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Texting improves testing: a randomized trial of two-way SMS to increase postpartum prevention of mother-to-child transmission retention and infant HIV testing

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Objective: Many sub-Saharan African countries report high postpartum loss to follow-up of mother–baby pairs. We aimed to determine whether interactive text messages improved rates of clinic attendance and early infant HIV testing in the Nyanza region of Kenya.

Design: Parallel-group, unblinded, randomized controlled trial.

Methods: HIV-positive pregnant women at least 18 years old and enrolled in the prevention of mother-to-child transmission of HIV programme were randomized to receive either text messages (SMS group, $n = 195$) or usual care ($n = 193$). Messages were developed using formative focus group research informed by constructs of the Health Belief Model. The SMS group received up to eight text messages before delivery (depending on gestational age), and six messages postpartum. Primary outcomes included maternal postpartum clinic attendance and virological infant HIV testing by 8 weeks postpartum. The primary analyses were intention-to-treat.

Results: Of the 388 enrolled women, 381 (98.2%) had final outcome information. In the SMS group, 38 of 194 (19.6%) women attended a maternal postpartum clinic compared to 22 of 187 (11.8%) in the control group (relative risk 1.66, 95% confidence interval 1.02–2.70). HIV testing within 8 weeks was performed in 172 of 187 (92.0%) infants in the SMS group compared to 154 of 181 (85.1%) in the control group (relative risk 1.08, 95% confidence interval 1.00–1.16).

Conclusions: Text messaging significantly improved maternal postpartum visit attendance, but overall return rates for these visits remained low. In contrast, high rates of early infant HIV testing were achieved in both arms, with significantly higher testing rates in the SMS compared to the control infants.

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Introduction

Many HIV-positive pregnant women in sub-Saharan Africa are lost to follow-up after delivery [1–4]. The WHO recommends virological HIV testing for HIV-exposed infants at 4–6 weeks after delivery [5], but only 28% of such infants in low and middle-income countries were tested within 2 months of birth in 2010 [6]. In Kenya, only 39% of eligible infants received virological HIV testing in 2011 [7].

With the exponential increase in the number of mobile phone connections in sub-Saharan Africa, mobile technology is a promising strategy to strengthen healthcare programmes (mHealth) [8]. Few studies provide strong evidence that mHealth approaches improve retention in prevention of mother-to-child transmission (PMTCT) programmes.

We evaluated the effect of an interactive, individually tailored, two-way text messaging system informed by behavioural theory on maternal postpartum clinic attendance and infant HIV testing within 8 weeks after birth.

Methods

Trial design and participants

We conducted a parallel-group, unblinded, randomized controlled trial in the Nyanza region of Kenya. Participants were recruited from among HIV-positive women attending antenatal care (ANC) or HIV clinics at five health facilities, including a mix of rural and urban settings [9]. Participants were eligible for enrolment if they were at least 18 years old, between 28 weeks gestation and delivery, enrolled in PMTCT, planning to remain in the study area, had access to a mobile phone, and reported ability to read or had someone who read short message service (SMS) on their behalf. Women who shared phones were eligible only if they had disclosed their HIV status to the person with whom the phone was shared.

Randomization and masking

Participants were randomized to the intervention (individually tailored, theory-based two-way SMS) versus the control condition (no SMS, standard of care) in a 1 : 1 ratio, stratified by clinic. A block randomization scheme with variable block sizes was used. Investigators and study staff were unaware of block numbers, sizes, or sequences. Intervention groups were assigned using sealed, opaque envelopes.

Procedures

After randomization, participants' phone numbers and SMS preferences were recorded by sending a text message from their phone. This message included date of last normal menstrual period and preferred language (English, Kiswahili, or Dholuo). For participants randomized to the intervention, the message also included preferred time for receiving SMS, and preferred name. Participants' phones were loaded with Kenya Shillings 20 (US$ ~0.25) to cover the cost of this message.

Intervention

Development of the intervention is detailed in a separate manuscript (submitted). Briefly, we conducted focus group discussions (FGDs) with health workers and women attending ANC, postnatal care, and PMTCT clinics. The facilitation guide and our interpretation of FGD findings were informed by theoretical constructs of the Health Belief Model [10,11]. We crafted intervention SMS based on key themes from the FGD.

The intervention consisted of 14 messages. Up to 8 were sent during pregnancy (weeks 28, 30, 32, 34, 36, 38, 39, and 40). Additional messages were sent weekly for the first 6 weeks after delivery (see Table, Supplemental Digital Content 1, http://links.lww.com/QAD/A556). We used custom-built, automated software to send and receive messages.

Participants in both arms were allowed to call or send SMS to the study nurse at any time. To minimize costs, they could request a call by sending a free 'call back' message. Participants were free to withdraw at any time either in person or by sending an SMS containing the word 'STOP'.

Study staff called participants in the SMS arm weekly beginning at 38 weeks gestation to ascertain whether delivery had occurred. Delivery dates for participants in the control arm were abstracted from clinic records. If control women did not return, they were contacted either in person or by phone. Women's return visits and infant HIV testing data were extracted from clinic records.

Ethical review

All participants provided written informed consent. The study was approved by ethical review committees at the Kenya Medical Research Institute, the University of Washington, and the University of California San Francisco.

Sample size

Sample size calculations were based on the infant HIV testing outcome. We assumed that 37% of infants in the control group would undergo HIV testing within 8 weeks as observed in the Nyanza region. With 194 women in each arm, and presuming 10% loss to follow-up, we estimated achieving at least 80% power to detect a difference of at least 15% in the proportion of infants tested using $\alpha = 0.05$.

Statistical analysis

Stata/SE v12.1 (Stat Corp., College Station, Texas, USA) was used for analysis. All tests were two-sided. Our primary analyses followed the intent-to-treat principle [12]. Postpartum retention in PMTCT was defined as return for at least one visit at the PMTCT or postnatal clinic within 8 weeks after delivery. Infant HIV testing was defined as obtaining a dried blood spot (DBS) sample for virological HIV testing within 8 weeks after birth. We compared the proportions of women retained and infants tested by study arm using unadjusted relative risk regression with a log link and robust error variance.

We also compared time to clinic visit and time to infant HIV testing by study arm using Kaplan–Meier methods and log-rank tests. For each outcome, we used unadjusted Cox regression to estimate a hazard ratio comparing intervention to control arms. Survival time was censored at 8 weeks or at maternal or infant death.

We conducted a secondary per-protocol analysis in which participants were analysed according to the actual intervention received. We also estimated the infant HIV-1 incidence rate.

Results

Study participants

We pre-screened 1324 women between April and October 2012, and enrolled 388 who were randomized to either the intervention group ($N=195$) or the control group ($N=193$) (Fig. 1). Follow-up was completed in March 2013. A total of 381 (98.2%) women had outcome information. These 381 women delivered 374 live babies (singleton or first baby for multiple pregnancies). Six (1.6%) infants died within 4 weeks after birth, leaving 368 who were analysed for the HIV testing outcome. Five women who were assigned to the control arm erroneously received SMS. Maternal characteristics were balanced between study arms at baseline (Table 1).

Maternal clinic attendance and infant HIV testing

In the SMS group, 38 of 194 (19.6%) women attended a postpartum clinic visit compared to 22 of 187 (11.8%) in the control group [relative risk (RR) 1.66, 95% confidence interval (CI) 1.02–2.70, $P=0.04$]. In the SMS group, 172 of 187 (92.0%) infants had DBS testing, compared to 154 of 181 (85.1%) in the control group (RR 1.08, 95% CI 1.00–1.16, $P=0.04$). Kaplan–Meier

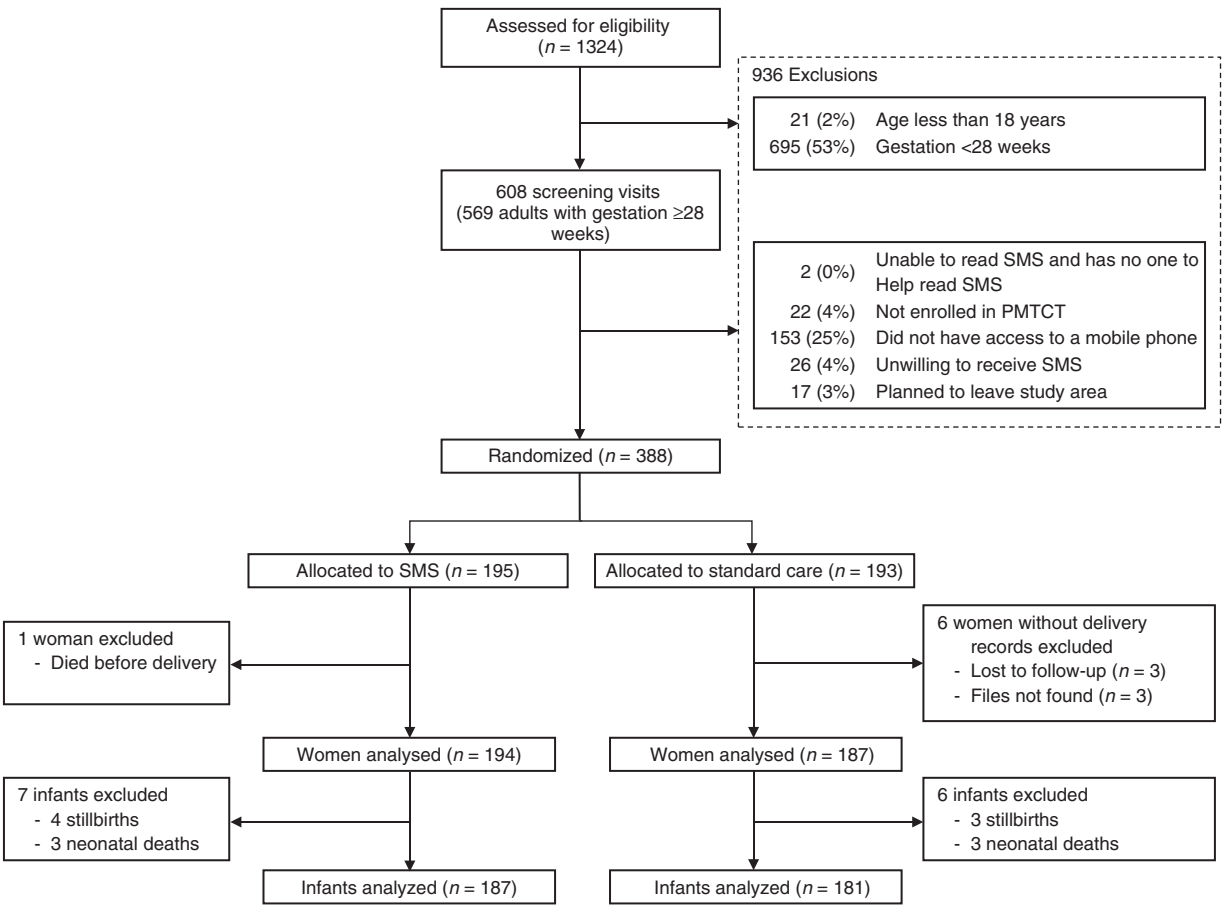

Fig. 1. Trial profile showing flow of study participants.

Table 1. Maternal baseline characteristics.

Characteristics	SMS group ($n=195$) *n* (%)	Control group ($n=193$) *n* (%)
Maternal age		
18–24	60 (30.8)	65 (33.7)
25–34	111 (56.9)	111 (57.5)
35+	24 (12.3)	17 (8.8)
Gestational age at enrolment – median weeks (IQR)	34 (32–36)	34 (32–36)
Shared phone	51 (26.2)	50 (25.9)
Employed	35 (17.9)	39 (20.2)
Education		
None	3 (1.5)	3 (1.6)
Primary	115 (59.0)	110 (57.0)
Secondary	64 (32.8)	55 (28.5)
Post-secondary	13 (6.7)	25 (13.0)
Ethnicity		
Luo	188 (96.4)	177 (91.7)
Other	7 (3.6)	16 (8.3)
Married or with regular live-in partner (versus no partner)	169 (86.7)	171 (88.6)
First pregnancy	27 (13.8)	29 (15.0)
WHO stage (highest recorded)		
1	110 (56.4)	103 (53.4)
2	55 (28.2)	57 (29.5)
3	23 (11.8)	27 (14.0)
4	7 (3.6)	6 (3.1)
Most recent $CD4^+$ cell count (cells/μl)		
<200	22 (11.3)	18 (9.3)
200–349	40 (20.5)	38 (19.7)
350–500	54 (27.7)	55 (28.5)
500+	78 (40)	82 (42.5)
On ART for own health	101 (51.8)	102 (52.8)
Received ZDV prophylaxis	85 (43.6)	81 (42.0)
Received ZDV + 3TC + NVP (delivery pack)	60 (30.8)	53 (27.5)
Received ZDV + 3TC (post-delivery pack)	60 (30.8)	51 (26.4)
Nevirapine prophylaxis for baby issued	139 (71.3)	133 (68.9)
HIV diagnosed today	5 (2.6)	5 (2.6)
HIV counselling done with partner	40 (20.5)	49 (25.4)

3TC, lamivudine; IQR, interquartile range; NVP, nevirapine; ZDV, zidovudine.

estimates of the cumulative probabilities of clinic attendance and infant HIV testing at 8 weeks by study arm yielded similar results (see Figures, Supplemental Digital Content 2, http://links.lww.com/QAD/A556). Virological HIV test results were available for 325 of 326 infants. Of these, five (1.5%) tested positive (incidence rate 0.04 per 100 infant-weeks, 95% CI 0.02–0.09) – two in the SMS group and three in the control group.

In the per-protocol analysis, women in the SMS arm had a significantly higher probability of attending clinic within 8 weeks compared to those in the control arm (RR 1.83, 95% CI 1.11–3.01). Similarly, the probability of infant HIV testing within 8 weeks was significantly higher in the SMS than in the control group (RR 1.09, 95% CI 1.01–1.17).

Discussion

In this randomized trial, we demonstrated that individually-tailored, theory-based SMS improved both postpartum retention in PMTCT, and the rate of infant virological HIV testing compared to standard care. Both effects were modest, but statistically significant. This study is among the first mHealth interventions to successfully use theory-based SMS to improve retention in PMTCT for mother–baby pairs.

Individually-tailored public health interventions may be more efficacious than generic interventions [13–16]. We tailored text messages based on recipient's gestational age, name, preferred time, desired language, date of delivery, and infant's name. This enabled us to direct messages to individuals, a feature that added a 'personal touch'. We also allowed participants to send SMS, call, or request to be called back. This interactivity provided an opportunity to respond to participants' needs.

Although postpartum PMTCT retention improved significantly with SMS, the overall proportion of women attending clinic (16%) was unexpectedly low even for this region. Only about 47% of women in Kenya overall and 34% of women in the Nyanza region are estimated to receive postnatal care services [17]. It is likely that important structural factors associated with low postnatal follow-up rates may not be modifiable through a text messaging intervention [18].

A striking and somewhat unexpected finding was the high proportion of infants tested for HIV in the control arm (85%). This was substantially higher than the 39% observed in Kenya overall [19]. The high testing rate in our control group might have been due to our recruitment and screening procedures, which included a one-on-one counselling session. Other studies have shown that antenatal counselling is associated with improved infant outcomes [20].

One important strength of our study was the underpinning of the intervention with behavioural theory. The importance of theoretically-informed formative research for developing mHealth interventions has been underscored recently [21–23]; mHealth applications may require 'theoretical and qualitative approaches' to enable an understanding as to why they may be effective [24]. The theoretical foundation for our formative research, based on the Health Belief Model, could facilitate adaptation of this intervention to other settings. Another important strength was that many elements of the trial were designed to approximate real-world conditions. For example, study staff members were community health workers who incorporated study procedures into daily tasks, data were abstracted from routine records, and women were not given additional incentives. These features are well suited to allow PMTCT programmes to implement this intervention independently and with high fidelity to our model.

The study had limitations. First, we excluded women who lacked access to phones, or who shared phones but had not disclosed their HIV status. This group might be poorer or less empowered. The importance of restricting to women with phones is likely to decrease as mobile access in Kenya continues to expand rapidly [25,26]. Second, phone calls to women in the intervention arm might have contributed to the efficacy of the intervention. We consider these calls to be key operational elements of the intervention. In expanding this intervention, such calls would constitute an integral part of the intervention. Finally, while messages were developed based on constructs of the Health Belief Model, it would be difficult to tease apart particular elements that led to the intervention's efficacy. In future studies, qualitative 'exit' interviews could provide insight into perceptions of the messages, potentially illuminating their mechanism of action.

In conclusion, we demonstrated that text messaging improved maternal attendance at postpartum PMTCT clinic visits and led to higher rates of infant HIV testing. Our results suggest that SMS can be leveraged to bridge gaps in the cascade of care for mother–baby pairs in PMTCT programmes. With the goal of elimination of mother-to-child transmission of HIV by 2015, HIV programmes in sub-Saharan Africa should consider expanding this affordable and easily accessible intervention.

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Author contributions: T.A.O. and R.S.M. conceptualized, designed, and conducted the study, analysed and interpreted the data, and drafted the manuscript. E.A.B. and C.R.C. further conceptualized the study, participated in the study design, provided mentorship during study conduct, and made substantial contributions to interpretation of the results and drafting of the manuscript. K.Y. contributed to statistical analysis, data interpretation, and drafting of the manuscript. C.S.C. participated in the study design, provided mentorship during study conduct, contributed to data interpretation, and reviewed the manuscript. All authors read and approved the final manuscript.

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Conflicts of interest

Financial: Financial competing interests include but are not limited to paid employment or consultancy: C.R.C.

served as a paid consultant for CerMed Inc. to help them develop a barrier contraceptive/HIV prevention device. This consultancy ended in 2012.

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Nonfinancial (professional): Acting as an expert witness – C.R.C. has served as an expert witness on a case in New York City involving a malpractice suit of a woman who died after delivery due to infectious complications.

Membership in a government or other advisory board: C.R.C. was a nonpaid consultant on a WHO panel to assess the risk of hormonal contraception and HIV acquisition in women.

R.S.M. has received a donation of study product for treatment of vaginal infections from Embil Pharmaceutical Company.

All other authors have declared that no conflicts of interest exist.

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