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Innovation in sexually transmitted disease and HIV prevention: Internet and mobile phone delivery vehicles for global diffusion

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Abstract

Purpose of review—Efficacious behavioral interventions and practices have not been universally accepted, adopted, or diffused by policy makers, administrators, providers, advocates, or consumers. Biomedical innovations for sexually transmitted disease (STD) and HIV prevention have been embraced but their effectiveness is hindered by behavioral factors. Behavioral interventions are required to support providers and consumers for adoption and diffusion of biomedical innovations, protocol adherence, and sustained prevention for other STDs. Information and communication technology such as the Internet and mobile phones can deliver behavioral components for STD/HIV prevention and care to more people at less cost.

Recent findings—Recent innovations in STD/HIV prevention with information and communication technology-mediated behavioral supports include STD/HIV testing and partner interventions, behavioral interventions, self-management, and provider care. Computer-based and Internet-based behavioral STD/HIV interventions have demonstrated efficacy comparable to face-to-face interventions. Mobile phone STD/HIV interventions using text-messaging are being broadly utilized but more work is needed to demonstrate efficacy. Electronic health records and care management systems can improve care, but interventions are needed to support adoption.

Summary—Information and communication technology is rapidly diffusing globally. Over the next 5–10 years smart-phones will be broadly disseminated, connecting billions of people to the Internet and enabling lower cost, highly engaging, and ubiquitous STD/HIV prevention and treatment support interventions.

Keywords

e-Health; evidence-based interventions; health IT; information and communication technology; m-Health; mobile phones

Introduction

Our current healthcare crises are rooted in urgent needs to prevent disease and promote well being, but the costs of current approaches far exceed available financial and human resources. Sexually transmitted diseases (STDs), including HIV, are no exception. HIV/AIDS has been a rallying point for funding and innovation in testing, prevention, and treatment of STD/HIV over the past 25 years. Efficacious biomedical STD/HIV preventive interventions include testing, male circumcision, condoms, human papillomavirus (HPV) vaccine, and treatment of both HIV and STDs [1••]. Biomedical interventions are not ‘magic bullets’, but are dependent on behavioral and structural intervention components for their effectiveness [2••].

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Acknowledging this reality, combination prevention for HIV/STD is being supported that integrates biomedical, behavioral, and structural interventions [3••]. Reaching more people to provide behavioral intervention and support at less financial and personnel costs requires 'disruptive innovations' in intervention design and delivery [1••]. The present article reviews information and communication technology (ICT), such as the Internet and mobile phones, as delivery vehicles for STD/HIV prevention and care that can be broadly diffused and sustained globally.

Biomedical innovations in sexually transmitted disease/HIV prevention require behavior change

There are currently five broad biomedical approaches to STD/HIV prevention: vaccines, male circumcision, barrier methods (male and female condoms), topical microbicides (often used with barriers), and pharmaceutical treatments that either clear infections or reduce infectiousness for incurable viral infections, including antiretroviral treatment (ART) for HIV, suppressive therapy for herpes simplex virus (HSV), and preexposure and postexposure prophylaxis (PEP and PREP) with ART to prevent HIV infection [1••]. Most of these biomedical innovations are still in development or have had disappointing effectiveness trial results, often due to poor adherence or partial (i.e. <100%) efficacy [2••]. Efficacious biomedical interventions (i.e. testing, condoms, male circumcision, HPV vaccine, treatment) must still be adopted and adhered to, and preventive behaviors sustained to prevent other infections [1••,2••].

Behavioral challenges deeply limit the effectiveness of every biomedical intervention. The challenges are diverse: providers' capacities (i.e. skills, time, organizational factors) to adopt and deliver interventions with fidelity and effectiveness, consumers' capacities to adopt and implement the change program, the need to sustain behaviors to become habits and routines, and high implementation costs. Thus, current behavioral 'technologies' such as evidence-based practices (EBPs), treatments, and interventions are challenging to scale nationally and globally [1••]. The WHO [4] recommends 'task shifting' prevention and disease management tasks to lower skilled community health workers to reduce costs and provider burden. Many of these tasks can also be shifted to automated or facilitated ICT delivery vehicles.

Web 2.0 is an environment to enhance risk and prevent disease

The broad dissemination of personal computers, Internet access, and social networking sites, particularly in developed countries, has created a new 'risk environment' in which potentially STD/HIV-infected sex partners meet and intervention can occur [5]. For example, men who have sex with men (MSM) and other adults use the Internet to find sex partners and negotiate both risky and safe sex [6–9]. Adolescents display risk behaviors on MySpace profiles, potentially linking them to risky social networks [10]. Thus, Web 2.0 is also an environment for conducting behavioral surveillance for hard-to-reach groups [11], intervention recruitment and delivery, and provider service coordination [5]. Smart-phones [e.g. iPhone (Apple, Cupertino, California, USA), Google Android phones (Google, Mountain View, California, USA)] are significantly extending the reach of this new risk environment by enabling Internet access that is always on, always worn, and context aware through global positioning satellite (GPS) radios in phones and geographic information systems (GIS) [12••].

Information and communication technology can transform targeted, routine, and consumer-controlled sexually transmitted disease/HIV testing and partner intervention

Recent STD/HIV testing innovations exemplify the potential for integration and synergy of biomedical and behavioral prevention components facilitated through ICT. STD/HIV testing is essential for treatment and prevention, but many people do not test due to fear of stigma and discrimination, misperceptions of risk, limited access to testing and treatment services, and asymptomatic infections. Four strategies are currently recommended to identify those unaware of their STD/HIV infections, each with recent ICT support examples: targeted testing of high-risk groups; routine testing in healthcare settings; consumer-controlled 'home' testing; and partner notification and testing. For example, targeted testing can be conducted online; a recent intervention trial used banner advertisements on social networking websites to link MSM to a website that conducts risk assessment and provides automated and tailored feedback, videos, games, links to testing sites, and e-mail follow-up to promote STD/HIV testing, as well as informed consent, randomization, and follow-up assessment for the intervention's efficacy trial [13].

Targeted risk-based screening, however, misses substantial proportions of infections, leading to recommendations for routine HIV testing in healthcare settings [14,15]. Routine testing is challenging for providers to implement due to costs, time limitations, and changes to clinical norms [16]. ICT can support shifts to routine testing, particularly if focused on reducing provider time burdens and costs. For example, task shifting provision of pretest information from providers to videos (available in the clinic and on the Internet) has been found to be as effective as face-to-face provider delivery for patients' comprehension of key content [17]. Computer-based reminders for providers to conduct risk assessment and HIV testing did not increase testing rates in one recent study, which concluded that time constraints and organizational factors superseded reminders [18]. However, a similar intervention did increase testing rates by also conducting social marketing with providers and task shifting some responsibilities to nurses [19].

Consumer-controlled self-sample 'home' testing using swab methods can also improve access to testing, with ICT being integral to requesting tests and receiving results. For example, chlamydia, gonorrhea, and trichomonas testing are being supported by Internet linkages to request free mail-in tests (e.g. iwanthekit.org), with 97% using the Internet to request tests versus a toll free phone number option [20••]. The website also incorporates educational components for all STDs and questionnaires for research and evaluation. Many testers also preferred results notification by e-mail [20••], and a similar study found that 70% preferred mobile phone calls or text messages to receive results [21].

Testing also enables partner interventions to notify, test, counsel, and treat potentially exposed sex partners, extending throughout sexual networks [22]. One recent study found that 'contact tracing' identified 25% more chlamydia cases in a population compared with no partner contact tracing [23]. Challenges to partner intervention include provider's organizational roles and priority in discussing partner notification, patient willingness to notify their partners, and provider's ability to secure patient agreement to partner notification [24•]. A widely available website, inSPOT.org, enables patients (and providers) to send anonymous e-mail 'postcards' to potentially exposed sex partners, and the site is designed to enable local content tailoring for each participating city, state, and country [25•]. Partner notification may also be delivered through sex partner-seeking websites; a recent feasibility study found that over 80% of MSM users would want an Internet-based partner notification system, with and without provider involvement, integrated into their sex partner-seeking website [26].

Information and communication technology transforms delivery of preventive behavioral interventions for sexually transmitted disease/HIV

The Internet and mobile phones are also used as delivery vehicles for behavioral interventions targeting a variety of challenges. STD/HIV prevention applications demonstrating feasibility and acceptability include STD/HIV question–answer counseling by e-mail [27] and online instant messaging [28]; interactive informational websites with tailored and directed feedback [29]; risk assessment websites [30,31]; brief online video interventions [32]; brief motivational interviewing and skill building websites [33]; and more intensive multisession interventions that can reach rural and isolated populations [34•]. Online intervention recruitment can be particularly effective; a recent trial used banner advertisements over a 6-week period to engage and screen almost 10 000 adolescents and young adults, enroll almost 3000, and retain high proportions for 1-month and 2-month follow-up assessments through automated e-mail and text-messaging [35•]. Mobile phone-based STD/HIV interventions, primarily text-messaging, are being used for appointment reminders, test results, health education messages, question-and-answer services, and treatment adherence, but no efficacy trial results have been published to date [36•,37•,38].

A recent systematic review and meta-analysis of computer-based and Internet-based STD/HIV interventions conducted through 2008 identified 12 randomized controlled trials (RCTs), finding effect sizes similar to human-delivered interventions (i.e. about 30% efficacy) for condom use, partner numbers, and incident STDs [39•]. Effect sizes were enhanced by use of individualized tailoring and more intervention sessions. More recently, an RCT of a 15 min interactive computerized intervention delivered in STD clinics significantly reduced chlamydia and gonorrhea incidence over 6 months [40], but a pair of RCTs testing a single-session computerized intervention with thousands of youth either in clinics or online (described above) was not efficacious, possibly due to poor retention of high-risk participants and the single-session design [41]. A recent review of non-STD/HIV text-message intervention RCTs (focused primarily on diabetes, but also on hypertension, smoking, and obesity) concluded that 13 of the 14 trials had positive short-term behavioral outcomes [42]. Thus, intervention intensity and exposure remain challenges but ICT-delivered STD/HIV prevention is feasible, acceptable, and potentially as efficacious as human-delivered interventions.

Information and communication technology transforms HIV care

HIV infection and incurable STDs are chronic illnesses requiring the same common elements for care and self-management of physical health, psychological functioning, and social relationships as all other chronic conditions, including preventing transmission [43•]. To reduce provider and patient time burdens and increase data sharing and care coordination, many ICT solutions have been developed for a variety of chronic conditions [44]. Examples in HIV/STD care focus on patient self-management, provider evidence-based decision-making and practice, and care coordination.

Self-management

Self-monitoring, skill building, risk reduction, and social support are all key elements of chronic disease self-management. Patients' ongoing self-monitoring of risk and health status has been delivered in HIV care settings via automated computer systems [45,46], resulting in significant behavioral changes without any other intervention [44,45]. The Expert Patient's Program, a peer-facilitated self-management intervention for all chronic conditions (including HIV), has adapted self-care skills training sessions for online delivery [47]. '+Click' is a web-based sexual risk reduction intervention for HIV-positive youth delivered as an adjunct to clinic-based self-management support and has demonstrated high usability, satisfaction, and

promising short-term impact [48]. Text messaging to support ART adherence is widely utilized and currently being tested in a RCT in Africa [36•]. Social support is highly utilized by people with HIV/AIDS in online groups (e.g. message boards) for a broader range of informational, emotional, moral, and instrumental support than might be expected in a text-based environment [49,50].

Evidence-based decision-making and practice

A key factor underlying efficacy of evidence-based interventions (EBIs) and EBP for prevention and care is providers' fidelity or adherence to evidence-based protocols [1••]. Effective HIV/STD prevention programs are argued to address five common factors: provide a frame to motivate change; convey issue-specific and population-specific information; build affective, cognitive, and behavioral skills; address environmental barriers to change; and build social support to sustain the change [51••]. Change is unlikely if these domains are not addressed, including for provider adoption of ICT and EBP; a recent Cochrane review of studies examining electronic retrieval of health information by healthcare providers found no evidence for professional behavior changes or use of evidence in practice, suggesting that motivation, skills, or environment are typically not adequately addressed to apply the information [52].

More successful strategies tend to focus on task shifting routine assessment tasks to automated ICT systems that reduce provider burden, such as self-administered computer-based risk assessments [45] and screening for adherence, depression, substance use, and condom use [46] in routine HIV care. ICT-based assessment tools can also generate automated reports and tailored advice sheets to guide providers' and patients' counseling priorities [53]. Need and acceptability have also been demonstrated for online decision-support tools to promote EBP by psychosocial counselors for people living with HIV/AIDS [54]. Mobile phones are being used to support peer and community health workers with their increasingly task-shifted responsibilities [55,56,57••]. Use of ICT to support implementation of manualized EBIs has great potential to enhance fidelity as well as adoption, sustainability, and effectiveness, but only one study has examined this approach, applied to teachers and substance abuse prevention EBI [58]. ICT has great potential to rapidly advance the limited work to date on interventions to support providers' adoption and delivery of EBI and EBP.

Care coordination with electronic health records and information and communication technology

Much more investment has been made in electronic health records (EHRs) and ICT systems to support providers in clinical management, reporting, and patient tracking, particularly for ART programs. Provider time-savings averaged 16 min/visit when an EHR/ICT care coordination system was implemented in HIV clinics [59], and another study significantly reduced loss to follow-up, a major barrier to scale-up of ART programs in developing countries [60]. However, there are still significant barriers to coordinating care across different providers, as EHRs and ICT care coordination systems do not have common platforms that enable information sharing and integration, and patients typically do not have access to retrieve or update their health information [61]. Thus, personally controlled health records (PCHRs) are being developed by major technology companies [e.g. Microsoft HealthVault (Microsoft, Redmond, Washington, USA)] that transfer the locus of control over health information to patients and enables them to securely access, update, integrate, store, and share their health information electronically [61].

Mobile phones transform data collection, diagnostics, and care coordination

Mobile phones are revolutionizing data collection for patients, providers, and researchers. Increasingly, phones' built-in sensors, including cameras and GPS, are being used as diagnostic

and data collection tools [62•]. Mobile phone cameras can take and send pictures of paper-based bioassays for expert analysis [63] or be fitted with small and inexpensive (i.e. <$10) microscopes to analyze blood cell stains for malaria [64], CD4 cell counts for HIV treatment management [65], and sputum samples for tuberculosis [66].

Integrated ICT care coordination and self-management systems are currently being implemented that link mobile phones, EHRs or PCHRs, and the Internet to collect, store, integrate, and share health-related information. Diabetes self-management systems integrating mobile phone data from patient input and peripheral devices (e.g. glucose meter, pedometer) with Internet-delivered visualization, automated feedback, and provider feedback have improved multiple clinical and behavioral outcomes [67,68]. Similar systems are being implemented for HIV/AIDS care throughout Africa, but focused on peer and community health workers deployed with mobile phones to receive supervision and support from higher trained providers [55], using GIS systems for participatory planning [56], GPS to monitor service delivery and data collection, and mobile diagnostic tools [57••].

Summary

Internet and mobile phone delivery of STD/HIV prevention and care interventions is feasible, acceptable, and efficacious for consumers and providers. There are concerns that lack of access to ‘e-Health’ tools, particularly personal computers and broadband Internet connections (i.e. the ‘digital divide’) will exacerbate health disparities [69]. However, mobile phones are demonstrating an ‘inverse digital divide’ with nearly half of African–Americans and Latinos accessing the Internet and e-mail on their mobile phones compared with just over a quarter of whites in the United States [70•]. There are currently estimated to be 3.5 billion mobile phone users globally, with the overwhelming majority in developing countries, and anticipated to reach 6 billion by 2013 [71•]. Mobile phone teledensity (i.e. number of phones per person) has reached above 100% in many developed countries, as well as South Africa, with 98% in Ghana, and Kenya and Tanzania soon following suit. India adds 15 million subscribers each month [71•]. The functions of personal computing, broadband Internet access, and mobile phones are rapidly converging in the form of smart-phones and $100 netbooks, which will be globally diffused over the next 5–10 years [71•]. This electronic expansion will enable low-cost, highly engaging, and ubiquitous STD/HIV prevention and treatment support interventions at an unprecedented scale.

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•• of outstanding interest

Additional references related to this topic can also be found in the Current World Literature section in this issue (pp. 180–182).

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