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EDITORIAL

Bridging the digital health divide: toward equitable global access to mobile health interventions for people living with HIV

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1. Introduction

Digital health is transforming the field of medicine; the term Digital health refers to the growing number of interactions that occur between digital technology and health. mHealth provides the opportunity to deliver healthcare interventions to patients on their smartphones; mHealth or 'mobile health' is a subset of digital health specifically dedicated to use of mobile devices and wearable technologies. Younger individuals constitute a disproportionate share of smartphone owners [1]. Younger individuals also disproportionately acquire HIV [2], representing almost one third of all new HIV infections globally [3]. Further, the incidence of HIV infection among young people is projected to increase globally [4]. Efforts to design interventions to end this disparity in HIV infection should recognize the opportunity of mHealth. mHealth interventions have demonstrated benefits for people living with HIV (PLWH). Some multilateral organizations and government programs have made important efforts to incorporate these technologies for the betterment of patient health. However, though the field of mHealth is promising, global median ownership of smartphones (the primary technology for accessing mHealth) reaches only 59% [5]. Older, less-educated, and lower-income individuals are more likely to lack smartphone and internet access [5]. It is imperative to recognize and close this 'digital divide' so that all patients have the opportunity to benefit from mHealth.

2. mHealth lessons from studies in HIV

mHealth interventions include text messaging services (often abbreviated SMS, for 'short message service') and mobile applications, typically accessed on smartphones. SMS-only interventions improve visit attendance, CD4 count, viral suppression, and medication adherence in patients living with HIV [6], and they improve the odds of medication adherence across chronic diseases two-fold, independent of SMS frequency [7]. Mixed mHealth interventions (using SMS, apps, and/or wearable devices) have shown positive outcomes in HIV retention in care and clinical outcomes [8], A review of 45 HIV-related mHealth interventions showed a primary focus on medication adherence, with an additional 17.8% targeting both medication adherence

and virologic suppression [9]. While a minority (42%) of interventions were based on behavioral theories, 74% of theory-driven interventions were efficacious in achieving outcomes of medication adherence, virologic suppression, and retention in care. mHealth interventions are promising tools to support the achievement of the UNAIDS 90-90-90 targets (90% of PLWH are aware of their status, 90% of PLWH are on antiretroviral therapy, and 90% of those on therapy have undetectable HIV viral loads [10]).

Beyond treatment and care of PLWH, mHealth interventions can also prevent new HIV diagnoses: Evidence is building to demonstrate increased medication adherence of pre-exposure prophylaxis for patients at risk of acquiring HIV [11,12]. There is additional interest in leveraging existing geosocial networking apps to deliver HIV prevention mHealth interventions [13]. Common among young men who have sex with men, geosocial networking apps connect users with others nearby and are often used to identify potential sexual partners [14]. One limitation of this approach is that the majority of geosocial networking app users are of higher education and higher income, limiting the ability to reach underserved individuals at risk for acquiring HIV [14].

Despite successes, results from mHealth interventions are heterogeneous [15]. This heterogeneity may derive from the inclusion of efficacy studies evaluating commercially produced applications, which are frequently not created in collaboration with clinicians [16,17], nor with the involvement of the target patient population [18], nor with theoretical grounding in or usage of evidence-based components [16,18,19]. Clinicians who wish to deploy mHealth interventions, as with any other therapeutic or preventive measure, should review the quality of evidence supporting their use.

3. Surmountable barriers to mHealth access

To participate in mHealth, patients must have mobile phones – and preferably, smartphones with data network access. Globally, the number of smartphone owners continues to rise: among 39 countries surveyed by Pew Research in 2018, 59% of individuals own a smartphone and 75% are online at least occasionally [5]. Even among groups traditionally considered to be 'disconnected,'

rates of mobile phone ownership and data network penetration are relatively high. For example, the United Nations High Commissioner for Refugees reports that 93% of all refugees live in areas serviced by at least a 2G data network with 62% of refugees living in 3G areas [20]. Some governments are taking concrete action to connect their entire populations: Brazil's 'Internet for All' program has launched a satellite and intends to install antennae so that the country's 57 million unconnected individuals can access the internet [21]. Additionally, global internet speeds are improving, if slowly [22]. Increasing fiber-optic network coverage and decreasing price (potentially by unbundling policies) in order to stimulate competition are associated with improved internet speed across various countries [22,23]. Some rural areas, ignored by large private sector companies, access community broadband through publicly-owned groups or utilities [23].

The digital divide is decreasing in some areas. White space broadband (reserved radio spectrum previously left empty to prevent interference between analog TV broadcasts) can deliver wireless internet across vast distances and through walls. After pilot studies throughout the globe, the first commercial application of white space was deployed in rural northern California [24]. mHealth can even disproportionately improve health among vulnerable populations. As a measure of province population, impoverished and rural Limpopo consistently demonstrates the highest percentage of participants registered and completing the first antenatal visit with use of MomConnect, South Africa's national text messaging program to support pregnant women [25]. Internet access and mHealth interventions can improve the digital divide, especially among vulnerable populations.

Nonetheless, the digital divide persists globally, with older, less-educated, lower-income, and female individuals less likely to own a smartphone [5]. Even though 77% of all Americans own smartphones [5], there is a 10 percentage point gap in smartphone ownership for nonurban Americans [26]. In India (where only 28% of individuals own a smartphone) the rural-urban divide for smartphone ownership is twice that [27]. In emerging markets, the highest perceived barriers to mobile phone ownership relate not to values, security, or trust, but to handset cost [28]. The ability of an individual in an emerging market to purchase a smartphone varies widely, but multiple methods have demonstrated success in increasing smartphone access. Microfinancing, savings platforms, partnering with rural agent networks, localization of components, and personalization to local markets all increase smartphone access in emerging economies [28]. Revisiting internet speeds, countries who already have higher internet speeds are increasing speeds at a faster rate than those with slower internet speeds, resulting in a persistent and widening gap [22]. Without adequate attention to issues of mobile technology access, speed, and ownership, concern rightfully arises that the digital divide could widen instead of improve.

4. Rising global recognition of the importance of mHealth and access to mobile technologies

Despite barriers, the development of international programs and policies demonstrates growing recognition of mHealth's potential to improve the health of individuals worldwide. To encourage global adoption of information technologies for the betterment of patient health, the World Health Organization (WHO) and the International Telecommunication Union (ITU) have together elaborated an eHealth Strategy Toolkit [29]. The WHO-ITU partnership further created the Be He@lthy, Be Mobile Initiative to implement mHealth strategies targeting noncommunicable disease prevention and management [30]. WHO-ITU also created the European Union mHealth Hub to increase mHealth collaboration throughout the region [31].

Few actionable national policies related to mHealth exist [32], but they are emerging. All 10 African countries surveyed by GMSA as part of the mNutrition initiative have national mHealth policies, with many embedded into larger health policy [33]. Though most countries of the EU have not initiated national mHealth legislation, at least four member states have systems to endorse or certify mHealth applications [34]. The United States has passed mHealth legislation focused on expansion of mHealth related technologies and incorporation of mHealth into health systems. In 2012, the Federal Communications Commission (FCC) allocated specific radio spectrum to medical body area networks, in order to allow these wireless sensors to transmit patient health data directly to a healthcare team, whether in or outside of patient care areas [35]. Specifically citing the ability of mHealth to improve patient health outcomes, the FCC launched the Connected Care Pilot Program inquiry in 2018 to encourage the direct delivery of broadband-enabled health devices to low-income and rural Americans [36]. Additionally, the Centers for Medicare and Medicaid Services has linked Medicare payment adjustments to the incorporation of patient-generated health data into a certified electronic health record [37]. There are similar programs linking patient-generated data to electronic records scattered throughout small regions of the EU member states as well [34].

To expand internet access throughout the nation, the Independent Communications Authority of South Africa released regulations on the use of white spaces in 2018 [38]. With regard to internet speed, the FCC expanded the Mobility Fund in 2017 to improve 4G LTE coverage and deliver median data speeds of 10/1 Megabits per second across rural America and Tribal lands [39]. Madagascar achieved the fastest fixed broadband speeds in Africa – placing 2 spots after the US and 13 ahead of the United Kingdom – through partnership with private telecommunications operators to access the underwater EASSy cable [22,40]. Moving on to direct provision of smartphones, the United States FCC Lifeline program (originally established under President Reagan and further elaborated by President Obama) subsidizes broadband access as well as bundled voice and data plans for citizens living at or below 135% of the federal poverty line [41]. Similarly, the Indian state of Rajasthan provides smartphone subsidies to low-income citizens via the Bhamashah Digital Parivaar Yojana program [42].

The United Nations numbers information, health, education, and income among the human rights [43]. Further, the Human Rights Council has directed member states to formulate policies for universal access to the internet, with the goal of closing the gender and digital divides [44]. In the Information Age, access to the internet is necessary to exercise the rights to information, health, education, and income [45]. Philosophically speaking,

those conditions necessary to exercise human rights are indistinguishable from, and of equal status to, the rights themselves – that which is necessary to fully realize a human right is itself a right [46]. Since internet access promotes realization of the rights to information, health, education, and income [47], internet access can be considered philosophically indistinguishable from those rights. Smartphones, the most popular method to access the internet [48], assure the right to information and permit patients to take part in mHealth interventions. As such, access to the internet via smartphones approximates the human rights to information, health, education, and income. This rights-based approach to mHealth echoes the arguments made in the powerful UNAIDS 90-90-90 call [10].

5. Conclusion

mHealth interventions can improve patient outcomes in HIV, and this serves as a model for other chronic disease conditions. With growing network penetration and increasing mHealth efficacy, smartphone access may lessen the digital health divide, positively affecting youth at risk of HIV, minority populations, those of lower education, and those of lower socioeconomic status. The medical field should act to close the divide so that all patients – especially those living with HIV – can access the potential benefits of mHealth. It is necessary that patients have the ability to utilize a smartphone, accessing and participating with their digital health options via the internet. For those patients who lack the support to own these technologies, it is crucial that such be provided to them. In the Information Age, anything less is injustice.

Funding

Declaration of interest

Reviewer disclosures

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