3

Personal Computer, Mobile Phone and Internet Technologies to Increase HIV Testing and Prevention

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1. Introduction

Globally, since the AIDS epidemic began, nearly 60 million individuals have contracted HIV with 25 million having died from causes related to the infection (World Health Organization [WHO], 2009). In 2009, it was estimated that 33.4 million people world-wide were living with HIV (WHO, 2009). The Centers for Disease Control and Prevention (CDC) estimates that over one million individuals in the United States are living with HIV, and since the 1990s, the annual rate of individuals newly infected with HIV has remained relatively stable at about 56, 300 (CDC, 2010).

While the number of individuals reporting ever having been tested for HIV has been increasing steadily over time (Kaiser Family Foundation, 2006), a fifth (21%) of the HIV-infected population is unaware they are infected. This is an alarming statistic that continues to hamper efforts to substantially reduce the spread of the disease and improve the health of the public (CDC, 2010). Further, according to the CDC, among individuals appearing to a CDC-funded HIV-testing site in 2000, only 31% of those who tested positive for HIV ever returned to receive the results of the test (CDC, 2003).

Advances in medicine have proven effective in improving the quality of life of those who are HIV-positive. However, these improvements are more fully realized when HIV-positive status is identified early on. Early identification of HIV-positive status can be important in reducing morbidity and mortality (CDC, 2006), and studies have shown that individuals who are aware that they are HIV-positive will modify their behavior in an effort to prevent transmission of the virus (Marks et al., 2005).

The public health benefits of increased rates of HIV testing and awareness of HIV-positive status are clear. Consequently, strategies to increase HIV-testing, awareness of positive status, and motivation to obtain medical care are important in the effort to reduce the negative impact of HIV/AIDS. Today's technologies have the potential to substantially impact the AIDS epidemic by providing innovative and cost-effective means by which to reach more individuals and increase HIV-testing rates, awareness and motivation to change health behavior related to HIV/AIDS.

Researchers and clinicians working to influence and promote health behavior have only just begun to scratch the surface with regard to the uses of technologies in prevention and intervention programs. Examples that utilize technology to influence and promote health behavior include, but are not limited to, sending text messages to remind individuals of health care appointments, creating websites that provide specific health-related information and motivate individuals to seek health care services, and using tablet PCs or other mobile technologies to reach hidden populations and to administer assessments and interventions electronically. The potential for integrating and utilizing technology into health programs to influence and promote behavior is great and will continue to grow at a rapid pace. It is possible that as society continues to become more reliant on such technologies, health programs not utilizing or incorporating technologies will become less effective in comparison to technology-based health programs.

2. Advantages to using technology with HIV-positive and at-risk populations

The availability of, and advances in, personal computers, mobile phones and the Internet have grown exponentially over the last several years and growth continues at a staggering pace. As such, the use of these technologies is far reaching—impacting society in multiple ways. While the use of technology is pervasive in many ways, its application and potential benefit in raising awareness of and changing health behavior is much less pervasive, and thus potentially severely underutilized. To understand how technologies such as mobile phones, computers and the Internet can potentially positively impact the fight against HIV/AIDS, a general overview of the advantages of using or incorporating technology into programs created to change health behavior follows.

The use of technology to raise awareness of health concerns such as HIV-positive status and facilitate health behavior change is a relatively new and substantially understudied area. Given the apparent advantages to utilizing and incorporating technologies to impact the health outcomes of the public, including underserved populations, this line of research is likely to grow significantly over the next several years. The use and integration of technologies to influence and promote health behavior has several potential advantages (c.f., Bull, 2011). Below we reiterate and expand on the advantages of using technologies to influence and promote health as originally described by Bull (2011).

Reach. Perhaps the most significant and fundamental contribution technologies such as computers, mobile phones and the Internet have on promoting and changing health behavior is that of reach. Bull (2011) argues that the Internet offers an unprecedented opportunity to reach untold numbers of individuals. Likewise, the growing use and affordability of portable computers and mobile phones extends opportunities to connect with greater numbers of individuals. As a result, the effort to positively influence the health of the public can expand past traditional means of contact and interaction, thus reaching and impacting far more individuals than was previously thought possible. The use of the Internet, computers and mobile phones to promote and change health behavior has the potential to overcome many of the barriers that limit or preclude access to health programs (e.g., transportation and/or child care, inflexible work schedules of patients) (see, for example, DeLeon, Wakefield, & Hagglund, 2003; Nordal, Copans, & Stamm, 2003; Organista, Munoz, & Gonzalez, 1994; Stamm, 2003). This is especially true for women and minority individuals who are preferentially impacted by these barriers (Connell, Sanders, &

Markie-Dadds, 1997; National Institute of Mental Health, 2003; US Census Bureau, 2002; Weismann & Jensen, 2002). Highlighting the need to discover ways to overcome barriers, authors have noted that while a health program may be found efficacious, it may not necessarily have a substantial impact if it cannot reach the target population and engage that population over time for sustained effects (see Thyrian & Ulrich, 2007; Glasgow, Klesges, Dzewaltowski, Estabrooks, & Vogt, 2006; Klesges, Estabrooks, Dzewaltowski, Bull, & Glasgow, 2007).

Tailored Content. Technology can allow for health programs and interventions to be tailored to address patient factors (e.g., language barriers, low self-efficacy) and cushion provider bias (e.g. cognitive bias) and real-world system constraints (e.g., second/third-shift workers). Disadvantaged individuals tend to be more severely impacted by these factors and recent studies have shown that interactive multimedia computer programs can lessen these impacts (Jerant, Sohler, Fiscella, Franks, & Franks, 2010). Studies also indicate that information tailored to an individual becomes more relevant to the individual and thus is more likely to be read, comprehended and stored (Kreuter, Farrell, Olevitch, & Brennan, 2000; Stretcher, 1999). For instance, a computer-based health program designed to educate about the dangers of drug use can be programmed to discuss only issues related to drugs with which the respondent has indicated experience. A video-based health program would play through the dangers of all drugs, regardless of a drug's relevance to the respondent. As a result, respondents may become uninterested in the health program and fatigued by it because of what may be considered irrelevant information.

Feasibility. The use of technology in health programs and interventions can make the adoption, implementation and utilization of programs more feasible for community agencies. Glasgow, Lichtenstein, and Marcus (2003) argue that in order to reach some populations and have an impact on those populations, health programs must be made easy for community agencies to adopt, implement and utilize. Preliminary studies utilizing technology to promote health have shown that technology integration has promising potential to provide the means by which community agencies can easily implement and utilize proven health programs (Leeman-Castillo, Beaty, Raghunath, Steiner, & Bull, 2010; Cullen & Thompson, 2008; Skinner, Rivette, & Bloomberg, 2007). In short, utilizing a computer-based health program or intervention is often easier to implement and less expensive than hiring and training staff to deliver the same intervention.

Cost-Effectiveness. Technologies have the potential to lower costs associated with implementing and sustaining health programs and interventions. For example, the portability of computers, mobile phones and the Internet increases reach and reduces reliance on physical locations that require maintenance and which are often limited by size (see, for example, Booth, Nowson, & Matters, 2008; Brendryen & Kraft, 2008; Rainie, Horrigan, Wellman, & Boase, 2006). Home care programs can use camera phones to monitor patient wounds (estimated at 25% of home health admissions), thereby increasing the appropriate use of specialist services and decreasing associated costs (Sugrue & Riggs, 2005). Video phones used with patients receiving palliative care and antenatal home care have been shown to decrease isolation, save travel time and allow care team members to meet at a distance (Miyazaki, Stuart, Liu, Tell, & Stewart, 2003).

Standardization. Using technologies such as the Internet, mobile phones and computers, health programs can more readily standardize the content and delivery of the program.

Standardization helps ensure that each participant in the health program or intervention gets the content of the program exactly as it was intended. Further, standardization reduces variability, especially with regard to interactions with counselors or other content deliverers, and can substantially increase adherence to program curricula.

Interactive. Health programs can be technologically-enhanced to allow for a higher degree of interactivity than past means of health information delivery, such as video recordings and simple text-based or audio-assisted computer applications. For example, computers, mobile phones and the Internet can deliver health program content in multiple formats, including video-game formats. Similarly, health programs can be designed to mimic real-life interactivity with a counselor or other health care professional through the use of human simulation and artificial intelligence programs. Further, given that younger individuals are substantially more tech-savvy and reliant on technology, these individuals may, in fact, prefer interacting through computers, mobile phones and the Internet.

Anonymity & Confidentiality. While some caveats apply, technologies more readily offer anonymity to recipients of health programs and interventions. For example, through the use of a computer or mobile phone with Internet access, individuals can access and receive health program information and interventions without ever being personally identified. Likewise, technologies can store respondent information confidentially by generating unique identification codes or using biometric identification such as fingerprints, which can link several sources of data without identifying respondents.

Autonomy. Using technologies such as mobile phones, computers and the Internet, individuals can move through programs and interventions at their own pace. Further, individuals can be afforded the flexibility of accessing programs and interventions at times that are most convenient to them. For example, individuals who have work schedules that vary from week to week may not be able to readily access treatment or intervention services or may have trouble keeping appointments can benefit from the flexibility of accessing programs and services online at times and from locations convenient to their schedule.

Portability. Increasingly, over the past several years technologies have become more portable. Likewise, Internet access, especially free access, has become increasingly more common. Together, portability and Internet access allow individuals to easily access online content. Advances in mobile phone technologies (e.g., "smartphones") allow for the potential to create health prevention and intervention programs using software programs ("Apps") that can be downloaded to a smartphone and accessed anytime and anywhere, often without needing access to the Internet.

Storage & Backup. Technologies provide relatively easy and inexpensive storage and backup of information and can range from basic hard-drives or portable drives (e.g., flash drive, external hard drive) to more sophisticated devices such as secured networked drives with automatic and redundant backup. Further, electronic storage and backup can safeguard against information loss due to theft or disaster. For example, automatic backup and storage to a remote off-site location can protect information that might otherwise be destroyed in an on-site fire or other similar disaster.

The aforementioned discussion of the use of technology to influence and promote health behavior, including HIV-related testing and behavior, highlights the many potential advantages of using technology. Perhaps most importantly, technologies afford community

Advantage	Example
Reach	• Access to the Internet through free Wi-Fi is increasing. • Mobile phones ("smartphones") that can access the Internet have become more affordable. • Smart phones are able to run computer programs ("Apps"). • Internet-, computer- and mobile phone-delivered programs have the potential to always be on—allowing access at any time.
Tailored Content	• Programs can be tailored to the individual characteristics of the participant (e.g., an African-American female counselor can appear in a video for an African-American female client). • Content can be tailored based on the responses of the participant.
Feasibility	• Programs or interventions can be implemented with little or no training of staff, thus reducing potential costs to the agency. • An agency with limited staff may be able to provide additional services by utilizing technologies.
Cost-Effective	• Technologies can be utilized in place of more expensive program staff. • Technologies can reduce costs of training staff to conduct programming that can be done by a computer or other technology. • Technologies can be utilized off-site and have the ability to reach more individuals.
Standardization	• Content can be delivered exactly the same way each time. • Technologies can increase program fidelity. • Technologies can reduce the variability associated with individual differences of those delivering program content.
Interactive	• Technologies allow for interaction with computers, which may be more comforting for some participants, especially younger participants. • Content can be delivered using an approach that utilizes multiple forms of media (e.g., video, audio, games).
Anonymity & Confidentiality	• Participants can provide information or interact with a program anonymously through the Internet. • Participants can provide information or interact with programs on-site without revealing personally identifying information. • Technologies reduce the risk of breach of confidentiality because there are no hardcopy or paper formats of participant information.
Autonomy	• Participants can proceed through curricula or programming at their own pace without significant disruption to other participants or program staff.
Portability	• Technologies can be mobile and thus can remain in contact with the participant—providing continuous monitoring, support or communication.
Storage & Backup	• Participant information can be safely stored and backed-up to safeguard against theft or disaster.

Table 1. Examples of each potential advantage of using technologies to promote health.

agencies that serve at-risk HIV populations more options in which to provide services within limited and often shrinking operating budgets. For instance, as a result of federal and state cuts in funding for services, including services for minority populations (Zeanah, Stafford, & Zeanah, 2005), there have been calls to support the adoption of interventions that can be delivered in nontraditional and innovative ways that overcome traditional barriers to treatment provision and utilization (Hollon et al., 2002; National Institute of Mental Health, 2003).

Affordability of technology makes it increasingly possible for community agencies even in the poorest of neighborhoods, to utilize technology and technology-based services. As a result, technologies or technology-enhanced services can be more readily adopted, implemented and maintained allowing greater penetration into populations that are at risk for HIV. Additionally, the use of technology and technology-enhanced services allows agencies to expand evidence-based practices (EBPs) with minimal strain to limited staff and resources that are already stretched thin in many community agencies. Thus, technologies and technology-enhanced services can provide feasible real-world and evidence-based solutions that can reach even the most remote and underserved populations of individuals at risk for or living with HIV/AIDS.

3. Emerging literature

The emerging body of literature on computer-based interventions (including delivery via local computer or Internet, smart phone and social media) as applied to HIV testing, awareness and prevention shows great promise. Researchers point out that technological applications are especially important because significant investments have been made in the development of HIV prevention and behavioral interventions; however, there remain barriers to widespread use. These barriers include, but are not limited to, the cost of delivery (that is, requiring a human facilitator), maintenance to fidelity of interventions and distribution to remote or rural areas.

Noar (2011) presents a review of computer technology-based interventions in HIV prevention including interventions that are group-targeted, individually tailored and apply interactive video. The author presents a series of intriguing research questions regarding the use of technologies along the lines of reach (who are the appropriate audiences?), efficacy (what kinds of effects are possible?), adoption (who uses the technology?), implementation (what are the process issues?) and maintenance (how can the use of technology be sustained over time?). This work provides a framework for analyzing the newly emerging studies on the use of technology to promote HIV prevention.

Seeking health information online has become routine for most Americans. As such, it is no surprise that the Internet has been shown to be a source of sexual health information. Lesbian, gay, bisexual and transgender (LGBT) youth report that they use the Internet to seek sexual health information, particularly to avoid the stigma associated with asking questions of health care providers (Magee, Bigelow, DeHann, & Mustanski, 2011). Hightow-Weidman et. al (2011) developed a theory-based HIV/STI website for young, Black men who have sex with men (MSM) based on the Institute of Medicine's integrated model of behavior change and with input from young Black MSM focus group participants. Their interactive web site design uses live chats, quizzes, personalized health and "hook up/sex" journals. Clients reported high satisfaction with the approach, particularly due to its high

cultural relevance. Therefore, websites present the opportunity to tailor health information in a way that can be continuously updated, as opposed to brochures in print.

Most studies of the Internet and HIV prevention have focused on gay, bisexual, and MSM who seek sexual partners online. These interventions have sought to promote HIV testing. A community-based participatory research (CBPR) partnership developed and piloted *CyBER/testing,* an intervention using Internet chat rooms set up to promote HIV testing among MSM "chatters" (MSM who use the chat room). The intervention showed a significant increase in self-reported testing for the chatters overall (Rhodes, et. al, 2011). This result was also supported by a study promoting testing via an online community for high-risk clients in North Carolina (Feldacker, et. al, 2010). Holt et. al (2011) in Australia found that the Internet is an important way to promote HIV testing among MSM. In particular, this study found that Internet social networks present the opportunity to engage never-tested clients in chat rooms which leads to increased motivation for testing. Bowen et. al (2008) examined the use of the Internet to conduct HIV prevention outreach to rural MSM. Overall, their findings suggest that web-based interventions may make rural outreach more feasible.

Clearly, Internet and social networking holds promise for reaching adolescent populations, given the documented high use of technology among this age group. Bull et. al (2007) developed a theoretically-based online HIV/STD and pregnancy prevention intervention aimed at 15-25 year old participants. The youth in this study felt that role model-delivered messages about HIV/STD and pregnancy risk, attitudes about condoms, norms and self-efficacy for negotiation would have a high impact. The youth preferred highly interactive websites such as chat rooms and message boards. The participants also felt that effective websites would give facts and real stories; however, they felt that reading should be short and to the point.

An interesting target population is that of homeless adolescents. A recent study (Young and Rice, 2011) found that in a sample of 201 homeless youth in Los Angeles, 79% reported using MySpace and/or Facebook almost every week. The adolescents used the Internet sites to communicate with others about drinking, drugs, parties, sex, being homeless and school experiences. The authors found that online social networks can be associated with both potential increases and potential decreases in HIV/STD risk among homeless youth. As an example of potential increases in HIV/STD risk, some homeless youth reported that they used social network sites to sell sex. Overall, however, online social network use was associated with increased knowledge and HIV/STD prevention behaviors among homeless youth. The authors conclude that homeless youth need more access to the Internet, since access may facilitate contact with family and home-based peers. This contact was found to be associated with decreased risk and increased testing. However, the authors caution that online environments need to be carefully monitored to prevent youth from soliciting sex online.

Using the Internet to reach high-risk individuals is a strategy being used in HIV prevention globally. Blas et. al (2007) used an Internet intervention in Peru to access high risk MSM. In this context, the authors describe how Peruvian MSM are shifting from physical to virtual places, not only to look for sexual partners but also to look for HIV-related health information. The study concluded that attracting high-risk MSM not tested for HIV to an intervention may be feasible by on-line recruitment.

Brief computerized interventions to reduce risk and increase HIV testing have been found to be effective. Alemagno et. al (2009) developed and implemented a computerized, self-administered HIV/STD risk screen using the "brief negotiation interviewing" (BNI) approach. Participants were able to answer a set of risk questions via computer, receive immediate risk feedback and work through a plan to increase motivation for testing. The participants in the computerized BNI intervention group were more likely to obtain an HIV test by the 3-month follow-up interview as compared to the controls. Grimley and Hook (2009) also found that a 15-minute interactive, computerized condom use intervention increased condom use. The intervention was conducted in a clinical setting and self-administered by the participants. The authors concluded that the intervention held considerable promise in that there was no additional burden on clinicians or staff.

Another promising technology for HIV prevention is the use of mobile phones. A recent study finds that riskier youth (in terms of HIV/STI risk behavior) are online and using cell phones frequently (Whiteley et. al, 2011). This study of over 1,500 African American adolescents found that over 90% of adolescents used their cell phones every day and 60% used social networking sites. The authors conclude that mobile phone interventions may be promising to reducing risks by providing health information.

Text messaging is an application that is emerging to reach target populations. A pilot program aimed at young Black men using a 12-week text message program found that the intervention group showed a trend toward increased monogamy at follow-up compared to controls (Juzang, Fortune, Black, Wright, & Bull, 2011). The intervention group also had higher awareness of sexual health compared to the controls. Another study found that young persons have positive attitudes toward text messages as appointment or medication reminders or for health information related to HIV (Person, Blain, Jiang, Rasmussen, & Stout, 2011). Receiving a text message was perceived as more acceptable than having to answer the phone. A message could be saved for viewing at a later time. One drawback of using text messages is that target populations must have sufficient literacy and there is the obvious cost associated with a mobile phone with text capabilities. This study also points out that less frequent, targeted reminders are most acceptable so the frequency is an important consideration.

4. Cautions in using technologies

While the use of technologies such as computers, mobile phones and the Internet show significant promise, careful consideration should be given to address any potential concerns. Below we discuss several potential issues that could arise when utilizing technologies in health-promoting programs for populations living with or at risk for HIV/AIDS. As more research emerges on the topic of technology-based health promotion, so should solutions to these potential issues.

Literacy. Even though it is possible to program computers to read text to participants, the use of health education websites or the use of health messages sent by text message requires participants to have the ability to read and understand the content. Few studies have examined the impact of literacy on mobile device use.

Confidentiality. There are confidentiality concerns regarding information that is disclosed on Internet sites and mobile devices, including risks related to self-disclosure and risks related

to unintended persons viewing information transmitted to mobile devices. While providers may feel assured that they are transmitting information to the correct person based on a mobile number, there is no control over who is reading the information once delivered to the device. Participants in chat rooms or using social media that is not properly secured and protected may have a false sense that their identities are not available to other participants.

Adverse Use. Several studies have voiced concerns that participants engaged in interventions may use computers for alternative purposes. For example, online interventions using chat rooms have been used by participants to solicit sex. This is especially concerning for interventions targeted at adolescents.

Cost to Participants. Not all intervention programs can afford to provide participants with necessary intervention technologies (e.g., mobile phones, Internet). As such, participants

Concerns	**Example**
Literacy	• Use of websites and text messaging requires a basic level of computer literacy and reading level. • Participants may not understand health information and take adverse actions based on misunderstanding. • Participants who take online risk screening may have a false sense of safety regarding their risks.
Confidentiality	• Confidential health information cannot be transmitted on the Internet in some settings. • Other persons may gain access to a mobile device and read text messages with sensitive information. • Participants may disclose personal information on the Internet.
Adverse Use	• Participants may misuse online chat rooms or social media sites for soliciting sex, selling drugs or other illegal trade. • Adolescents may engage in inappropriate activities or be solicited.
Cost to Participants	• While mobile devices may be inexpensive, services required (e.g., Internet access, mobile cell service providers) to use such devices is still relatively costly. • Mobile devices are transitional; participants change providers and phone numbers frequently making prolonged contact challenging.
Cost of Technology and Application Development	• Providers may need to invest considerable costs in the development of web-based interventions or other content ("Apps"). • Providers may need to train staff to implement and utilize the technologies.
Replacement of the Human Factor	• The impact of substituting a computer for a person conducting an intervention is unknown; removing the human factor from the intervention may not be effective in all settings or for all participants.
Digital Divide	• While the use of computer, Internet and mobile phones is increasing for all populations, there remains a considerably large number of individuals within target populations for HIV prevention and testing who do not have access to these technologies.

Table 2. Examples of concerns related to the use of technologies to promote health.

may need to pay for monthly mobile phone or Internet access in order to remain a participant in the intervention. Well-intended participants may withdraw from an intervention solely because they cannot afford the required technology, thus continuous contact with participants may become challenging for intervention providers.

Cost of Technology and Application Development. While there are savings associated with the use or incorporation of technologies, there are also costs related to the purchase of computers, design of websites, and programming of software applications. Further, there may also be costs associated with the training needs of staff using or implementing the technologies. Some uses of technologies may require the need for additional staff. For instance, additional staff may be needed to monitor chat rooms and social media sites.

Replacement of the Human Factor. The vast majority of evidence-based interventions to reduce HIV risk and increase testing have been designed to be delivered by human interventionists. Much is yet to be learned about the efficacy of replacing humans with technology-based intervention platforms. Future research is clearly needed to examine what benefits or shortfalls emerge when an intervention is delivered solely by a computer or mobile device devoid of personal contact.

Digital Divide. Despite the growing use of and reliance on technologies by society, some populations do not have access to it. This is especially notable among the very poorest populations (National Telecommunications and Information Administration and US Department of Commerce, 1999). Interventions targeting such populations will need to be provided to participants or available to participants in convenient locations.

5. Future directions

It will be important for future research to address research questions related to the use of technologies to increase HIV testing and reduce HIV/AIDS in at-risk populations. The majority of work to date has been on MSM; little is known about how interventions should be developed differently across populations or for those who lack computer skills. Further, few studies have examined the lasting impact of technology-based interventions or the ability to maintain contact with clients over time when interventions utilize these technologies.

Our review of the literature for this chapter did not reveal any "bundled" HIV intervention approaches that examine the efficacy of combining in-person and computer-based interaction in an intervention. Measuring the efficacy of the technology-based interventions as compared to traditional in-person approaches is in early stages, and rarely have studies been conducted comparing human-administered intervention to the same content delivered by a computer or a mobile phone. There may well be target populations for whom such technology-based approaches are not appropriate.

One thing is for certain, the technologies available for use in HIV-related interventions increases daily. There are new mobile devices with new "Apps" emerging all the time and the use statistics indicate that virtually everyone will eventually have some access to computers and/or mobile devices, even in remote countries around the world. The ability to examine such interventions with different target populations in different cultural contexts opens a new world for health education and interventions. There is a need for information regarding the barriers and facilitators to adoption of technologies for HIV-specific programs.

There is also a need for more information on the capacity of organizations to implement technologies in place of more traditional approaches. In this new era of technology-based interventions for HIV prevention, the only thing that remains certain is that opportunities to apply these technologies will grow much more quickly than our ability to understand all of the implications.

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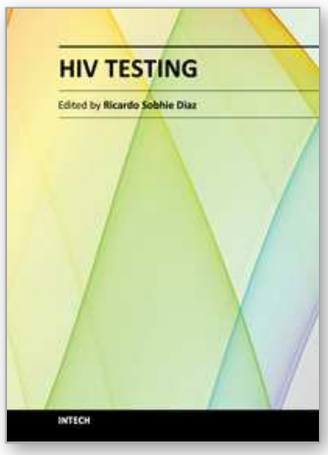

HIV Testing

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It can be said that now is the best time for everyone infected to become aware of their own HIV status. The state of the art in HIV management progressively reveals that antiretroviral treatment can prevent transmission, as well as chronic damage in the human body, if started early. Unfortunately, antiretrovirals are not widely available in many places, especially in developing countries. In these parts of the world, diagnosis of HIV infection must be kept in the agenda as a priority, in order to understand specific details of local epidemics and as an effort to interrupt the chain of HIV transmission.

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