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## eHealth and Prevention of Mother-to-Child Transmission of HIV

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### Abstract

**Purpose of review**—The goal of this paper is to describe areas in prevention of mother-to-child transmission of HIV (PMTCT) programs that could benefit from ehealth and to summarize current evidence of ehealth effectiveness in PMTCT.

**Recent findings**—PMTCT programs require maternal retention, adherence to antiretroviral treatment (ART) and return for infant diagnosis of HIV. eHealth systems for PMTCT could either be integrated within MCH ehealth systems or within HIV adherence ehealth systems. PMTCT ehealth messages need to balance maternal concerns about pregnancy, childbirth and infant care with need for clinic retention and ART adherence for PMTCT. Health approaches currently being assessed for effects on PMTCT outcomes include SMS, phone reminders, and integration of laboratory results and health worker reminders. Randomized trials are ongoing to determine effect of PMTCT ehealth interventions on retention, adherence, viral suppression and early infant diagnosis (EID). There is evidence that ehealth for PMTCT improves early retention and EID, while data on long-term outcomes are accruing.

**Summary**—PMTCT ehealth interventions may be useful to enhance maternal retention and ART adherence and decrease risk of infant HIV infection. Ongoing clinical trials will be important to determine effectiveness of mhealth approaches in improving PMTCT outcomes.

### Keywords

PMTCT; HIV; ehealth; mhealth; retention; adherence

### Introduction

Because prevention of mother-to-child transmission of HIV (PMTCT) occurs within the framework of general antenatal and postnatal care, interventions and innovations need to be integrated within the maternal child health (MCH) system. eHealth innovations for PMTCT need to acknowledge and balance the competing needs that women have for MCH and HIV counseling and information and strategically leverage advances in each of these domains to optimize PMTCT outcomes and general maternal child health outcomes.

#### Compliance with Ethics Guidelines

#### Conflict of Interest

Grace John-Stewart declare that she has no competing interests.

#### Human and Animal Rights and Informed Consent

This article does not contain any studies with human or animal subjects performed by any of the authors.

## **Prevention of mother-to-child HIV transmission (PMTCT) programs have markedly decreased infant HIV infections**

PMTCT has been a remarkable success story. MTCT was the first HIV transmission model in which the effectiveness of antiretroviral treatment for prevention and pre-exposure prophylaxis was demonstrated; years before these interventions were shown to be effective in prevention of sexual HIV transmission<sup>1,2</sup>. An array of expanded antiretroviral options were subsequently shown to improve effectiveness in decreasing MTCT, culminating in WHO recommendations for Option B+ (lifelong ART for all pregnant HIV infected women)<sup>3</sup>. Over the past decade, PMTCT programs have been scaled up globally, with an estimated 76% of HIV-infected pregnant women accessing antiretrovirals in 2016<sup>4</sup>. This has resulted in a marked decline (47% decline between 2010 and 2016) in infant HIV infections<sup>4</sup>. Notably, declines in PMTCT incidence have been responsible for a large component of overall decline in HIV incidence in the past decade<sup>4</sup>.

### **There is room to improve PMTCT**

Although PMTCT programmatic expansion has resulted in rapid declines in infant HIV infections globally, PMTCT programs in high HIV prevalence settings have noted imperfect retention and adherence to Option B+ ART regimens. Indeed, in the first Option B+ implementation setting in Malawi, only 77% of mothers were retained at 1-year post-delivery suggesting low ART adherence and suboptimal PMTCT programmatic performance<sup>5</sup>. Retention rates <80% have been observed in PMTCT programs in sub Saharan Africa<sup>6,7</sup>. Among women who attend postpartum clinic visits, ART adherence of 30–50% has been observed at 12 months and viral failure was noted in 16% of mothers at 6 months postpartum in a recent study from Malawi<sup>8,9</sup>. Non-retention, non-adherence and infant infection have been associated with adolescent mothers, non-disclosure of HIV status to male partners, and new diagnosis of HIV<sup>10</sup>. Estimates of 6-week MTCT rates demonstrate marked declines in infant HIV infections and likely overestimate PMTCT programmatic effectiveness; estimates of later postnatal infections are less precise and demonstrate persistent MTCT likely due to non-retention and non-adherence in the later postpartum period.

### **eHealth interventions could improve PMTCT program effectiveness**

PMTCT programmatic interventions include health systems strategies to improve efficiencies or counseling, partner engagement, peer counselors, and active tracking of participants to increase retention<sup>11,12</sup>. For PMTCT retention and adherence, ehealth offers an attractive strategy that may complement these other approaches. Option B+ requires either continuation or initiation of antiretroviral treatment (ART) for life during pregnancy and thereafter. An increasing number of women are already on ART when they become pregnant and sustaining good ART adherence is important in this group. Some women are newly diagnosed with HIV during pregnancy and start ART at this time. This group of women needs to initiate good habits of ART adherence that goes beyond pregnancy and postpartum. eHealth approaches could be tailored to these groups to support PMTCT and address unique retention and adherence challenges.

## eHealth tool use is proliferating in general maternal child health (MCH) care

Over the past decade, ehealth tools are increasingly being used to improve antenatal and postnatal care globally. eHealth tools for MCH care include messaging for visit reminders, counseling about maternal nutrition and birth preparation, incentives to ensure facility-based delivery, and general information about pregnancy and infant care. Some systems have been built to engage mothers directly, while others focus on engaging health care workers who care for mothers and infants. For example, the Mobile Alliance for Maternal Action (MAMA) group uses mobile technology to improve maternal health and has been deployed in South Africa, India and Bangladesh (<http://www.askmama.co.za/>). The MAMA system includes personalized information and options to chat with experts and has been connected to the MomConnect program as a national service in South Africa, which facilitates linkages with national registry data. MAMA has been deployed to >450,000 mothers in South Africa. In its first 17 months the MomConnect service was offered to 583,929 women in South Africa (46% of public sector pregnancies) and mothers were generally enthusiastic about use of the system<sup>13</sup>. Another more comprehensive integrated system, MOTECH, combines Mobile Midwife and Client Data Applications to link health information systems and messaging systems to include patient care information, patient data, provider alerts, patient-provider communication. This system has been deployed by the Ghana national health service to improve MNCH<sup>14</sup>.

**Emerging evidence on MCH ehealth effectiveness is mixed**—A recent systematic review retrieved 245 studies of RMNCH mhealth interventions, including 51 RCTs, of which some showed positive effects on exclusive breastfeeding and ANC attendance; however, 43% had negative or unclear results<sup>15</sup>. The widely deployed MAMA program has not been assessed for impact on MCH outcomes. One study demonstrated increase antenatal clinic and skilled birth attendance in a cluster RCT in Zanzibar; additionally there was decreased perinatal mortality in infants in facilities randomized to the mhealth intervention<sup>16,17</sup>. A recent evaluation of MOTECH Mobile Midwife was conducted among 7370 women enrolled in pregnancy and 14867 women enrolled postpartum<sup>14</sup>. Disappointingly, only 25% of pregnant women received and listened to at least one first trimester message and by 6–12 months postpartum less than 6% of women were exposed to at least one message, suggesting that there was need to more carefully assess delivery of messages and exposure to messages. Family planning services have also been a target of mhealth applications with some evidence that mhealth family planning messaging leads to increases in contraceptive knowledge<sup>18</sup>.

There is also evidence that suggests that ehealth systems to engage providers may improve MCH service coverage. The CommCare mhealth platform customized to MCH services resulted in improved MCH delivery of eight indicator services (including early registration of pregnant women, early breastfeeding, three antenatal visits, and facility delivery) in India<sup>19</sup>. Community health workers play a key role in improving MCH and ehealth interventions have been tailored to improve health worker effectiveness in monitoring and educating women<sup>20</sup>. A customized ehealth system delivered to health extension workers resulted in more antenatal and postnatal care utilization in Ethiopia<sup>21</sup>. Another ehealth system linking community health extension workers and their supervisors in Ethiopia

resulted in increased antenatal clinic attendance and skilled delivery<sup>22</sup>. As MCH ehealth programs have expanded in settings with high HIV prevalence, some systems have incorporated PMTCT within their general MCH ehealth framework<sup>23</sup>.

### **PMTCT ehealth approaches need to balance HIV and MCH**

For a variety of chronic illnesses, medication adherence has been addressed successfully with mhealth interventions<sup>24,25</sup>. HIV adherence to ART has also been addressed with mhealth interventions with some evidence of benefit (demonstrated increase in viral suppression in the WelTel randomized trial)<sup>26–29</sup>. PMTCT has unique issues distinct from general HIV ART adherence. ART adherence and HIV in the context of pregnancy are often less a priority for mothers than their pregnancy and childbirth issues. Women are concerned about their pregnancy health, the wellbeing of their infant, their options for a safe delivery, and decisions about postpartum contraception. eHealth systems for PMTCT could be added into existing MCH mhealth systems or into existing HIV ehealth systems. A key consideration in PMTCT is whether women desire messages regarding their PMTCT ART and visits to be focused solely on HIV versus integrated into communication about their pregnancy and childbirth. From a clinical perspective, women need information on both topic areas and both pregnancy/childbirth and HIV will be of concern to women. In a clinical conversation, discussions may move seamlessly between the two areas, while SMS messaging is more structured. For PMTCT, it is not clear how best to integrate systematic messages that address both MCH and HIV without diluting messages about ART adherence.

### **Women in PMTCT programs vary in their past ART and pregnancy experience and in disclosure status resulting in distinct needs for support during mhealth messaging**

Women attending PMTCT include those who have already established good ART habits who need only to sustain these habits during pregnancy, delivery and postpartum. It is possible that these women only require a few messages directly anticipating specific challenges to sustained adherence during key transitions in the peripartum period. In contrast, for women newly diagnosed with HIV during pregnancy, there is need to accept a new HIV diagnosis and commit to ART adherence. Specific messages to this group may influence establishment of good ART adherence habits. Adolescent mothers face unique challenges – very young mothers need specialized support and pregnancy care as well as counseling on infant care. Support systems for adolescent mothers may be limited and ART adherence may be a particular challenge. For all pregnant women, co-medications including vitamins, iron, cotrimoxazole, vaccinations, testing/treatment for STIs and syphilis add to complexity of management. Finally, for women who have not disclosed HIV status, taking ART in crowded home situations may be risky or challenging. Encouragement of partner disclosure and testing is important and could provide additional treatment support for PMTCT. However, the most vulnerable women with unstable relationships or risk of partner violence may not be able to disclose status without adverse repercussions. eHealth for PMTCT in these extreme circumstances needs to be flexible to address potential lack of confidentiality of phone messages and risk of messaging that could disclose maternal HIV diagnosis in an unstable partnership.

## PMTCT mhealth topics for messaging

Given the parallel important issues in MCH and HIV that women could benefit from, mhealth systems need to address lifelong ART adherence, retention, and infant early diagnosis and testing for HIV-related issues. In Table 1 below, relevant issues and selected sample messages from the ongoing Mobile WACH-X study are listed. For MCH issues, pregnancy, birth planning, delivery, postpartum maternal and infant health, breastfeeding and family planning decision-making are issues that could be supported by mhealth. The timeline of pregnancy and postpartum period includes key points that could align with specific messaging and support (Figure 1). In one PMTCT SMS intervention, messages were constructed based on the Health Belief Model and included a combination of specific supportive and encouraging messages such as “*We wish you a good and healthy pregnancy. We are here to support you during this journey. If you have questions please call or flash ---.*”<sup>30</sup>.

## Current evidence for mhealth in PMTCT

In a systematic review of PMTCT interventions for retention, phone (SMS or call) interventions were found to be associated with retention<sup>12</sup>. To date, there have been 3 studies evaluating mhealth for retention in PMTCT<sup>32</sup>. One system included 14 SMS (8 prenatal, 6 postnatal) and found a higher retention at 8 weeks postpartum (RR 1.66,  $p=0.04$ )<sup>30,33</sup>. In another randomized trial, biweekly calls resulted in higher 10 week postpartum retention (RR 1.86,  $p<0.0001$ )<sup>34</sup>. Finally an observational post- vs. pre-study that evaluated a combination of text and calls did not result in higher 12 month retention (RR 1.03,  $p=0.81$ )<sup>35</sup>.

eHealth PMTCT interventions have also focused on early infant HIV diagnosis. In a systematic review of 34 studies focused on EID interventions, 5 included phone interventions<sup>32</sup>. In this review, phone interventions were associated with a significant improvement in EID uptake (RR 1.18,  $p=0.005$ )<sup>32</sup>. A multi-pronged approach (HITS 1.0) has been designed to improve EID uptake<sup>36</sup>. This includes system alerts involving lab, hospital, mother. Preliminary evaluation noted that the post- vs. pre- comparison of the HITS system demonstrated increased EID retention, decreased turnaround time for results, and increased proportion of infants starting ART. eHealth systems have also been built to enhance health worker tracking of women in PMTCT. The ANC/PMTCT Adherence System (APAS) was implemented among community health workers to facilitate tracking of women throughout the PMTCT program. Use of APAS was associated with more frequent clinic visits and lower MTCT<sup>37</sup>. The T-HITS system in Tanzania, a tablet-based data collection tool, that captures and reports PMTCT data, was shown to be acceptable and feasible by health workers, although effects on PMTCT programs were not assessed for this tool<sup>38</sup>.

Several mhealth PMTCT randomized clinical trials have been conducted or are ongoing. In a Pub Med data search in March 2018 (mhealth and PMTCT OR ehealth and PMTCT OR SMS and PMTCT), recent and ongoing randomized clinical trials were identified (Table 2). One cluster RCT found no benefit of mhealth system for maternal ARV uptake or EID<sup>39</sup>. This system included PMTCT appointment reminders, adherence support, motivational messages, partner engagement and MCH messages with 3–6 messages per week. In contrast,

another RCT in Kenya found a benefit of encouraging and supportive SMS on postpartum attendance and EID<sup>30,33</sup>. Several other studies are ongoing to assess PMTCT mhealth interventions. The TEXT-IT study, a randomized stepped wedge trial with 14 SMS messages occurring at 1–2 times per week with endpoints including 1-year retention and EID uptake<sup>40</sup>. The HITS 2.0 system (adapted from HITS 1.0 system discussed above) is being evaluated in a 2-arm RCT anticipated to be completed in 2018 and evaluating 12-week retention, EID and pregnancy ART adherence<sup>41</sup>. WelTel model (previously shown to be effective to improve ART adherence in general adults) is being assessed in PMTCT with weekly messages ‘*problem?*’ with escalation call and will assess effects on 24 month retention, ART adherence and cost-effectiveness analyses<sup>42</sup>. The Mobile WACH-X clinical trial will assess 2-way vs. 1-way vs. control SMS system that includes a 2:1 ratio of adherence:MCH messages sent weekly. Endpoints for this RCT include 24 month retention, ART adherence, viral suppression, resistance and cost-effectiveness<sup>31</sup>. Finally, a factorial cluster RCT will evaluate the effects of community-based mentor mothers and 2-way SMS on self-reported ART adherence, viral suppression, infant antiretroviral prophylaxis and retention<sup>43</sup>.

### **PMTCT message challenges**

There are several challenges to ehealth systems for PMTCT. Because the delivery date is not perfectly predictable, it is challenging to time messages accurately regarding birth planning, delivery and the immediate postpartum period. Women need to notify the system when delivery occurs so that the system can re-calibrate schedule for standard postpartum messages. Prior to delivery, gestational age estimates are useful to provide tailored messaging during pregnancy and to anticipate a window during which delivery is anticipated. Infant loss due to miscarriage or stillbirth requires tailored messaging to support mothers during a difficult period<sup>44</sup>. With PMTCT and differing rates of stigma, partner disclosure (regarding HIV status), and phone-sharing, the role of overt messaging (referring to HIV and ART) vs. covert messaging (with coded messages) is important to assess. In a recent mixed methods study in Kenya, women expressed interest in being provided the option to receive overt HIV messages if they had disclosed their status. To date, most women participating in the ongoing trial have opted for overt messages<sup>45</sup>. This suggests that having the option to receive more overt messages may be useful for women but also that covert messages for women who have not disclosed their HIV status will remain important<sup>46</sup>.

### **Lessons from implementation**

Implementation of ehealth systems for PMTCT has been acceptable with women desiring the connection to providers for information and advice. Women may share a phone or report limited text use prior to enrollment in the study but still be successful in using 2-way SMS for PMTCT and MCH. In Mobile WACH-X, the 2-way SMS system incorporates sending automated messages that end with a question. Although women are free to ask questions at any time, it appears that the standard sent message is perceived as ‘permission’ for women to ask questions or talk to the provider about a variety topics related or unrelated to the sent message. Women frequently ask questions in the peripartum period regarding pregnancy, birth and infant illnesses, as well as HIV and ART. To date, there are more questions on MCH than PMTCT. Balancing ART adherence messaging while addressing diverse MCH

concerns is a challenge and more qualitative work may be useful to understand the best way to balance addressing adherence in the context of competing high-priority life events.

## Conclusion

### New directions

As noted above, there are several ongoing ehealth studies with 1- and 2-year postpartum follow-up underway which will provide important insights into the use of ehealth for PMTCT. Each RCT tests a different ehealth tool, and this diversity may help the field to discern key elements to engage and retain women and support their adherence to PMTCT and prevent infant HIV infection. For PMTCT ehealth, there is likely to continue to be learning on how to best tailor systems to address key groups of women in PMTCT (experienced and new ART users) and to pivot to critical periods for maximal effectiveness. Qualitative and RCT data will be helpful to better understand the balance of MCH and HIV messaging – assessments of message interactions and content may be particularly useful in this regard. Finally, health systems savings and costs in terms of expense, client and provider time, averted adverse outcomes, and enhanced satisfaction with care and efficacy for self-management will be important to help policy-makers and program leaders to decide on the role of these tools. Globally, generic mHealth tools for MCH appear to be likely to remain in use in the public and private health sector. mHealth tools for HIV and ART adherence are less widely used. For PMTCT, eHealth tools may be particularly useful as a time-limited support for both MCH and HIV care.

## References

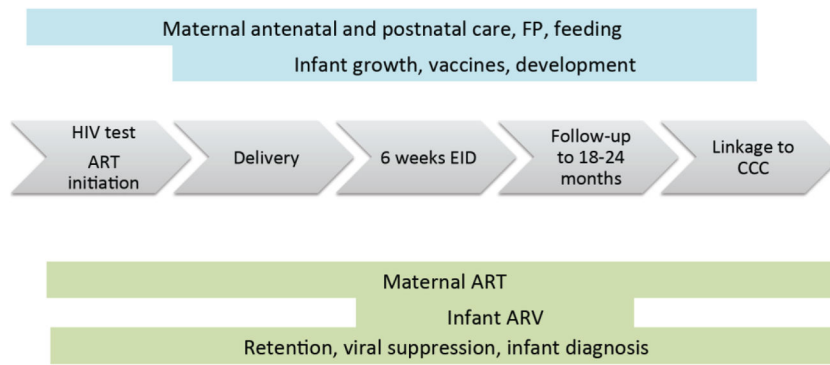
1. Connor EM, Sperling RS, Gelber R, et al. Reduction of maternal-infant transmission of human immunodeficiency virus type 1 with zidovudine treatment. Pediatric AIDS Clinical Trials Group Protocol 076 Study Group. *N Engl J Med.* 1994; 331:1173–80. [PubMed: 7935654]
2. Kumwenda NI, Hoover DR, Mofenson LM, et al. Extended antiretroviral prophylaxis to reduce breast-milk HIV-1 transmission. *N Engl J Med.* 2008; 359:119–29. [PubMed: 18525035]
3. WHO. Use of antiretroviral drugs for treating pregnant women and preventing HIV infection in infants. 2012. [http://www.who.int/hiv/PMTCT\\_updatepdf](http://www.who.int/hiv/PMTCT_updatepdf)
4. UNAIDS. Fact sheet: Latest statistics on the status of the AIDS epidemic. 2017. <http://www.unaids.org/en/resources/fact-sheet>
5. Haas AD, Tenthani L, Msukwa MT, et al. Retention in care during the first 3 years of antiretroviral therapy for women in Malawi's option B+ programme: an observational cohort study. *Lancet HIV.* 2016; 3:e175–82. [PubMed: 27036993]
6. Miller K, Muyindike W, Matthews LT, Kanyesigye M, Siedner MJ. Program Implementation of Option B+ at a President's Emergency Plan for AIDS Relief-Supported HIV Clinic Improves Clinical Indicators But Not Retention in Care in Mbarara, Uganda. *AIDS Patient Care STDS.* 2017; 31:335–41. [PubMed: 28650703]
7. Atanga PN, Ndetan HT, Achidi EA, Meriki HD, Hoelscher M, Kroidl A. Retention in care and reasons for discontinuation of lifelong antiretroviral therapy in a cohort of Cameroonian pregnant and breastfeeding HIV-positive women initiating 'Option B+' in the South West Region. *Trop Med Int Health.* 2017; 22:161–70. [PubMed: 27865052]
8. Erlwanger AS, Joseph J, Gatora T, et al. Patterns of HIV Care Clinic Attendance and Adherence to Antiretroviral Therapy Among Pregnant and Breastfeeding Women Living With HIV in the Context of Option B+ in Zimbabwe. *J Acquir Immune Defic Syndr.* 2017; 75(Suppl 2):S198–S206. [PubMed: 28498190]

9. Hosseinipour M, Nelson JAE, Trapence C, et al. Viral Suppression and HIV Drug Resistance at 6 Months Among Women in Malawi's Option B+ Program: Results From the PURE Malawi Study. *J Acquir Immune Defic Syndr*. 2017; 75(Suppl 2):S149–S55. [PubMed: 28498184]
10. McGrath CJ, Singa B, Langat A, et al. Non-disclosure to male partners and incomplete PMTCT regimens associated with higher risk of mother-to-child HIV transmission: a national survey in Kenya. *AIDS Care*. 2017:1–9.
11. Vrazo AC, Firth J, Amzel A, Sedillo R, Ryan J, Phelps BR. Interventions to significantly improve service uptake and retention of HIV-positive pregnant women and HIV-exposed infants along the prevention of mother-to-child transmission continuum of care: systematic review. *Trop Med Int Health*. 2018; 23:136–48. [PubMed: 29164754]
12. Geldsetzer P, Yapa HM, Vaikath M, et al. A systematic review of interventions to improve postpartum retention of women in PMTCT and ART care. *J Int AIDS Soc*. 2016; 19:20679. [PubMed: 27118443]
13. Barron P, Pillay Y, Fernandes A, Sebidi J, Allen R. The MomConnect mHealth initiative in South Africa: Early impact on the supply side of MCH services. *J Public Health Policy*. 2016; 37:201–12. [PubMed: 27899795]
14. LeFevre AE, Mohan D, Hutchful D, et al. Mobile Technology for Community Health in Ghana: what happens when technical functionality threatens the effectiveness of digital health programs? *BMC Med Inform Decis Mak*. 2017; 17:27. [PubMed: 28292288]
15. Chen H, Chai Y, Dong L, Niu W, Zhang P. Effectiveness and appropriateness of mHealth interventions for maternal and child health: systematic review. *JMIR*. 2018:6.
16. Lund S, Nielsen BB, Hemed M, et al. Mobile phones improve antenatal care attendance in Zanzibar: a cluster randomized controlled trial. *BMC Pregnancy Childbirth*. 2014; 14:29. [PubMed: 24438517]
17. Lund S, Rasch V, Hemed M, et al. Mobile phone intervention reduces perinatal mortality in zanzibar: secondary outcomes of a cluster randomized controlled trial. *JMIR Mhealth Uhealth*. 2014; 2:e15. [PubMed: 25098184]
18. Johnson D, Juras R, Riley P, et al. A randomized controlled trial of the impact of a family planning mHealth service on knowledge and use of contraception. *Contraception*. 2017; 95:90–7. [PubMed: 27421767]
19. Balakrishnan R, Gopichandran V, Chaturvedi S, Chatterjee R, Mahapatra T, Chaudhuri I. Continuum of Care Services for Maternal and Child Health using mobile technology - a health system strengthening strategy in low and middle income countries. *BMC Med Inform Decis Mak*. 2016; 16:84. [PubMed: 27387548]
20. Kallander K, Tibenderana JK, Akpogheneta OJ, et al. Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low- and middle-income countries: a review. *J Med Internet Res*. 2013; 15:e17. [PubMed: 23353680]
21. Shiferaw S, Spigt M, Tekie M, Abdullah M, Fantahun M, Dinant GJ. The Effects of a Locally Developed mHealth Intervention on Delivery and Postnatal Care Utilization; A Prospective Controlled Evaluation among Health Centres in Ethiopia. *PLoS One*. 2016; 11:e0158600. [PubMed: 27383186]
22. Atnafu A, Otto K, Herbst CH. The role of mHealth intervention on maternal and child health service delivery: findings from a randomized controlled field trial in rural Ethiopia. *Mhealth*. 2017; 3:39. [PubMed: 29184891]
23. UNICEF. Report on mHealth strategies to strengthen collaboration and increase the impact of PMTCT initiatives. 2011. [http://www.mhealthknowledge.org/sites/default/files/19\\_UNICEF\\_playbook\\_PreventingMotherChild.pdf](http://www.mhealthknowledge.org/sites/default/files/19_UNICEF_playbook_PreventingMotherChild.pdf)
24. Hall CS, Fottrell E, Wilkinson S, Byass P. Assessing the impact of mHealth interventions in low- and middle-income countries--what has been shown to work? *Glob Health Action*. 2014; 7:25606. [PubMed: 25361730]
25. Thakkar J, Redfern J, Chow CK. Targeted Text Messaging Support for Patients With Coronary Heart Disease--Reply. *Jama*. 2016; 315:1056–7.



26. Lester RT, Ritvo P, Mills EJ, et al. Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. *Lancet*. 2010; 376:1838–45. [PubMed: 21071074]
27. Lester RT, Mills EJ, Kariri A, et al. The HAART cell phone adherence trial (WelTel Kenya1): a randomized controlled trial protocol. *Trials*. 2009; 10:87. [PubMed: 19772596]
28. King E, Kinvig K, Steif J, et al. Mobile Text Messaging to Improve Medication Adherence and Viral Load in a Vulnerable Canadian Population Living With Human Immunodeficiency Virus: A Repeated Measures Study. *J Med Internet Res*. 2017; 19:e190. [PubMed: 28572079]
29. Mills EJ, Lester R, Thorlund K, et al. Interventions to promote adherence to antiretroviral therapy in Africa: a network meta-analysis. *Lancet HIV*. 2014; 1:e104–11. [PubMed: 26424119]
30. Odeny TA, Newman M, Bukusi EA, McClelland RS, Cohen CR, Camlin CS. Developing content for a mHealth intervention to promote postpartum retention in prevention of mother-to-child HIV transmission programs and early infant diagnosis of HIV: a qualitative study. *PLoS One*. 2014; 9:e106383. [PubMed: 25181408]
31. Drake AL, Unger JA, Ronen K, et al. Evaluation of mHealth strategies to optimize adherence and efficacy of Option B+ prevention of mother-to-child HIV transmission: Rationale, design and methods of a 3-armed randomized controlled trial. *Contemp Clin Trials*. 2017; 57:44–50. [PubMed: 28315480]
32. Ambia J, Mandala J. A systematic review of interventions to improve prevention of mother-to-child HIV transmission service delivery and promote retention. *J Int AIDS Soc*. 2016; 19:20309. [PubMed: 27056361]
33. Odeny TA, Bukusi EA, Cohen CR, Yuhas K, Camlin CS, McClelland RS. Texting improves testing: a randomized trial of two-way SMS to increase postpartum prevention of mother-to-child transmission retention and infant HIV testing. *Aids*. 2014; 28:2307–12. [PubMed: 25313586]
34. Kebaya L, Nduati R, Wamalwa D, Kariuki N, Bashir A. Efficacy Of Mobile Phone Use On Adherence To Nevirapine Prophylaxis And Retention In Care Among The Hiv-exposed Infants In Pmtct: A Randomised Controlled Trial. *BMJ Arch Dis Child*. 2014; 99doi: 10.1136/archdischild-2014-307384.911
35. Schwartz SR, Clouse K, Yende N, et al. 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; 19:2029–37. [PubMed: 25656728]
36. Finocchiaro-Kessler S, Gautney BJ, Khamadi S, et al. If you text them, they will come: using the HIV infant tracking system to improve early infant diagnosis quality and retention in Kenya. *Aids*. 2014; 28(Suppl 3):S313–21. [PubMed: 24991904]
37. Mushamiri I, Luo C, Iiams-Hauser C, Ben Amor Y. Evaluation of the impact of a mobile health system on adherence to antenatal and postnatal care and prevention of mother-to-child transmission of HIV programs in Kenya. *BMC Public Health*. 2015; 15:102. [PubMed: 25886279]
38. Bull S, Thomas DS, Nyanza EC, Ngallaba SE. Tanzania Health Information Technology (T-HIT) System: Pilot Test of a Tablet-Based System to Improve Prevention of Mother-to-Child Transmission of HIV. *JMIR Mhealth Uhealth*. 2018; 6:e16. [PubMed: 29335236]
39. Kassaye SG, Ong'ech J, Sirengo M, et al. Cluster-Randomized Controlled Study of SMS Text Messages for Prevention of Mother-to-Child Transmission of HIV in Rural Kenya. *AIDS Res Treat*. 2016; 2016:1289328. [PubMed: 28053784]
40. WHO. Text messaging to improve early infant testing for HIV in Kenya: KEMRI's TextIT. 2016. [http://apps.who.int/iris/bitstream/10665/185103/1/WHO\\_RHR\\_1435\\_eng.pdf](http://apps.who.int/iris/bitstream/10665/185103/1/WHO_RHR_1435_eng.pdf)
41. Finocchiaro-Kessler S, Goggin K, Khamadi S, et al. Improving early infant HIV diagnosis in Kenya: study protocol of a cluster-randomized efficacy trial of the HITS system. *Implement Sci*. 2015; 10:96. [PubMed: 26155932]
42. Awiti PO, Grotta A, van der Kop M, et al. The effect of an interactive weekly mobile phone messaging on retention in prevention of mother to child transmission (PMTCT) of HIV program: study protocol for a randomized controlled trial (WELTEL PMTCT). *BMC Med Inform Decis Mak*. 2016; 16:86. [PubMed: 27401475]

43. Odeny TA, Onono M, Owuor K, et al. Maximizing adherence and retention for women living with HIV and their infants in Kenya (MOTIVATE! study): study protocol for a randomized controlled trial. *Trials*. 2018; 19:77. [PubMed: 29378622]
44. Unger JA, Kinuthia J, John-Stewart G. Texting Condolences: Adapting mHealth Programs After Unexpected Pregnancy and Infant Outcomes. *JMIR Mhealth Uhealth*. 2017; 5:e176. [PubMed: 29222078]
45. Ronen K, Unger JA, Drake AL, et al. SMS messaging to improve ART adherence: perspectives of pregnant HIV-infected women in Kenya on HIV-related message content. *AIDS Care*. 2018; 30:500–5. [PubMed: 29254362]
46. Nachega JB, Skinner D, Jennings L, et al. Acceptability and feasibility of mHealth and community-based directly observed antiretroviral therapy to prevent mother-to-child HIV transmission in South African pregnant women under Option B+: an exploratory study. *Patient Prefer Adherence*. 2016; 10:683–90. [PubMed: 27175068]



**Figure 1.**  
Key points for specific messages during antenatal and postnatal care

**Table 1**

## Messaging issues and approaches for MCH and HIV

MCH Issues	Potential messaging approach	Selected sample messages*
Pregnancy and postpartum clinic attendance	Visit reminders	We missed you in clinic today. You are due for your visit. Please come in. <i>Are you having trouble getting to clinic? When will you come in?</i>
Birth preparedness	Education and reminder	
Assisted delivery (facility)	Advice	
Notification of birth details	Reminder for women to inform mhealth system	
Early postnatal maternal and infant care	Education, support and advice for queries	
Breastfeeding	Support and advice	Breastfeeding a baby right after birth helps the milk come. The first yellow sticky milk has many vitamins & cleans out the stomach. Milk has all the water the baby needs, avoid other liquids. <i>Are you planning to breastfeed?</i>
Contraception	Education and advice	
Immunizations	Visit reminders and advice for queries	Your baby will receive important vaccines at the next visit. Please bring your book and ask your nurse to check you receive everything. <i>Do you have any questions?</i>
HIV Issues	Potential messaging approach	
Clinic attendance for ART refills	Visit reminders	
ART adherence	Encouragement and support, advice	Your health is very important. Make sure to take your medication every day and come in for more when you need them. If you are having challenges let us know. <i>Are you having any challenges with your medications? When are you due to come in for more?</i>
Early infant HIV diagnostic testing	Reminder and education	
Infant antiretroviral prophylaxis	Education and support	
Continuation of ART during breastfeeding	Encouragement and support	
Transition to routine ART care	Education and information	

\* Sample messages from Mobile WACH-X, normal font 1-way messages, italicized 2-way messages<sup>31</sup>

Table 2

Ongoing and recently completed PMTCT eHealth clinical trials

Name	Topics	Study design	Frequency	Outcomes or findings	Completion
Kassaye, EGPAF	PMTCT, visit reminders, adherence, motivational, MCH	Cluster RCT	SMS 3-6 per week	No effect on maternal ARV uptake or EID	2016
Odeny	Encouragement and support	RCT, 388	8 pre-delivery 6 postpartum SMS	Increased postpartum attendance, EID	2014
TEXT-IT		Stepped wedge	14 SMS 1-2 per week	1 year retention, EID at 8 weeks	2017
HITS 2.0	Provider alerts, messages to women	RCT, 162		12 week postpartum retention, EID, adherence	2018
WelTel	WelTel 'shida?' ('problem?') with escalation to call	RCT, 600	Weekly	2 year postpartum retention, adherence, cost-effectiveness	NA
Mobile WACH-X		RCT, 875 2-way vs. 1-way SMS vs. control	Weekly	2-year postpartum retention, adherence, VL, cost-effectiveness	2019
MOTIVATE!	Mentor mothers and/or 2-way SMS	RCT, 1386 factorial cluster; 2-way SMS vs. mentor mothers vs. both, vs. none	Weekly	1-year postpartum Self-reported adherence VL<1000 c/ml Infant ARV Retention	2019