

Virtual case management: a differentiated approach to HIV prevention, treatment, and care

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Introduction

The global HIV response is at a critical inflection point. The COVID-19 pandemic caused widespread disruption of in-person HIV services, reducing access to and retention in care, and further exacerbating the ability to reach vulnerable populations for prevention and treatment services [1]. In 2021, there were 1.5 million new HIV diagnoses – the smallest annual decline in years – and 650 000 AIDS-related deaths [2]. In addition, the annual increase of people with HIV receiving antiretroviral therapy (ART) was the smallest in over a decade [2]. These trends highlight the need for increased and sustained investment in HIV programs and, specifically, for innovations addressing key gaps, including reaching ‘last mile’ clients unreached by traditional programs.

The COVID-19 pandemic, despite its devastating impact, accelerated one critical innovation in HIV programming – virtual interaction – amplifying the value of virtual approaches for a differentiated mix of access options responding to and resonating with client preferences and needs. The development and use of virtual tools prior to the pandemic, coupled with the rapidly expanding global use of mobile devices and online platforms, presents a unique opportunity for HIV programs to leverage virtual services to provide tailored, on-demand support [3]. Case management, or the provision of individualized assistance and treatment support, is an important service to help improve health

outcomes among people with HIV and to improve uptake of preexposure prophylaxis (PrEP) to prevent HIV. To date, use and study of single-purpose digital tools and approaches targeting HIV service cascade elements have become widespread. However, little investment has been made in a comprehensive approach for leveraging virtual tools for case management in low-income and middle-income countries (LMICs), despite rapid increases in digital connectivity. We believe virtual case management (VCM) is poised to become a powerful force in the global HIV response, specifically in LMICs, for differentiated service delivery through reducing the burden on already constrained health systems and supplementing in-person service delivery [4]. In this article, we define VCM, examine the evidence base for the application of VCM, introduce a framework for a comprehensive approach, and call for more widespread implementation and evaluation of VCM approaches.

HIV case management and virtual approach

HIV case management is the personalized, one-to-one relationship between individuals seeking HIV-related clinical services (i.e. clients) and those providing support (i.e. case managers). Roles of case managers may differ across settings, but the overarching goal is to provide

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individualized assistance to clients to improve their health [5]. Functions may include client advocacy, care coordination, needs assessment and case monitoring, community engagement, education, administration activities, psychosocial support, and service navigation [6]. Studies in various settings demonstrated that case management improves care engagement and clinical outcomes and is acceptable to both clients and clinical teams [7–13]. In one study, most participants who were virally unsuppressed at enrollment spoke positively about their case management experience, highlighting case managers' critical role in providing nonjudgmental services and emotional support [7].

Case management services are virtual when provided via online platforms or telephones as part of differentiated service delivery approaches. Case management, including virtual approaches, is often associated with linkage to care and treatment support for people with HIV [8]. There is untapped potential for VCM to support PrEP use. In a recent systematic review, Patel *et al.* [9] suggest a model for comprehensive virtual PrEP service delivery using evidence-based innovations, which includes online demand generation, online appointment booking, HIV self-testing (HIVST), virtual risk assessment, and virtual follow-up and monitoring. VCM also has potential to amplify critical messages related to HIV prevention, such as U=U (undetectable = untransmittable) to increase engagement in HIV prevention and care services [10]. VCM's potential must be complemented with data privacy and protection, which is a key piece of the WHO's Global Strategy on Digital Health 2020–2025 guidance on digital health governance, especially for HIV services because of stigma and the increasing threat of laws against homosexuality and other identities [11].

Opportunities for virtual case management

The rapidly growing use of mobile devices provides opportunity for VCM. In 2022, more than two-thirds of the global population owned a mobile phone, 62.5% were connected to the internet, and there are now over 4.6 billion social media users [3]. Despite global expansion, digital divides remain. Internet connectivity in regions of Africa, southern Asia, and the Caribbean range from 24 to 66%, compared with northern America and western Europe ranging from 92 to 98% [3]. In sub-Saharan Africa, the region most affected by HIV, mobile internet connectivity has increased approximately 15% and gaps in coverage decreased from 50 to 19% from 2014 to 2021 [12]. These data indicate the potential for VCM not only in resource-rich settings but also where HIV disease burden is the greatest, particularly as human resource constraints may limit the reach of traditional models. The potential impact of VCM to improve client engagement across the HIV prevention and treatment cascade here warrants consideration.

Past trends indicate that digital connectivity will only continue to increase, with lower connectivity regions demonstrating the most rapid growth [13]. In the past decade, year-over-year growth has occurred across all digital connectivity metrics, including mobile phone ownership, internet use, and social media use globally [3]. The COVID-19 pandemic accelerated global shifts and expansion of virtual health services. The United States Agency for International Development reported the introduction and expansion of virtual and telehealth services in their programs because of clinic closures and limitations on in-person services experienced early in the pandemic [14]. Programs successfully used social media and other online platforms for client outreach and mobilization, electronic case management systems to track and contact clients with treatment information, and virtual counseling for PrEP services [14].

Existing tools for virtual case management

To date, most implementation and corresponding research has been fragmented and often focused on single-purpose applications or interventions, rather than a comprehensive VCM approach. Below, we outline some promising virtual approaches at relevant points along the HIV prevention and treatment cascades.

HIV testing and linkage to prevention and care

Virtual approaches are increasingly used to generate demand for HIV testing and link individuals to care (treatment or prevention services). Mobile health (mHealth) and other digital health interventions can be useful for reaching first-time HIV testers and hard-to-reach populations including gay, bisexual, and other MSM, transgender women, and sex workers by providing potential clients with private, confidential, and judgment-free services [15]. One review found that nearly half of first-time testers preferred virtual HIV testing approaches over in-person or hybrid options [16]. In the Philippines, a demonstration project allowed MSM and transgender women to sign up online for HIVST; 54.6% of participants were first-time testers [17]. Similarly, in Thailand, a digital health intervention, Adam's Love, was implemented to reach MSM and transgender women for HIV testing; participants in the intervention arm were significantly more likely to be first-time testers or nonrecent testers [18]. MSM and transgender women in Thailand report primarily seeking HIV and sexual health information online because of fear of stigma from clinicians or other sources, further emphasizing the

potential of virtual approaches to reach these populations [19]. Men, who typically have lower engagement with healthcare systems, expressed interest in using mobile applications to order HIVST kits and communicate with testing counselors in Uganda [20]. Adolescents and youth may have higher rates of HIV testing if receiving targeted communication through mHealth and social media platforms, and youth in LMICs frequently report high acceptability, appropriateness, and feasibility of HIV mHealth interventions [21,22].

Once virtual approaches draw individuals into HIV testing, the goal is to link them to care, either through initiating ART or connecting to prevention services such as PrEP. In the Philippines study described above, 85.7% of individuals with reactive tests were linked to care and 51% initiated ART; however, only 0.3% of individuals with nonreactive tests initiated PrEP [17]. Studies in the United States and South Africa demonstrated higher rates of ART or PrEP initiation and adherence for specific subgroups using digital tools supporting HIV testing and treatment but not across all participants [23,24]. Additionally, a systematic review found a wide range of efficacy (53–100%) for web-based approaches for linkage to care after HIVST [16]. These varying results highlight the need for further study of barriers to shifting from online to offline services and in identifying clients at risk of not being linked to services for additional support. A comprehensive VCM approach may be an integral component to improving linkage to care through online interventions [25].

The online reservation and case management (ORA) app has been used to engage clients not reached by traditional, face-to-face approaches in HIV programs in Africa. Using data obtained from social media mapping, programs promote ORA as a client-led approach allowing clients to understand their risk and book services at sites of their choice [26]. Once clients arrive at clinics, the system is updated to include information on services received. Across 26 countries that have used ORA, an average of 71% of clients who booked their appointment on ORA attended their appointment, potentially because of short message service (SMS) reminders sent to clients 48 and 24 h prior to appointments [27]. Data have also consistently demonstrated higher case finding among clients who booked services online as compared with traditional peer outreach; across all country programs that have used ORA, case finding among clients who booked online is close to 21%, although these results are skewed toward people with HIV and not all new testers because many countries used ORA to enroll people on ART. In Burundi, additional analysis indicates that close to 10% of clients reached online self-reported no previous access to HIV programs, while in the Democratic Republic of Congo, 30% of clients self-reported never having tested for HIV [27].

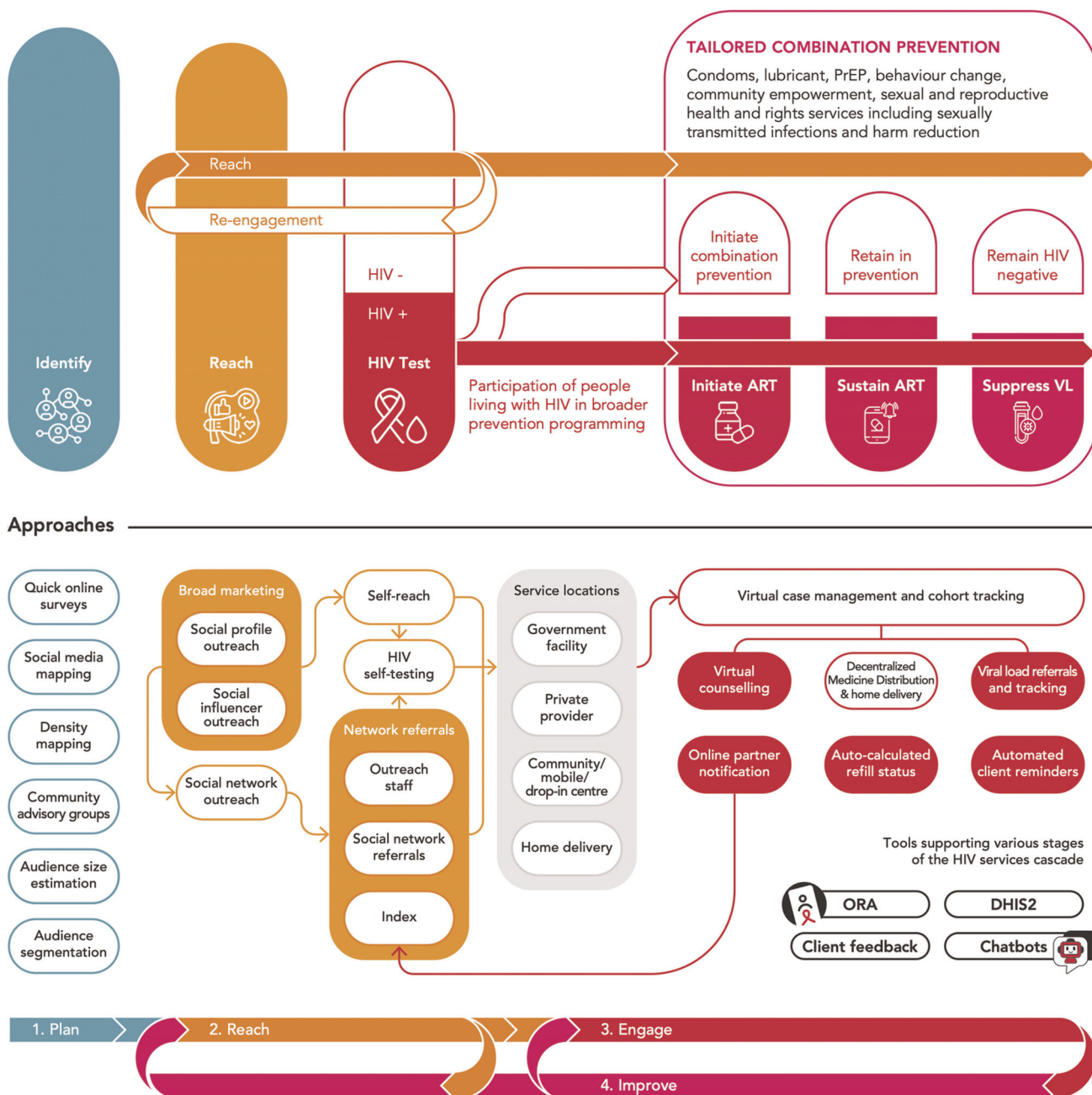
Treatment support and antiretroviral therapy adherence

MHealth, primarily the use of SMS, has been widely studied as an intervention for ART adherence. SMS or other message reminders have consistently been shown to significantly increase ART adherence along with viral suppression and reduce treatment interruptions [28–34]. Multiple studies have also demonstrated the acceptability of reminder messages among patients and the feasibility of programs to implement them [33–35]. Two meta-analyses of various electronic health (eHealth) approaches, including SMS, telephone calls, mobile applications, web-based programs, and electronic adherence monitoring devices, showed they all had a significant positive effect on ART adherence and other treatment outcomes, such as pharmacy visits and refill records, CD4⁺ cell count, viral suppression, and retention in care [36,37].

A recent study in South Africa combined the use of SMS reminders with peer navigation to increase engagement and care retention for people with HIV. Participants receiving both SMS reminders and peer navigator support on average had approximately two more clinic visits during the study period and were significantly more likely to be retained in care than patients only receiving SMS reminders or the standard of care [32]. Peer navigation shares similarities with case management; therefore, this study provides potential insight to the benefits of incorporating digital tools into a comprehensive VCM approach.

Comprehensive virtual case management

The study of comprehensive VCM approaches is limited. Most research to date has focused on intervention design and acceptability/feasibility studies. Clients, case managers, and clinical care teams all typically endorse the use of virtual approaches to communicate about HIV-related services [38–41]. Furthermore, a study of a cell-phone-based case manager approach – which included weekly text messages, predelivery and postdelivery telephone calls, and on-demand phone calls if requested – for pregnant women living with HIV in South Africa found high intervention acceptability and feasibility [42]. A smartphone-application-based case management service cascade for people with HIV is currently being tested in China. The mobile application provides participants one-on-one virtual communication with case managers, appointment reminders, services support information, and educational articles [43]. A similar interactive mHealth intervention being tested in the Philippines provides MSM with medication adherence reminders, adherence feedback, symptom reporting, and health tips [44]. The Adam's Love platform described above has been used to support more comprehensive case management



ART antiretroviral therapy

DHIS2 District Health Information Software 2

ORA Online Reservation and Case Management App

Fig. 1. Framework for virtual intervention approaches across the HIV prevention and treatment cascades, including virtual case management. The top of the figure outlines the main steps along the cascade, showing differentiation in steps following HIV testing based on HIV status (white depicting HIV-negative; red depicting HIV-positive). The bottom portion of the figure outlines virtual approaches that can be used at each step, including virtual case management, which has utility for both individuals who are HIV-negative engaged in biomedical prevention services and those living with HIV engaged in HIV-related care. Reproduced with permission from [8].

where potential clients for PrEP were provided online counseling, appointment bookings, and quick response code e-tickets to present at check-in. The quick response code system allowed for follow-up and case monitoring. This approach resulted in 53.2% of HIV-negative clients initiating PrEP, but further study of adherence and follow-up services is needed [45].

Conceptual framework for virtual case management as a differentiated service delivery approach

A more defined, comprehensive approach to VCM is needed. We present one potential framework (Fig. 1) that fills key gaps highlighted above, including leveraging virtual options to provide continuity between stages of the HIV service cascade, offering pathways for using VCM for prevention and treatment, and defining a comprehensive approach. This framework was developed for use in programs and by partners at FHI 360 and was recently published by The Joint United Nations Programme on HIV/AIDS (UNAIDS) and the WHO [8]. Focusing on delivering HIV-related services for both prevention and treatment, the framework outlines specific ones that can be provided virtually. These services include video-based and phone-based counseling and support, online partner notification systems, and automated appointment booking and reminders for clients. VCM tools for case managers include the ability to track referrals online, see when client medications are running low, and organizing drug delivery. The framework allows for a more seamless integration of virtual approaches into existing clinical and community-based services aimed at attaining viral suppression for people with HIV and maintaining negative serostatus for PrEP clients [25,46].

This framework has been applied in programming to strengthen retention and achieve viral suppression among a cohort of clients in South Africa who are living with HIV. The program is using the ORA app to help case managers track clients using messenger apps to communicate and the ORA app to book services, note services received, and identify clients for follow-up. However, more research is needed to understand implementation and effectiveness of this program.

In conclusion, VCM shows promise for improving HIV prevention and treatment outcomes. However, there is ambiguity about what services are included, roles and responsibilities of individuals at different steps along the service cascade, and how to link online and offline services. Clear operational definitions for VCM –adaptable based on setting and context – are needed to have shared understanding for clinical and programmatic

implementation. Currently, most VCM services are implemented through single-purpose tools or approaches that have proven effective across various outcomes including HIV testing, linkage to care, and medication adherence. A comprehensive VCM approach that integrates digital tools could be a way to improve continuity throughout the HIV service cascade. The goal of VCM is to supplement and support in-person service delivery by increasing the reach, maximizing efficiency, and expanding differentiated options for health service delivery. Although our experience implementing these programs shows promise, research is needed to establish an evidence base and answer key questions related to efficiency, efficacy, and sustainability. Increased investment in research to answer these questions would help advance the field of HIV care and, ultimately, improve the health and well being of communities across the globe.

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Conflicts of interest

There are no conflicts of interest.

References

1. Stover J, Kelly SL, Mudimu E, Green D, Smith T, Taramusi I, *et al.* **The risks and benefits of providing HIV services during the COVID-19 pandemic.** *PLOS ONE* 2021; **16**:e0260820.
2. In danger: UNAIDS Global AIDS Update 2022. Geneva Joint United Nations Programme on HIV/AIDS; 2022. License: CC-BY-NC-SA 3.0 IGO.
3. Digital 2022: Global Overview Report. DataReportal - Glob. Digit. Insights. Available at: <https://datareportal.com/reports/digital-2022-global-overview-report>. [Accessed 30 June 2022]
4. International AIDS Society. About | What is DSD? 2022. Available at: https://differentiatedservicedelivery.org/about_DSD. [Accessed 30 June 2022]

5. Noriega Minichiello S, Zinck M, Eveslage B. Virtual case management: a technical guide for virtual case management and cohort tracking for antiretroviral Therapy (ART) and preexposure prophylaxis (PrEP) services. *FHI 360* [in progress].
6. Kelly KJ, Doucet S, Luke A. **Exploring the roles, functions, and background of patient navigators and case managers: a scoping review.** *Int J Nurs Stud* 2019; **98**:27–47.
7. Tolley EE, Hamilton EL, Eley N, Maragh-Bass AC, Okumu E, Balán IC, *et al.* **The role of case management in HIV treatment adherence: HPTN 078.** *AIDS Behav* 2022; **26**:3119–3130.
8. Innovate, implement, integrate: virtual interventions in response to HIV, sexually transmitted infections and viral hepatitis. Geneva: Joint United Nations Programme on HIV/AIDS and the World Health Organization [2022]. Available at: https://www.unaids.org/sites/default/files/media_asset/policy-brief_virtual-interventions_en.pdf. [Accessed 30 June 2022]
9. Patel P, Kerzner M, Reed JB, Sullivan PS, El-Sadr WM. **Public health implications of adapting HIV preexposure prophylaxis programs for virtual service delivery in the context of the COVID-19 pandemic: systematic review.** *JMIR Public Health Surveill* 2022; **8**:e37479.
10. Eisinger RW, Dieffenbach CW, Fauci AS. **HIV viral load and transmissibility of HIV infection: undetectable equals untransmittable.** *JAMA* 2019; **321**:451–452.
11. *Global strategy on digital health 2020–2025.* Geneva: World Health Organization; 2021.
12. The State of Mobile Internet Connectivity Report 2021 - mobile for development. *Hrefmobilefordevelopment* Mobile Dev. Available at: <https://www.gsma.com/r/somic/>. [Accessed 12 August 2022]
13. Digital 2021: Global Overview Report — DataReportal - global digital insights. Available at: <https://datareportal.com/reports/digital-2021-global-overview-report>. [Accessed 30 June 2022]
14. Hoover JR, Frymus DE, Ifafore-Calfree TA. **Recognizing and supporting health workers to advance and sustain HIV gains: lessons from PEPFAR programmes during the COVID-19 response.** *AIDS* 2021; **35**:2047–2050.
15. Rousseau E, Julius RF, Madubela N, Kassim S. **Novel platforms for biomedical HIV prevention delivery to key populations — community mobile clinics, peer-supported, pharmacy-led PrEP delivery, and the use of telemedicine.** *Curr HIV/AIDS Rep* 2021; **18**:500–507.
16. McGuire M, de Waal A, Karellis A, Janssen R, Engel N, Sampath R, *et al.* **HIV self-testing with digital supports as the new paradigm: a systematic review of global evidence (2010–2021).** *EclinicalMedicine* 2021; **39**:101059.
17. Eustaquio PC, Figuracion R, Izumi K, Morin MJ, Samaco K, Flores SM, *et al.* **Outcomes of a community-led online-based HIV self-testing demonstration among cisgender men who have sex with men and transgender women in the Philippines during the COVID-19 pandemic: a retrospective cohort study.** *BMC Public Health* 2022; **22**:366.
18. Anand T, Nitpolprasert C, Kerr SJ, Apornpong T, Ananworanich J, Phanuphak P, *et al.* **Implementation of an online HIV prevention and treatment cascade in Thai men who have sex with men and transgender women using Adam's Love Electronic Health Record system.** *J Virus Erad* 2017; **3**:15–23.
19. Anand T, Nitpolprasert C, Kerr SJ, Muessig KE, Promthong S, Chomchey N, *et al.* **A qualitative study of Thai HIV-positive young men who have sex with men and transgender women demonstrates the need for eHealth interventions to optimize the HIV care continuum.** *AIDS Care* 2017; **29**:870–875.
20. Muwanguzi PA, Nasuuna EM, Namimbi F, Osingada CP, Ngabirano TD. **Venues and methods to improve professional men's access to HIV self-testing and linkage to HIV prevention or treatment: a qualitative study.** *BMC Health Serv Res* 2021; **21**:1217.
21. Zanon BC, Elliott RJ, Neilan AM, Haberer JE. **Screening for HIV and linkage to care in adolescents: insights from a systematic review of recent interventions in high- versus low- and middle-income settings.** *Adolesc Health Med* 2018; **9**:211–235.
22. Nwaozuru U, Obiezu-Umeh C, Shato T, Uzoaru F, Mason S, Carter V, *et al.* **Mobile health interventions for HIV/STI prevention among youth in low- and middle-income countries (LMICs): a systematic review of studies reporting implementation outcomes.** *Implement Sci Commun* 2021; **2**:126.
23. Sullivan PS, Stephenson R, Hirshfield S, Mehta CC, Zahn R, Bauermeister JA, *et al.* **Behavioral efficacy of a sexual health mobile app for men who have sex with men: randomized controlled trial of mobile messaging for men.** *J Med Internet Res* 2022; **24**:e34574.
24. Venter WDF, Fischer A, Lalla-Edward ST, Coleman J, Lau Chan V, Shubber Z, *et al.* **Improving linkage to and retention in care in newly diagnosed HIV-positive patients using smartphones in South Africa: randomized controlled trial.** *JMIR MHealth UHealth* 2019; **7**:e12652.
25. FHI 360, LINKAGES Project. 2019. A Vision for Going Online to Accelerate the Impact of HIV Programs. Washington, DC: FHI 360.
26. FHI 360, EpiC Project. Social Media Mapping Technical Brief. 2021. Available at: <https://www.fhi360.org/sites/default/files/media/documents/resource-social-media-mapping.pdf>. [Accessed 20 November 2022]
27. Program Data. QuickRes Syst. Program data. Available at: <https://www.quickres.org>. [Accessed 18 August 2022]
28. Lester RT, Ritvo P, Mills EJ, Kariri A, Karanja S, Chung MH, *et al.* **Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WeTel Kenya1): a randomised trial.** *Lancet* 2010; **376**:1838–1845.
29. Pop-Eleches C, Thirumurthy H, Habyarimana JP, Zivin JG, Goldstein MP, de Walque D, *et al.* **Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders.** *AIDS* 2011; **25**:825–834.
30. Maduka O, Tobin-West CI. **Adherence counseling and reminder text messages improve uptake of antiretroviral therapy in a tertiary hospital in Nigeria.** *Niger J Clin Pract* 2013; **16**:302–308.
31. Haberer JE, Musiimenta A, Atukunda EC, Musinguzi N, Wyatt MA, Ware NC, Bangsberg DR. **Short message service (SMS) reminders and real-time adherence monitoring improve antiretroviral therapy adherence in rural Uganda.** *AIDS* 2016; **30**:1295–1299.
32. Steward WT, Agnew E, de Kadt J, Ratlhagana MJ, Sumitani J, Gilmore HJ, *et al.* **Impact of SMS and peer navigation on retention in HIV care among adults in South Africa: results of a three-arm cluster randomized controlled trial.** *J Int AIDS Soc* 2021; **24**:e25774.
33. Daher J, Vijh R, Linthwaite B, Dave S, Kim J, Dheda K, *et al.* **Do digital innovations for HIV and sexually transmitted infections work? Results from a systematic review (1996–2017).** *BMJ Open* 2017; **7**:e017604.
34. Lee SB, Valerius J. **mHealth interventions to promote antiretroviral adherence in HIV: narrative review.** *JMIR MHealth UHealth* 2020; **8**:e14739.
35. Muessig KE, LeGrand S, Horvath KJ, Bauermeister JA, Hightow-Weidman LB. **Recent mobile health interventions to support medication adherence among HIV-positive MSM.** *Curr Opin HIV AIDS* 2017; **12**:432–441.
36. Manby L, Aicken C, Delgrange M, Bailey JV. **Effectiveness of eHealth interventions for HIV prevention and management in sub-Saharan Africa: systematic review and meta-analyses.** *AIDS Behav* 2022; **26**:457–469.
37. Wang Z, Zhu Y, Cui L, Qu B. **Electronic health interventions to improve adherence to antiretroviral therapy in people living with HIV: systematic review and meta-analysis.** *JMIR MHealth UHealth* 2019; **7**:e14404.
38. Fonner VA, Kennedy S, Desai R, Eichberg C, Martin L, Meissner EG. **Patient-provider text messaging and video calling among case-managed patients living with HIV: formative acceptability and feasibility study.** *JMIR Form Res* 2021; **5**:e22513.
39. DiAndreth L, Krishnan N, Elf JL, Cox S, Tilchin C, Nthulana M, *et al.* **Formative research for an mHealth program to improve the HIV care continuum in South Africa.** *AIDS Care* 2020; **32**:744–748.
40. Hirsch-Moverman Y, Daftary A, Yuengling KA, Saito S, Ntoane M, Frederix K, *et al.* **Using mHealth for HIV/TB treatment support in Lesotho: enhancing patient-provider communication in the START Study.** *J Acquir Immune Defic Syndr* 1999 **17** (Suppl 1):S37–S43.
41. Gilbert M, Salway T, Haag D, Fairley CK, Wong J, Grennan T, *et al.* **Use of GetCheckedOnline, a comprehensive web-based testing service for sexually transmitted and blood-borne infections.** *J Med Internet Res* 2017; **19**:e81.

42. Schwartz SR, Clouse K, Yende N, Van Rie A, Bassett J, Ratshefolo M, Pettifor A. **Acceptability and feasibility of a mobile phone-based case management intervention to retain mothers and infants from an Option B+ program in postpartum HIV care.** *Matern Child Health J* 2015; **19**:2029–2037.
43. Fan X, She R, Liu C, Zhong H, Lau JTF, Hao C, *et al.* **Evaluation of smartphone APP-based case-management services among anti-retroviral treatment-naïve HIV-positive men who have sex with men: a randomized controlled trial protocol.** *BMC Public Health* 2020; **20**:85.
44. O'Connor C, Leyritana K, Doyle AM, Lewis JJ, Gill R, Salvaña EM. **Interactive mobile phone HIV adherence support for men who have sex with men in the Philippines Connect for Life Study: mixed methods approach to intervention development and pilot testing.** *JMIR Form Res* 2022; **6**:e30811.
45. Anand T, Nitpolprasert C, Trachunthong D, Kerr SJ, Janyam S, Linjongrat D, *et al.* **A novel Online-to-Offline (O2O) model for preexposure prophylaxis and HIV testing scale up.** *J Int AIDS Soc* 2017; **20**:21326.
46. Eveslage B. **Virtual HIV interventions: a budgeting and programming aid.** Version 2. Durham (NC): FHI 360; 2022. Available at: <https://fhi360.org/goingonline>. [Accessed 20 November 2022]