Investigation into the Use of Short Message Services to Expand Uptake of Human Immunodeficiency Virus Testing, and Whether Content and Dosage Have Impact

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Abstract

Objective: South Africa has one of the highest human immunodeficiency virus (HIV) prevalence rates in the world, but despite the well-established benefits of HIV counseling and testing (HCT), there is low uptake of HCT. The study aimed to investigate the effectiveness of using short message services (SMSs) to encourage HCT while interrogating the impact of altering SMS content and dosage (the number of SMSs). Materials and Methods: About 2,533 participants were recruited via an SMS sent to 24,000 mobiles randomly sampled from a pre-existing database. Recruits were randomly allocated to four intervention groups that received 3 or 10 informational (INFO) or motivational (MOTI) SMSs, and a control group. After the intervention, participants were prompted to go for HCT, and postintervention assessment was done after 3 weeks. Results: In comparison with the control, receipt of 10 MOTI messages had the most impact on uptake of HCT with a 1.7-fold increased odds of testing (confidence interval 95%; p = 0.0036). The lack of efficacy of three SMSs indicates a threshold effect, that is, a minimum number of MOTI SMSs is required. INFO SMSs, whether 3 or 10 were sent, did not have a statistically significant effect. The cost can be calculated for the marginal effect of the SMSs, that is, the cost to get people to test over and above those who were likely to test without the intervention. Use of 10 MOTI SMSs yielded a cost-per-tester of $2.41. Conclusions: While there are methodological issues apparent in our study, the results demonstrate the potential of SMSs to influence the uptake of HCT, the importance of appropriate content, and the need to determine a threshold for SMS-based interventions. These results indicate a potential for SMSs to be used more generally for interventions encouraging people to take health-related actions, and the need for further research in this field. The reasonable cost-per-tester is promising for the scale-up of such an intervention.

Key words: e-health, telecommunications, telehealth, HIV, HIV testing

Introduction

South Africa has one of the highest HIV morbidity and mortality rates in the world.1 Around 5.7 million South Africans are living with HIV,1 and acquired immune deficiency syndrome (AIDS)-related illnesses account for over half of adult deaths.2 Numerous studies have demonstrated the potential benefits of HIV counseling and testing (HCT) in addressing both prevention and transmission, and timely access to HIV treatment, care, and support services.3,4 Unfortunately, however, many South Africans have not tested: in the 2008 South African national HIV prevalence survey, only half of respondents indicated that they had tested for HIV.5 Realizing the potential of HCT, the South African government has shifted from voluntary counseling and testing (VCT) to HCT being part of procedure at all health facilities. Through its national HCT campaign, the government aimed to test 15 million South Africans by May 2011.5 The shift from VCT to provider-initiated HCT is potentially significant as increases in patients tested per healthcare worker have been shown in comparison with VCT.5 The challenge, however, is to get people who do not routinely engage with public healthcare services to present at HCT sites. Reluctance to test is associated with complex barriers ranging from AIDS-related stigmas,6,7 to lack of knowledge/misinformation about HIV and AIDS.8–10 Innovative means of encouraging people to test for HIV could reach those not presenting for HCT. South Africa has a remarkably high proportion of its population with mobile cellular subscriptions, at 93%.11 This presents an opportunity to use mobiles to get messages to people to increase HCT uptake and impact on other key health decision making. The extensive use of short message services (SMSs) in South Africa, which are cost-effective to send and are free to receive whether the person has airtime or not, makes interventions via SMS even more appealing. For instance the country’s largest network, Vodacom, reports 6 billion messages sent by 26 million subscribers in their 2009/10 financial year.12 However, to our knowledge, there is no published literature examining SMS interventions for increasing uptake of HCT in South Africa, and globally only one other study has demonstrated this. In that study, men who have sex with men who had attended a sexual health clinic in Australia were reminded via SMS to return for HIV testing.13 The potential of SMSs for HIV-related communications in South Africa and other African countries has been demonstrated. For example, SMS-based interventions have been successfully tested for promoting antiretroviral drug adherence,14 for reducing HIV-related...
risk behaviors and for promoting uptake of HIV/AIDS telephonic counseling. However, a major concern with regard to SMS-based interventions is the variability in the magnitude of study outcomes. Excluding obvious methodological shortcomings such as statistical underpowering and ineffective outcome evaluation procedures, studies reported thus far do not permit for inferences to be made regarding the exact components of SMS-based interventions that affect their efficacies.

The aim of this study was to investigate the effectiveness of using SMSs to facilitate uptake of HCT in South Africa. We also interrogated the impact of using two forms of SMS content and varying the dosage levels (the number of SMSs) on the efficacy of our SMS-based intervention. The study followed an innovative methodology, where recruitment of study participants, consent, and post-intervention assessment were done via SMS.

Materials and Methods

A randomized control trial study design was used for the evaluation with four experimental options, including both informational (INFO) and motivational (MOTI) content for the messaging, and sets of either 3 or 10 messages being delivered. Two groups of intervention SMSs were created: INFO and MOTI. They were guided by the information-motivation-behavioral skills model of AIDS risk reduction, which hypothesizes that behavioral skills, information (knowledge), and motivation (attitudes and beliefs) are critical in influencing behavioral changes. This model has been used to understand and influence various AIDS-related behaviors. A brief literature search of published barriers to uptake of HCT was incorporated in the drafting of the SMSs. See Figure 1 for the overall design.

Participants who opted into the study were allocated to five groups: the control, INFO-3, INFO-10, MOTI-3, and MOTI-10. The MOTI-3 and INFO-3 groups each received 3 SMSs encouraging them to test for HIV, while MOTI-10 and INFO-10 each received 10 such SMSs. The SMSs were sent using Mobilisr, a Web-based system that allows for prescheduling and sending of SMSs in bulk. They were sent 3 days apart; hence, the groups that got three SMSs received them over 9 days, and the groups that got 10 SMSs got them over a month. A week after completion of each SMS intervention, an SMS reminding the recipient to go for HCT was sent. The control group did not receive any intervention SMSs.

Three weeks after the intervention for groups that received 10 SMSs, an SMS was sent requesting all groups to indicate whether they tested or not (see Table 1 for details of the SMSs). Two separate “please-call-me” (PCM) lines were set up: one captured PCMs from participants indicating that they had tested since the start of the intervention, while the other captured PCMs from participants who had not tested since that date. All participants who responded with PCMs were compensated with R10 (approximately $1.40) worth of airtime.

RECRUITMENT AND SAMPLE SIZE

Participants were recruited from a database of 104,733 mobile numbers collated from mobile-based competitions. These competitions are run by Cell-Life. They had been advertised on the Soul City television and radio programs, and involved the watcher/listener responding to program content-related question via SMS. Soul City is an “edutainment” initiative that uses television, radio, and print to engage people about health and other social issues and has remarkably high reach and popularity in South Africa, with around 87% of the adult population having been reached by one or more Soul City programming components in 2006.

A target sample of 2,400 was sought, and split across the five conditions, to ensure adequate power for the statistical calculations. It was difficult to estimate rates of testing, so a conservative approach necessitated a large sample. An SMS was sent to 24,000 mobile numbers that were randomly selected from the Soul City database via a simple Perl script (for SMS text see Table 1). Participants consented to the study by sending a PCM to a mobile number specified in the recruitment SMS. PCMs are free SMSs available in some developing countries, and are used to ask another party to call the sender back. The PCMs were used to remove cost as a barrier to opt-in. Previous experience
callers requested more information about the study. For queries, which resulted in approximately 50 phone calls. Most
for unpublished work at Cell-Life had shown an opt-in rate of around 10% via SMS. In this case, 10.5% opted in (2,533 participants). See Figure 1 for the trial profile.

The recruitment SMS included a local landline telephone number for queries, which resulted in approximately 50 phone calls. Most callers requested more information about the study.

### STATISTICAL ANALYSIS

We examined the impact of the SMSs in encouraging participants to go for HCT in comparison with the control group. A per-protocol analysis was conducted; thus, the potential benefit of SMSs was analyzed only for participants who were retained throughout the study. Odds ratios for the likelihood to test were calculated for the combined set of intervention groups against the control, and for each intervention group separately against the control.

To investigate the impact of content, we paired and computed the odds of testing between the MOTI and INFO groups that received equal number of SMSs. The impact of SMS dosage was based on calculating the odds of testing between the groups that received similar content at different dosages. All statistical procedures were performed using the R statistical software.  

### TELEPHONE SURVEY

This was done 2 weeks after completion of the study. Eighty-four participants who were retained for the duration of the study were randomly sampled irrespective of their intervention groups. In brief, participants who self-reported as having gone for HCT were asked whether they felt that the SMSs were what made them get tested, and if so how the SMSs helped (For instance, they were asked “whether they had tested and the SMS were the reason,” and “How did the SMSs help you to test?”). If the SMSs were not the reason they tested, an open-ended question on their decision to test was administered. While for participants who indicated that they had not tested, an open-ended question on their reasons was administered.

### ETHICAL CONSIDERATIONS

The full study was approved by the IRB of Faculty of Health Sciences of Stellenbosch University. All information were collected anonymously.

### Results

Overall, 30.2% of participants self-reported having tested since the start of the intervention SMSs, while 22.3% reported that they did not test. However, a small proportion of participants (2.0%) self-reported as having tested for HIV as well as not having tested. Counts of the testers, non-testers, and the erroneous testers are shown in Figure 1. Overall, there was a retention rate of 54.1% (i.e., 54.1% indicated whether they had tested).

### IMPACT OF SMSs ON DECISION TO TEST

All participants who received SMSs are more likely to test for HIV in comparison with the control group, although the odds are not statistically significant. When the impact of the SMSs on each intervention group was analyzed individually in comparison with the control, we found that receipt of 10 MOTI-style SMSs was effective in influencing an individual to go for HCT, with a statistically significant p-value of 0.0036. Three INFO SMSs had a marginally positive effect, and three MOTI SMSs had a marginally negative effect in comparison with the control group. The outcome measures are summarized in Table 2.

### DOSAGE AND CONTENT

Results of the impact of dosage and content of the SMSs are indicated in Table 3. Our results suggest an SMS threshold effect; that is, a minimum number of SMSs that is required to effectively influence participants to test. This threshold effect is illustrated particularly for the MOTI group. SENDING 10 MOTI SMSs had a statistically significant impact, in comparison with three MOTI SMSs. There was no real discernable effect from the INFO messages, either from 3 or 10 messages. The MOTI-style SMS content was more effective than INFO style at 10 SMSs. The difference in the impact on testing is not statistically significant between the two content styles at three SMSs, reinforcing the likelihood of an SMS threshold effect.

### Table 1. Sample of Intervention Short Message Services

<table>
<thead>
<tr>
<th>DESCRIPTION OF SMS</th>
<th>SMS TEXT</th>
</tr>
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<tbody>
<tr>
<td>Recruitment</td>
<td>Hi I am from Cell Life an organisation in Cape Town. We got your cell from the Soul City database. We are running a research study. It will involve maybe getting SMSes about HIV for 1 to 4 weeks. Then we will ask you some questions. It is anonymous so we do not know your name. If you have not tested for HIV in the last year and you would like to be part of the study send a please call me to 0797064014 by Wednesday this week. Got a question? Call 0214691111. Thanks.</td>
</tr>
<tr>
<td>Informational-style SMS</td>
<td>In SA 1,400 people get HIV every day. Test for HIV so you know if you're one (so then u can look after yourself) or if you're negative make sure u stay that way.</td>
</tr>
<tr>
<td>Motivational-style SMS</td>
<td>If you test and you’re HIV+ you can go on free drugs when you need to. HIV is no longer a death sentence. You can live a long, normal life with HIV. Plz test!</td>
</tr>
<tr>
<td>Request for participants to indicate whether they tested</td>
<td>Thanks for being part of our research study. We don’t need to know your HIV status! We just want to know if u tested or not. U will earn airtime … If u HAVE tested for HIV after 22 September this year send a please-call-me to 0714331022. Plz send this before 21 November. If u have NOT tested for HIV after 22 September this year send a please-call-me to 0714331022 Plz send this before 21 November. If u do this u will earn R10 airtime (whether u tested or not!). We will load it in a week or two. Questions? Call 0214691111</td>
</tr>
</tbody>
</table>

SMS, short message service; HIV, human immunodeficiency virus.
COST OF SENDING SMSs

The formula below was used to calculate the cost per tester in the MOTI-10 group (where SMSs made a statistically significant impact on influencing people to test). The formula takes into consideration the cost of the SMSs for those who dropped out, and the fact that some people would have tested anyway.

\[
\text{Cost per additional tester} = \frac{X}{(Y - Z)}
\]

Where \(X\) = cost of SMSs to 100 people in MOTI-10, \(Y\) = MOTI-10s who tested per 100 people, and \(Z\) = controls who tested per 100 people.

Given the above formula, the cost per additional tester = \((100 \times 10 \text{ SMSs each } \times \text{R0.2}) \div (69 - 57) = \text{R17 (SMSs costing R0.2)}\). This equates to about R2.41.

BARRIERS TO HCT ADDRESSED/NOT ADDRESSED BY SMS INTERVENTION

In the telephonic survey, the majority (42) of the 47 participants who had tested confirmed that the SMSs were the reason for their uptake of HCT. The following comments capture the effectiveness of the SMSs, "Your SMSs helped me a lot…if I didn’t get them I was not going to test"; “The SMSs were the reason for me to test. Thank you and please don’t stop what you are doing"; and “The SMSs opened my eyes that it was important to know my status.” Five indicated that they had tested but gave other reasons. These included that they had always wanted to test anyway; one had done research 2 years previously and tested every year; and another was not feeling well and this prompted them to test.

Qualitative analysis of comments from the non-HCT takers indicated that lack of time due to things like family responsibilities hindered them. Inaccessibility of HCT services was also reported as a reason for not testing by five of the participants. Although most did not state what they meant by inaccessibility, one full-time employed participant reported that they could not test since most HCT services operate during working hours. Fear seemed to be a major barrier to testing. Many reported that the SMSs had helped them address their fears, although others gave fear as a reason why they did not test. Some participants indicated that they were just not ready to go for HCT.

Discussion

This study demonstrates the potential for SMSs to communicate motivational messages and information to influence people to test for HIV. The results are preliminary and further investigation is required for this to be included more broadly in campaigns. This study clearly indicated that the content of the messages is of key importance, and that there is a threshold number of SMSs needed for positive impact.

While there is a growing body of studies investigating the use of SMSs for health promotion and management, literature about factors that are critical to the efficacy of SMS-based interventions is relatively sparse. This study evaluated both dosage and content of SMSs. Our finding that MOTI messages are more effective than INFO ones for increasing uptake of HCT is supported by literature on barriers to testing.

The threshold effect of 10 SMSs was effective while 3 were largely ineffective is puzzling. It may be that there is a resistance to testing and the consistency of the 10 SMSs arriving every 3 days did eventually provide the impetus to get the person to act. Three may have been easier to ignore, or there may have been specific issues in the content of the messages. It does imply that for an intervention such as SMSs to be useful in the context of a behavior, like testing, there are considerable barriers, for example, a certain number is required for the intervention to be successful. Clearly, the knowledge that we do have that different behaviors require different messages and intensity applies to SMS-based approaches as to other intervention approaches. Further study of intervention content and the impact of information intensity is clearly required as part of SMS-based campaigns in the future.

The results of the telephone interviews provide support for the use of SMSs for getting information to respondents. As most of the respondents were very supportive of receiving the SMSs and indicated that these messages were crucial in assisting them to overcome their fears, it provides support to the analyzed outcome that it is a combination of the delivery system and the content of the messages that produced the desired outcome. The specific content of the additional 7 messages may also indicate why there was a threshold effect at 10

### Table 2. The Odds of Uptake of Human Immunodeficiency Virus Counseling and Testing Within a Group in Comparison with Control

<table>
<thead>
<tr>
<th>GROUP</th>
<th>ODDS RATIO (P-VALUE)</th>
<th>P-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention(^a)</td>
<td>OR = 1.06; 95% 0.83–1.34</td>
<td>0.67</td>
</tr>
<tr>
<td>MOTI-3</td>
<td>OR = 0.73; 95% 0.53–1.01</td>
<td>0.059</td>
</tr>
<tr>
<td>INFO-3</td>
<td>OR = 0.92; 95% 0.66–1.27</td>
<td>0.62</td>
</tr>
<tr>
<td>MOTI-10</td>
<td>OR = 1.70; 95% 1.19–2.44</td>
<td>0.0036</td>
</tr>
<tr>
<td>INFO-10</td>
<td>OR = 1.05; 95% 0.77–1.44</td>
<td>0.809</td>
</tr>
</tbody>
</table>

\(^a\)All intervention groups combined (INFO-3, INFO-10, MOTI-3, and MOTI-10). OR, odds ratio.

### Table 3. Impact of Dosage and Content on Decision to Test for Human Immunodeficiency Virus

<table>
<thead>
<tr>
<th>ANALYSIS</th>
<th>GROUP</th>
<th>ODDS RATIO</th>
<th>P-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content</td>
<td>MOTI-3 vs. INFO-3</td>
<td>OR = 0.80; 95% 0.55–1.14</td>
<td>0.233</td>
</tr>
<tr>
<td></td>
<td>MOTI-10 vs. INFO-10</td>
<td>OR = 1.62; 95% 1.10–2.39</td>
<td>0.016</td>
</tr>
<tr>
<td>Dosage</td>
<td>INFO-10 vs. INFO-3</td>
<td>OR = 0.88; 95% 0.61–1.25</td>
<td>0.47</td>
</tr>
<tr>
<td></td>
<td>MOTI-10 vs. MOTI-3</td>
<td>OR = 2.322; 95% 1.55–3.50</td>
<td>2.2e-05</td>
</tr>
</tbody>
</table>

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messages. This adds further support to the idea that both the method of delivery and the content of the messages require specific attention.

A major innovation of this study was the successful use of PCMs, which bear no cost to the sender. Previous text-based interventions in resource-limited regions purchased airtime for participants to encourage responses; however, this affects the feasibility of scale-up. A further innovation was that participants were asked via SMS whether they had tested, removing the potential logistical difficulties of contacting each participant in person or by telephone. A potential limitation is that one cannot verify whether participants followed instructions correctly. Further, study participants were explicitly asked whether they had tested after the start of the intervention. Some may have reported that they had tested, but had in fact done so before the start of the intervention. Failure to follow instructions could be due to the use of English only in the intervention SMSs, or due to a lack of familiarity with this method of providing feedback.

Individuals’ self-reporting of testing is a limitation in that participants could have given a socially acceptable answer. It is hoped that the confidentiality kept potential self-reporting bias to a minimum. In addition, the use of random allocation and a control would alleviate this self-reporting bias. Mitigation of this potential limitation was also limited by the fact that HIV testing is confidential and it is not possible to independently validate whether someone has tested for HIV in South Africa, without drawing on significant resources (for instance, to verify testing in a manner that does not compromise confidentiality). The use of an airtime incentive could also have introduced a bias through people giving a socially acceptable answer. We tried to mitigate this through clear indication in the text of the SMS asking whether they had tested, that the incentive would be earned whether they had tested or not. However, this bias would be the same for all conditions so it should not have affected the overall study results. The potential for bias in the database (as the Soul City show deals with HIV) was mitigated by the fact that Soul City has such broad viewership and according to research, the vast majority of South African adults have been reached by one or more Soul City programming components (87% in 2006).

Several other factors are important for the interpretation of these findings. Lack of demographic information on the participants is a major concern for the internal validity of the study. For example at baseline, demographic information could not be used to assess the effectiveness of the randomization of the control and the intervention groups. The absence of baseline demographic variables makes it difficult to analyze for specific higher effectiveness or response in certain sectors.

Future Works

The retention rate of 58% is in line with a response rate of 55.6% to paper surveys, and surpasses an average response rate of 39.6% from 68 electronic (e-mail and Web) surveys reported in 49 studies. The authors know of no published literature or studies looking at response rates for questions or surveys administered via SMS. Administration of questionnaires via SMS coupled with the use of PCM lines for responses is an innovative methodology. Given the potential of reaching many people using mobile, especially in developing countries, further examination of SMS survey methodologies would be useful.

A future study could incorporate some important methodological changes: probing of reasons for attrition, inclusion of demographic information, and means of corroborating responses from participants could be included. The SMS content could be translated into local languages, and collection of baseline data including independent variables known to influence HCT could facilitate a more robust analysis. Further exploration of the nature of the threshold effect is needed, to understand whether it is consistent with other interventions and if so, how to ascertain what level of intensity to pitch an intervention. It would also be important to know whether there is a dosage effect once the threshold is reached. It is possible that once the threshold has been reached, additional doses may actually have a negative effect and reduce the impact.

Conclusions

Our results demonstrate the strong potential of SMSs as a tool for influencing the uptake of HCT, and the importance of the content of the messages. Our results also suggest the importance of determining a threshold for SMS-based interventions, although this is likely to vary according to the content and target of the particular intervention.

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Disclosure Statement

No competing financial interests exist.

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