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The Future of Digital Games for HIV Prevention and Care

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Abstract

Purpose of review—While there has been a significant increase in mHealth interventions addressing the HIV prevention and care continuum, interventions using game mechanics have been less explored. Digital games are rapidly becoming an important tool for improving health behaviors and supporting the delivery of care and education. The purpose of this review is to provide a historical context for the use of gamification and videogames (including those using virtual reality) used in technology-based HIV interventions and to review new research in the field.

Recent findings—A review of recently published (1/1/2016–3/31/2017) or presented abstracts (2016) identified a paucity of technology-based interventions that included gamification elements or any terms associated with videogames or gameplay. A larger portfolio of digital gaming interventions is in the pipeline.

Summary—Use of digital games that include elements of gamification or consist of standalone videogames or virtual reality-based games, represent a promising intervention strategy to address the HIV prevention and care continuum, especially among youth. Our review demonstrates that there is significant room for growth in this area in designing, developing, testing and most importantly, implementation and dissemination these novel interventions.

Keywords

videogame; gamification; digital games; youth; HIV continuum

Introduction

Digital games are rapidly becoming an important tool for improving health behaviors and supporting the delivery of care and education (1). While definitions vary, key components of games include goals, rules, challenge and interaction. In addition, games, unlike work, are designed to be “fun”. Digital games can be used to educate, entertain, and motivate

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Conflicts of interest

None.

participants by delivering highly engaging content, enhancing the degree and depth of participant interaction and increasing learning opportunities. Distinctions in digital games can be made between gamification (the use of game design components outside of gaming contexts) and “serious games”, defined as a game (usually a videogame) designed for a primary purpose other than pure entertainment (2–4). Each provide opportunities for sophisticated engagement of participants in technology-based behavioral interventions. Both the use of gamification and videogame interventions (henceforth referred to as digital games) have demonstrated efficacy in affecting behaviors related to health promotion and disease management including such areas as depression, asthma, diabetes, cancer, nutrition and sexual health (5–8).

The HIV epidemic continues to impact youth and young adults disproportionately. In 2015, youth aged 13 to 24 accounted for 22% of all new HIV diagnoses in the United States (US). Most of those new diagnoses among youth (81%) occurred among gay and bisexual males. (9) Digital games are particularly well suited to adolescents and young adults given their familiarity with and access to mobile devices and their propensity to play games. Among teens (ages 13–17) in the US, 92% report going online daily, including 24% who go online “almost constantly”. Most teens (91%) access the internet from a mobile device; approximately 88% of teens own or have access to a cell phone or smartphone (10). Rates are even higher among youth ages 18–29; 98% own a mobile phone, 86% of which are smartphones (11). About half of American adults (49%) ever play videogames, with the percentage increasing to 67% among those aged 18–29 years (12). Fully 99% of teenage boys and 94% of teenage girls play videogames (13).

While there has been a significant increase in technology-based interventions addressing HIV specific outcomes, such as HIV testing and antiretroviral (ART) adherence (14, 15), interventions that utilize principles and features of digital games, particularly gamification, have been less explored (16, 17). This review provides a historical context for the use of gamification and videogames (including virtual reality (VR)-based games) in technology-based HIV interventions and highlights new studies that have the potential to transform the future of the field

Methods

We searched PubMed from 1/1/2016 to 3/31/17, using the following keywords and Mesh terms in combination: HIV/HIV Infections or AIDS; Pre-Exposure Prophylaxis or PrEP; HIV test/HIV testing; HIV prevention; antiretroviral/anti-retroviral/antiretroviral therapy/highly active antiretroviral therapy/HAART/; adherence; gamification/gamify*/gaming/game or game(s)-based (leader/reward/badge/points/incentive/story/trophy/challenge/competition/”level up”); or “serious games” or “video game(s)” or videogame(s) and mobile applications; telemedicine/videoconferencing/”video conferencing”; “social media”/”social networking”; “text messaging”/texting/text/”text message”/SMS; technology/computerized; Smartphone/”cell phone”/”mobile phone” or app/application or internet/online/web/”web 2.0” or Twitter/Facebook/Grindr/Jack’d or mhealth or “virtual reality”/VR. These gamification features searched follow the elements of gamification identified by Cugelman and discussed by Brown (3, 4). We searched NIH Reporter and select conference databases

for 2016 including *Conference on Retroviruses and Opportunistic Infections (CROI); International AIDS Society (AIDS2016); International Association of Providers of AIDS Care (Adherence 2016).*

Among the articles and abstracts indexed through these searches, we focused on studies that reported the development and pilot testing, or randomized controlled trial (RCT), of an HIV prevention and/or care intervention that utilized internet and/or smartphone-based technology as a primary component. We excluded publications that: 1) did not include a well-described intervention, 2) exclusively used text-based/SMS technologies, 3) did not include an HIV-specific outcome (e.g. focused exclusively on pregnancy or other sexually transmitted infections (STIs)), and/or 4) were not in the English language. Of the 455 published articles extracted, 3 met inclusion criteria (18–20). We also identified 14 studies in NIH Reporter of planned interventions (Table 1), and 3 presented conference abstracts (21–23).

That Intervention's "Got Game"

Gamification is a technique that aims to replicate the intrinsic motivational pull of videogame play by employing game-design elements in non-game contexts. To effectively incorporate gamification into behavioral change interventions, the key elements must first be defined. While there have been a number of frameworks put forth in both the academic sphere and private sector (for in-depth reviews refer to: the blog of Yu-Kai Chou (http://yukaichou.com/) or the seminal book, "For the Win" by Werbach and Hunter (24.)), Cugelman identified seven core ingredients of gamification that have clear linkages to proven behavior change strategies or engagement (3). These include: 1) Goal setting; 2) Capacity to overcome challenges; 3) Providing feedback on performance; 4) Reinforcement (gaining rewards, avoiding punishments); 5) Comparing and monitoring with self and others; 6) Social connectivity; and 7) Fun and playfulness.

We highlight two interventions that incorporate many of the gamification features defined above.

Epic Allies is a theory-informed smartphone app that utilizes gamification to improve engagement in HIV care, ART uptake, adherence, and viral suppression among HIV-positive young men who have sex with men (YMSM) and transgender women (TW) who have sex with men (19). Users progress through *Epic Allies'* virtual world, creating allies with other users, and earning achievement medals for specified behaviors (e.g. consecutive ART adherence days, reading daily knowledge articles) and acquiring tokens. Tokens can be used within the app to play one of three entertaining "mini-games" that are unrelated to medication adherence. Profile pages and avatars allow users to compare their achievement medals with others using the intervention and send encouragement messages ("kudos").

healthMpowerment (HMP) is a mobile phone optimized, internet-based intervention designed to reduce sexual risk behaviors among HIV-positive and HIV-negative black YMSM by providing information, resources, tailored feedback, and allowing social interactions between users (18). Users acquire reputation points based on site activity.

Accumulation of these points increases their level within the site and can be used to "purchase" tangible incentives (e.g. t-shirts, sweatshirts, iPod shuffles). Contests and challenges (e.g. name that STI image contest) provide opportunities for competition and collaboration between users. A profile page displays point totals and "overall reputation" levels.

Five interventions in development plan to exploit gamification elements to increase engagement and impact the HIV continuum (Table 1).

Shall We Play a Game?

Wikipedia defines a videogame as "an electronic game that involves interaction with a user interface to generate visual feedback on a video device such as a TV screen or computer monitor". Key components of videogames are goals, rules, challenge, and interaction. In addition, videogames are designed to be "fun". Videogames can offer unique opportunities to impact behavior change by creating intrinsically motivating scenarios and story-based environments that capture ones' attention in both an immersive and entertaining fashion (25, 26). Multiple reviews have found health benefits of videogames to address a variety of health conditions, target populations and socioeconomic groups (5, 8, 27).

Fiellin and colleagues were among the first to develop videogames to address HIV risks. *PlayForward* is an evidence-based videogame intervention focused on risk reduction and HIV prevention among at-risk young (aged 11–14 years) racial/ethnic minority boys and girls (16). In a recently completed 12 month RCT, the *PlayForward* group demonstrated an improvement in sexual health attitudes and sexual health knowledge when compared to the control group (28).

Our review only identified one in press article describing a planned RCT for a videogame. *SwaziYolo* is an interactive smartphone delivered videogame (designed for young adults aged 18–29 years) that puts the player in the role of a young adult looking for love in Swaziland, making relationship and sexual health choices. The decisions players make impact behaviors and outcomes for other players and well as their own health and safety. Feedback is provided as players' progress (20).

As shown in table 1, seven interventions were identified that are in the formative or development stage. In a novel attempt to correlate adherence behaviors with gameplay, two interventions, both targeting ART adherence, include the combination of a smart pill bottle with their mobile gaming app. In both, adherence data from participants' bottle cap (e.g. Wisepill/Vitality Cap) will be integrated into the app/game wirelessly and will translate into the ability to access the videogame or lead to enhancements during game play.

Making the Virtual the Real

Virtual reality (VR) has been defined as an "immersive, interactive experience generated by a computer" and is transforming the way we experience everything from movies to sports to medical training. One needs only to look at the phenomenon of Pokémon Go to understand the impact that a VR-based videogame can have on human behavior. Launched in July 2016,

the game has 650 million downloads, earning a revenue of approximately 1 billion dollars to date (29). Notably, the videogame significantly impacts physical activity, adding an estimated 144 billion steps to US physical activity according to a recent study (30).

VR has great potential as an educational tool by offering participants a safe, situated learning space where they can build self-efficacy through role-playing in a realistic environment that enables the transfer of skills learned in VR into real life (31, 32). Compared to simply watching a video vignette or even engaging in traditional videogame play, VR offers more "true to life" environments and risk contexts including realistic sensory cues such as sounds, sights, and rich, interactive scenarios. Additionally, incorporating interactivity and additional gamification elements (e.g. customizable virtual characters/ avatars, social interactions) is highly innovative and can provide participants with a compelling, engaging experience aimed at increasing motivation and supporting behavior change.

Given their highly experiential nature, the potential for the application of VR games to the field of the HIV prevention and care continuum is great. In work started over a decade ago, Miller and colleagues were pioneering in their early recognition of the power of virtual environments to impact behavior. Using an approach called Socially Optimized Learning in Virtual Environments (SOLVE), her team demonstrated reductions in condomless anal sex through exposure to interactive, media-based interventions designed to simulate and immerse high-risk YMSM in a virtual world simulating many common obstacles to safer sex (alcohol, attractive "hook-ups") (17, 33).

A more recent intervention, *Tough Talks*, is a VR-based videogame that also incorporates natural language processing, and is designed for HIV-positive YMSM to practice disclosing their status to intimate partners in a safe, confidential environment (21). Realistic scenarios and true-to-life avatars allow participants to feel immersed and invested, resulting in strong emotional responses. After engaging with *Tough Talks*, 11 HIV-positive YMSM participating in a feasibility pilot demonstrated increases in self-efficacy to disclose their HIV status.

As VR technology becomes less expensive and more widespread, it is likely that researchers will find new and innovative uses for inclusion of VR-based videogames in HIV focused interventions. Head mounted display products like the Oculus Rift, HTC Vive, and Google Cardboard offer investigators the prospect of simulating virtually any real-world experience thus providing unprecedented opportunities for experiential learning leading to the adoption of safer sex and HIV prevention behaviors.

It's Not Whether You Win or Lose…

Evaluating how participants "play the game" is critical for determining both intervention efficacy and effectiveness, both of which affect the potential for future scale-up and dissemination. Thus, particular attention prior to intervention development must be paid to the collection and analysis of all gameplay data. Development of user journeys or intervention maps can help delineate key metrics of game usage and gamification elements

to be measured; ensuring that upon completion it is possible to determine the distinct impact of each respective element on the health outcome of interest (34). Only one study explicitly defined the use of gamification points and provided information on association with usage (18). Further, research that more explicitly evaluates the effects of digital games on motivation across populations and with regard to specific HIV prevention and care outcomes is warranted. As this area continues to develop, researchers are encouraged to explore whether a game has a finite amount of gameplay and/or if it will be designed to be continually updated with new content (e.g., new levels, virtual or tangible incentives). Similar to other modes of intervention delivery, some games will be short and finite to parallel the dosage of a brief intervention, whereas others may require greater engagement and interactivity to achieve the desired behavior change outcomes.

Discussion

While there have been notable digital gaming interventions targeting HIV risk behaviors (16, 17), the field is still in its infancy and the use of gamification is even less well studied. Given the number of currently funded interventions in the pipeline or under development it is likely that there will be a substantial increase in our knowledge of the effectiveness of videogames and gamification across the HIV prevention and care continuum in the near future. Our review demonstrates that there is significant room for growth in this area in designing, developing, testing and most importantly, implementation and dissemination these novel interventions. After efficacy of game-based intervention is proven, it will be crucial to conduct open-label effectiveness studies that explore their dissemination and uptake through non-research venues such as the health care system (e.g. pediatricians, Federally Qualified Health Centers).

It is exciting that two studies (20) identified in this review focus on the development of digital games in resource-limited settings. The prevalence of videogame playing is on the rise in low to middle income countries with videogames being one of the common activities in which youth engage (35). For example, ninety-two percent of high school aged South African youth report playing games on their mobile phones[3] with 53% doing so daily (36). It is likely that in the coming years we will see, not only an increase in videogame interventions but also the use of gamification in interventions in resource-limited settings.

Technology-based interventions are often cited as being “low-cost” due in part to their putative ability to be efficiently scaled up and disseminated once demonstrated efficacious. However, high costs of initial development of digital gaming interventions are often incongruous with conventional NIH funding paradigms that typically confer lower funds to developmental projects compared to larger scale trials of efficacy. Thus, to streamline development, researchers need to ensure their respective intervention focuses on videogames or gamification elements with the most potential. This can be achieved in various ways, including collaborating with companies who focus on technology, adapting existing technology platforms to include gamification elements (rather than starting from scratch), and exploring non-traditional funding mechanisms. As shown in this review, many of the currently funded interventions under development were awarded through the NIH small business grant (Small Business Innovation Research (SBIR)/Small Business Technology

Transfer (STTR)) mechanism. These programs prioritize monies to foster research and development that has a strong potential for technology innovation and commercialization.

Identifying the length of time required to develop and subsequently maintain any clinical benefits derived from these interventions is not yet known. Much could be learned by incorporating information from either the field of commercial [video] game production or for-profit gamification, such as mechanisms to improve overall game playability and current gaming trends among target populations. While direct comparisons between commercial videogames, designed for entertainment purposes, and digital games should be discouraged, given clear differences in purpose, development costs, and marketing, fostering these collaborations may offer additional insights to inform health behavior interventions in an effort to improve relevance, cost-effectiveness and sustainability.

The field of digital games offers both methodological challenges as well as opportunities for moving the field forward. Selecting the proper control group upon which to test for intervention efficacy can be difficult, given that a true attention-control condition may not be financially possible or scientifically appropriate. Further, with regard to videogames, study designs and analytic plans that allow for detailed metrics regarding gameplay progression are crucial for evaluating how the videogame impacted outcomes. Similarly, thoughtful consideration of the role each gamification element plays and how engagement with each will be captured in a meaningful way can inform future intervention iterations and possible scale up and dissemination.

Conclusion

Digital games represent a promising intervention strategy to address the HIV prevention and care continuum, especially among youth. Young people are constantly connected and online; they play games, engage with social media, and interact with others. Digital games can be used to meet youth “where they are” and with the tools they prefer to use, can educate and interface in a more dynamic, immersive and engaging way to promote positive health behavior change. This review provides insights into how researchers are targeting youth using gamification and videogames across the prevention and care continuum and provides concrete recommendations for future research on this emerging field of study.

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* Of importance

** Of major importance

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Key Points

- Digital games are rapidly becoming an important tool for improving health behaviors and supporting the delivery of care and education, yet their use for addressing HIV-specific outcomes has been less well-studied.
- Use of digital games that include elements of gamification or consist of standalone videogames (including virtual reality-based games), represent a promising intervention strategy to address the HIV prevention and care continuum, especially among youth.
- Thoughtful consideration in the design and evaluation of digital gaming interventions is needed to ensure all gameplay metrics are captured in a meaningful way to measure the impact of individual gaming elements on study outcomes.
- Multiple digital game interventions are in the research pipeline, highlighting the potential for growth in designing, developing, testing and most importantly, implementation and dissemination of these novel interventions.

Table 1

Digital Games in Development Identified on NIH Reporter

Primary Investigator/Organization Name	Funding period	Funding mechanism	Target Population	Target behavior	Proposed technology Platform	Description of game-based elements
Gamification						
Dowshen, Children's Hospital of Philadelphia	9/2014–7/2017	K23	HIV-positive YMSM, ages 14–24	ART adherence	App	Points, leaderboard, customizable avatar
McCoy, University of California at Berkeley	8/2015–5/2018	R34	Young high-risk MSM, ages 18–26	HIV testing, sexual risk reduction	Web	Tangible prize system linked to points earned through online and real-world activities
Hightow-Weidman, University of North Carolina at Chapel Hill/Hosek, Stroger Hospital	8/2015–5/2017	R21	HIV-positive YMSM, ages 16–24	Engagement and retention in care, ART adherence	App	Social connectivity, character-driven narrative elements, level progression, challenges, avatars
Horvath, University of Minnesota/Amico, University of Michigan	9/2017–5/2020	Research study within larger U19 grant	HIV-positive YMSM, ages 15–24	ART adherence	Web	Badges, level progression
LeGrand, Duke University/Hightow-Weidman, University of North Carolina at Chapel Hill	6/2017–5/2021	Research study within larger U19 grant	HIV-negative YMSM/TG on PrEP, ages 17–24	PrEP adherence	App	Social connectivity, character-driven narrative elements, level progression, challenges, avatars
Videogames						
Greenberg, MEDIA REZ, LLC/Castel, George Washington University	9/2016–2/2018	R43	Adolescents and young adults, ages 13–24	HIV testing	Smartphones, tablets and web	Game (simulates social media experience)
Greenberg, MEDIA REZ, LLC/Castel, George Washington University	9/2014–7/2017	R43	HIV+ adolescents and young adults, ages 13–24	ART adherence	Smartphones, tablets and web	Video game
Brown, Rhode Island Hospital	9/2012–6/2017	R01	HIV-positive youth, ages 14–26	ART adherence	App	Combination of smart pill bottle cap with mobile gaming application
Schell, Schell Games, LLC/Fiellin, Yale University	5/2016–4/2017	R41	Adolescents, ages 15–16	HIV testing	Tablet	Video game
Ma, Benten Technologies, Inc.	9/2012–8/2017	R44	African American adolescents, ages 13–24	Sexual risk reduction	App	Mobile game
Whiteley, Rhode Island Hospital	3/2015–1/2018	R34	Males on PrEP, ages 18 and over	PrEP adherence	App	Combination of smart pill bottle cap with mobile gaming application

Primary Investigator/Organization Name	Funding period	Funding mechanism	Target Population	Target behavior	Proposed technology Platform	Description of game-based elements
Winskell, Emory University	7/2015–4/2018	R34	African preadolescents, ages 11–14	Education on sexual health and HIV	App (Android)	Game
Virtual Reality-based videogames						
Adams Larsen, Virtually Better, Inc./ Hightow-Weidman, University of North Carolina at Chapel Hill	6/2016–5/2018	R43	HIV-negative YMSM, ages 14–19	HIV testing	App (iOS)	Virtual Reality game