is in front of the provider. As such, they have the potential to improve quality of care, for example, they can result in increased prevention interventions by busy clinicians.

In HIV care, clinical reminders were associated with more timely initiation of recommended practices. For example, Kitahata et al. demonstrated that HIV clinical reminders delivered at the time that HIV care is provided were associated with improvement in adherence to practice guidelines. Safran et al. demonstrated that when alerts and reminders are linked with a patient’s computer-based patient record, adherence to a set of HIV practice guidelines can be improved. Despite evidence that they improve adherence to guidelines, the U.S. Veteran’s Health Administration has experienced challenges in having providers consistently use clinical reminders as intended.
Creative utilization of hospital data environments may be an inexpensive route to improved compliance with practice guidelines. Shuter et al. reported that after the initiation of a weekly computer-based Pap smear reminder list in an HIV care clinic, the prevalence of scheduled women with up-to-date Pap smears increased from 61.4% to 73.2% (P < 0.001) during 1 year. The improved rate of up-to-date Pap smears showed no sign of attenuation over time.107

SUPPORT FOR PEOPLE LIVING WITH HIV

ICTs can help people with chronic diseases such as HIV to self-manage their treatment regimens, as well as to facilitate connection to others for psychological support. Gustafson and colleagues utilized one of the first web-based support sites for people living with HIV, known as the “Comprehensive Health Enhancement Support System.”108 Others have used the web to create virtual support or affinity groups, such as for HIV-positive adolescents.109

A randomized trial conducted by Flatley-Brennan et al. involved the use of a home-based computer network connected to the Internet (the ComputerLink) designed for people with AIDS to determine if the program would reduce social isolation and improve confidence and skill in decision making without causing differential decline in health status among people with AIDS. Services available included an online electronic encyclopedia, public and private communication, and a decision support system; a registered nurse coordinated all services. The authors concluded that computer networks provide feasible alternatives for the delivery of health services to homebound individuals. Communication services were used more extensively than other services, suggesting that the primary mechanism of intervention is peer contact. The system use improved confidence, though not skill, in decision making.110

Virtual Hospital is a telemedicine web system for improving home integral care of chronic HIV patients through the Internet implemented in Spain.111 Using the videoconference, chat, or messaging tools included in the system, patients can visit their health-care providers (physician, psychologist, nurse, psychiatrist, pharmacist, and social worker), and gain access to the electronic patient record. The system also provides a telepharmacy service that controls treatment, medication adherence education; they found a short-term impact on self-reported adherence.112

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Garcia et al. designed CREAIDS (Center of Reference for AIDS), a four-module patient-directed interactive software program for improving adherence to antiretroviral therapy.113 Brock and colleagues have used PDAs to deliver medication adherence education; they found a short-term impact on self-reported adherence.114

Figure 108-5 shows computer screenshot examples of a computer counseling tool called “CARE+” that was designed to provide ART adherence and HIV transmission risk reduction. A randomized controlled trial among 240 adults with HIV in Seattle, WA, found that among those with detectable viral load at baseline (n = 90), the CARE+ intervention participants were twice as likely as controls to have undetectable viral load at the 6-month follow-up visit (RR 1.9, 49% vs. 26%; p = 0.04). There was a statistically significant reduction in condom use errors in the intervention arm at 6-month follow-up (RR 0.44, exact p = 0.05).115

Several studies utilizing human staff-delivered and automated text messages delivered to pagers and cell phones have been conducted in the United States, with a range of results.116 Some have not found a meaningful impact of telephone-delivered support on outcomes of interest such as measures of depression among HIV-positive participants.117 Others have found that use of interactive voice response-delivered phone calls to HIV-positive problem drinkers resulted in lower drinking levels over time.118 Another study led by Reynolds for the AIDS Clinical Trials Group, found among 109 newly treated HIV-infected patients, a significantly better overall treatment effect at 64 weeks in the telephone group (p = 0.023); calls were associated with a promising but nonsignificantly reduced risk (HR = 0.68; 95% CI 0.38–1.23) for treatment failure.119 Another randomized trial among HIV-positive patients who smoked found that participants who received a cellular telephone intervention were 5.6 times (95% CI 1.3–9.9) more likely to quit smoking compared with participants who received usual care.120

Potential benefits of phone interventions (accessibility of delivery, potential cost-effectiveness as compared with...
in-person delivery) must be weighed against the need for confidentiality (e.g., determining that the cell phone respondent is the participant/patient), targeting (e.g., actively substance-using patients may do better with face-to-face rather than telephone counseling delivery)\textsuperscript{120} and sustainability, as effects may wane over time unless maintained, as was found in one study with HIV-positive adolescents.\textsuperscript{122}

Cell phones are being used to support patient medication adherence in resource-constrained settings. In South Africa, the project Cell Life is using cell phones to monitor adherence for the management of HIV disease in patients on antiretroviral therapy. Some of the platforms used by Cell Life include a global system for mobile communications, wireless Internet gateway, and a geographical information system database.\textsuperscript{123} A cell phone system in use in Rwanda over the course of 2 years connected 75\% of the country’s 340 HIV clinics and covered 32,000 people. Patient entry data are transmitted centrally to Kigali, and weekly reports are created from digital cameras.\textsuperscript{124} In 2007, Voxiva announced an agreement with the U.S. President’s Emergency Plan for AIDS Relief to utilize cell phone systems with HIV patients in 10 African countries.\textsuperscript{125} While some have questioned health intervention delivery models that assume individual cell phone ownership,\textsuperscript{126} such ownership and cell phone penetration are varied by setting, and also are increasing over time; it is estimated that within a few years, 80\% of Africans will live in areas that will have cell phone coverage.

\section*{Consultation Using Telemedicine}

Telemedicine supports health-care delivery in remote areas.\textsuperscript{127–129} Telemedicine holds the promise of improving access to health care, especially in areas where there are geographical barriers, and of reducing costs.\textsuperscript{127} Several studies of telemedicine to support HIV patients are reported in the developed world,\textsuperscript{111, 112} but data are limited in developing countries.

In rural areas, telemedicine may support access for teleconsultation. TeleMedMail\textsuperscript{130} is a software application to facilitate store-and-forward telemedicine by secure e-mail of images from digital cameras. TeleMedMail is written in Java and allows structured text entry, image processing, image and data compression, and data encryption. This web-based telemedicine system is currently under evaluation in South Africa and Peru, and Spanish and English versions are available. The Internet has the potential to enhance collaboration among researchers by facilitating rapid dispersal of information and the coordination of numerous, complex, real-time interactions. One example of a working group was the Great Lakes Regional Center for AIDS Research. The Great Lakes Regional consortium of scientists at Northwestern University, the University of Minnesota, the University of Michigan, and the University of Wisconsin–Madison consolidated their complementary scientific expertise. Core facilities allowed investigators to join proteomics, genomics, bioinformatics, animal models, and clinical studies into a unified whole. Figure 108–6 summarizes the range of information technology tools that a patient living with HIV might use.

\section*{Provider Training}

\subsection*{Computer-Based Training Programs}

Digital resources can potentially serve as a powerful medium for the training of clinicians and other HIV/STI workers, delivered via CD-ROMs,\textsuperscript{131} e-mail lists,\textsuperscript{132} and in recent years via the Internet.\textsuperscript{133} Advanced communication technologies can create a cost-effective infrastructure to disseminate new intervention models to service providers worldwide.\textsuperscript{134}

Given the necessity to support clinicians in treating patients with antiretroviral therapy, many institutions and organizations are developing computer-training programs for health-care providers working in developing countries.

The International Training and Education Center for HIV (I-TECH), which provides training in 25 countries, offers a wide range of training products tailored to each country’s needs to help educate all members of society about HIV/AIDS. I-TECH (www.go2itech.org) has produced a broad spectrum of supportive media products and teaching aids, including videos in multiple languages, CD-ROM toolkits, compendiums; brochures for patients, and pocket guides and posters for health-care workers. I-TECH has assembled a listserve to include in-country clinicians in the periodic updates e-mailed to the I-TECH Clinical Team. I-TECH posts an electronic library of teaching cases for clinical training on HIV/AIDS care, and treatment with WHO and other partners.

I-Med Exchange, launched in July 2000 by the International Association of Physicians in AIDS Care, is a program directed to physicians and allied health professionals providing HIV/AIDS care in southern African countries—Botswana, Lesotho, Namibia, South Africa, and Swaziland. I-Med Exchange proposed to “bridge the digital divide” between the developing world and the developed world for health information, using information technology. The main, formal activity of physicians enrolled in the program was to participate in interactive online presentations accessed live on the Internet, or viewed as archived seminars either on an I-Med Exchange Web site or CD-ROM.\textsuperscript{135}

The Institute of Tropical Medicine, Antwerp set up a computer-aided training program for health-care providers, working in more than 17 developing countries. Expert advice from HIV/AIDS specialists on treatment of HIV infection and
management of opportunistic infections have been offered to colleagues working in different countries. The telemedicine advice was organized initially through an e-mail network on a list server but later, in response to the need of continuous medical education on HIV and treatment, through a discussion forum on a telemedicine Web site (http://telemedicine.itg.be). E-mails have been used for years by the Antwerp Institute as a low cost telemedicine support for colleagues working in low resource countries. By giving the opportunity to trained clinicians to access continuous support and education through a discussion forum and policy documents on the Web site, the idea is to lower the threshold to launch HIV treatment projects in low resource settings.

HIV eDucation is an interactive, HIV clinical management course tailored to the needs of clinicians in those regions of the world that have been hardest hit by the HIV epidemic. The course combines computer-based self-study modules, participatory clinical case studies, e-assisted tutoring, on-site workshops, and the building of peer consultation networks to provide an integrated clinical program. HIV eDucation has continuing education courses that can be completed online or with a jump/thumb drive, uploading pre/post test scores to the Web site: http://www.hiveducation.net.

Cure4Kids (http://www.cure4kids.org) is an Internet learning network that delivers medical education to doctors and nurses on pediatric cancer and AIDS. Cure4Kids also provides web conferencing tools for communication and collaboration.

In China, Tucker et al. developed a HIV/STI training page for the Web site of the Chinese National AIDS Prevention and Control Center (http://www.aids.net.cn).

A number of PDA-based resources are available for the HIV/STI clinician, some of them free of charge. Tice and Bhan reviewed many useful PDA-based resources for the infectious diseases specialist. Additional resources can be found in review articles by Keplar.

CONTINUOUS EDUCATION ON THE INTERNET

There is enormous potential to implement web-based continuing education in developing countries through online courses that can train and provide current information to health-care professionals in the management of HIV/STI. Studies have shown that web-based continuing education can improve health-care professionals’ practical skills. Technological advances that allow inclusion of interactive...

FIGURE 108-6. Overview of information and communication technologies available for HIV patients.
links, video, images, and sounds make it increasingly feasible to illustrate and encourage realistic clinical problem solving. Other advantages of web-based continuing education include absence of geographical barriers, user interaction, real-time interactivity, flexibility and potential low cost, important issues to consider in developing countries.

Most participants who engage in a web-based continued education are satisfied with the experience and find it to be an effective learning format. Barriers to web-based continued education include technical difficulties and lack of computer knowledge.

For any web-based course to succeed, Wong et al. proposed the following 10 overlapping and iterative areas of activity that must be addressed: the market for the course; course aims and intends learning outcomes; choice of software platform; staff training needs; writing high-quality study materials; design features for active learning; technical and administrative challenges; evaluation and quality improvement; mainstreaming the course within the institution; and financial viability.

Table 108-1 summarizes some of the free continuing education courses and activities for doctors and other health-care professionals. Of particular interest are learning tools for STI training available from the CDC STD Prevention Training Centers—e.g., Self-study STD Modules for Clinicians; ready-to-use curriculum for the clinical educators; and STD 101-in-a-box—all available at http://www.cdc.gov/std/training/default.htm. Also available is a comprehensive Web site developed by Drs. Spach and Marrazzo that features interactive case studies covering a broad array of topics related to hepatitis (http://www.hepwebstudy.org).

Impact of Information Technologies Related to HIV/STI in Resource-Constrained Settings

Informatics is particularly useful for electronic health records, telemedicine, clinical decision systems, and improving access to information. Yet, resource-constrained countries that can benefit the most from the use of informatics and telemedicine, are the ones that have the least access to them, and the highest burden of disease. Despite growing interest in telemedicine and medical informatics in these countries, issues of affordability, cost-effectiveness, and sustainability remain to be addressed.

Information systems should be carefully planned and integrated across different programs, especially in resource-constrained settings. Prabhulal (2005) has reported that health workers in many developing countries spend as much as 40% of their time filling out paper-based forms, and compiling and copying data from different programs (e.g., tuberculosis, malaria, HIV/AIDS). By choosing the most appropriate information technology, duplication can be avoided and appropriate devices—e.g., cell phones, Internet—can be deployed to report from public health programs. Development and evaluation of practical, low cost clinical information systems should be a priority in rolling out HIV treatment in developing countries.

There is great potential to improve health through the use of ICTs in developing countries. The problems of low Internet diffusion and the digital divide are obstacles that developing countries face in using the Internet for development purposes. In some countries, one user may access the Internet in numerous ways including wireless, Internet cafes, kiosks, home, work, and/or school accounts. Single accounts may be shared by many users. Some users are heavy users and others light users; some started long ago while others started recently. The diffusion of innovation is contingent not only on willingness to adapt to new technologies, but also on the financial and human resource base able to support these tools.

E-health in developing countries is a nascent reality that offers opportunities that need to be explored. Given the widespread access through Internet cafes in Latin America, there is potential to deploy web-based prevention intervention programs as well as educational interventions for HIV/STI, especially to difficult-to-reach populations and higher-risk groups such as men that have sex with men. Those can be delivered at low cost and can be accessed by a great number of participants in innovative ways. In addition, the Internet also can be used to recruit people for randomized trials (for example, hard-to-reach populations like MSM) and to deliver testing and prevention messages.

In many developing countries, health workers have limited access to the Internet in their workplace. They may instead gain access from Internet cafes and other venues. While countries in Africa have the world’s lowest Internet penetration (as a percentage of population), the continent also has the largest absolute growth in Internet usage from 2000 to 2007. Moreover, up to 80% of Africans are projected to live within mobile phone coverage areas by 2010, making cell phone delivered data collection and interventions more feasible. The dramatically falling costs of computers suitable for Internet use should go some way to closing the gap between rich and poor. This price drop and accessibility to computers brings a unique opportunity for health-care delivery and research.

The past few years have witnessed several developments that are making access to information for scientists in the developing world more affordable. These include initiatives promoted by scientists, libraries, publishers, academies, and societies. The WHO Sexually Transmitted Diseases Diagnostics Initiative (http://www.who.int/STI_diagnostics/) posts summaries and critical reviews of key articles related to STI screening approaches and technologies on a Web site to enhance access to the STD diagnostics literature in developing countries. The Public Library of Science (http://www.publibraryofscience.org) is a nonprofit...
### Table 108-1. A Selection of Free HIV/STI Continuing Education Resources

<table>
<thead>
<tr>
<th>Name</th>
<th>Courses, Online Modules</th>
</tr>
</thead>
</table>
| California STI/HIV Prevention Training Center  http://www.STIhivtraining.org/ | - Online Chlamydia course: The training is designed to increase knowledge of asymptomatic Chlamydia infection, the importance of screening young, sexually active women and the management of Chlamydia infected patients and their partners. During the course, you evaluate and treat two simulated patients.  
- Online STI case series: Presented by the National Network of STI/HIV Prevention Training Centers & Centers for Disease Control and Prevention (CDC).  
- CDC training and continuing education online  http://www2a.cdc.gov/phthonline/  
  - Incorporating HIV prevention into the medical care of persons living with HIV (web on demand).  
  - Prevention with positives: HIV risk reduction strategies for health-care providers (web on demand).  
  - Rapid testing: advances for HIV prevention (web on demand).  
- Clinical care options Hepatitis http://clinicaloptions.com/Hepatitis.aspx  
  - A series of text-based or case-based interactive activities concerned with aspects of Hepatitis B and Hepatitis C infection.  
- Clinical care options HIV http://clinicaloptions.com/HIV.aspx  
  - A series of text-based or case-based interactive activities concerned with aspects of HIV/AIDS.  
- FreeHepatitisInfo http://www.freehepatitisinfo.com/  
  - HepatitisWATCH news is a monthly CE-accredited newsletter that brings updates on new information on the topics of hepatitis and hepatitis/HIV coinfection.  
- HCV advocate’s online education center http://www.hepeducate.org/quizical/login.php (free registration required)  
  - Diagnosing HCV: Topics covered are the types of tests used to diagnose HCV, antibody tests, HCV viral load tests, the hepatitis C virus and its lifecycle, HCV genotypes and quasispecies, biochemical liver function tests, the significance of ALT levels, liver biopsies, the four histological stages of liver damage.  
- HIV web study http://depts.washington.edu/hivaid/index.html  
  - Twelve half-hour modules concerning diagnosis and treatment of HIV/AIDS—initial evaluation; dermatologic manifestations; oral manifestations; opportunistic infections: prophylaxis; opportunistic infections: treatment; antiretroviral Rx; antiretroviral Rx: resistance; anti retroviral Rx: adverse effects; drug-drug interactions; postexposure prophylaxis; perinatal transmission; special populations.  
- International AIDS Society USA: cases on the web  http://www.iasusa.org/cow/  
  - A series of online continuing education (CE) activities sponsored by the International AIDS Society USA, including  
  - clinical management of treatment-experienced patients presenting with virologic failure.  
  - diagnosis and management of immune reconstitution syndrome in HIV-infected patients.  
  - the importance of viral fitness and drug resistance in chronic and recent HIV infection.  
  - perinatal HIV: special considerations.  

(continued)
<table>
<thead>
<tr>
<th>Name</th>
<th>Courses, Online Modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medscape HIV/AIDS</td>
<td>CE activities of special interest to physicians who treat HIV/AIDS. Medscape contains a variety of educational formats:</td>
</tr>
<tr>
<td><a href="http://www.medscape.com/hiv-aidshome">http://www.medscape.com/hiv-aidshome</a></td>
<td>- Conference coverage—Reports of advances presented at major medical conferences; typically includes several tracks with news stories, expert interviews, and in-depth topic overviews.</td>
</tr>
<tr>
<td></td>
<td>- Clinical update—Comprehensive original review article on scientific advances in a clinical topic.</td>
</tr>
<tr>
<td></td>
<td>- Fast track clinical update—Narrowly focused original review article on scientific advances in a clinical topic.</td>
</tr>
<tr>
<td></td>
<td>- CE-live—Real-time online events with streaming video, synchronized visuals, and interactive questions and answers; archived for 1 year.</td>
</tr>
<tr>
<td></td>
<td>- News-CE—Daily reports of major current medical research articles; 0.25 credits each</td>
</tr>
<tr>
<td></td>
<td>- Journal CE—Articles selected from a wide selection of conference reports and peer-reviewed journals.</td>
</tr>
<tr>
<td></td>
<td>- Special report CE—Topic-based monthly email newsletter distributed to Medscape’s professional member database by specialty.</td>
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<tr>
<td></td>
<td>- Interactive patient cases—Original CE activity presented to the physician in an interactive, clinical case-based format.</td>
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<tr>
<td></td>
<td>- CE circle: Multimedia content certified by other accredited professional education providers, typically from live symposia or monographs, and then posted on Medscape and archived for 1 year.</td>
</tr>
<tr>
<td>Medscape infectious disease</td>
<td>CE activities of special interest to infectious disease specialists. Educational formats are similar as &quot;Medscape HIV/AIDS.&quot;</td>
</tr>
<tr>
<td><a href="http://www.medscape.com/infectiousdiseaseshome">http://www.medscape.com/infectiousdiseaseshome</a></td>
<td></td>
</tr>
<tr>
<td>MMWR continuing education programs (Centers for disease control)</td>
<td>This site contains the PDF versions of several HIV-related articles published in the morbidity and mortality weekly Reports. You download and read the articles, then submit your quiz answers online.</td>
</tr>
<tr>
<td><a href="http://www2.cdc.gov/ce/availableactivities.asp">http://www2.cdc.gov/ce/availableactivities.asp</a></td>
<td></td>
</tr>
<tr>
<td>NNPTC online case series (National Network of STI/HIV Prevention Training Centers)</td>
<td>The series includes case presentations of common STI-related syndromes. The guided interactive process helps you to evaluate each case, arrive at a diagnosis and provide recommended treatment.</td>
</tr>
<tr>
<td><a href="http://www.STIhivtraining.org/nnptc/start.cfm">http://www.STIhivtraining.org/nnptc/start.cfm</a></td>
<td></td>
</tr>
<tr>
<td>STI/HIV case series (in Spanish). Universidad Peruana Cayetano Heredia/University of Washington</td>
<td>An interactive course with clinical cases to train health-care workers in the management of patients with STIs.</td>
</tr>
<tr>
<td><a href="http://cursos.redpreven.org/">http://cursos.redpreven.org/</a></td>
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</tbody>
</table>

**Table 108-1. A Selection of Free HIV/STI Continuing Education Resources (Continued)**

organization of scientists committed to making the world’s scientific and medical literature freely accessible to scientists and to the public around the world for the benefit of scientific progress, education, and the public good. The Open Archives Initiative (http://www.openarchives.org), supported by the Digital Library Federation and National Science Foundation, has its roots in an effort to enhance access to e-print archives as a means of increasing scholarly
communication. PubMed Central (http://www.pubmedcentral.gov) is a free-and-unrestricted digital archive of life sciences journal literature, developed and managed by the National Center for Biotechnology Information (NCBI) at the U.S. National Library of Medicine (NLM).

Many journals already have online publishing operations, and there is a growing tendency to publish material online only, to the exclusion of print. This literature must be preserved in a form that ensures open access to it over the longer term.148 A number of journals and archives are now available free on the web. The Open Society Institute (Soros Foundation, http://www.soros.org/openaccess) has supported alternative journals and open archiving initiatives.

There are several nonprofit publishers/distributors of developing country journals and information. These include BioMed Central (http://www.biomedcentral.com), which hosts electronic versions of many developing country journals (most of them at a modest subscription fee); International Network for the Availability of Scientific Publications, or INASP (www.inasp.info/index.html), a cooperative network of partners whose mission is to enhance the flow of information within and between countries, especially those with less developed systems of publication and dissemination; SciELO (http://www.scielo.org), which hosts multiple journals published in Latin American countries; and African Journals Online or AOJOL (http://www.inasp.info/ajol/index.html), which provides free online access to titles and abstracts of multiple African journals and full text on request. HINARI (Health Internet, http://www.healthinternetwork.org), a UN/WHO initiative, aims to provide commercial medical journals free to licensed countries in the developing world. PERI (Programme for the Enhancement of Research Information, http://www.inasp.info/per/index.html) supports information production, access, and dissemination for research partners in developing and transitional countries utilizing ICTs.

HIF-net, launched in July 2000 by the International Network for the Availability of Scientific Publication and the WHO, is an e-mail discussion list (hif-net@dgroups.org), which serves in a form that ensures open access to it over the longer term.149 A number of journals and archives are now available free on the web. The Open Society Institute (Soros Foundation, http://www.soros.org/openaccess) has supported alternative journals and open archiving initiatives.

There are several nonprofit publishers/distributors of developing country journals and information. These include BioMed Central (http://www.biomedcentral.com), which hosts electronic versions of many developing country journals (most of them at a modest subscription fee); International Network for the Availability of Scientific Publications, or INASP (www.inasp.info/index.html), a cooperative network of partners whose mission is to enhance the flow of information within and between countries, especially those with less developed systems of publication and dissemination; SciELO (http://www.scielo.org), which hosts multiple journals published in Latin American countries; and African Journals Online or AOJOL (http://www.inasp.info/ajol/index.html), which provides free online access to titles and abstracts of multiple African journals and full text on request. HINARI (Health Internet, http://www.healthinternetwork.org), a UN/WHO initiative, aims to provide commercial medical journals free to licensed countries in the developing world. PERI (Programme for the Enhancement of Research Information, http://www.inasp.info/per/index.html) supports information production, access, and dissemination for research partners in developing and transitional countries utilizing ICTs.

HIF-net, launched in July 2000 by the International Network for the Availability of Scientific Publication and the WHO, is an e-mail discussion list (hif-net@dgroups.org) targeted mainly for providers and users of health information in resource-poor settings. It has more than thousands of subscribers spread over 130 countries. Another global networking health group is the Program for Monitoring Emerging Diseases, ProMEDmail (http://www.promedmail.org), which is an Internet-based reporting system that provides rapid information to public health officials and health care providers worldwide.

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