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

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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

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Introduction

Our current healthcare crises are rooted in urgent needs to prevent disease and promote wellbeing, 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••]. 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 smartphones 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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References and recommended reading

Papers of particular interest, published within the annual period of review, have been highlighted as:

- • of special interest
- •• 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).

1 •• Rotheram-Borus MJ, Swendeman D, Chovnick G. The past, present, and future of HIV prevention: integrating behavioral, biomedical, and structural intervention strategies for the next generation of HIV prevention. Annu Rev Clin Psychol 2009; 5:143–167.
This article provides a comprehensive review of the current state of behavioral and biomedical HIV prevention, details adherence challenges in biomedical interventions, and anticipates possible paradigm shifts in prevention.

2 •• Weiss HA, Wasserheit JN, Barnabas RV, *et al.* Persisting with prevention: the importance of adherence for HIV prevention. Emerg Themes Epidemiol 2008; 5:8.
This article, written by researchers implementing large-scale biomedical HIV prevention effectiveness trials, highlights the importance of behavioral adherence for the effectiveness of all biomedical HIV prevention interventions.

3 •• Merson MH, O'Malley J, Serwadda D, *et al.* The history and challenge of HIV prevention. Lancet 2008; 372:475–488.
This article details the history of HIV prevention, competition between biomedical, behavioral, and structural prevention strategy camps for resources, and new commitments toward multilevel or combination prevention.

4 World Health Organization (2008). Task shifting: global recommendations and guidelines. http://data.unaids.org/pub/Manual/2007/ttr_taskshifting_en.pdf. Accessed 10 August 2009.

5 Rietmeijer CA, McFarlane M. Web 2.0 and beyond: risks for sexually transmitted infections and opportunities for prevention. Curr Opin Infect Dis 2009; 22:67–71.

6 Horvath KJ, Rosser BR, Remafedi G. Sexual risk taking among young internet-using men who have sex with men. Am J Public Health 2008; 98:1059–1067.

7 Horvath KJ, Oakes JM, Rosser BRS. Sexual negotiation and HIV serodisclosure among men who have sex with men with their online and offline partners. J Urban Health 2008; 85:744–758.

8 Hooper S, Rosser BR, Horvath KJ, *et al.* An online needs assessment of a virtual community: what men who use the Internet to seek sex with men want in internet-based HIV prevention. AIDS Behav 2008; 12:867–875.

9 Al-Tayyib AA, McFarlane M, Kachur R, *et al.* Finding sex partners on the Internet: what is the risk for sexually transmitted infections? Sex Transm Infect 2009; 85:216–220.

10 Moreno MA, Parks MR, Zimmerman FJ, *et al.* Display of health risk behaviors on MySpace by adolescents. Arch Pediatr Adolesc Med 2009; 163:27–33.

11 Zhang D, Bi P, Hiller JE, *et al.* Web-based HIV/AIDS behavioral surveillance among men who have sex with men: potential and challenges. Int J Infect Dis 2008; 12:126–131.

12 •• Honan M. I am here: one man's experiment with the location-aware lifestyle. Wired 2009; 19 January 2009. http://www.wired.com/gadgets/wireless/magazine/17-02/lp_guineapig. Accessed 10 August 2009.
This article describes GPS-enabled geo-location or context-aware features of mobile phones and intersections with social networking services, including description of a potential anonymous sexual encounter.

13 Mikolajczak J, Kok G, Hospers HJ, *et al.* Queermasters: developing a theory- and evidence-based Internet HIV-prevention intervention to promote HIV-testing among men who have sex with men (MSM). Appl Psychol 2008; 57:681–697.

14 Rotheram-Borus MJ, Leibowitz AA, Etzel MA. Routine, rapid HIV testing. AIDS Educ Prev 2006; 18:273–280.

15 Branson BM, Handsfield HH, Lampe MA, *et al.* Revised recommendations for HIV testing of adults, adolescents, and pregnant women in health-care settings. MMWR Morb Mortal Wkly Rep 2006; 55 (RR-14):1–17.

16 Burke RC, Sepkowitz KA, Bernstein KT. Why don't physicians test for HIV? A review of the US literature. AIDS 2007; 21:1617–1624.

17 Merchant RC, Clark MA, Mayer KH, *et al.* Video as an effective method to deliver pretest information for rapid human immunodeficiency testing. Acad Emerg Med 2009; 16:124–135.

18 Sundaram V, Lazzeroni LC, Douglass LR, *et al.* A randomized trial of computer-based reminders and audit and feedback to improve HIV screening in a primary care setting. Int J STD AIDS 2009; 20:527–533.

19 Goetz MB, Hoang T, Bowman C, *et al.* A system-wide intervention to improve HIV testing in the veterans health administration. J Gen Intern Med 2008; 23:1200–1207.

20 •• Gaydos CA, Barnes M, Aumakhan B, *et al.* Can e-technology through the Internet be used as a new tool to address the *Chlamydia trachomatis* epidemic by home sampling and vaginal swabs? Sex Transm Dis 2009; 36:577–580.
This article describes a widely available free home STD testing service that uses a website to request tests, consent, evaluate, educate, and provide results and links to treatment.

21 Buhrer-Skinner M, Muller R, Bialasiewicz S, *et al.* The check is in the mail: piloting a novel approach to *Chlamydia trachomatis* testing using self-collected, mailed specimen. Sex Health 2009; 6:163–169.

22 Hogben M, Niccolai LM. Innovations in sexually transmitted disease partner services. Curr Infect Dis Rep 2009; 11:148–154.

23 Forbes G, Clutterbuck DJ. How many cases of chlamydial infection would we miss by not testing partners for infection? Int J STD AIDS 2009; 20:267–268.

24 • Swendeman DT, Grusky O, Swanson AN. HIV partner notification: predictors of discussion and agreements from provider reports. AIDS Behav 2009; 13:573–581.
This is one of the first studies to examine the intersection of organizational factors, provider characteristics, and patient characteristics that influence partner notification in HIV testing.

25 • Levine D, Woodruff AJ, Mocello AR, *et al.* inSPOT: the first online STD partner notification system using electronic postcards. PLoS Medicine 2008; 5:1428–1431.
This article describes a widely available website for STD/HIV infected patients to send anonymous partner notification emails to exposed sex partners.

26 Mimiaga MJ, Fair AD, Tetu AM, *et al.* Acceptability of an Internet-based partner notification system for sexually transmitted infection exposure among men who have sex with men. Am J Public Health 2008; 98:1009–1011.

27 Wynn LL, Foster AN, Trussell J. Can I get pregnant from oral sex? Sexual health misconceptions in e-mails to a reproductive health website. Contraception 2009; 79:91–97.

28 Moskowitz DA, Melton D, Owczarzak J. PowerON: the use of instant message counseling and the Internet to facilitate HIV/STD education and prevention. Patient Educ Couns 2009; 77:20–26.

29 Halpern CT, Mitchell EMH, Farhat T, *et al.* Effectiveness of web-based education on Kenyan and Brazilian adolescents' knowledge about HIV/AIDS, abortion law, and emergency contraception: findings from TeenWeb. Soc Sci Med 2008; 67:628–637.

30 Mindel A, McHugh L, Christie E, *et al.* Genital herpes: an internet-based risk survey. Int J STD AIDS 2009; 20:785–789.

31 Lee DM, Fairley CK, Sze JK, *et al.* Access to sexual health advice using an automated, internet-based risk assessment service. Sex Health 2009; 6:63–66.

32 Chiasson MA, Shaw FS, Humberstone M, *et al.* Increased HIV disclosure three months after an online video intervention for men who have sex with men (MSM). AIDS Care 2009; 21:1081–1089.

33 Carpenter KM, Stoner SA, Mikko AN, *et al.* Efficacy of a web-based intervention to reduce sexual risk in men who have sex with men. AIDS Behav 2009 [Epub ahead of print].

34 • Bowen AM, Williams ML, Daniel CM, *et al.* Internet based HIV prevention research targeting rural MSM: feasibility, acceptability, and preliminary efficacy. J Behav Med 2008; 31:463–477.
This article describes recruitment, intervention acceptability, and preliminary outcomes in an online STD/HIV preventive intervention specifically targeted to rural MSM.

35 • Bull SS, Vallejos D, Levine D, *et al.* Improving recruitment and retention for an online randomized controlled trial: experience from the Youthnet study. AIDS Care 2008; 20:887–893.
This article describes online recruitment and retention of thousands of adolescents and young adults for an online STD/HIV prevention intervention.

36 • Lester RT, Mills EJ, Kariri A, *et al.* The HAART cell phone adherence trial (WelTel Kenya1): a randomized controlled trial protocol. Trials 2009; 10:87.
This article describes the study protocol currently being implemented to assess the efficacy of text-messaging to support antiretroviral adherence for HIV-positive people.

37 • Lim MSC, Hocking JS, Hellard ME, *et al.* SMS STI: a review of the uses of mobile phone text messaging in sexual health. Int J STD AIDS 2008; 19:287–290.
This article provides the first review of text-messaging interventions for STD prevention.

38 Lim EJ, Haar J, Morgan J. Can text messaging results reduce time to treatment of *Chlamydia trachomatis*? Sex Transm Infect 2008; 84:563–564.

39 • Noar SA, Black HG, Pierce LB. Efficacy of computer technology-based HIV prevention interventions: a meta-analysis. AIDS 2009; 23:107–115.
This article presents a meta-analysis of 12 rigorous RCTs of computer-based and Internet-delivered HIV/STD prevention interventions conducted through 2008.

40 Grimley DM, Hook EW. A 15-min interactive, computerized condom use intervention with biological endpoints. Sex Transm Dis 2009; 36:73–78.

41 Bull S, Pratte K, Whitesell N, *et al.* Effects of an Internet-based intervention for HIV prevention: the Youthnet trials. AIDS Behav 2009; 13:474–487.

42 Fjeldsoe BS, Marshall AL, Miller YD. Behavior change interventions delivered by mobile telephone short-message service. Am J Prev Med 2009; 36:165–173.

43 • Rotheram-Borus MJ, Ingram BL, Swendeman D, *et al.* Common principles embedded in effective adolescent HIV prevention programs. AIDS Behav 2009; 13:387–398.
This article reviews chronic disease self-management literature, including for HIV/AIDS, and highlights commonalities across chronic diseases and HIV-specific challenges.

44 Solomon MR. Information technology to support self-management in chronic care a systematic review. Dis Manag Health Outcomes 2008; 16:391–401.

45 Lightfoot M, Rotheram-Borus MJ, Comulada S, *et al.* Efficacy of brief interventions in clinical care settings for persons living with HIV. J Acquir Immune Defic Syndr 2009 [Epub ahead of print].

46 Schackman BR, Dastur Z, Rubin D, *et al.* Feasibility of using audio computer-assisted self-interview (ACASI) screening in routine HIV care. AIDS Care 2009; 21:992–999.

47 Kennedy A, Rogers A, Sanders C, *et al.* Creating 'good' self-managers? Facilitating and governing an online self care skills training course. BMC Health Serv Res 2009; 9:93.

48 Markham CM, Shegog R, Leonard AD, *et al.* +CLICK: harnessing web-based training to reduce secondary transmission among HIV-positive youth. AIDS Care 2009; 21:622–631.

49 Bar-Lev S. We are here to give you emotional support: performing emotions in an online HIV/AIDS support group. Qual Health Res 2008; 18:509–521.

50 Coursaris CK, Liu M. An analysis of social support exchanges in online HIV/AIDS self-help groups. Comput Hum Behav 2009; 25:911–918.

51 •• Rotheram-Borus MJ, Swendeman D, Flannery D, *et al.* Common factors in effective HIV prevention programs. AIDS Behav 2009; 13:399–408.
This article presents a framework hypothesizing that five common factors underlie the efficacy of all effective and evidence-based HIV prevention interventions, and proposes a paradigm shift for design, diffusion, and fidelity based on common factors.

52 McGowan JL, Grad R, Pluye P, *et al.* Electronic retrieval of health information by healthcare providers to improve practice and patient care (review). Cochrane Database Syst Rev:CD004749.

53 Chen HT, Grimley DM, Waithaka Y, *et al.* A process evaluation of the implementation of a computer-based, health provider-delivered HIV-prevention intervention for HIV-positive men who have sex with men in the primary care setting. AIDS Care 2008; 20:51–60.

54 Kukafka R, Millery M, Chan C, *et al.* Assessing the need for an online decision-support tool to promote evidence-based practices of psychosocial counseling in HIV care. AIDS Care 2009; 21:103–108.

55 Chang LW, Kagaayi J, Nakigozi G, *et al.* Responding to the human resource crisis: peer health workers, mobile phones, and HIV care in Rakai, Uganda. AIDS Patient Care STDs 2008; 22:173–174.

56 Chirowodza A, van Rooyen H, Joseph P, *et al.* Using participatory methods and geographic information systems (GIS) to prepare for an HIV community-based trial in Vulindlela, South Africa (Project Accept-HPTN 043). J Community Psychol 2009; 37:41–57.

57 •• Leach-Lemens C. Using mobile phones in HIV care and prevention. HIV & AIDS Treatment in Practice #137. http://www.aidsmap.com/cms1323130.asp. Accessed 10 October 2009. pp. 2–7.
This article presents case studies of mobile phones applied to support providers and patients in HIV treatment and care programs in Africa.

58 Hansen WB, Bishop DC, Bryant KS. Using online components to facilitate program implementation: impact of technological enhancements to all stars on ease and quality of program delivery. Prev Sci 2009; 10:66–75.

59 Magnus M, Herwehe J, Andrews L, *et al.* Evaluating health information technology: provider satisfaction with an HIV-specific, electronic clinical management and reporting system. AIDS Patient Care STDs 2009; 23:85–91.

60 Forster M, Bailey C, Brinkhof MW, *et al.* Electronic medical record systems, data quality and loss to follow-up: survey of antiretroviral therapy programmes in resource-limited settings. Bull World Health Org 2008; 86:939–947.

61 Mandl KD, Kohane IS. Tectonic shifts in the health information economy. N Engl J Med 2008; 358:1732–1777.

62 • Kwok R. Personal technology: phoning in data. Nature 2009; 458:959–961.
This article briefly presents innovative uses of mobile phones to collect data across a range of disciplines, including the significance of GPS location data.

63 Martinez AW, Phillips ST, Carrilho E, *et al.* Simple telemedicine for developing regions: camera phones and paper-based microfluidic devices for real-time, off-site diagnosis. Anal Chem 2008; 80:3699–3707.

64 Blum Center for Developing Economies. Portable, low-cost imaging for monitoring and disease diagnosis. http://blumcenter.berkeley.edu/global-poverty-initiatives/mobile-phones-rural-health/remote-disease-diagnosis. Accessed 15 October 2009.

65 NIH recognizes engineering professor's innovative research with major award. UCLA Newsroom press release, 2 October 2009. http://newsroom.ucla.edu/portal/ucla/ucla-engineering-professor-recognized-102562.aspx. Accessed 8 October 2009.

66 Breslauer DN, Maamari RN, Switz NA, *et al.* Mobile phone based clinical microscopy for global health applications. PLoS One 2009; 4:e6320.

67 Yoo HJ, Park MS, Kim TN, *et al.* A ubiquitous chronic disease care system using cellular phones and the Internet. Diabet Med 2009; 26:628–635.

68 McTigue KM, Conroy M, Hess R, *et al.* Translation of an intensive lifestyle intervention to an online setting. Ann Behav Med 2008; 35:S167.

69 Baur C. An analysis of factors underlying e-health disparities. Camb Q Healthc Ethics 2008; 17:417–428.

70 • Horrigan J. Mobile access to data and information. Pew Internet and American Life Project. Pew Research Center. 5 March 2008. Retrieved 17 February 2009. http://www.pewinternet.org/pdfs/PIP_Mobile.Data.Access.pdf.
This report describes the diffusion and use of mobile phones in the United States by major demographic categories, highlighting the 'inverse digital divide' of rapid adoption by African–Americans, Latinos, and young people.

71 • Mobile marvels: a special report on telecoms in emerging markets. The Economist 26 September 2009.
This report describes the rapid diffusion of mobile phones globally, projections for the future, and the convergence of Internet and personal computing via smartphones that will rapidly increase global Internet access.