HHS Public Access

Author manuscript

J Acquir Immune Defic Syndr. Author manuscript; available in PMC 2023 July 01.

Published in final edited form as:

J Acquir Immune Defic Syndr. 2022 July 01; 90(Suppl 1): S226–S234. doi:10.1097/QAI.0000000000002983.

Explorations of the role of digital technology in HIV-related implementation research: Case comparisons of five Ending the HIV Epidemic supplement awards

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Abstract

Introduction: The use of digital technology in HIV-related interventions and implementation strategies is increasing. Whether the use of technology is to directly improve patient outcomes (i.e., part of the intervention) or as part of the strategy to implement interventions has important implications. In this paper, we present five case studies of projects that feature the use of technology in HIV-related implementation research to identify and describe challenges specific to technology-based implementation research with respect to study design, outcome measurement, implementing in an evolving technology landscape, and equity.

Methods: For each case study, we identified the technological components, classified the components as intervention or implementation strategy, and identified implications for measuring performance and ensuring equity. The Exploration, Preparation, Implementation, and Sustainment (EPIS) framework was used to identify the research stage of each project.

Results: Technology is being leveraged across a diverse array of implementation strategies to promote Ending the HIV Epidemic in the US. The case studies were primarily in the exploration and preparation phases of implementation, yet technology played a different role in each project - developing educational materials, mass media to recruit participants or distribute evidence-based campaigns, providing training, guiding tailoring, and implementing novel methods to democratize intervention development.

Discussion: Technology can play multiple roles in HIV-related implementation research projects, including serving as the intervention, being leveraged within implementation strategies, or both. We identified multiple considerations across projects that should be taken into account when measuring success and planning for equitable and sustained impact.

Introduction

Digital technologies (hereafter: technology) are increasingly used in the design and implementation of HIV prevention and treatment interventions, taking advantage of the proliferation of technology in daily life. Among young adults aged 18–29 in the United States, the group at highest risk of HIV[1], 99% use the internet[2], 96% own a smartphone[3], and 90% use social media.[4] Examples of the use of technology in HIV prevention include the use of social media posts and advertisements for recruiting sexual minority men[5], smartphone apps to deliver HIV prevention information and services[6,7], and interventions delivered via existing social media platforms and standalone websites.[8–11]

Technology within HIV-related implementation research may constitute the intervention of interest or serve as an implementation strategy to enhance the adoption, implementation, and sustainability of an evidence-based intervention.[12] Delineating the evidence-based intervention and the implementation strategy (i.e., methods to enhance adoption, implementation, and sustainability of the evidence-based intervention, program or practice) is key to effective monitoring and evaluation and for measuring implementation outcomes. In many instances, technology plays a role in both the intervention and the implementation strategy. Proper testing, adaptation, and dissemination of technology-based interventions requires being able to accurately distinguish core and peripheral intervention components from implementation strategies. Specification of implementation strategies must be precise

enough to enable measurement and reproducibility, and the use of technology to design and implement HIV-related interventions expands the universe of considerations for reporting and evaluation.[13]

Technology-based approaches offer multiple opportunities for increasing reach (i.e., the proportion of a population that receives an intervention[14]) including reducing geographic barriers, utilizing economies of scale, and increased anonymity for participants. Thus, technology has the potential to improve equity by removing barriers to access; however, the technology infrastructure (e.g., cellular towers, broadband access) is not equitable in itself, and implementers must assess how an intervention or implementation strategy might cause or exacerbate inequities. Privacy concerns must also be taken into account with respect to how participants' data are managed and stored and whether third party actors are able to gain access to data about those participating in research studies or accessing interventions.[15]

Technology can facilitate highly adaptable interventions that tailor content and delivery strategies to a user's specific needs. However, ensuring user engagement with the content in technology-delivered interventions is a major challenge.[16] Massive scale-up of technology-based approaches might be possible with relatively low marginal capital and workforce costs, so technology-based interventions and implementation strategies have huge potential benefits of scale.

We present five case studies from awards funded through the Ending the HIV Epidemic (EHE) Initiative[17] that feature the use of technology in HIV-related implementation research, and explore the role of technology in each project. We situate the case studies according to their implementation stage, using classification based on the Exploration, Preparation, Implementation, and Sustainment (EPIS) framework[18] to consider the role of technology across implementation phases. We focus on examples that are in the exploration, planning, and implementation phases based on currently funded EHE initiatives. The case studies motivate a discussion of the role of technology in implementation research and recommendations for best practices in study design, measurement, reporting of implementation research with a technology component, and methods to ensure equitable implementation of technology-based approaches. Our goal is to identify and describe considerations specific to technology-based implementation research with respect to outcome measurement, implementing in an evolving technology landscape, and equity.

Methods

We prepared case studies of five ongoing implementation research projects funded via EHE Supplement Awards, supported through NIH-funded Centers for AIDS Research and NIMH-funded AIDS Research Centers. EHE projects were supported through implementation science technical hubs and studies were identified during the formative stages of development as each study team encountered similar issues with respect to delineating implementation strategies and interventions and selecting appropriate process and implementation outcomes. Thus, we followed an inductive approach in which an emergent phenomenon led us to systematically explore these issues.

Each case study was developed in collaboration with the investigator(s) leading the study. For each case study, we described the use of technology and identified whether technology is being used as an intervention, implementation strategy, or both. Technology was considered to be used as an intervention if the role of technology was integral to the intervention content and intended to result in changes in patient/consumer outcomes; it was considered to be used as an implementation strategy if the role of technology reflected strategies to facilitate delivery or uptake of evidence-based interventions as outlined by the Expert Recommendations for Implementing Change (ERIC) project.[19] We present structured vignettes to identify technology components, classify these components as intervention or implementation strategy, describe critical characteristics of the interventions and implementation strategies with respect to replicability and evaluation, and identify characteristics of interventions likely to be modified over time. We used the EPIS framework[18] to categorize implementation stage as exploration, preparation, implementation, or sustainment. We focused on the eight domains of Proctor's Taxonomy of Implementation Outcomes[12], with an emphasis on outcomes for technology-based interventions as characterized by Hermes et al[20], as well as the reach measure from RE-AIM.[12]

Results

Case study results are summarized in Table 1 and described in detail below.

Case Study 1: Social media campaign to address stigma and increase HIV prevention behaviors among adolescents

Description: This project is an adaptation of an existing traditional media-delivered prevention messaging campaign, Project iMPPACS[21,22], to social media with the goal of promoting safe sex, prevention and reduction of HIV-related stigma, and sexual empowerment. The name Project iMPPACS was developed as an acronym to reflect the locations where the project was delivered (in Macon, Providence, Philadelphia, Atlanta, Columbia, and Syracuse). iMPPACS was originally implemented via radio and television ads and incorporated counter-narrative messaging to enhance sexual health empowerment and sexual risk reduction attitudes, beliefs, and behaviors. Project iMPPACS is being adapted by updating intervention materials to align messages with current African American teens' attitudes, beliefs, and behaviors about safe sex, adding an HIV stigma prevention/reduction component, and attending to African American teens' contemporary social media use.

Role of Technology and Technology Components: The primary use of technology for this project is an implementation strategy for mass media distribution of the adapted intervention. Focus groups are being conducted to identify appropriate social media networks that allow audio and/or video streaming for dissemination. Using social media will allow users to access the intervention content free of charge and put the intervention in a location that is already frequently accessed by the target population.

Implementation and Process Outcomes: Acceptability of the social media platform, reach, engagement (i.e., views, user interactions with posts), and self-reported exposure among African American teens.

Implications for Equity: The implementation of Project iMPPACS will be adapted to the preferences of African American youth in Philadelphia. Data from focus groups and discussions from youth community advisory board meetings about implementation strategies (i.e., appropriate social media platforms and messaging resonance) will maximize opportunities for equity.

Implications for Scale: The strategy can be scaled by migrating to additional social media sites and by expanding targeting via adapting advertising and recruiting materials. Expanding reach will incur additional costs to pay staff to conduct these monitoring activities, develop and refresh ad content, and pay for recruitment advertisements to engage new users. Continual monitoring and surveillance of consumer trends, preferences, and media sharing capabilities will be required to ensure continued engagement with target users.

Case study 2: Designathon to develop provider-targeted communications strategies to reduce stigma and promote PrEP uptake in MSM of color

Description: Applying a crowdsourcing approach[23], the goal of this project is to integrate advanced health communications research and social marketing methods to develop new message frames and/or technology-enabled communications strategies and tools for providers to facilitate PrEP uptake among MSM of color. Data from an on-going online cohort of MSM of color (UH3 AI133675–04; Grov, PI) and an active intervention-planning study (R34 MH121295–01; Frye, PI) were used to inform the development of stigma-reducing messaging frames. A virtual ‘designathon’ event was then conducted to bring together interdisciplinary teams with diverse skills, experiences, expertise, priorities, and opinions to develop novel technology-enabled communications concepts for providers and users to facilitate PrEP uptake. A distinguished panel of diverse stakeholders reviewed final concepts, and the most promising were awarded a cash prize and free design consultation services.

Role of Technology and Technology Components: Technology is being used as a strategy to build a coalition by recruiting and enhancing relationships with implementation partners to develop intervention content. Social media platforms and webinars were used to foster broad reach and participation, with the aim to involve individuals with diverse backgrounds, technical skills, expertise, and perspectives in the designathon. Cloud-based databases were used to obtain and track registration and preliminary proposals and to organize competing designathon teams. The final output of this project will be novel, technology-driven communications tools for providers and users to facilitate PrEP uptake.

Implementation and Process Outcomes: Reach is being measured by the number of designathon applicants and participants engaged and the number of prototypes of communication tools generated. Perceived usability and acceptability of prototypes were

assessed among potential providers and acceptability and intention to initiate/sustain/recommend PrEP were hypothetically rated by potential PrEP MSM clients of color. Effectiveness will be measured based on new knowledge of patient-centered and culturally-tailored communication strategies and the creation of new organizational capacities (e.g., provider-patient communication teams). The designathon's success in engaging a diversity of talented individuals and community-serving entities supports an ethos affirmative of health equity as a necessary condition of sustainable public health solutions to end the HIV epidemic.

Implications for Equity: Targeted recruitment strategies were utilized to engage a range of different communities to ensure equitable representation of diverse perspectives among designathon participants.

Implication for Scale: The designathon challenge explicitly called for concepts that showcase interventions that integrate tech-supported strategies that address scalability, an often-overlooked element of the exploratory phase of implementation. The designathon was completed virtually, so these methods could be used to scale up intervention-development approaches across geographic and population boundaries. The entrepreneurial facet of the designathon underscores the need to support promising concepts with an effective 'business model,' to promote uptake and inform sustainability. A focus on access and acceptability also addresses challenges of scalability, given that the aim is to look for solutions that serve to democratize technology and capacities for communication and learning.

Case Study 3: Social media mining methods to recruit MSM into research

Description: The purpose of the project is to develop algorithms to identify a virtual cohort of sexual minority men based on self-declarations (e.g., "As a gay man…") and analyze their Twitter posts containing PrEP-implementation relevant content. Users from the virtual cohort will be recruited to complete a web-based survey on PrEP barriers. Findings from the analysis of tweets and the survey will be triangulated to inform implementation strategies. From the survey sample, Twitter users from Philadelphia will be recruited to complete a discrete choice experiment[24] on PrEP delivery attributes to inform local PrEP implementation with the Philadelphia Department of Public Health.

Role of Technology and Technology Components: Twitter is being used as a source of material for a local needs assessment to guide implementation strategy tailoring and to recruit research participants via mass media. Advanced text-based analysis[25] will be used to analyze the content of tweets to develop algorithms for identifying sexual minority men based on the content of their tweets. A web-based survey will be used to identify common barriers to PrEP use.

Implementation and Process Outcomes: The number of Tweets identified from sexual minority men, the precision of the developed algorithm (e.g., based on F-measure scores[26]), and the number (reach) of sexual minority men successfully recruited to participate in web-based surveys.

Implications for Equity: Equitable representation of different communities of sexual minority men will depend on the participation of these communities on Twitter. Expansion of these methods to other social networks might be needed to develop interventions that address the needs of all sexual minority men.

Implications for Scale: These data mining techniques could be used to analyze the contents of posts on other social media platforms (e.g., Facebook) and for a large number of sexual minority men from diverse geographic regions. Developing and deploying the framework requires advanced text mining skills, requiring an expert with sophisticated computer science/social informatics capabilities. Generalizability of the findings across geographic areas would improve scalability but would need to be verified empirically. Once established and validated, continuous operation of the social media framework is feasible without sophisticated expertise.

Case Study 4: Crowdsourcing to develop a U=U campaign among African American communities

Description: The goal of this project is to use crowdsourcing to develop a novel campaign to promote “undetectable = untransmittable” (U=U) messaging over social media platforms in Baltimore, Maryland and Washington, DC.

Role of Technology and Technology Components: In this project, technology is being used as an implementation strategy and as the intervention delivery platform (i.e., social media messaging). Participants will be recruited online, including via social media platforms, to a project website where they can digitally submit ideas for the U=U campaign. Similar methods will be used to promote the contest and recruit additional people to vote on the project website to select a winning campaign design. The final campaign will be disseminated via mass media leveraging the platforms of a coalition of community-based organizations.

Implementation and Process Outcomes: Reach and engagement of social media posts will be measured across all social media platforms (e.g., Facebook, Instagram). Google analytics will be used to track engagement with the project website (e.g., unique visitors, demographic characteristics of visitors).

Implications for Equity: On the basis of our previous experience and feedback from community partners, complementing online-based activities with strong in-person engagement events is an essential component of organizing more effective and inclusive contests. In-person engagement events are intended to reach marginalized groups with limited internet access and are key to building good rapport and trust with local partners and contributors. Events hosted in collaboration with local community partners were used to promote the contest and engage communities.

Implications for Scale: If successful, the contest methods can be easily adapted to other settings. The reliance on local stakeholders to facilitate reaching the target audience will require using existing relationships with community partners or building new relationships.

The contest website could be duplicated and adapted or repurposed for future crowdsourcing events.

Case Study 5: Systems-level intervention to optimize HIV testing and PrEP delivery among young sexual and gender minorities in Philadelphia

Description: The Health Access Initiative (HAI) is a systems-level intervention originally developed to improve the general and sexual health care experiences of sexual and gender minority youth using online and in-person trainings, as well as personalized technical assistance.[27] The current EHE supplement adapts and extends the HAI training strategy into a fully-online program designed to support HIV prevention staff in Philadelphia to improve cultural humility and provision of HIV prevention services for young sexual and gender minority communities.

Role of Technology and Technology Components: Technology will be used as an implementation strategy to deliver, decentralize, and scale training. Virtual sessions and training on how to provide HIV testing and related services via telehealth were added in response to restrictions on in-person gatherings due to COVID-19. As opposed to full-day in-person trainings, staff have access to 90-minute online modules. This online learning strategy allows for additional didactic modules (e.g., cultural humility) and audit strategies (e.g., feedback loops, including stakeholder testimonials) to be created, readily available to new staff as an on-going resource, and scalable across the jurisdiction.

Implementation and Process Outcomes: Technical challenges with adapting to a virtual environment (e.g., connectivity issues; reduced engagement) will be reported by the implementation team. Participant acceptability (i.e., satisfaction), appropriateness, and feasibility of the online implementation strategy will be assessed after the training session. Unique user codes will be generated to track attendance and engagement with the webinars.

Implications for Equity: All training modules are anchored within a health equity framework. For example, training modules include topics relted to health equity and HIV, followed by modules on cultural humility on HIV service delivery, cultural competence when working with intersecting key populations (e.g., sexual and gender minorities who are also racial/ethnic minorities), and radical customer service. The virtual delivery of these modules allows for a readily accessible and sustainable repository of resources for existing and new HIV prevention staff in Philadelphia.

Implications for Scale: Delivery of training via videoconference has the potential for scalability due to reduced costs related to travel and securing event spaces. Recordings of training materials, including the cultural humility webinar, can be replayed as booster sessions for previous attendees or delivered to new hires or audiences at low marginal cost. Monitoring engagement of attendees and developing engagement strategies for the virtual environment (e.g., break-out rooms) will be necessary to ensure that effectiveness is not diminished.

Discussion

These case studies of ongoing EHE-funded projects demonstrate diverse ways that technology can play a role in HIV-related interventions and the execution of various ERIC implementation strategies. The role of technology in each project was determined by the research stage and question, the behavioral target of the innovation, and practical considerations, such as COVID-19 mitigation measures. The technologies used in the projects, in turn, influenced study design and outcome measurement. Of note, the projects featured in the case studies were primarily in the exploration and preparation phases, a reflection both of the mechanism used to fund the supplemental studies and of the state of the field of technology-based interventions. Although the case studies presented here are not an exhaustive representation of the ways in which technology is used for implementation research, we observed technology being employed in multiple ERIC strategies. As more tech-focused studies move to the implementation phase, linking process and implementation outcomes as proximal outcomes to effectiveness will be critical to evaluate their impact on HIV outcomes.

As these case studies show, it can be difficult to distinguish technology's role in the intervention versus the implementation strategy. For example, in case study 1, technology is clearly conceptualized as the implementation strategy: offering social media delivery (i.e., new implementation strategy) over existing radio and television HIV prevention messaging (i.e., existing intervention). However, users will engage differently with intervention content delivered over social media compared with radio and television advertisements. Messages can be watched and replayed on-demand and shared with other members of the social network, which might result in a collateral benefit of increased reach. Interaction with the intervention content will likely also affect how other, unrelated content is targeted to them on the social network because of marketing algorithms -- another potential benefit towards increased exposure to prevention or healthcare information. Thus, the change in implementation strategy inherently changes the intervention, and thought should be given to whether and how to characterize these downstream effects. Careful articulation of the intervention strategy and intervention components and appropriate measurement of each will be necessary for successful implementation and adaptation of HIV-related interventions.

Distinguishing between an intervention and an implementation strategy can help to clarify the targeted end-users of the innovation and thus support appropriate evaluation of intervention effectiveness and implementation outcomes.[28] When implementing an evidence-based intervention via a new implementation strategy, implementation outcomes are key. If, however, the intervention itself is modified, then outcomes related to intervention efficacy and effectiveness might need to be considered as well. Careful attention to study design, relying on existing frameworks, and adhering to reporting guidelines can help to identify distinctions between interventions and implementation strategies.[28] Whether technology is a strategy to provide interventions or is the intervention itself, there are some common factors to consider to increase and sustain uptake in terms of both capital and human resources. Some amount of technological capability is required to implement technological interventions and implementation strategies, so ensuring staff have the appropriate training and resources when technical assistance is needed will be key to

success.[29] For example, Case Study 3 relies on lexical analysis, a highly specialized skill set, to identify a cohort of Twitter users. Replication of this method in other settings will require engaging people with these skills or automation of the methods.

In Case Study 1 continual monitoring of social media users' preferences will be used to ensure that the intervention reaches its intended target. This invokes another important aspect of technology-based interventions: they are often inherently more dynamic than traditional interventions. Whereas there might be variations in the delivery of traditional interventions due to individual heterogeneity in the person(s) leading the intervention, continual iteration and refinement of the intervention and/or implementation strategy is frequently employed in technology-based interventions to optimize outcomes. For example, methods for targeting advertisements are monitored to identify the demographic and behavioral characteristics of people who respond to the ads and app use data can be used to understand which parts of an app might need to be modified to increase engagement. Systematically documenting and reporting on these iterations and their empiric relation to reach, equity and acceptability will be important to promote generalizability and transportability.

Technology-based interventions are often scalable, a characteristic often touted as a key advantage; however, research remains nascent in this stage. The Keep It Up! intervention[10,11,30] is currently being scaled up in a Type III hybrid-effectiveness study[31]; however, few other technology-based interventions have reached this stage of development. Increasing scale increases expenses for the hard infrastructure of technology (e.g., bandwidth, servers) and for reaching the target population (e.g., social media advertisements). The increased scalability of technology-based interventions and strategies and, when the technology delivers the intervention, increased fidelity of intervention, have the potential to offset some costs of technical maintenance and fidelity monitoring. Implementers should consider delivery platforms (e.g., mobile operating systems), minimum technical requirements (e.g., broadband access), and outreach methods to ensure the target population will have access to the necessary technology and be aware of the opportunity to participate. For example, eschewing traditional in-person events to engage individuals with no or limited internet access in Case Study 4 might systematically exclude some key stakeholders from the campaign. Conversely, these methods might also serve to broaden representation in intervention development by including people from more remote areas, resulting in greater reach and effectiveness of the ultimate intervention.

The use of technology also has important implications for equity. The term TechQuity has been coined to refer to equity in access to technology along five dimensions: affordability, availability, accessibility, accommodation, and acceptability.[32] The HIV epidemic in the United States is concentrated among sexual minorities, women of color, and in low-income communities.[33] To ensure that the use of technology reduces rather than amplifies existing inequities, careful consideration of factors including recruitment methods and technology availability is needed when developing HIV-related interventions and implementation strategies. Technology can be used to engage users in novel and innovative ways that are less dependent on existing institutional structures and may employ democratizing approaches to promote community engagement and ownership. In this way technology can facilitate

community-centered research and help ensure that interventions and implementation strategies are tailored to the population(s) they target. This was demonstrated in Case Studies 2 and 4 which both used crowdsourcing approaches to facilitate community engagement and ownership in the development of intervention content.

Technology can be used to provide additional support in resource-limited settings. In this sense, technology has the potential to improve delivery to communities experiencing health disparities, such as rural communities, youth and sexual, gender, and racial minorities.[34,35] However, individuals without access to a smartphone or a private place to access the internet might not be able to utilize technology-based interventions and might not be reached by technology-based implementation strategies. Disconnects between the developer of the technology and the end user, particularly a lack of community involvement in development, will likely lead to inequities in implementation, something that the case studies here proactively address in their designs.

Finally, delineating implementation strategies and interventions has implications for sustainability. Our case studies focused on the exploration, planning, and implementation phases of intervention development, but ensuring sustainability is key for long-term impact. Given the ever-evolving technological landscape, it will be necessary to develop standards to identify when new evidence is needed for intervention effectiveness. For example, does adapting an existing app-based HIV prevention intervention to a new mobile platform (e.g., different mobile operating system) require new evidence of intervention effectiveness? Or should the focus be on measurement of implementation to maximize intervention impact? Although these questions might be less pressing for technology-based implementation strategies that are often iterative by design, these will be key questions to answer for technology-based interventions given that funding for interventions is often contingent on their evidence for effectiveness (e.g., inclusion in the Compendium of Evidence-Based Interventions and Best Practices for HIV Prevention).

Technology has enormous potential to change the landscape of the development and dissemination of HIV-related interventions. Researchers should carefully consider which technological components of a project are core to the intervention and which are implementation strategies, and plan monitoring and measurement accordingly - focusing on clinical effectiveness outcomes and implementation strategies to optimize delivery of the technology in the former case, versus implementation and process outcomes pertinent to the technology in the latter. At all stages, efforts should be made to ensure that technological approaches reduce - rather than exacerbate - inequities.

Funding details:

JK was supported by NIAAA (K01AA028199). SM, JB, and GG were supported through NIH/NIAID and NIH/NIMH supplements to the Penn Center for AIDS Research (P30AI045008) and the Penn Mental Health AIDS Research Center (P30MH097488). CY is supported by the Johns Hopkins University Center for AIDS Research (P30AI094189). DL, TH, VF and CG are supported through NIH/NIAID P30AI124414, UH3 AI133675-04, and R34 MH121295-01. TH is additionally supported by CDC/NCCDPHP U48DP006396. SB and SS were supported through the MACC+ Implementation Science Consultation Hub and the HIV and IS Fellowship for ESIs both funded by the NIH/NIAID through supplements to the Johns Hopkins University Center for AIDS Research (P30AI094189). PS is supported by the Center for AIDS Research at Emory University (P30AI050409).

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Table 1.

Summary of interventions, implementation strategies, the use of technology, and implications for equity and sustainability in 5 HIV-related implementation research projects.

Case Study Elements	*Case Study 1: Social media campaign*	*Case Study 2: Design-a-thon*	*Case Study 3: Twitter mining*	*Case Study 4: Crowdsourcing*	*Case Study 5: Health systems intervention*
Intervention	Culturally sensitive mass media campaign to reduce stigma and increase HIV prevention behaviors among adolescents	Innovative strategies to improve community engagement to enhance and support HIV prevention and promote PrEP uptake in MSM of color	Pre-exposure prophylaxis (PrEP) for sexual minority men	U=U health education campaign among African American communities	Health systems approach to build provider knowledge, skills and cultural humility for HIV testing and PrEP among young sexual and gender minorities in Philadelphia
Implementation Strategies (per ERIC [19])	• Mass media distribution of the adapted EBI through social media platforms	• Use digital spaces to build a coalition by recruiting and building relationships with implementation partners • Create a learning collaborative to generate intervention content • Stage intervention scale up to develop scalable entrepreneurial venture solutions via a virtual design-a-thon	• Conduct local needs assessment through social media mining • Identify early PrEP adopters via social media mining Use mass media to reach and recruit large number of sexual minority men for research • Tailor strategies to increase PrEP demand and use through online preference surveys	• Use advisory boards and workgroups to inform and augment crowdsourcing activities • Use mass media (social media platforms) to reach multiple stakeholders • Develop education materials via a crowdsourcing contest • Distribute educational messages via social media and intervene with patients/ consumers to enhance uptake and adherence	• Use technology to deliver ongoing training • Make training dynamic through testimonials and interactive online components to complement pre-recorded didactic material • Audit and feedback
EPIS Phase of Tech Component	Exploration, Preparation, Implementation	Exploration, Preparation	Exploration, Preparation	Exploration, Preparation	Preparation, Implementation
Tech Components	Using social media networks to disseminate intervention	Social media networks used to recruit diverse stakeholders for the design-a-thon; cloud-based management of teams and submissions; development of new technology-based HIV prevention strategies	Text-based analysis to develop targeting algorithm; algorithm will be used to inform Twitter-based recruitment; online survey to identify barriers to PrEP use; online discrete	Social media recruitment; Contest online on project website; Ultimate intervention will be distributed online via social media	Implementing training sessions via videoconference and webinar

J Acquir Immune Defic Syndr. Author manuscript; available in PMC 2023 July 01.

Case Study Elements	*Case Study 1: Social media campaign*	*Case Study 2: Design-a-thon*	*Case Study 3: Twitter mining*	*Case Study 4: Crowdsourcing*	*Case Study 5: Health systems intervention*
			choice experiment to identify PrEP promotion strategies		
Key tech-based implementation and process outcomes	• Acceptability of social media platform(s) • Social media ads overall & by time (fidelity, maintenance) • # African American teens reached (social media metrics) • # interactions with social media posts • Implementation costs	• Acceptability, appropriateness, feasibility of the design-a-thon • # innovators and contributors reached • # innovators and contributors participating in the designathon (adoption) • Diversity of innovators and contributors • # of tech-enabled solutions generated	• # sexual minority men (& Tweets) identified for potential engagement • # sexual minority men recruited (reached) to complete online survey • Precision of algorithm to identify sexual minority men (fidelity)	• # users reached across each social media platform • # campaign messages put forward by community • # interactions with social media posts (competition & campaign) • # unique visitors to project website • Acceptability of crowdsourcing process	• Acceptability (satisfaction), appropriateness and feasibility of online training • Adoption of providers (attendance of webinars) • Quality (fidelity) of online training • Cost of training
Equity Implications	Targeting strategies must be community solicited and monitored to ensure equitable distribution of the intervention	Deliberate targeting and recruiting through venture networks to ensure equitable representation; Venture solutions are accessible to and address the needs of diverse communities	Artificial intelligence-based algorithms have the potential to exacerbate disparities[36]; targeting can be optimized to focus on priority populations	Not including traditional in-person events might exclude participants with no or limited online presence; opportunity to democratize intervention development	Online sessions might result in greater and sustained access to training opportunities for organizations that were previously underserved
Sustainability/ Scale-Up	Potential to scale across geographic regions and social media networks; will require monitoring of changing consumer trends and preferences	Need to consider the “business model” of developed strategies to ensure sustainability	Advanced skill sets required for text-based analysis and algorithm development; generalizability to broader geographic areas will need to be verified empirically	Methods can be easily adapted to new settings; requires existing partnerships to leverage for recruiting contest participants	High potential for scalability depending on the level of interaction retained; considerations for conducting synchronous or asynchronous sessions; can address staff development in cases of turnover