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GUEST EDITORIAL

Re-shaping HIV Interventions with Technology

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This special issue presents 12 articles which outline some of the epidemiological and intervention strategies that mobile and electronic technologies offer that may improve and extend the reach, penetration rates, and efficacy for HIV interventions.

Since the 1990s global explosion of communication and computational technologies has been unprecedented. Today, about 5.6 of the world's seven billion people have mobile phones [1]. These mobile phones create access to the internet, for more than three billion users, a number that continues to increase over time [2]. Concurrently, more than 1.75 billion persons have smart phones, with the estimate that at least 2 billion smart phones will be utilized by the end of 2016 [3, 4]. Consumers' preference for the latest and greatest devices in high income countries has led to a secondary market for smart phones that will quickly expand penetration in low and middle income countries (LMIC). The speed with which these technologies have been adopted is staggering.

The range of the new technology is simultaneously often overwhelming. Social media platforms in particular are capturing the attention of large populations in a relatively short period of time. Facebook went from zero to 1 billion followers in 8 years [5]. Grindr, a geo-spatial networking application that aims to link together men-who-have-sex-with-men, went from zero to six million users in 4 years [6]. These new technologies (e.g., text messaging, geo-fencing, video/social gaming, embedded sensors for reading biorhythms, patient control of electronic medical records) offer the potential to disrupt the way HIV researchers conduct business [7]. Health-related technology has not only increased in availability, it is also rapidly adopted. While introduced only 20 years ago, over 2.2 trillion text messages are sent annually worldwide with 6 billion messages sent daily in the United States alone [8]. Communication technologies such as SMS and electronic medical records may offer a less expensive solution to extending healthcare outside of primary healthcare offices [10, 11]. Additionally, embedded sensing applications and products may be the future of health monitoring, allowing users to monitor their health on a daily basis. In the United States, sales of fitness bands and activity trackers grew 500 % annually over a 3 year period [9].

Compared to the success of new technologies, uptake of both behavioral and biomedical HIV interventions and assessment tools is moving slowly. In the last 25 years (since 1989), there have been 84 behaviorally-oriented, evidence-based HIV interventions identified by the Centers for Disease Control and Prevention [12]. Another six HIV evidence-based programs are on the National Registry of Evidence-based Programs and Practices site of the Substance Abuse and Mental Health Services Administration [13]. The penetration rate of these interventions remains low and is dropping over time, with a set of complex reasons.

Our scientific norms require replication with fidelity of programs and, specifically, manualized interventions. However, neither replication nor replication with fidelity appears to be viable diffusion strategies [14]. Only about half of providers who are trained will try to implement an evidence-based program and, among those who do try to implement the program, only 20 % implement activities that can be recognized as the original program. Perhaps more important, however, is the advent of pre-exposure prophylaxis (PrEP) and anti-retroviral treatment as

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prevention, which have created a range of new HIV prevention strategies that are more likely to be widely used in local communities with uptake of these intervention strategies with variations by region, risk profile, cultural and racial background, and income.

Certainly, regional implementation of the treatment cascade at a community level is currently far more important. How will we harvest knowledge from existing evidence-based HIV interventions accumulated over the last 25 years through investments by prevention researchers, global donors, and policy makers, and leverage it with these new technologies?

The articles in this issue of *AIDS and Behavior* attempt to address some of these questions. Together this is a highly diverse set of technological approaches aiming to influence the HIV pandemic. The interventions vary along multiple dimensions. The technological strategy being utilized ranges from social media sites and applications (e.g., Facebook) to simple text messaging. Given the range of complexity of applications, the potential access, diffusion and uptake is likely to vary by region, population, and targeted problem.

Geospatial networks such as Grindr have proliferated among MSM and new companies are emerging to target heterosexual adults (e.g., Blendr). There are basic questions about these technologies, for example, as to whether use of the technology increases HIV risk (see Holloway and colleagues this issue). Alternatively, other researchers in this series (Che, Chiu, and Young), have used social media to contact persons living with HIV as an outreach tool to reduce risk. The high rates of use of social media (about 34 hours per week) suggest that engagement with media rivals the impact of a full-time job [15]. The yet-untapped impact of these apps sits as an opportunity waiting to be leveraged.

When reviewing even one of these technologies, text messaging, there is a dearth of data to inform researchers on how often to text, the length of an optimal text, the message frame, and the degree of responsiveness to require from a targeted participant [16]. However, given the large, successful businesses that are dominating consumers' lives today, it is likely that this knowledge resides in multiple places, just not in the scientific literature. Reback and colleagues' fine-tuning of a text messaging intervention for MSM (based on theories of change) begins to suggest how researchers will have to systematically address the design of technology-based interventions [17]. Reback's work addresses a major concern regarding technological innovations: they are atheoretical and stop at the phase of developing pilot projects. Presently, her intervention is in Phase 3 implementation and is being integrated into platforms offered by private enterprise companies. In this issue, Horvath and colleagues review the potential success of mobile phone text-messaging to reduce viral load and improve antiretroviral therapy adherence, similar to the findings of how text messaging improves the outcomes from other chronic diseases [18].

Finally, the benefits of shared electronic medical records suggest a novel strategy that harnesses both the power of self-monitoring, as well as high-level medical expertise. It is likely that the medical practice of the future will routinely reflect these approaches. In this issue, Dawson-Rose and colleagues discuss the successes and challenges of implementing a technology-based intervention using a web-based portal linked to a personal health record. It has been hypothesized that the patient will be in charge of most of their medical interventions, as s/he will be most knowledgeable about her/his condition.

The risk profiles of the participants in each of these studies reflect those in greatest need of intervention. Among MSM, rates of methamphetamine use are especially high [19]. In 1992, I remember publishing about young adolescent MSM using methamphetamine who had become HIV infected [20]. I believed I had been late to identify the problem and the consequences of the culture of methamphetamine use. More than 20 years later, methamphetamine remains one of the biggest risks for acquiring HIV, with the risk increasing consistently over the last two decades among MSM [21, 22]—for example, MSM who reported consistent methamphetamine use over a 6 month period have an HIV prevalence of 42 % in Los Angeles [23].

Studies with persons living with HIV in India [24] and MSM in Peru [25] reflect how technology may be particularly important in LMIC to overcome some of the barriers present that stigma and lack of resources create. The manpower is lacking in LMIC for professionals who have the skills, expertise, and status to intervene with persons with HIV to deliver interventions. Task-shifting from professional to paraprofessional staff will be required [26]. Yet, we generally lack the training protocols, monitoring strategies, and feedback loops necessary to iteratively improve the quality of the layperson's implementation of HIV protocols. In this issue, Robbins and colleagues demonstrate how technology may be used to improve the skills of lay intervention agents.

African-American MSM as a subgroup are at the highest risk of contracting HIV in the United States, with approximately 50 % of the epidemic's prevalence among this group [27]. Accessing and identifying African American MSM with non-stigmatizing outreach strategies and maintaining ongoing contact and relationships has been a persistent and unmet challenge for HIV researchers for more than 30 years. Social media offers a potential route to reach this population. Sean Young and colleagues share experiences in using social media to address their needs [28].

Overall, the goals of these different technological approaches vary widely. Technology was used to increase HIV testing; improve adherence; reduce sexual and drug

use risk behaviors; and improve skills of lay professionals. These are such diverse outcomes that it is critical to synthesize knowledge across interventions, rather than creating novel evidence-based interventions for each one. There is not enough funding in the world to systematically study each of these potential problems. These studies suggest the need for altering our scientific strategies about how to identify and define *evidence* [29]. Researchers will need to learn more from each other about the underlying and robust principles, and elements and processes that are common across the different populations and targeted outcomes.

This is an impressive set of articles that describe novel strategies technology has created for HIV researchers. There are, however, many more technological opportunities that have not been addressed by this issue. Universal readers of *point-of-contact* diagnostic tools (Ozcan) are available, which could alter the landscape of rural health globally by putting the ability to simultaneously diagnose multiple diseases into the hands of paraprofessionals [30]. Machine learning to improve the precision of our algorithms of how and where and with whom to intervene, based on online behaviors, is becoming a more highly utilized tool [31]. Analyses of anonymized *big data* potentially accessible to researchers may help inform novel theoretical approaches to addressing risk for HIV, adherence to medical regimens, or emerging epidemics and hot spots for infection.

The relevant opportunities today do not necessarily reside with the traditional research community. Expertise related to technology often rests with private enterprises, not academic researchers. Without new partnerships, it is unlikely that the research community will gain the expertise and depth of experience required to scale novel interventions to entire populations. The articles in this special issue showcase investigators who are forging new, innovative relationships required by all of us to succeed in leveraging new technologies to address HIV and its comorbid conditions, and implementing a broad-based public health strategy.

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