Published in final edited form as:

AIDS Care. 2019 May ; 31(5): 636–646. doi:10.1080/09540121.2018.1549723.

Content Guidance for Mobile Phones Short Message Service (SMS)-Based Antiretroviral Therapy Adherence and Appointment Reminders: A Review of the Literature

Andrew Kerrigan¹, Nadi N. Kaonga^{1,2,†}, Alice M. Tang¹, Michael R. Jordan^{1,3}, and Steven Y. Hong^{1,3,*}

¹Department of Public Health and Community Medicine, Tufts University School of Medicine, Boston, MA, USA

²Tufts University Clinical and Translational Science Institute, Boston, MA, USA

³Division of Geographic Medicine and Infectious Diseases, Tufts Medical Center, Boston, MA, USA

Abstract

Mobile phones are increasingly being used to support health activities, including the care and management of people living with HIV/AIDS. Short message service (SMS), in particular, has been explored as a means to optimize and support behaviour change. However, there is minimal guidance on messaging content development. The purpose of this review was to help inform the content of SMS messages for mobile health (mHealth) initiatives designed to support anti-retroviral therapy (ART) adherence and clinic appointment keeping in resource-limited settings. PubMed, OvidMedline, Google Scholar, K4Health's mHealth Evidence database, the mHealth Working Group project resource, and Health COMpass were searched. A request to online communities for recommendations on message content was also made. 1010 unique sources were identified, of which 51 were included in this review. The information was organized into three categories: pre-message development, message development, and security and privacy. Fifteen of the publications explicitly provided their message content. Important lessons when developing the content of SMS were: 1) conducting formative research; 2) grounding content in behaviour change theory; and 3) reviewing proposed content with experts. Best practices exist for developing message content for behaviour change. Efforts should be continued to apply lessons learned from the existing literature to inform mHealth initiatives supporting HIV/AIDS care and treatment.

Keywords

HIV; biotechnology; SMS; adherence; infectious disease; mobile phone

*Corresponding Author: Steven Y Hong; Address: Tufts University School of Medicine, 150 Harrison Avenue, Jaharis 2, Boston, MA 02111; phone: (617) 636-0827; shong@tuftsmedicalcenter.org.

†Co-First Author

Declaration of Interest: The authors of this manuscript have read and understood AIDS Care's policy on declaration of interests and declare that we have no competing interests, or conflicts of interest.

Geolocation Information: By nature of our methodology, our literature search was not restricted to any particular geolocation and included research papers from various countries across the world. A listing of these countries can be found in Table 1.

Introduction

Globally, the number of mobile phone subscriptions has been increasing with the fastest growth in resource-limited settings (GSMA, 2013; Tortora, 2015). This growth is due in part to reduction in the cost of mobile phones and subscription plans (Mahajan, 2001). The evidence base for applying mobile technologies for health systems strengthening (also known as mobile health, or mHealth) has expanded. Public and private institutions are integrating mobile technologies into the health systems infrastructure. mHealth has been used to support data collection and reporting, to enhance timely communication, and to function as a decision-support tool at the point-of-care. The support for public health programming has primarily been provided through short message services (SMS, also referred to as text messages), pre-loaded (or pre-installed) applications, data applications (i.e., smartphone apps), and voice and web-based portals (e.g., for data entry or accessing reports) (Labrique et al., 2013). Amongst the ways that mHealth has been used, SMS is appealing due to its low-cost and ease of customization (Free et al., 2013).

mHealth has been used to support health systems strengthening across multiple diseases. The treatment of HIV/AIDS has benefited extensively from various mHealth applications such as SMS which support medication adherence and retention in care (Betjeman et al., 2013; Catalani et al., 2013). Initial data indicate that the use of SMS reminders is acceptable and feasible for persons living with HIV. While the data supporting improved health outcomes is promising, SMS reminders have not always been shown to lead to significant improvements in outcomes – that is, improving adherence, decreasing virologic failure, or increasing CD4 cell count (Horvath et al., 2012; Lester et al., 2010; Van Velthoven et al., 2013).

The variability in outcomes may be correlated to variability in SMS reminder composition. SMS are highly customizable and optimization of SMS content, such as message, security and timing, is likely to be important to optimizing potential intervention benefits. Currently there is no standard on SMS content. Previous reviews do not discuss the content of SMS or the content development process (Free et al., 2013; Catalani et al., 2013, Horvath et al., 2012). Therefore, we reviewed the literature to help inform SMS content development for mHealth initiatives designed to support antiretroviral therapy (ART) adherence and clinic appointment reminders in resource-limited settings. Our goal is to help establish standard guidelines for developing SMS reminders for HIV. We believe that these findings will be useful to other researchers and public health and ART program decision makers (Gilks et al., 2006; WHO, 2009).

Methods

This review was conducted in January 2017 and searched literature published from 1 January 2000 to 1 January 2017. An initial exploration of articles in PubMed was carried out to develop and refine search terms and inclusion and exclusion criteria. Search terms of “mobile phone” and “HIV adherence” were used in PubMed and Google Scholar. OvidMedline was searched under “Cell Phone” and “HIV Infection” subject lines.

K4Health's mHealth Evidence database, the mHealth Working Group, and Health COMPASS resources were also searched. The search term used in the mHealth Evidence database was "HIV" and all listings were screened for inclusion or exclusion. Health COMPASS search was limited to the topic of "HIV/AIDS" and a search for mobile phone was made. For the mHealth Working Group, which did not contain a pre-set filter related to HIV, the entire list of references was screened. A request to online mHealth and HIV adherence communities for recommendations on message content yielded additional information not found in the formal literature. Additional relevant references were identified from the citation lists of articles that met the inclusion criteria.

Titles and abstracts of the articles were reviewed. Full-text articles were obtained and reviewed for those whose titles and abstracts potentially met the inclusion criteria or whose full text was required to determine eligibility. The full-text articles were assessed according to predefined inclusion and exclusion criteria.

Articles were included if they dealt specifically with SMS interventions for medication adherence and/or appointment reminders for HIV/AIDS. Articles were excluded for the following reasons: (1) article covered topics *not* directly related to HIV/AIDS, medication adherence, appointment reminders, or non-SMS based initiatives (e.g., voice, phone applications) and (2) did not include information on message content development or messaging content. Commentaries, editorials, articles focused on formative research (i.e., exploring mobile phone ownership in a particular population), or studies conducted before 2000, due to mHealth not yet being defined, were also not included in the review.

A data extraction sheet was developed to collect the following information from each article meeting the inclusion criteria: article type (e.g., report, protocol, journal, review), article title, journal, primary author, date, country(-ies) of focus/implementation, type of SMS intervention (e.g., adherence, appointment reminder or both), categorization based on the Mobile Behaviour Change Communication (mBCC) field guide, (Umapathy et al., 2012) study type, study population, sample size, observed effect, and user satisfaction. Two authors (NNK and ARK) were responsible for the data extraction. A third author (SYH) inspected and appraised the initial author's extraction. Disagreements were resolved by discussion between the three authors.

Results

Article characteristics

Of 1010 unique articles identified, 51 met the inclusion criteria and were included for further review (Figure 1). Of these, 7 were systematic reviews, 9 were protocols, and the remainder were original research articles (n=35). Three of the systematic reviews included meta-analyses, and six of the protocols described randomized controlled trials (RCTs). Original research articles included qualitative studies (n=9), feasibility studies (n=9), RCTs (n=11), and cross-sectional studies (n=4). The majority (n=44) of manuscripts had been published within the last six years (2012-2017). Most articles (n=35) dealt with SMS for supporting adherence to ART, rather than appointment reminders (n=7), or both adherence and appointment reminders (n=6).

Original research studies had sample sizes that ranged from 21 to 1,016 participants. Sub-Saharan Africa was the most common location (n=24), and >75% of studies with reported countries, were done in developing nations. Almost all studies were gender inclusive (n=47), with only 4 male specific (all men who have sex with men) and 1 female specific. The majority of studies were in adults (n=30), an additional 11 studies had wide age ranges, consisting mostly of adults, 9 included children (<18yo) and 4 focused specifically on adolescents (14-25yo). Most studies did not have strict inclusion/exclusion criteria for ART history (n=32), 10 papers looked at those non-naïve to care, 5 looked at those naïve to care and an additional 5 looked at those with history of poor adherence. These data and other characteristics are summarized in Table 1.

SMS acceptability and efficacy

Measures of acceptability and efficacy were variable. The most common measure was self-reported adherence (n=17), followed by self-reported acceptability (n=16). An additional 9 studies looked at lab markers such as viral load or CD4+ count. Directly measured adherence (pill counts or electronic pill boxes) was used in 7 studies. Five studies looked at kept-appointments and five more measured retention in care. Participants in many studies were receptive to the use of SMS for adherence and appointment reminders (n=24). In terms of intervention efficacy, 31 of the sources reported on the success or failure of the intervention, with the majority reporting some benefits (n=27). Only one review article concluded that SMS interventions did not improve adherence (Van Velthoven et al., 2013). Of original research, only two articles found no significant differences in adherence (Mbuagbaw et al., 2012b; Orrell, 2015); however, Orrell et al.(2015) did find improvements in adherence-related outcomes. Another article found no significant differences in clinic attendance (Kliner et al., 2013).

SMS Content

Fifteen of the publications explored in this review explicitly shared their messaging content and from the seven additional resources identified through contacting HIV and mHealth research communities, three could be found in the formal and grey literature (Oregon Reminders, 2018; Azih et al., 2012; Uhrig et al., 2011).

Developing Content

The data on message content development gathered from the 51 articles have been synthesized and organized into three broad categories modelled after the mBCC field guide: *pre-message development*, *message development*, and *security and privacy* also shown in Table 1. *Pre-message development* deals with the steps to consider before content is developed. *Message development* uses information from *pre-message development* to craft, evaluate, and refine message content. Lastly, *security and privacy* deals with ensuring patient confidentiality and data security.

Pre-Message Development—In the pre-message development phase, researchers typically used a mix of approaches, including literature reviews, interviews, focus groups, and surveys, to engage both patients and providers. Some initiatives also worked with behaviour change experts. Behaviour change experts helped with intervention design, as

well as developing, reviewing, and refining content (Furberg et al., 2012; Da Costa et al., 2012; Cook et al., 2015). Through formative research carried out before content development, one study found that differences in mobile phone ownership by gender necessitated gender-specific content and dissemination strategies (Crankshaw et al., 2010).

Message Development—Message development had several considerations, including; grounding the messages in behaviour change theory, identifying any needs for segmenting the audience, catering to patient preferences through tailoring or targeting the messages, and determining appropriate message timing and frequency.

Behaviour Change Theory: Grounding the message content in behaviour change theory was deemed to be highly important (Table 2) (Coomes et al., 2012). Menacho et al. (2013) used the Information-Motivation Behavioural Skills Model and Social Support Theory to help develop SMS content. Another theory that researchers found useful, was the Stages of Change Model. In one study, the Stages of Change Model formed the basis of a program (Klein et al., 2014). In another study, the authors used the Stages of Change Model to design SMS messages from the time of diagnosis, to therapy initiation up through long-term use of ART (Van der Kop et al., 2013). The individual behavioural change model used in each study did not appear to be chosen due to a specific attribute of their SMS program. This suggests that several behavioural change theories can be adapted to suite SMS content development needs.

Behaviour change theories can be used as a framework to structure SMS message content. As an example, we mapped available SMS message content from the literature to a framework of three behaviour change models in Table 3 (Prochaska & Velicer, 1997; Shaw et al., 2013; Shared Action, 2018; WHO, 2003). The premise was that the use of multiple models can help ensure that there is a stimulus for an individual at any stage of the behaviour change process, as long as each model provided a different approach to and perspective on behaviour change.

Audience Segmentation: When developing the message content, attention was paid to audience segmentation. Segmentation addresses specific sub-groups within the target group. For example, the target group can be segmented based on age, peer group, gender, community or language. Different audience segments may require distinct messages. Four studies identified the need to adjust message development by gender, community and language (Mbuagbaw et al., 2011; Crankshaw et al., 2010; Kinyua et al., 2013; Davey et al., 2016).

Tailored or Targeted Messages: Researchers found that tailored or targeted messages were more effective than generic messages (n=15) (Mbuagbaw et al., 2013a; Park et al., 2014; Pellowski & Kalichman, 2012; Mbuagbaw et al., 2013c; Dowshen et al., 2013; Dowshen et al., 2013; Klein et al., 2014; Lewis et al., 2013; Mbuagbaw et al., 2012; Smillie et al., 2014; Uhrig et al., 2012; Georgette et al., 2016; Rana et al., 2016; Rana et al., 2015; Sabin et al., 2015). Patients preferred interactive messages, which was due to patients feeling like they were supported and not alone (Curioso et al., 2009; Smillie et al., 2014; Georgette et al., 2016; Rana et al., 2015). Furthermore, interactivity was found to increase retention

and improve viral load suppression (n=3) (Mbuagbaw et al., 2013a; Lewis et al., 2013; Mbuagbaw et al., 2013d). Strategies used to enhance interactivity included using live or algorithm-based bi-directional messaging, personalizing messages, changing the message every few weeks, using a blend of different types of messages (e.g., motivational, educational), and having each individual patient design his/her own batch of messages (Finitsis et al., 2014; Park et al., 2014; Hailey & Arscott, 2013; Ingersoll et al., 2014; Kliner et al., 2013; Mbuagbaw et al., 2012; Mbuagbaw et al., 2012b; Smillie et al., 2014; Tran & Houston, 2012; Davey et al., 2016; Cook et al., 2015; Rana et al., 2016). Finally, two studies explored two SMS-based interventions (SMS-alone and SMS plus a phone call) compared to standard of care (no appointment reminder), for youth living with HIV/AIDS in Cameroon (Bigna et al., 2013; Bigna et al., 2014). The researchers found that SMS combined with a phone call was most effective, but costly.

Timing and Frequency of Messages: Data suggests that weekly or more frequent, but not daily, messages are effective (n=7) (Horvath et al., 2012; Lester et al., 2010; Mbuagbaw et al., 2013a; Mbuagbaw et al., 2013c; Maduka & Tobin-West, 2013; Mbuagbaw et al., 2012; Pop-Eleches et al., 2011). In two studies, patients were able to select when they wanted to receive the messages, and how frequently (Park et al., 2014; Rana et al., 2016). Other studies used audience segmentation to inform the timing and frequency of the messages (n=4) (Bigna et al., 2013; Ammassari et al., 2011; Bigna et al., 2014; Lewis et al., 2013). One study used a survey to determine if there was a need for audience segmentation. Their findings indicated that they would need to adjust messaging frequency based on regimen and time since initiating therapy (Lewis et al., 2013). Another three studies provided SMS reminders solely to non-adherent individuals (Ammassari et al., 2011; Orrell et al., 2015; Sabin et al., 2015).

Security and Privacy—While security and privacy were important considerations, they did not appear to be barriers to patients wanting to enrol in SMS-based reminder programs (n=5) (Baranoski et al., 2014; Kunutsor et al., 2010; Mbuagbaw et al., 2012; Ramanathan et al., 2013; Rana et al., 2015). Mechanisms to ensure patient privacy included having patients craft their own messages (Park et al., 2014; Rana et al., 2016) or use code words/phrases (i.e., weather, jokes, words of encouragement) (Curioso et al., 2009; Hardy et al., 2011; Ingersoll et al., 2014; Siedner et al., 2015). One study found that using code words was as effective at increasing clinic attendance; however, pre-coded 4-digit “PIN” messages and nonsense codes (i.e. “ABCDEFGH”) were less effective for return to care (Siedner et al., 2015).

Discussion

Mobile phone SMS is a promising tool for use in supporting ART adherence and retention in care in resource-limited settings. Identifying effective SMS messaging content along with optimal timing and frequency of messages is an important step in developing an mHealth intervention. Our review contained papers largely from resource-limited countries, without strong gender bias, and primarily adults, with some child and adolescents. This review has identified several themes related to the development of SMS messages. These themes include the following: 1) conducting formative research, such as interviews with key

stakeholders, to help identify message content and frequency and timing preferences; 2) grounding the message content in behaviour change theory; and 3) reviewing the proposed message content with experts (e.g., behaviour change specialists, physicians). All these themes relate back to understanding the particular needs of the target population.

Formative research plays an important role in ensuring that messages are crafted and utilized in such a way as to be appropriate for the target population. Findings from formative research can be used to meet the varying needs of individuals and different patient populations on ART. Formative research typically involves key informant interviews and/or focus group discussions. Through engaging people who will receive the messages and those involved in patient care, the intervention can be optimized to increase the likelihood for meaningful behaviour change. In addition to formative research, pre-testing, and ongoing evaluations can help refine message content and incorporate patient preferences in order to create a system that can adapt to changing patients and patient contexts.

Behaviour change theories attempt to understand and outline the drivers that influence changes in behaviour along with different stages that an individual may go through as their behaviour changes. Not only do behaviour change theories provide a framework for message content, they can also be used to guide message distribution. The target population can receive appropriately tailored messages based on their stage of behaviour (e.g., just initiating therapy versus on ART for months or years) and needs.

An important consideration in designing SMS interventions in resource-limited settings is confidentiality. Despite campaigns to reduce stigma, disclosure of one's HIV sero-status remains an important and delicate issue. To protect an individual's privacy, message content can be coded, preferably with a memorable or personable code. Nevertheless, it would still be important to fully explain to patients that coding does not preclude full security and privacy. If the program is well-known, the public may be aware of the content and be able to identify recipients of such content as having HIV. Additionally, the mobile network operator providing support to such an SMS-based initiative will have access to the phone numbers and other identifiable information of message recipients. Therefore, full disclosure of the risks associated with enrolling in the program should be discussed with the intended target population and their full consent obtained prior to enrolment.

Limitations

Limitations of this review include the relatively small number of studies identified that included actual message content. Rather than generate all new messages, efforts should be made to build upon existing work. In order to access more messaging content, we were able to approach the mHealth and HIV/AIDS adherence communities and had an overwhelmingly positive response. A preferable alternative would be for journals to encourage and provide a means for researchers to publish their messaging content. Another limitation of the evidence base is a lack of operational information. Some questions that we had regarding the operations of programs included: *How did programs deal with costs of sending messages? If donor-funded, what were the long-term plans for the program? How did programs deal with broken or disabled phones or when patients changed numbers? A*

final limitation was the lack of studies carried out over more than one year. Because HIV is a chronic disease, it is imperative that evaluations explore both the short-term and long-term implications of the intervention. Considerations would also need to be made to identify how best to align an SMS program with facility and national-level health care systems for sustainability.

Conclusion

The current published data indicate that best practices do exist for developing SMS message content for behaviour change, particularly as it relates to HIV/AIDS. We believe that the most important lesson is that the target population must be a part of the message development and program design process. By engaging with the target population and understanding their needs and context, optimal personalization, timing, content, and frequency can be identified. Appropriate behaviour change theories can be used to structure the content and its dissemination. There should be continued efforts to learn from and use lessons from the literature to inform the overarching structure and approach of a public health program that uses mHealth. In order to realize the last point, greater transparency and mechanisms to share messaging content will be needed. Efforts should also be made to investigate, and compare, content development in other mobile modalities, such as smartphone applications. Research on the prevalence of smartphone ownership required for a feasible SMS intervention is also necessary. This could not only lead to improved collaborations and content but could also facilitate learnings and applications beyond HIV/AIDS.

Acknowledgements:

The authors would like to thank the respondents of the mHealth Working Group, mHealth Student Group and HAART Adherence listservs. We would also like to thank the researchers and implementers who took the time to answer questions regarding their research and/or provide messaging content: Daniel Beck and Bhupendra Sheoran (Oregon Reminders), Jennifer Uhrig, Allison Bailey Hughley, Amy Styles, Karen Ingersoll, Jessica Haberer, Nathan Georgette, Carol Golin, Nicolette Naidoo, Thomas Odeny and Lawrence Mbuagbaw. Finally, we would like to thank Marzieh Mirhashemi, Shreya Kulkarni and Heather Cole-Lewis for their close readings of the manuscript.

Funding: This project was supported by the National Center for Advancing Translational Sciences (NCATS), National Institutes of Health (NIH), under grant UL1 TR001064 (NNK); the Lifespan/Tufts/Brown Center for AIDS Research (CFAR) (AMT, MRJ), under grant P30 AI042853 and the NIH under grant 1K23AI097010-01A1 (SYH).

References

1. Ammassari A, Trotta MP, Shalev N et al. (2012). Timed Short Messaging Service Improves Adherence and Virological Outcomes in HIV-1-Infected Patients With Suboptimal Adherence to Antiretroviral Therapy. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 59(1). doi: 10.1097/qai.0b013e318244d873
2. Azih C, Pao A, Narayan V. (2012) Swaziland: Improving client follow-up with automated text messaging. Retrieved 1 1, 2017, from <https://www.gfmer.ch/mhealth/coursefiles2013/improvingclientfollowupSwaziland.pdf>
3. Baranoski AS, Meuser E, Hardy H, Closson EF, Mimiaga MJ, Safren SA, ... Kumar VS (2013). Patient and provider perspectives on cellular phone-based technology to improve HIV treatment adherence. *AIDS Care*, 26(1), 26–32. doi:10.1080/09540121.2013.802282 [PubMed: 23742640]
4. Betjeman TJ, Soghoian SE, & Foran MP (2013). MHealth in Sub-Saharan Africa. *International Journal of Telemedicine and Applications*, 2013, 1–7. doi:10.1155/2013/482324

5. Bigna JJ, Kouanfack C, Noubiap JJ, Plottel CS, & Koulla-Shiro S (2013). A randomized blinded controlled trial of mobile phone reminders on the follow-up medical care of HIV-exposed and HIV-infected children in Cameroon: Study protocol (MORE CARE). *Trials*,14(1), 313. doi: 10.1186/1745-6215-14-313 [PubMed: 24066735]
6. Bigna JJ, Noubiap JJ, Kouanfack C, Plottel CS, & Koulla-Shiro S (2014). Effect of mobile phone reminders on follow-up medical care of children exposed to or infected with HIV in Cameroon (MORE CARE): A multicentre, single-blind, factorial, randomised controlled trial. *The Lancet Infectious Diseases*,14(7), 600–608. doi:10.1016/s1473-3099(14)70741-8 [PubMed: 24932893]
7. Catalani C, Philbrick W, Fraser H et al. (2013). MHealth for HIV Treatment & Prevention: A Systematic Review of the Literature. *The Open AIDS Journal*,7(1), 17–41. doi: 10.2174/1874613620130812003 [PubMed: 24133558]
8. Christopoulos KA, Riley ED, Tulskey J, Carrico AW, Moskowitz JT, Wilson L, ... Hilton JF (2014). A text messaging intervention to improve retention in care and virologic suppression in a U.S. urban safety-net HIV clinic: study protocol for the Connect4Care (C4C) randomized controlled trial. *BMC Infect Dis*, 14, 718. doi:10.1186/s12879-014-0718-6 [PubMed: 25551175]
9. Cook PF, Carrington JM, Schmiede SJ, Starr W, & Reeder B (2015). A counselor in your pocket: feasibility of mobile health tailored messages to support HIV medication adherence. *Patient Preference Adherence*, 9, 1353–1366. doi:10.2147/PPA.S88222 [PubMed: 26491263]
10. Coomes CM, Lewis MA, Uhrig JD, Furberg RD, Harris JL, & Bann CM (2012). Beyond reminders: A conceptual framework for using short message service to promote prevention and improve healthcare quality and clinical outcomes for people living with HIV. *AIDS Care*,24(3), 348–357. doi:10.1080/09540121.2011.608421 [PubMed: 21933036]
11. Crankshaw T, Corless IB, Giddy J, Nicholas PK, Eichbaum Q, & Butler LM (2010). Exploring the Patterns of Use and the Feasibility of Using Cellular Phones for Clinic Appointment Reminders and Adherence Messages in an Antiretroviral Treatment Clinic, Durban, South Africa. *AIDS Patient Care and STDs*,24(11), 729–734. doi:10.1089/apc.2010.0146 [PubMed: 21039181]
12. Curioso WH, Quistberg DA, Cabello R et al. (2009) “It’s time for your life”: How should we remind patients to take medicines using short text messages? *AMIA Annu Symp Proc*. 2009: 129–133. [PubMed: 21633523]
13. Da Costa TM, Barbosa BJ, Costa DA, Sigulem D, Marin HD, Filho AC, & Pisa IT (2012). Results of a randomized controlled trial to assess the effects of a mobile SMS-based intervention on treatment adherence in HIV/AIDS-infected Brazilian women and impressions and satisfaction with respect to incoming messages. *International Journal of Medical Informatics*,81(4), 257–269. doi: 10.1016/j.ijmedinf.2011.10.002 [PubMed: 22296762]
14. Davey DJ, Nhavoto JA, Augusto O, Ponce W, Traca D, Nguimfack A, & Sousa CP (2016). SMSaúde: Evaluating Mobile Phone Text Reminders to Improve Retention in HIV Care for Patients on Antiretroviral Therapy in Mozambique. *JAIDS Journal of Acquired Immune Deficiency Syndromes*,73(2). doi:10.1097/qai.0000000000001115
15. Dowshen N, Kuhns LM, Johnson A, Holoyda BJ, & Garofalo R (2012). Improving Adherence to Antiretroviral Therapy for Youth Living with HIV/AIDS: A Pilot Study Using Personalized, Interactive, Daily Text Message Reminders. *Journal of Medical Internet Research*,14(2). doi: 10.2196/jmir.2015
16. Dowshen N, Kuhns LM, Gray C, Lee S, & Garofalo R (2013). Feasibility of Interactive Text message Response (ITR) as a Novel, Real-Time Measure of Adherence to Antiretroviral Therapy for HIV Youth. *AIDS and Behavior*,17(6), 2237–2243. doi:10.1007/s10461-013-0464-6 [PubMed: 23546844]
17. Finitis DJ, Pellowski JA, & Johnson BT (2014). Text Message Intervention Designs to Promote Adherence to Antiretroviral Therapy (ART): A Meta-Analysis of Randomized Controlled Trials. *PLoS ONE*,9(2). doi:10.1371/journal.pone.0088166
18. Free C, Phillips G, Watson L et al. (2013). The effectiveness of mobile-health technologies to improve health care service delivery processes: a systematic review and meta-analysis. *PLoS Med*. 2013;10(1): e1001363. [PubMed: 23458994]
19. Furberg RD, Uhrig JD, Bann CM, Lewis MA, Harris JL, Williams P, ... Kuhns L (2012). Technical Implementation of a Multi-component, Text Message-Based Intervention for Persons Living with HIV. *JMIR Research Protocols*,1(2). doi:10.2196/resprot.2017

20. Georgette N, Siedner MJ, Zandoni B, Sibaya T, Petty CR, Carpenter S, & Haberer JE (2016). The Acceptability and Perceived Usefulness of a Weekly Clinical SMS Program to Promote HIV Antiretroviral Medication Adherence in KwaZulu-Natal, South Africa. *AIDS Behav*, 20(11), 2629–2638. doi:10.1007/s10461-016-1287-z [PubMed: 26781866]
21. Gilks CF, Crowley S, Ekpini R, Gove S, Perriens J, Souteyrand Y, ... Cock KD (2006). The WHO public-health approach to antiretroviral treatment against HIV in resource-limited settings. *The Lancet*, 368(9534), 505–510. doi:10.1016/S0140-6736(06)69158-7
22. Google Scholar, Google. (n.d.): Retrieved 1 1, 2017 from <http://scholar.google.com/>
23. GSMA and Boston Consulting Group (2013). Sub-Saharan Africa Mobile Economy. Retrieved 1 1, 2017 from http://gsma.com/newsroom/wp-content/uploads/2013/12/GSMA_ME_Sub_Saharan_Africa_ExecSummary_2013.pdf
24. Hailey JH, & Arscott J (2013). Using Technology to Effectively Engage Adolescents and Young Adults into Care: STAR TRACK Adherence Program. *Journal of the Association of Nurses in AIDS Care*, 24(6), 582–586. doi:10.1016/j.jana.2013.03.001 [PubMed: 23809658]
25. Hardy H, Kumar V, Doros G, Farmer E, Drainoni M, Rybin D, ... Skolnik PR (2011). Randomized Controlled Trial of a Personalized Cellular Phone Reminder System to Enhance Adherence to Antiretroviral Therapy. *AIDS Patient Care and STDs*, 110216131322053. doi:10.1089/apc.2010.0006
26. Health COMPass, Health Communication Capacity Collaborative, HC3. (n.d.) Retrieved 1 1, 2017 from <http://www.healthcommcapacity.org/health-compass/>
27. Horvath T, Azman H, Kennedy GE, & Rutherford GW (2012). Mobile phone text messaging for promoting adherence to antiretroviral therapy in patients with HIV infection. *Cochrane Database of Systematic Reviews*. doi:10.1002/14651858.cd009756
28. Ingersoll K, Dillingham R, Reynolds G, Hetteima J, Freeman J, Hosseinbor S, & Winstead-Derlega C (2014). Development of a personalized bidirectional text messaging tool for HIV adherence assessment and intervention among substance abusers. *Journal of Substance Abuse Treatment*, 46(1), 66–73. doi:10.1016/j.jsat.2013.08.002 [PubMed: 24029625]
29. Fisher Fisher & Harman (2008). Information-Motivation and Behavioral Skills Model. Retrieved 1 1, 2017 from http://programtoolkit.sharedactionhd.org/contentOnly/images/httpdocs/accionmutua/pdf/IMB_Model.pdf
30. Kinyua F, Kiptoo M, Kikui G, Mutai J, Meyers AF, Muiruri P, & Songok E (2013). Perceptions of HIV infected patients on the use of cell phone as a tool to support their antiretroviral adherence; a cross-sectional study in a large referral hospital in Kenya. *BMC Public Health*, 13(1). doi: 10.1186/1471-2458-13-987
31. Klein M, Mogles N, & Wissen AV (2014). Intelligent mobile support for therapy adherence and behavior change. *Journal of Biomedical Informatics*, 51, 137–151. doi:10.1016/j.jbi.2014.05.005 [PubMed: 24858491]
32. Kliner M, Knight A, Mamvura C, Wright J, & Walley J (2013). Using no-cost mobile phone reminders to improve attendance for HIV test results: A pilot study in rural Swaziland. *Infectious Diseases of Poverty*, 2(1), 12. doi:10.1186/2049-9957-2-12 [PubMed: 23849508]
33. Kunutsor S, Walley J, Katabira E, Muchuro S, Balidawa H, Namagala E, & Ikoona E (2010). Using Mobile Phones to Improve Clinic Attendance Amongst an Antiretroviral Treatment Cohort in Rural Uganda: A Cross-sectional and Prospective Study. *AIDS and Behavior*, 14(6), 1347–1352. doi:10.1007/s10461-010-9780-2 [PubMed: 20700644]
34. Labrique AB, Vasudevan L, Kochi E, Fabricant R, & Mehl G (2013). MHealth innovations as health system strengthening tools: 12 common applications and a visual framework. *Global Health: Science and Practice*, 1(2), 160–171. doi:10.9745/ghsp-d-13-00031
35. Lester RT, Ritvo P, Mills EJ et al. (2010). Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. *Lancet*. 376(9755): 1838–1845. doi: 10.1016/S0140-6736(10)61997-6 [PubMed: 21071074]
36. Lewis MA, Uhrig JD, Bann CM, Harris JL, Furberg RD, Coomes C, & Kuhns LM (2013). Tailored text messaging intervention for HIV adherence: A proof-of-concept study. *Health Psychology*, 32(3), 248–253. doi:10.1037/a0028109 [PubMed: 22545972]

37. Lippman SA, Shade SB, Sumitani J, DeKadt J, Gilvydis JM, Ratlhagana MJ, ... Steward WT (2016). Evaluation of short message service and peer navigation to improve engagement in HIV care in South Africa: study protocol for a three-arm cluster randomized controlled trial. *Trials*, 17, 68. doi:10.1186/s13063-016-1190-y [PubMed: 26852237]
38. Maduka O, & Tobin-West C (2013). Adherence counseling and reminder text messages improve uptake of antiretroviral therapy in a tertiary hospital in Nigeria. *Nigerian Journal of Clinical Practice*, 16(3), 302. doi:10.4103/1119-3077.113451 [PubMed: 23771450]
39. Mahajan V (2009). Africa rising: How 900 million African consumers offer more than you think. *Choice Reviews Online*, 46(07). doi:10.5860/choice.46-3938
40. Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lester RT, Mills E, Volmink J, ... Ondo HA (2011). The cameroon mobile phone sms (CAMPS) trial: A protocol for a randomized controlled trial of mobile phone text messaging versus usual care for improving adherence to highly active anti-retroviral therapy. *Trials*, 12(1). doi:10.1186/1745-6215-12-5
41. Mbuagbaw L, B., & Thabane L (2012a). Considerations in using text messages to improve adherence to highly active antiretroviral therapy: A qualitative study among clients in Yaoundé, Cameroon. *HIV/AIDS - Research and Palliative Care*, 45. doi:10.2147/hiv.s29954
42. Mbuagbaw L, Thabane L, Ongolo-Zogo P, Lester RT, Mills EJ, Smieja M, ... Kouanfack C (2012b). The Cameroon Mobile Phone SMS (CAMPS) Trial: A Randomized Trial of Text Messaging versus Usual Care for Adherence to Antiretroviral Therapy. *PLoS ONE*, 7(12). doi: 10.1371/journal.pone.0046909
43. Mbuagbaw L, Kop ML, Lester RT, Thirumurthy H, Pop-Eleches C, Ye C, ... Thabane L (2013a). Mobile phone text messages for improving adherence to antiretroviral therapy (ART): An individual patient data meta-analysis of randomised trials. *BMJ Open*, 3(12). doi:10.1136/bmjopen-2013-003950
44. Mbuagbaw L, Kop ML, Lester RT, Thirumurthy H, Pop-Eleches C, Smieja M, ... Thabane L (2013b). Mobile phone text messages for improving adherence to antiretroviral therapy (ART): A protocol for an individual patient data meta-analysis of randomised trials. *BMJ Open*, 3(5). doi: 10.1136/bmjopen-2013-002954
45. Mbuagbaw L, Ongolo-Zogo P, & Thabane L (2013c). Investigating community ownership of a text message programme to improve adherence to antiretroviral therapy and provider-client communication: A mixed methods research protocol. *BMJ Open*, 3(6). doi:10.1136/bmjopen-2013-002816
46. Mbuagbaw L, Thabane L, & Ongolo-Zogo P (2013d). Opening communication channels with people living with HIV using mobile phone text messaging: Insights from the CAMPS trial. *BMC Research Notes*, 6(1), 131. doi:10.1186/1756-0500-6-131 [PubMed: 23557081]
47. Menacho LA (2013). Short Text Messages to Motivate HIV Testing Among Men Who have Sex with Men: A Qualitative Study in Lima, Peru. *The Open AIDS Journal*, 7(1), 1–6. doi: 10.2174/1874613601307010001 [PubMed: 23802032]
48. mHealth Evidence, K4Health. (n.d.). Retrieved 1 1, 2017 from <https://www.mhealthevidence.org/>
49. mHealth Working Group, K4Health. (n.d.) Retrieved 1 1, 2017 from <https://www.mhealthworkinggroup.org/resources>
50. Oregon Reminders. (n.d.) Retrieved 1 1, 2017 from <http://www.oregonreminders.org/>
51. Orrell C, Cohen K, Mauff K, Bangsberg DR, Maartens G, & Wood R (2015). A Randomized Controlled Trial of Real-Time Electronic Adherence Monitoring With Text Message Dosing Reminders in People Starting First-Line Antiretroviral Therapy. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 70(5), 495–502. doi:10.1097/qai.0000000000000770 [PubMed: 26218411]
52. Ovid MEDLINE, U.S. National Library of Medicine. (n.d.) Retrieved 1 1, 2017 from <http://www.ovid.com/site/catalog/databases/901.jsp#horizontalTab1>
53. Park LG, Howie-Esquivel J, & Dracup K (2014). A quantitative systematic review of the efficacy of mobile phone interventions to improve medication adherence. *Journal of Advanced Nursing*, 70(9), 1932–1953. doi:10.1111/jan.12400 [PubMed: 24689978]

54. Pellowski JA, & Kalichman SC (2012). Recent Advances (2011–2012) in Technology-Delivered Interventions for People Living with HIV. *Current HIV/AIDS Reports*,9(4), 326–334. doi:10.1007/s11904-012-0133-9 [PubMed: 22922945]
55. Pop-Eleches C, Thirumurthy H, Habyarimana JP et al. (2011). Mobile phone technologies improve adherence to antiretroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders. *AIDS*. 25(6): 825–834. doi: 10.1097/QAD.0b013e32834380e1 [PubMed: 21252632]
56. Preferred Reporting Items for Systematic Reviews and Meta-Analysis, PRISMA (2015). Retrieved 1 1, 2017 from <http://www.prisma-statement.org/>.
57. PubMed, U.S. National Library of Medicine, National Institutes of Health. (n.d.) Retrieved 1 1, 2017 from <http://www.ncbi.nlm.nih.gov/pubmed>.
58. Ramanathan N, Swendeman D, Comulada WS, Estrin D, & Rotheram-Borus MJ (2013). Identifying preferences for mobile health applications for self-monitoring and self-management: Focus group findings from HIV-positive persons and young mothers. *International Journal of Medical Informatics*,82(4). doi:10.1016/j.ijmedinf.2012.05.009
59. Rana Y, Haberer J, Huang H, Kambugu A, Mukasa B, Thirumurthy H, ... Linnemayr S (2015). Short message service (SMS)-based intervention to improve treatment adherence among HIV-positive youth in Uganda: focus group findings. *PLoS One*, 10(4), e0125187. doi:10.1371/journal.pone.0125187 [PubMed: 25881059]
60. Rana AI, van den Berg JJ, Lamy E, & Beckwith CG (2016). Using a Mobile Health Intervention to Support HIV Treatment Adherence and Retention Among Patients at Risk for Disengaging with Care. *AIDS Patient Care STDS*, 30(4), 178–184. doi:10.1089/apc.2016.0025 [PubMed: 27028183]
61. Sabin LL, Bachman DeSilva M, Gill CJ, Zhong L, Vian T, Xie W, ... Gifford AL (2015). Improving Adherence to Antiretroviral Therapy With Triggered Real-time Text Message Reminders: The China Adherence Through Technology Study. *J Acquir Immune Defic Syndr*, 69(5), 551–559. doi:10.1097/QAI.0000000000000651 [PubMed: 25886927]
62. Shaw RJ, Bosworth HB, Hess JC, Silva SG, Lipkus IM, Davis LL, & Johnson CM (2013). Development of a Theoretically Driven mHealth Text Messaging Application for Sustaining Recent Weight Loss. *JMIR Mhealth and Uhealth*,1(1). doi:10.2196/mhealth.2343
63. Siedner MJ, Santorino D, Haberer JE, & Bangsberg DR (2015). Know your audience: predictors of success for a patient-centered texting app to augment linkage to HIV care in rural Uganda. *J Med Internet Res*, 17(3), e78. doi:10.2196/jmir.3859 [PubMed: 25831269]
64. Smillie K, Borek NV, Abaki J, Pick N, Maan EJ, Friesen K, ... Murray M (2014). A Qualitative Study Investigating the Use of a Mobile Phone Short Message Service Designed to Improve HIV Adherence and Retention in Care in Canada (WeTel BC1). *Journal of the Association of Nurses in AIDS Care*,25(6), 614–625. doi:10.1016/j.jana.2014.01.008 [PubMed: 24768442]
65. Tortora B (2014, 5 01). Africa Continues Going Mobile. Retrieved January 1, 2017, from <http://news.gallup.com/poll/168797/africa-continues-going-mobile.aspx>
66. Tran BX, & Houston S (2012). Mobile Phone-Based Antiretroviral Adherence Support in Vietnam: Feasibility, Patient's Preference, and Willingness-to-Pay. *AIDS and Behavior*,16(7), 1988–1992. doi:10.1007/s10461-012-0271-5 [PubMed: 22814571]
67. Uhrig JD, Harris J, Furberg R, et al. (2011) Communication-Focused Technologies: Health Messages for HIV-Positive Men Who Have Sex With Men—Final Report. AHRQ Publication No. 11–0063-EF
68. Uhrig JD, Lewis MA, Bann CM, Harris JL, Furberg RD, Coomes CM, & Kuhns LM (2012). Addressing HIV Knowledge, Risk Reduction, Social Support, and Patient Involvement Using SMS: Results of a Proof-Of-Concept Study. *Journal of Health Communication*,17(Sup1), 128–145. doi:10.1080/10810730.2011.649156 [PubMed: 22548606]
69. Umapathy S, O'Sullivan GA, Rahaim S. (2012) mBCC Field Guide: A Resource for Developing Mobile Behavior Change Communication Programs, Abt Associates Inc.
70. Prochaska J, Velicer W. (1997). The Transtheoretical Model of Health Behavior Change. *Am J Health Promot* 12(1):38 doi: 0890-117/97 [PubMed: 10170434]
71. Van der Kop ML, Ojaka DI, Patel A et al. (2013). The effect of weekly short message service communication on patient retention in care in the first year after HIV diagnosis: study protocol for

- a randomised controlled trial (WeTel Retain). *BMJ Open*. 3(6). doi: 10.1136/bmjopen-2013-003155
72. Van Velthoven MH, Brusamento S, Majeed A, & Car J (2013). Scope and effectiveness of mobile phone messaging for HIV/AIDS care: A systematic review. *Psychology, Health & Medicine*, 18(2), 182–202. doi:10.1080/13548506.2012.701310
73. Wagner N, Ouedraogo D, Artavia-Mora L, Bedi A, & Thiombiano BA (2016). Protocol for a Randomized Controlled Trial Evaluating Mobile Text Messaging to Promote Retention and Adherence to Antiretroviral Therapy for People Living With HIV in Burkina Faso. *JMIR Res Protoc*, 5(3), e170. doi:10.2196/resprot.5823 [PubMed: 27535717]
74. WHO. (2003). Adherence to Long-Term Therapies - Evidence for Action, WHO: Annex I, Section 4. Retrieved 11, 2017 from <http://apps.who.int/medicinedocs/en/d/Js4883e/9.1.4.html>.
75. WHO. (2009). Priority Interventions: HIV/AIDS prevention, treatment and care in the health sector. Retrieved 11, 2017 from http://www.who.int/hiv/pub/priority_interventions_web.pdf

Adapted from The PRISMA group, 2018

Figure 1.
PRISMA Flow Diagram

Table 1.

Summary of Articles Included in Review

Reference	mBCC Category (ies)	Article Type	Country (ies)	Type of SMS Intervention	Study Type	Study Population	Sample Size	Outcome Measures	Observed Effect	User Satisfaction	Shared Message Content
Ammassari et al., 2013	message development	Original Research	Italy	adherence	Single-arm intervention	HIV-infected adults (>18y), demonstrated poor adherence to ARTs	145	Self-reported adherence, Lab markers	Significant improvement in adherence and decrease in viral load noted throughout duration of the study.	Participants found the intervention helpful.	No
Baranowski et al., 2014	security and privacy	Original Research		adherence	Qualitative	HIV-infected adults (>18y), not ART-naïve; and providers	27 [13 patients, 14 providers]	Acceptability			No
Bigna et al., 2013	message development	Protocol	Cameroon	appointment	RCT	Children (<15 y) infected or exposed to HIV [paired with an adult >18y]	224	Kept appointments			Yes
Bigna et al., 2014	message development	Original Research	Cameroon	appointment	RCT	Children (<15y) infected with or exposed to HIV [paired with an adult (>18y)]	242	Kept appointments	SMS-based reminders can increase attendance. SMS and call most effective but SMS alone most efficient (based on cost and time).	Not Examined	No
Christopoulos et al., 2014	pre-message development, message development	Protocol	U.S.A.	appointment	RCT	HIV-infected adults (>18y); new to clinic or history of poor retention	304	Lab markers, Retention			Yes
Cook et al., 2015	pre-message development, message development	Original Research	U.S.A	adherence	Feasibility	HIV infected adults (18-81y)	37	Acceptability, Pill count	No difference between matching and mismatching to current psychological state; however messages on control beliefs, mood, stress, coping and social support improved adherence in both groups.	85% satisfaction and 76% enrollment with high attrition and low usefulness rating	Yes
Coomes et al., 2012	message development	Review	U.S.A.		Review				May be helpful for medication adherence. May have other health outcomes and benefits		No
Crankshaw et al., 2010	pre-message development, message development	Original Research	South Africa	adherence	Feasibility	HIV-infected adults (>18y)	300	Acceptability		Most participants okay with receiving verbal or text reminders.	No
Curioso et al., 2009	pre-message development; message development; privacy and security	Original Research	Peru	adherence	Qualitative	HIV-infected individuals	26	Acceptability		Participants open to the concept of SMS reminders.	No

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Reference	mBCC Category (ies)	Article Type	Country (ies)	Type of SMS Intervention	Study Type	Study Population	Sample Size	Outcome Measures	Observed Effect	User Satisfaction	Shared Message Content
Da Costa et al., 2012	pre-message development	Original Research	Brazil	adherence	RCT	HIV-infected females, not ART-naïve	21	Self-reported adherence, Pill count, MEMS	Intervention group had higher rate of adherence than control group.	Participants felt that the SMS intervention helped with their medication adherence.	Yes
Davey et al., 2016	message development	Original Research	Mozambique	appointment	RCT	HIV-infected adults (>18y)	830	Retention	Improved retention in urban patients and ART-naïve patients, did not improve retention in rural patients	Not examined	Yes
Dowshen et al., 2012	message development	Original Research		adherence	Feasibility	HIV-infected youth (14-29y)	25	Self-reported adherence, acceptability	Trend towards improvement of adherence in the intervention group.	Participants found the intervention helpful.	No
Dowshen et al., 2013	message development	Original Research		adherence	Feasibility	HIV-infected youth (14-29y)	25	Self-reported adherence	Trend of data indicated that adherence increased over duration of intervention.	Not Examined	No
Fintsis et al., 2014	message development	Review		adherence	Meta-analysis				SMS groups had higher adherence than controls and improved viral load and/or CD4 count. Treatment effect increased with limited frequency, bidirectional communication, personalized content and matching to dose schedule.		No
Furberg et al., 2012	pre-message development	Protocol		adherence	Qualitative	HIV-infected adults (>25y), MSM	52	Acceptability	[Low level of response.]	Respondents had positive perception towards the SMS medication reminders.	No
Georgette et al., 2016	message development	Original Research	South Africa	both	Cross-sectional study	HIV-infected adults (>18y); not ART-naïve	100	Self-reported adherence, acceptability		The majority would recommend program to a friend and felt it helped them remember appointments	Yes
Hailey et al., 2013	message development	Original Research	U.S.A.	adherence	Single-arm intervention	HIV-infected youth (15-24y) who demonstrated poor adherence	87	Self-reported adherence	Adherence increased.	Health care providers expressed benefits and satisfaction with program.	No

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Reference	mBCC Category (ies)	Article Type	Country (ies)	Type of SMS Intervention	Study Type	Study Population	Sample Size	Outcome Measures	Observed Effect	User Satisfaction	Shared Message Content
Hardy et al., 2011	privacy and security	Original Research	U.S.A.	adherence	RCT	HIV-infected adults (>18y)	23	Self-reported adherence, pill count, MEMS	Adherence increased over duration of study.	Most participants found the SMS intervention to be acceptable.	No
Horvath et al., 2012	message development	Review		adherence	Meta-analysis	HIV-infected individuals, not ART-naïve	969		2 RCTs indicated trend of SMS improving adherence, with one study having significant results.	Not Examined	No
Ingersoll et al., 2014	message development; privacy and security	Original Research		adherence	Qualitative	HIV-infected individuals	19	self-reported adherence	<i>Separate RCT underway.</i>	Perceptions were primarily positive with patients feeling connected to care.	No
Kinyua et al., 2013	message development	Original Research	Kenya	adherence	Cross-sectional study	HIV-infected adults (>18y)	500	Acceptability		Perceive and/or are comfortable with SMS-based medication reminders.	No
Klein et al., 2014	pre-message development; message development	Original Research		adherence	Feasibility	Adults (>20y)	57		Supported application of behavior models towards intervention.	Not Examined	No
Kliner et al., 2013	message development	Original Research	Swaziland	appointment	Feasibility	HIV-infected individuals	300	Acceptability	No detectible difference before and after intervention.	Not Examined	No
Kunutsor et al., 2010	security and privacy	Original Research	Uganda	appointment	Cross-sectional study	HIV-infected adults (>18y)	276	Kept appointments	Significant difference in adherence before and after intervention. [NB: Intervention were calls and/or SMS.]	Preferences were noted for voice rather than SMS.	No
Lester et al., 2010	message development	Original Research	Kenya	adherence	RCT	HIV-infected adults (>18y), initiating ART	538	Self-reported adherence, Lab markers	SMS support group had significantly improved adherence and viral suppression as compared to control group.	Not Examined	Yes
Lewis et al., 2012	message development	Original Research		adherence	Feasibility	HIV-infected adults (>25y), MSM	52	Self-reported adherence, Lab markers	Significant improvements in adherence and CD4 count and decrease in viral load.	Participants receptive to the intervention.	No
Lippman et al., 2016	message development	Protocol	South Africa	both	RCT	HIV-infected adults (>18y); newly diagnosed (within 1y)	750	Retention, Labs, self-reported adherence, PII count			No
Maduka et al., 2013	message development	Original Research	Nigeria	adherence	RCT	HIV-infected individuals	104	Self-reported adherence, Lab markers	Adherence and CD4 count significantly improved in SMS intervention group	Not Examined	No

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Reference	mBCC Category (ies)	Article Type	Country (ies)	Type of SMS Intervention	Study Type	Study Population	Sample Size	Outcome Measures	Observed Effect	User Satisfaction	Shared Message Content
									compared to control group.		
Mbuagbaw et al., 2011	message development	Protocol	Cameroon	adherence	<i>RCT</i>	<i>HIV-infected adults (>18y), already on ART</i>	<i>198</i>	Self-reported adherence			Yes
Mbuagbaw et al., 2012a	message development; security and privacy	Original Research	Cameroon	adherence	Qualitative	HIV-infected adults (>21y)	30	Acceptability		Participants liked the idea of an SMS intervention.	No
Mbuagbaw et al., 2012b	pre-message development; message development	Original Research	Cameroon	adherence	RCT	HIV-infected adults (>21y), not ART-naïve	200	Self-reported adherence	No significant difference in ART adherence between the intervention and control groups.	Patients were moderately satisfied with the SMS intervention.	No
Mbuagbaw et al., 2013a	message development	Review	Kenya, Cameroon	adherence	Meta-analysis (individual patient)	HIV-infected individuals, not ART-naïve	1166	Any method of adherence >95%	SMS improved adherence, influencers include education, gender, timing and interactivity (of messages).	Not Examined	No
Mbuagbaw et al., 2013b	message development	Protocol	Kenya, Cameroon	adherence	<i>Meta-analysis (individual patient)</i>	<i>HIV-infected individuals, not ART-naïve</i>	<i>1169</i>				No
Mbuagbaw et al., 2013c	message development	Protocol	Cameroon	both	<i>Exploratory sequential (qualitative followed by quantitative)</i>	<i>HIV-infected individuals</i>	<i>402 (quantitative portion)</i>	Acceptability			No
Mbuagbaw et al., 2013d	message development	Original Research	Cameroon	adherence	Cross-sectional study	HIV-infected adults (>21y)	200	Self-reported adherence		Participants moderately engaged in bidirectional communication.	No
Menacho et al., 2013	pre-message development; message development	Original Research	Peru	adherence	Qualitative	HIV-infected adults (>18y), MSM	62	Acceptability		Participants liked the idea of an SMS intervention.	Yes
Orrell et al., 2015	message development	Original Research	South Africa	adherence	RCT	HIV-infected participants (>15y), ART-naïve	230	MEMS, Lab markers	Significant improvement in count of treatment interruptions but not in adherence	Not examined.	Yes
Park et al., 2014	message development; security and privacy	Review		adherence	Quantitative Systematic Review		1,785		18/29 studies found significant improvement in medication adherence. Of 7 HIV/AIDS studies, 5 had significant findings.	Not Examined	No
Pellowski et al., 2012	message development	Review		adherence	Systematic review				10/12 studies reported improved health outcomes in intervention groups. [Remainder were feasibility studies.]		No

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Reference	mBCC Category (ies)	Article Type	Country (ies)	Type of SMS Intervention	Study Type	Study Population	Sample Size	Outcome Measures	Observed Effect	User Satisfaction	Shared Message Content
Pop-Eleches et al., 2011	message development	Original Research	Kenya	adherence	RCT	HIV-infected adults (>18y), already on ART	431	MEMS	Significant difference in adherence between the weekly SMS intervention group and control group. Intervention group significantly less likely to have treatment interruption as compared to control group.	Not Examined	Yes
Ramanathan et al., 2013	pre-message development; privacy and security	Original Research	U.S.A.	adherence	Qualitative	HIV-infected and non-HIV infected adults	53	Acceptability		Preferences were noted for customization of the intervention.	No
Rana et al., 2015	message development; security and privacy	Original Research	Uganda	adherence	Qualitative	HIV-infected youths (>18y)	39	Acceptability	Confidentiality was important for success, either through coding messages or not using words like “pill”. Also suggested messages be straight-forward	97% felt the program would help them improve adherence	No
Rana et al., 2016	message development	Original Research	U.S.A.	both	Qualitative	HIV-infected adults (>18y); ART-naïve, re-engaging in care or at risk for non-adherence	32	Kept appointment visits, Lab markers	Participants liked having the option to customize content and timing. They reported feeling supported from messages and that it helped them incorporate HIV adherence into their daily routine	Patients found the system easy, convenient and empowering	Yes
Sabin et al., 2015	message development	Original Research	China	adherence	RCT	HIV-infected adults (>18y); at risk for non-adherence	120	MEMS	Post intervention levels of adherence were significantly higher than control groups.	Not examined	No
Siedner et al., 2015	security and privacy	Original Research	Uganda	appointment	RCT	HIV-infected, currently under going CD4 count testing	385	Kept appointment visits	Coded messages were as effective as direct messages, however, messages requiring “PINS” were less frequently understood. Baseline literacy was important for all messages.	Not examined	No
Smillie et al., 2014	message development	Original Research	Canada	both	Qualitative	HIV-infected individuals (>14y), not ART-naïve/about to initiate therapy	25	Acceptability	Supported use of SMS to enhance care/provide linkages.	Intervention deemed as useful.	Yes
Tran et al., 2012	pre-message development; message development	Original Research	Vietnam		Feasibility	HIV-infected adults	1,016	Acceptability		Most respondents open to SMS based medication	No

Reference	mBCC Category (ies)	Article Type	Country (ies)	Type of SMS Intervention	Study Type	Study Population	Sample Size	Outcome Measures	Observed Effect	User Satisfaction	Shared Message Content
										reminder system.	
Uhrig et al., 2012	message development	Original Research		adherence	Feasibility	HIV-infected adults (>25y), MSM	52	Self-reported	Statistically significant reduction in risk-behavior.	Participants receptive to the intervention.	Yes
Van der Kop et al., 2013	message development	Protocol	Kenya	adherence	RCT	HIV-infected adults (>18y)	686	Retention			No
Van Velthoven et al., 2013	pre-message development	Review			Systematic review	HIV-infected individuals			26 studies reviewed and there was limited evidence supporting effectiveness of SMS medication adherence.	Not Examined	No
Wagner et al., 2016	message development	Protocol	Burkina Faso	both	RCT	HIV-infected adults (>15y)	3800	Retention, Self-reported adherence, Lab markers			Yes

SMS Short Message Service (or text message), HIV Human immunodeficiency virus, ART Antiretroviral therapy, RCT Randomized controlled trial. MSM Men who have sex with men, MEMS Medication Event Monitoring System

Boxes are left blank if no data is available or if the particular study did evaluate this area in explicit detail.

- Primary author(date): Primary author and date of article’s publication.
- Ref. #: Corresponding reference number from the references section of the manuscript.
- mBCC Category(ies): Refers to the most relevant Mobiles for Behavior Change Communication (mBCC) category or categories for the study. The three categories are: pre-message development, message development and security. All relevant categories were listed.
- Article Type: Type of manuscript. Only one of following was used: original research, review or protocol. Review refers to systematic review.
- Country(ies): Study setting; country-level information used. All relevant countries listed. Left blank if unclear.
- SMS Intervention Type: Designates the type of SMS reminder used in study: adherence (medication) reminder, appointment reminder or both.
- Study Type: Study design used.
- Study Population: Population under study.
- Sample Size: Number of participants enrolled in the study.
- Outcome Measures: Primary and secondary measures used to assess results of each study
- Observed Effect: Results. Not applicable for protocols, so left blank.
- User Satisfaction: Study-reported user satisfaction. If not discussed in the manuscript, marked as “not examined”. Left blank for protocols.
- Shared Message Content: Study shared excerpts from, or full text of, the messages that they either developed or us

Table 2.**Key Behavior Change Models**

Model	About the Model
Stages of Change (Transtheoretical Model)	According to the Stages of Change or the Transtheoretical model, behavior change can be divided into five categories based on an individual's readiness to change: (1) Pre-contemplation (2) Contemplation (3) Preparation (4) Action (5) Maintenance. The stages range from not considering the change in behavior (pre-contemplation), to considering the change (contemplation), to thinking about how to take action (preparation), to taking action (action), to maintaining the behavior change (maintenance). Along this continuum, individuals can relapse to any of the preceding stages if steps are not taken to maintain the behavior. (Prochaska & Velicer, 1997)
Rothman's Behavior Change Process	This four-step process (initiation, continuation, maintenance, habit) attempts to encompass action towards change from initial steps up through habit formation: (1) the unwanted behavior is recognized and an initial response takes place (initiation); (2) if that response is sustained (continuation), (3) there is continuation on to maintenance or there is relapse (maintenance), and (4) once a behavior is maintained, a habit can form (habit) or behavior can regress and undo progress. (Shaw et al., 2013)
Information-Motivation and Behavioral Skills Model	The Information-Motivation and Behavioral Skills (IMB) model provides a simple framework for addressing complex behaviors. The model posits that providing individuals with targeted information, motivation and behavior skills (i.e., tools, strategies) will lead to behavior change. (Fisher, Fisher & Harman, 2018; WHO, 2003)

Table 3.

Message Content, Categorized by Stage of Change and IMB Component

SMS	Stage(s) of Change	Rothman's Model	IMB Model Component(s)	Source
Adherence Reminders				
Welcome *! Thank you for signing up. We look forward to sending you health-related messages. †	All	Initiation	Information	Menacho et al., (2013)
Forming a habit takes less than a month with dedication and concentration.	Pre-Contemplation, Contemplation	Initiation	Information	N/A
Sometimes, it may feel like it, but you are not alone. Call # for more information and support.	Pre-Contemplation, Contemplation	Initiation	Motivation/Support	Uhrig et al., 2012
Taking care of yourself and health takes only a few minutes. Please take a few minutes for yourself today.	Pre-Contemplation, Contemplation	Initiation	Behavioral Skills	N/A
Never hesitate to ask your provider questions. If you don't understand the answer, keep asking until you do.	Preparation	Continuation	Information	Uhrig et al., 2012
Knowledge is power. Use yours to make responsible and healthy decisions.	Preparation	Continuation	Motivation/Support	Uhrig et al., 2012
You are strong AND responsible. You have the power to take care of your own health and protect others. Do the right thing.	Preparation	Continuation	Behavioral Skills	Uhrig et al., 2012
Don't forget that you are	Preparation	Continuation	Motivation/Support, Behavioral Skills	Wagner et al., 2016

SMS	Stage(s) of Change	Rothman's Model	IMB Model Component(s)	Source
strong, unique, funny and blessed. You are needed. This is why I would like to remind you to regularly take your pills.				
Think about what makes it hard for you to take medication right now, and tell your health care providers.	Preparation	Continuation	Information	Cook et al., 2015
If you need info on what to do to take care of yourself, call or text # +.	Action	Continuation,	Information	Uhrig et al., 2012
Friends can be good medicine. If you need to talk, give a friend a call or call this number # +.	Action	Continuation, Maintenance	Motivation/Support	Uhrig et al., 2012
A vacation from meds is no vacation for you! People are counting on you to take the best care of your health that you can.	Action	Continuation, Maintenance	Motivation/Support	Cook et al., 2015
*Practice what you know. Make healthy choices today!	Action	Continuation, Maintenance	Behavioral Skills	N/A
Have you forgotten something?	Action	Continuation, Maintenance, Habit	Behavioral Skills	Orrell et al., (2015)
Be strong and courageous. We care about you.	Action, Maintenance	Continuation, Maintenance, Habit	Motivation/Support	Pop-Eleches et al., 2012
*[Family member/ Child's Name] * said to take your medicine	Action, Maintenance	Continuation, Maintenance, Habit	Motivation/Support	Rana et al., 2016(adapted)

SMS	Stage(s) of Change	Rothman's Model	IMB Model Component(s)	Source
Don't forget about God!	Action, Maintenance	Continuation, Maintenance, Habit	Motivation/Support	Rana et al., 2016
Take care of yourself today. Eating healthy foods, reducing stress, getting some exercise, and sleeping well all help.	Maintenance	Maintenance, Habit	Information	Uhrig et al., 2012
Scientists have proven that smiling makes you healthier. Share a laugh with a friend today.	Maintenance	Maintenance, Habit	Motivation/Support	Uhrig et al., 2012
This is your life! Remember to take the time to enjoy it.	Maintenance	Maintenance, Habit	Behavioral Skills	Dowshen et al., 2012 (adapted)
Appointment Reminders				
This is your reminder for tomorrow *.	All	All	Information, Behavioral Skills	Pop-Eleches et al., 2012
Don't forget *. Your appointment is tomorrow!	All	All	Information, Behavioral Skills	N/A
*You have missed your appointment. Call or text # to re-schedule + or come in at any time!	All	All	Information, Behavioral Skills	N/A
Hello *, this is your clinic. We are concerned about you. Remember that visiting your clinic on schedule helps keep you healthy.	All	All	Information, Behavioral Skills	Georgette et al., 2016
*Your health matters! It's never too late to make an appointment. Call or text # +!	All	All	Information, Behavioral Skills	N/A
Good morning family!!	All	Initiation	Information	Davey et al., 2016

SMS	Stage(s) of Change	Rothman's Model	IMB Model Component(s)	Source
Welcome to the health services of *				
With health there is joy. Love yourself. Come to your Health Center for your next visit scheduled for * day!	All	All	Information, Behavioral Skills	Davey et al., 2016
Stay strong, the clinic cares about you.	Pre-contemplation, Contemplation	Initiation	Motivation/Support	Christopoulos et al., 2014
Be active in your health care. Keep your scheduled appointments.	Pre-contemplation, Contemplation	Initiation	Behavioral Skills	Christopoulos et al., 2014
Call your case manager – he/she can help you get to clinic	Action	Continuation, Maintenance	Motivation/Support	Rana et al., 2016

SMS Short Message Service (or text message), *IMB* Information Motivation Behavior, *N/A* Not Applicable

* Denotes an opportunity for personalization.

⁺ Denotes an opportunity for interaction.

Placeholder for phone number.