

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

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Published online: 6 February 2015
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Abstract The objective of this study was to assess the acceptability and feasibility of a cell phone based case manager intervention targeting HIV-infected pregnant women on highly-active antiretroviral therapy (HAART). Pregnant women ≥ 36 weeks gestation attending antenatal care and receiving HAART through the Option B+ program at a primary care clinic in South Africa were enrolled into a prospective pilot intervention to receive text messages and telephone calls from a case manager through 6 weeks postpartum. Acceptability and feasibility of the intervention were assessed along with infant HIV testing rates and 10-week and 12-month postpartum maternal retention in care. Retention outcomes were compared to women of similar eligibility receiving care prior to the intervention. Fifty women were enrolled into the pilot from May to July 2013. Most (70 %) were HAART-naive at time of conception and started HAART during antenatal care. During the intervention, the case manager sent 482 text messages and completed 202 telephone calls, for a median of 10 text messages and 4 calls/woman.

Ninety-six percent completed the postpartum interview and 47/48 (98 %) endorsed the utility of the intervention. Engagement in 10-week postpartum maternal HIV care was >90 % in the pre-intervention ($n = 50$) and intervention ($n = 50$) periods; by 12-months retention fell to 72 % and was the same across periods. More infants received HIV-testing by 10-weeks in the intervention period as compared to pre-intervention (90.0 vs. 63.3 %, $p < 0.01$). Maternal support through a cell phone based case manager approach was highly acceptable among South African HIV infected women on HAART and feasible, warranting further assessment of effectiveness.

Keywords HIV-1 · Prevention of mother-to-child transmission · Option B/B+ · Retention in care · South Africa

Introduction

Despite improved treatment coverage and meaningful reductions in mother-to-child transmission (MTCT) in sub-Saharan Africa over the past several years, continued improvements in prevention of mother-to-child transmission (PMTCT) programs are required if Millennium Development Goals are to be met by 2015 [1]. In 2011, the Malawi Ministry of Health introduced the Option B+ PMTCT program to close existing programmatic gaps [2]. Since this time, Option B+, which expands lifelong highly active antiretroviral therapy (HAART) to all HIV-infected pregnant women independent of CD4 cell count and clinical staging, has received endorsement by the World Health Organization [3] and has been adopted or considered by more than 20 countries [4]. Other countries, such as South Africa, are have been offering Option B as the standard of care, which provides lifelong treatment for all HIV-infected pregnant women with CD4 cell

Electronic supplementary material The online version of this article (doi:10.1007/s10995-015-1715-0) contains supplementary material, which is available to authorized users.

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counts $\leq 350 \text{ mm}^3$, while HAART throughout pregnancy and breastfeeding to women with CD4 counts $>350 \text{ mm}^3$. Both Option B and B+ programs facilitate rapid HAART initiation by removing laboratory and transport times which typically delay immediate treatment initiation when dependent on CD4 staging. Rapid treatment initiation of women eligible for HAART is important as delayed treatment increases the risk of mother-to-child transmission [5, 6].

However as Option B/B+ programs are scaled up across different settings, program success will hinge upon the ability of programs to retain mothers in care not just through delivery, but throughout breastfeeding and beyond. A recent South African study found that 58 % of HIV-infected pregnant women testing positive for HIV during pregnancy were lost-to-care by 6 months postpartum [7]. Although early reports from Malawi suggested that Option B+ programs can retain patients at levels comparable to retention of non-PMTCT patients [8], more recent data from across 540 Malawian health centers indicate that women who start HAART as part of the Option B+ program were five times more likely not return to the clinic after HAART initiation as compared to women who were started on treatment due to low CD4 cell counts [9]. This evidence raises concerns as how to implement such an ambitious program effectively [10].

Case management approaches utilizing face-to-face visits with patients may be one way to improve retention in HIV care, however few data are available, particularly in a resource-limited setting [11–13]. Health interventions which utilize mobile phone technology to contact patients with text messages require fewer human resources than face-to-face visits and have been shown to have a positive impact on adherence to HAART within the general population [14, 15]. In South Africa where mobile coverage is estimated to be 86 % [16], a mobile health or *mhealth* intervention to support pregnant and postpartum mothers, which also includes elements of personal support offered through a case management approach, such as telephone calls by a case manager counsellor and face-to-face visits at the clinic, could potentially improve postpartum retention in care of mothers and uptake of HIV infant testing.

In this paper we present results from a mobile phone-based case management intervention piloted at a primary health center implementing Option B+ in South Africa. The objective of the study was to assess the acceptability, feasibility and potential for scale-up of the pilot intervention.

Methods

Study Context, Design and Intervention

This study was conducted at Witkoppen Health and Welfare Centre (WHWC), a high volume non-governmental

primary health clinic in Johannesburg, South Africa, which serves the urban township of Diepsloot and surrounding areas. WHWC sees 680 pregnant women a month, 33.0 % of which are HIV-infected (national HIV prevalence amongst antenatal women is 29.5 % [17]). While Option B+ was not yet standard of care in South Africa at the time of this study [18], Option B+ was introduced as standard of care at WHWC in November 2012.

The pilot study prospectively enrolled HIV-infected, pregnant women attending antenatal care (ANC) at WHWC from May to July, 2013. All HIV-infected pregnant women ≥ 36 weeks gestation, were systematically approached at the ANC clinic and offered participation in the case management intervention. Additional eligibility criteria included owning a cell phone, being able to read text messages in English, and willingness to receive text messages and calls from a case manager (CM). Both women already on HAART at time of pregnancy and women not yet HAART-initiated at time of pregnancy were eligible for this study. Written informed consent was administered in private rooms by a research assistant. Following enrollment, the research team administered baseline questionnaires in English, Zulu or Sesotho and then introduced participants to the CM. No remuneration was provided for study participation.

The CMs' overall role was to provide support and motivation for participants to remain in care. The two CMs were female, senior HIV lay counselors with previous PMTCT counseling experience (only one CM was initially planned and had to be replaced when she left for a new position). After enrollment, participants were introduced to the CM who reviewed study procedures and tested the participant's cell phone number. The CM then sent weekly pre-scripted text messages to the participants' cell phones which continued until 6 weeks postpartum (or up to 8 weeks if the participant did not return for the 6 week clinic visit). In addition to scheduled text messages, CMs made one pre-delivery and two post-delivery telephone calls to study participants during follow-up to discuss delivery plans and postpartum care. Additional telephone calls were made to the participant if requested by free-of-charge "Please Call Me" text messages. Face-to-face contact between the CM and participant was limited, although the CM interacted with participants during routine clinic visits whenever possible and counseling was available. The CMs maintained participant notes, including potential retention barriers, and consulted the notes when calling participants. CMs received logistical support from a part-time project manager and consulted clinicians at the clinic when unable to answer technical questions.

Postpartum interviews were conducted at the first clinic visit ≥ 6 weeks post-delivery or by telephone when participants had travelled away from the clinic. The postpartum interviews were semi-structured and included both

closed and open-ended questions about the intervention benefits and acceptability. Maternal and infant medical records were reviewed for retention and health outcomes at 10 weeks postpartum; maternal retention in care was also assessed at 12 months post-delivery.

The formulation of the intervention was guided by the theory of Information, Motivation and Behavioral Skills (IMB) model which stipulates that information and motivation trigger behavioral skills that are required to change behavior [19]. Content of the text messages thus included visit reminders, motivational support, pregnancy and infant-related health information, and reminders that participants can send “Please Call Me” messages at any time to talk to the CM. Examples of messages sent are provided in a *supplemental table*. Messages did not disclose HIV status or test results. Phone calls focused on visit reminders and ascertainment of delivery status, but also included counseling and support as needed.

To contextualize the intervention findings, we conducted a retrospective file review of 50 HIV-infected, pregnant women attending ANC at WHWC during the period immediately preceding the intervention (February–May, 2013). Women in the pre-intervention standard of care cohort were eligible for inclusion in the analysis based on the same clinical eligibility criteria (HIV-infected and ≥ 36 weeks gestation) and received Option B+ at the clinic in the same manner as the intervention group. As the clinic keeps statistics sheets of all women attending ANC, the first 50 eligible women attending care immediately prior to the intervention period were selected for the pre-intervention cohort. Whether individuals in the pre-intervention cohort could read English text messages is unknown.

Data Analysis

Cohort characteristics and implementation of the intervention are described. Characteristics and outcomes between the pre-intervention and intervention cohorts were compared using Wilcoxon rank sums and Chi squared statistics to assess differences in medians and distributions. Data was entered into RedCap [20] and analysis was performed using Stata 12.1 (StataCorp, College Station, TX). This research was approved by the institutional review boards at the University of North Carolina at Chapel Hill and the Wits Human Ethics Committee at the University of the Witwatersrand.

Results

Study Population

All HIV-infected women ≥ 36 weeks gestation attending ANC at WHWC were consecutively screened for study

eligibility, including cell phone ownership and ability to read English text messages. The first 50 eligible pregnant women were prospectively enrolled and followed in a pilot case management intervention. All women screened who met the HIV infection and gestational criteria were eligible to participate in the study. Only one eligible woman declined participation in the study. Seventy percent of women enrolled initiated HAART during their current pregnancy, while 30 % had initiated HAART previously. The median CD4 count at the time of the first ANC visit among those initiating HAART during pregnancy was 434 cells/mm³ [interquartile range (IQR): 297–515] as compared to 539 cells/mm³ [IQR: 303–617] among women who had previously initiated HAART ($p = 0.28$).

Overall, women enrolled into the pilot intervention study were similar to women enrolled into the pre-intervention standard of care cohort in terms of age, total number of ANC visits, HAART history, CD4 count and viral suppression (Table 1).

Implementation and Acceptability of the Intervention

Figure 1 illustrates the timing of study activities delivered during the pilot intervention period. In total, the CM sent 482 texts and attempted 283 telephone calls before and after delivery as part of the pilot. Each participant received a median of 10 text messages over the course of follow-up [IQR: 9–11], the majority (71 %) of which were sent in the postpartum period.

Overall 48/50 participants (96 %) completed the postpartum questionnaire. In terms of acceptability, all but one person (47/48, 98 %) indicated that it was helpful to have a CM assigned to support them during their pregnancy and postpartum, and all women indicated that they would recommend the case management program to a friend. The top reasons highlighted were: [1] emotional support, including making the participant feel important and that there was someone there for her (62 %); [2] educational information and the ability to contact the CM directly with questions (21 %); and [3] reminders of appointment dates or to take medication (15 %). The one woman who did not find the intervention useful had provided an incorrect number to the CM. In the postpartum questionnaire, none of the participants reported an issue with receiving English language texts and 68 % identified English as one of their preferred languages.

In terms of the frequency of contact, 43/47 (91.5 %) women who were successfully contacted during the intervention and completed the postpartum questionnaire felt that the number of text messages sent and calls made were just right, while the others would have appreciated more contact. No participants reported that the contact was too frequent. The majority (70 %) preferred to receive more post-partum versus pre-delivery support.

Table 1 Characteristics of pregnant women enrolled into research at the antenatal clinic

Characteristics	Women enrolled in the pilot study (n = 50)	Women enrolled into pre-intervention cohort (n = 50)	p value [†]
Age (years), median [IQR]	28 [26–34]	29 [26–33]	0.46
Gestational weeks at time of first ANC visit, median [IQR]	22 [15–27]	21 [14–26]	0.86
Gestational weeks at time of study enrollment, median [IQR]	37 [36–38]	37 [36–38]	0.27
Total number of ANC visits during pregnancy, median [IQR]	6 [5–7]	6 [4–7]	0.94
HAART status at time of pregnancy, n (%)			
Initiated HAART prior to current pregnancy	15 (30 %)	8 (16 %)	0.11
Initiated on HAART during current pregnancy	35 (70 %)	40 (80 %)	
Not initiated on HAART during current pregnancy	0 (0 %)	2 (4 %) ^a	
Average months on HAART at enrollment, median [IQR]	3.7 [1.9–10.4]	3.2 [1.9–4.9]	0.45
Most recent CD4 count at enrollment ^b			
≤350 cells/mm ³	15 (31 %)	13 (28 %)	0.87
351–500 cells/mm ³	16 (33 %)	15 (32 %)	
>500 cells/mm ³	17 (35 %)	19 (40 %)	
Most recent viral load at enrollment ^c			
Suppressed at <50 copies/ml	7 (30 %)	5 (24 %)	0.62
Detectable virus ≥50 copies/ml	16 (70 %)	16 (76 %)	

[†] Comparisons of medians and distributions estimated using Wilcoxon rank sum and Chi squared statistics respectively

^a Two women in the pre-intervention period were not initiated on HAART during pregnancy as they requested to delay initiation until they felt more ready; zidovudine was initiated for these women during pregnancy and maternal HAART was later initiated in the post-partum period

^b 2 women enrolled in the pilot study and 3 women part of the pre-intervention cohort did not have CD4 cell counts on record at time of enrollment into the study

^c For patients initiating HAART, baseline viral loads are not taken. However viral loads were assessed during pregnancy among women initiated for at least three months; thus by 36–40 weeks gestation, some women initiated during pregnancy had a viral load taken. For this reason viral loads at time of enrollment into the study were available for some women not on HAART prior to pregnancy, however viral loads were not available for 27 women in the pilot and 29 women in the pre-intervention period

Of the 21 messages piloted, favorite text messages received by participants were: *A healthy baby starts with a healthy mother! Be sure to take your tablets every day. To talk to me, send a Please Call Me to this number and Congratulations on ur new baby! I hope this is a special time for you. To talk to me, send a Please Call Me to this number.* No messages were indicated as inappropriate.

Regarding telephone conversations, participants listed discussions around HIV treatment adherence (56 %), infant feeding options (12 %), baby preventative treatment and care (9 %), general support (9 %), delivery logistics (e.g. when, where, how to get to delivery location) (7 %), and healthy living (7 %) as the most important topics discussed. In the postpartum interviews, women consistently highlighted the importance of the support and frequently mentioned the CM as the only person that was there to support her and give her strength and hope.

The case manager made me feel that I am important and I am not alone. The information she gave me was very helpful. Even the support made me survive. [Through] the support and consistency in sending SMSs [text messages], the study made me believe that there is life after being

HIV-positive [30 year-old participant, newly initiated on HAART].

She encouraged me to take my tablets. She was the only one knowing my status and she was always there for me [22 year-old participant, newly initiated on HAART].

Overall, 26/50 (52 %) women participating in the study contacted their CM at least once during study follow-up, either in response to a text message, through “Please Call Me” messages, or through unprompted text messages and calls made to the CM. There were no major socio-demographic differences between women who initiated contact with the CM as compared to women who did not, however those contacting the CM were less likely to have disclosed their status to their partner and were less likely to have a known HIV-infected partner (Table 2).

Feasibility

We found that one HIV counselor with limited additional training could successfully manage a case load of 50 women, which could likely be expanded up to 100 under the current model if the text messages were automated and

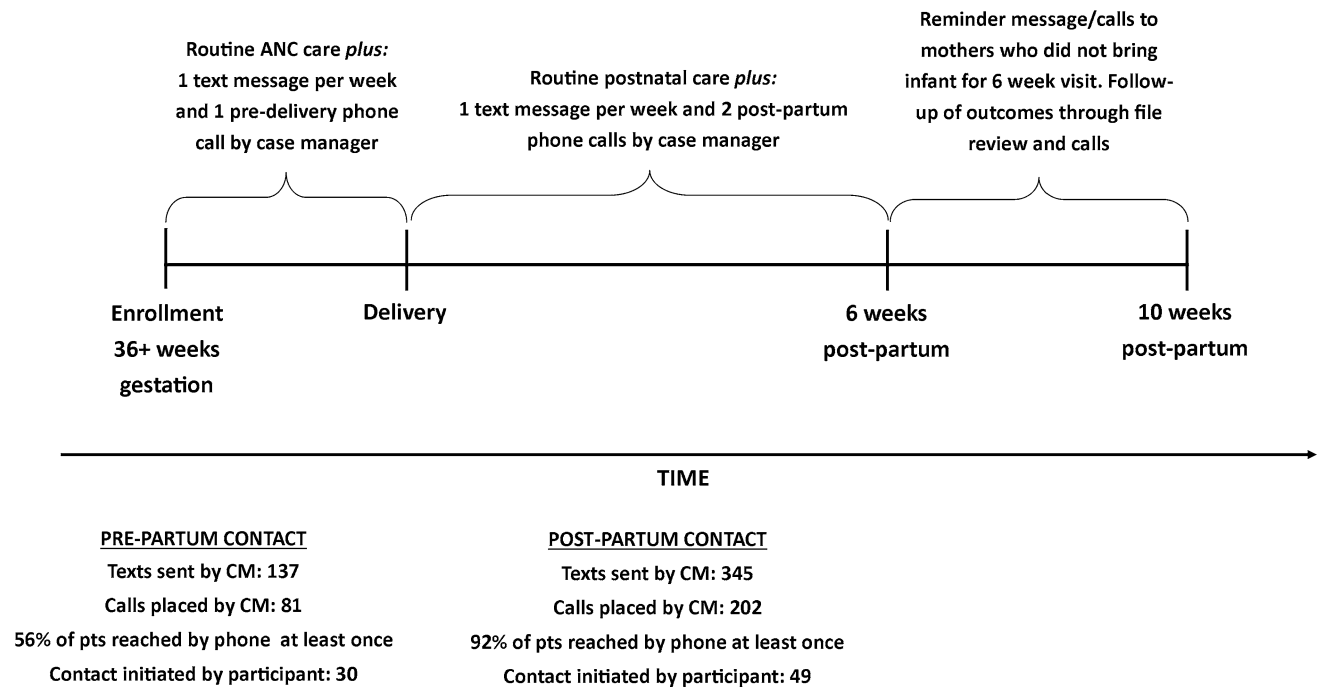


Fig. 1 Description of activities during the pilot intervention

Table 2 Comparison of characteristics of women who initiated contact with the case manager

Characteristics	Did not contact CM directly (n = 24)	Contacted CM directly (n = 26)	p value [†]
Age (years), median [IQR]	28 [26–33]	29 [26–35]	0.41
Employed, (%)	66.7 %	57.7 %	0.51
Monthly income, median USD [IQR]	278 [197–414]	253 [182–354]	0.72
Prior parity, (%)			
No children	20.8 %	26.9 %	0.61
One or more children already at time of pregnancy	79.2 %	73.1 %	
Reported pregnancy was planned, (%)	21.7 %	42.3 %	0.13
Planned/known travel before or after delivery, (%)	29.2 %	19.2 %	0.41
HAART status at time of pregnancy, (%)			
Initiated HAART prior to current pregnancy	37.5 %	23.1 %	0.27
Initiated on HAART during current pregnancy	62.5 %	76.9 %	
Currently has a partner, (%)	87.5 %	88.5 %	0.92
Partners' HIV status, (%)			
HIV infected	52.4 %	17.4 %	0.04
HIV uninfected	14.3 %	13.0 %	
HIV status unknown	33.3 %	69.6 %	
Disclosed HIV status to male partner, (%)	100 %	73.9 %	0.01

[†] Comparisons of medians and distributions estimated using Wilcoxon rank sum and Chi squared statistics respectively

no outside counseling duties were required. Need for consultation by the CM from clinicians external to the study was infrequent (<5 times over 4 months), however the project manager was a nurse and provided occasional assistance to the CM.

In terms of feasibility of contacting participants through cell phones, the CM successfully spoke with 56 % of the enrolled women at least once prior to delivery and 92 % of women in the postpartum period. Combined, the CM successfully talked to 96 % of women at least once over the

Table 3 Engagement in postpartum HIV clinical care among women and babies

Maternal and infant outcomes	Pilot study participants (n = 50)	Pre-intervention cohort (n = 50) ^{a,b}	p value
<i>Maternal engagement in care</i>			
At least one of more ARV pick-ups after delivery (between 0 and 10 weeks postpartum)	46 (92 %)	45 (90 %)	0.73
Actively engaged in HIV care at 10 weeks or transferred out to another site	47 (94 %)	48 (96 %)	0.65
ART retention at 12-months post-delivery			
Active at clinic	36 (72 %)	33 (66 %)	0.71
Transferred out	3 (6 %)	5 (10 %)	
Lost to follow-up	11 (22 %)	12 (24 %)	
<i>Infant engagement in care</i>			
Known to have received PCR at WHWC or elsewhere at 6 weeks	38 (76.0 %)	22 (44.9 %)	<0.01
Known to have received PCR at WHWC or elsewhere by 10 weeks	45 (90.0 %)	31 (63.3 %)	<0.01

^a Comparisons between groups estimated using Chi squared statistics respectively.

^b The denominator for infant outcomes in the pre-intervention period is 49, as one pregnancy resulted in a stillbirth

phone during the study and reached each participant by phone a median of 4 times [IQR: 2–5]. The median call duration was 1 min and 2 s, however calls ranged from 6 s to 14 min and 35 s.

Only one woman was never reached by the CM, but indicated during a later clinic visit that she had provided the study team with an incorrect telephone number. Two other women later became unreachable and two other women reported lost cell phones during study follow-up, limiting contact with the CM. An additional woman requested the CM to stop contacting her during the postpartum period, indicating that someone else was reading her messages. Overall, telephone contact was maintained at 6-weeks postpartum with 44/50 (88 %) women enrolled.

The primary costs associated with implementing the intervention were salary for a senior HIV lay counselor, part-time assistance by the project manager organizing text and calling schedules, R3,631 (USD 364) in total cellular communication costs over 4 months [R73 per participant (USD 7)], and R289 (USD 29) for a basic mobile phone for the CM. A small private space for calling/counseling activities was also required.

Maternal Retention in Care and Infant Testing Outcomes

In the pre-intervention period (n = 50) there was one stillborn and one infant diagnosed with HIV. During the pilot period (n = 50) all pregnancies resulted in a live birth and no infant deaths or infant infections were recorded. Table 3 presents maternal and infant engagement in care. Throughout both the pre-intervention and pilot periods ≥90 % of women attended WHWC to collect their HIV

medication at least once during the first 10 weeks postpartum. In the pre-intervention and intervention periods, 100 % of women who had initiated HAART prior to pregnancy collected their medication at least once by 10 weeks post-delivery, compared to 88 % of women who initiated HAART during pregnancy ($p = 0.09$). At 12 months post-partum, 21/23 (91 %) of women on HAART prior to pregnancy remained engaged in ART care, whereas 48/77 (62 %) of women initiated on HAART during or soon after pregnancy remained actively engaged in care at the clinic ($p < 0.01$). There were no significant differences in 12-month maternal retention in ART care between women in the pre and post intervention periods. In terms of infant testing, 38/50 (76 %) infants in the pilot period received infant polymerase chain reaction (PCR) HIV testing at the recommended 6 weeks as compared to 22/49 (45 %) among infants in the pre-intervention period ($p < 0.01$). By 10 weeks, testing increased in both groups, but remained statistically significantly higher in the pilot group (90 vs. 63 %, $p < 0.01$).

Discussion

We found the pilot intervention to provide support to HIV-infected women on HAART during late pregnancy and for 6 weeks postpartum to be feasible and highly acceptable. Post-partum contact at 6-weeks was maintained via cell phone with 88 % of enrolled women and via telephone or clinic visits amongst 96 %. We did not find that willingness to participate was different between women newly initiated on HAART and women who had been on HAART prior to coming for ANC. The sustained contact maintained with

study participants throughout the 6-week postpartum period and the substantial proportion of participants (52 %) who directly contacted the CM further support the feasibility and acceptability of a cellphone-based case management intervention to target women in PMTCT programs.

High acceptability and feasibility alone may not warrant further intervention evaluation if there is no initial indication that the intervention may have a public health impact. Maternal and infant outcomes in the pre-intervention and pilot periods were assessed to better understand the potential merit of the intervention. We compared results of women participating in the intervention to similar women receiving care prior to the pilot. Overall we found high retention in care among both pre-intervention (96 %) and intervention participants (94 %) at 10-weeks postpartum. By 12 months retention in ART care dropped to 72 % in the intervention period and 66 % pre-intervention. Thus while the retention at 10-weeks was much higher than those in other B+ settings like Malawi, by 12-months the results were comparable [8, 9]. This highlights that the duration of an effective intervention would likely need to continue well beyond 6 weeks post-partum. Our findings also emphasize that the women in greatest need for interventions are those initiated on HAART during pregnancy. Despite these challenges with maternal retention, early infant testing rates were substantially higher among intervention participants, a finding that is encouraging and supports the notion this approach could potentially result in improved infant HIV testing uptake.

Facility and community-based interventions in Mozambique and Malawi have previously demonstrated improved infant testing rates. In Malawi a case management pilot study using community health workers achieved an HIV infant testing rate of 81 %, although there was no comparison group and long-term retention of mothers in ART treatment programs was not assessed [13]. A facility-based intervention in Mozambique was able to increase infant testing uptake by more than three times through an enhanced referral process that escorted women to the testing site [21], however this approach only reaches women who have already returned to the health facility in the postpartum period. Currently there are large *mhealth* initiatives focused on PMTCT in South Africa, including the Mobile Alliance for Maternal Action (www.mobilemaalliance.org) and mothers2mothers (<http://www.m2m.org>), among others. The content of these initiatives range from mobile phone provision and SMS messages to peer support from ‘Mentor Mothers’ [22, 23]. These initiatives have undergone rapid expansion reinforcing the acceptability of mobile-based initiatives, however rigorous evaluations to assess the effectiveness of interventions have been more limited. The South African government has

recently adopted a text message program for pregnant women called *MomConnect* (<http://www.praekeltfoundation.org/mom-connect.html>) which will subsidize text messaging during pregnancy and postpartum. Thus the generalizability of mobile phone interventions within South Africa is broad and efficacy data are needed. However the applicability of mobile interventions in countries outside of South Africa and even within some rural areas of South Africa may be more limited. It is also possible that the poorest and most vulnerable women may not have cell phones, but are still in need of adherence support. Feasibility and acceptability of interventions in these other contexts should also be evaluated.

Emotional and motivational support particularly during the postpartum period, were most frequently cited by participants in our study as the greatest participation benefits. Based on the differences between patients who did and did not directly contact the CM, it appears that this support may be particularly important for women who have HIV-uninfected partners or partners of an unknown HIV status, suggesting that the CM may in many cases fill some of the support needs that they are not getting from their partner. While we anticipated that women who had not disclosed their HIV-infection status to their partner may have been more concerned about communicating with a CM, we found the opposite: women who had not disclosed to their partner were actually more likely to contact the CM. We did not detect a significant difference between women contacting their CM if they initiated HAART during the current pregnancy as compared to prior to this pregnancy, however there was a trend. Together, these findings indicate that case management support may be particularly important for women newly initiated on HAART and those with less partner support.

We demonstrated the study’s feasibility but identified much room for improvement. Manual texting was time consuming. An automated system would decrease the CM workload, however transitioning from pre-delivery to postpartum messaging necessitates delivery confirmation, and we found that expected delivery dates are frequently off by 2 weeks or more. Potential incentives, such as phone credit, to encourage participants to inform the CM when they deliver could also aid implementation and ensure that messaging is properly targeted to the pre and postpartum periods. The study underwent changes in personnel during the intervention. Thus additional counselors were used to help support the intervention during the hiring of a new CM. Despite the turnover, there were no complaints or attrition that was attributed to a rotating case management support team.

Our study has limitations. As a pilot, the primary purpose of the study was to assess acceptability and feasibility of the case management intervention. Thus, the study was

not powered or designed to assess efficacy. However based on the 12-month retention data presented here, the intervention duration would likely need to be extended in order to have an impact on long-term maternal retention in ART care. Furthermore we only collected prospective data and completed questionnaires with women enrolled in the pilot intervention. Pre-intervention data was collected retrospectively to obtain an understanding of the potential efficacy of the intervention and ability to read English texts in the pre-intervention period was not assessed. Despite this limitation, none of the participants screened in the intervention period were ineligible based on the language criteria and a larger intervention would be encouraged to translate messages into additional languages. Furthermore, outside of the intervention, there were no changes in clinical care or educational messages at the clinic between the pre and post-intervention periods which were adjoining, and to our knowledge there were no differences in community educational campaigns during these periods either. Finally, the intervention implemented involved two components, a text message strategy and a case management approach. The cost implications of the two strategies are different and future work should attempt to tease out the comparative effectiveness of each strategy. Thus, based on our findings, a randomized intervention with an extended implementation period which assesses costs and effectiveness of these separate strategies to improve maternal and infant outcomes over a longer period of follow-up is warranted.

As Option B and B+ continue to be rolled out across Sub-Saharan Africa, approaches to maximize not only the immediate prevention benefits of maternal HAART during pregnancy, but also the long-term benefits to mothers and infants of lifelong treatment through sustained retention in care will be necessary. Women starting HAART during pregnancy are faced with many rapid changes in their lives and additional support—particularly in the postpartum period—may help women adjust to taking HAART for their own health and not just to prevent transmission to the infant while pregnant. In our experience, a case management cell phone-based approach demonstrates potential for providing this support and encouraging a positive, lasting relationship between clinic and patient.

Acknowledgments We are grateful to the Witkoppen Health and Welfare Centre team and patients for their time and for making this study possible. The support of Thembisile Makhomboti and all of the staff at the antenatal clinic was essential to this research. We would also like to thank Ntombenhle Shipalana, Nokuthula Mccunu and Mantombi Ntuli at Witkoppen Health and Welfare Centre for assistance with this study and for the dedication they provided to the participants. Clarence Potter at the North Carolina Translational and Clinical Sciences Institute provided the study with REDCap database support. This study was funded by the United States Agency for International Development (USAID) under award number AID-674-1200033. Sheree Schwartz

received support for this work from the UJMT Fogarty Grant, supported by the Fogarty International Center of the National Institutes of Health under Award Number R25TW009340. SS, KC, AVR, JB & AP conceived of the study; the study was implemented by NY, SS, KC, JB and MR. Data analysis was done by SS. Writing, interpretation of results and intellectual contribution to the paper were contributed by all authors. All authors have read and approved the text as submitted. The content is solely the responsibility of the authors and does not necessarily represent the official views of USAID or the National Institutes of Health.

Conflict of interest There are no conflicts of interest to declare.

References

1. World Health Organization (2013). UNAIDS report on the global AIDS epidemic.
2. Malawi Ministry of Health (2011). Clinical management of HIV in children and adults.
3. World Health Organization (2013). Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection: Recommendations for a public health approach.
4. Ryan C (2013). The critical role of high impact interventions in achieving an AIDS-free generation. In *International conference on AIDS and STIs in Africa*. Oral presentation.
5. Hoffman, R. M., Black, V., Technau, K., et al. (2010). Effects of highly active antiretroviral therapy duration and regimen on risk for mother-to-child transmission of HIV in Johannesburg, South Africa. *Journal of Acquired Immune Deficiency Syndromes*, 54(1), 35–41. doi:10.1097/QAI.0b013e3181cf9979.
6. Chibweshwa, C. J., Giganti, M. J., Putta, N., et al. (2011). Optimal time on HAART for prevention of mother-to-child transmission of HIV. *Journal of Acquired Immune Deficiency Syndromes*, 58(2), 224–228. doi:10.1097/QAI.0b013e318229147e.
7. Clouse, K., Pettifor, A., Shearer, K., et al. (2013). Loss to follow-up before and after delivery among women testing HIV positive during pregnancy in Johannesburg, South Africa. *Tropical medicine & international health: TM & IH*, 18(4), 451–460. doi:10.1111/tmi.12072.
8. Centers for Disease Control and Prevention. (2013). Impact of an innovative approach to prevent mother-to-child transmission of HIV—Malawi, July 2011–September 2012. *MMWR Morbidity and Mortality Weekly Report*, 62(8), 148–151.
9. Tenthani, L., Haas, A. D., Tweya, H., et al. (2014). Retention in care under universal antiretroviral therapy for HIV-infected pregnant and breastfeeding women ('Option B+') in Malawi. *AIDS*, 28(4), 589–598. doi:10.1097/QAD.000000000000143.
10. Shaffer, N., Abrams, E. J., & Becquet, R. (2014). Option B+ for prevention of mother-to-child transmission of HIV in resource-constrained settings: great promise but some early caution. *AIDS*, 28(4), 599–601. doi:10.1097/QAD.000000000000144.
11. Craw, J. A., Gardner, L. I., Marks, G., et al. (2008). Brief strengths-based case management promotes entry into HIV medical care: results of the antiretroviral treatment access study-II. *Journal of Acquired Immune Deficiency Syndromes*, 47(5), 597–606. doi:10.1097/QAI.0b013e3181684c51.
12. Gardner, L. I., Metsch, L. R., Anderson-Mahoney, P., et al. (2005). Efficacy of a brief case management intervention to link recently diagnosed HIV-infected persons to care. *AIDS*, 19(4), 423–431.
13. Kim, M. H., Ahmed, S., Buck, W. C., et al. (2012). The Tingathe programme: a pilot intervention using community health workers to create a continuum of care in the prevention of mother to child

- transmission of HIV (PMTCT) cascade of services in Malawi. *Journal of the International AIDS Society*, 15(Suppl 2), 17389. doi:10.7448/IAS.15.4.17389.
14. Mbuagbaw, L., van der Kop, M. L., Lester, R. T., et al. (2013). Mobile phone text messages for improving adherence to anti-retroviral therapy (ART): an individual patient data meta-analysis of randomised trials. *BMJ Open*, 3(12), e003950. doi:10.1136/bmjopen-2013-003950.
 15. Pop-Eleches, C., Thirumurthy, H., Habyarimana, J. P., et al. (2011). Mobile phone technologies improve adherence to anti-retroviral treatment in a resource-limited setting: a randomized controlled trial of text message reminders. *AIDS*, 25(6), 825–834. doi:10.1097/QAD.0b013e32834380c1.
 16. South African Audience Research Foundation. Cell Phone Trends. <http://www.saarf.co.za/amps/cellphone.asp>. Accessed 30 Jan 2014.
 17. Republic of South Africa Department of Health (2012). The 2011 National Antenatal Sentinel HIV & Syphilis Prevalence Survey in South Africa.
 18. Republic of South Africa Department of Health (2013). The South African Antiretroviral Treatment Guidelines: PMTCT Guidelines Revised March 2013.
 19. Fisher, J. D., & Fisher, W. A. (1992). Changing AIDS-risk behavior. *Psychological Bulletin*, 111(3), 455–474.
 20. Harris, P. A., Taylor, R., Thielke, R., et al. (2009). Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *Journal of Biomedical Informatics*, 42(2), 377–381. doi:10.1016/j.jbi.2008.08.010.
 21. Ciampa, P. J., Burlison, J. R., Blevins, M., et al. (2011). Improving retention in the early infant diagnosis of HIV program in rural Mozambique by better service integration. *Journal of Acquired Immune Deficiency Syndromes*, 58(1), 115–119. doi:10.1097/QAI.0b013e32822149bf.
 22. World Health Organization (2013). Supporting pregnant women and new mothers in South Africa Cell-Life's MAMA SMS.
 23. Baek, C. M. V., Mkhize, S., Friedman, I., Apicella, L., & Rutenberg, N. (2007). Horizons final report: Key findings from an evaluation of the mothers2mothers program in KwaZulu-Natal, South Africa. Washington.