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Cost Effectiveness of Text Messages to Reduce Methamphetamine Use and HIV Sexual Risk Behaviors among Men who have Sex with Men

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Abstract

Methamphetamine use is highly prevalent among gay, bisexual, and other men who have sex with men (MSM) in the United States and has been associated with condomless anal intercourse (CAI), a common route of HIV infection. Text messaging is a very low-cost method of delivery for intervention content. This paper presents a cost-effectiveness analysis of a randomized controlled trial testing three nested methods of text message delivery designed to reduce methamphetamine use and HIV sexual risk behaviors among MSM (*Project Tech Support2*). From March 2014 to January 2016, 286 non-treatment seeking methamphetamine-using MSM were randomized into one of three study arms: 1) Interactive text message conversations with Peer Health Educators, plus five daily automated, unidirectional theory-based messages, plus a weekly self-monitoring text message assessment (TXT-PHE; n = 94); or, 2) Five daily automated, unidirectional theory-based messages plus a weekly self-monitoring text message assessment (TXT-Auto; n = 99); or, 3) The weekly self-monitoring text message assessment only (AO; n = 93). Methamphetamine use at nine months post-enrollment was lower than at baseline in all three arms. The addition of Peer Health Educators and/or theory-based text messages did not produce cost-effective reductions in methamphetamine use over the weekly AO text messages. However, both intervention arms outperformed the AO arm in reducing HIV risk behaviors, but the TXT-Auto arm dominated the TXT-PHE arm in achieving greater reductions in days of methamphetamine use and CAI at lower cost. The TXT-Auto arm achieved greater reductions in CAI than the attentional control at a cost

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in the base case of ~$37.50 per episode of CAI reduced per month. Sensitivity analyses showed that results were robust to a number of changes in assumptions. Interventions seeking to reduce methamphetamine use among non-treatment-seeking MSM may seek to add minimal attentional control-style text messages to their routines querying about recent methamphetamine use and/or high-risk sex. Interventions seeking to additionally reduce HIV sexual risk behaviors among non-treatment-seeking MSM, specifically engagement in CAI, may seek to additionally apply theory-based text messages.

Keywords

men who have sex with men (MSM); methamphetamine; HIV; mHealth; cost effectiveness analysis (CEA); text messaging (SMS)

1. INTRODUCTION

Men who have sex with men (MSM) are significantly more likely to use methamphetamines than their non-MSM counterparts (CBHSQ 2016; Medley et al., 2016). Previous studies have demonstrated that methamphetamine use increases the risk of HIV transmission among MSM (Vosburgh, Mansergh, Sullivan, & Purcell, 2012; Boone, Cook, & Wilson 2013; Pantalone, Huh, Nelson, Pearson & Simoni, 2014; Vu, Maher, & Zablotska 2015; Halkitis, Levy, & Solomon 2016; Hoenigl et al., 2016) due to increased numbers of sexual partners and increased engagement in condomless anal intercourse (CAI) (Hoenigl et al., 2016). Approximately 70% of newly discovered HIV infections in the United States each year occur among MSM (CDC 2018), and concurrent methamphetamine use and HIV sexual risk behaviors have been identified as critical factors fueling such outcomes (e.g., Hoenigl et al., 2016).

Numerous behavioral intervention strategies have been developed to reduce methamphetamine use and HIV sexual risk behaviors among MSM (e.g., Rajasingham et al., 2012; Reback et al., 2012; Schnall, Travers, Rojas & Carballo-Diéguez, 2014). These strategies differ in their effectiveness and in their resource use, yet it is not known whether the additional cost of more intensive interventions is warranted by their increased effectiveness. To address this question, we conduct a cost-effectiveness analysis examining the cost relative to effectiveness of interventions that used three different approaches to reducing methamphetamine use and sexual risk behaviors among MSM. Findings on cost effectiveness can be useful in guiding policy-makers' resource allocation decisions.

Formative pilot research has demonstrated that MSM who received theory-based text messages reported lower methamphetamine use and HIV sexual risk behaviors over time (Reback, Ling, Shoptaw, & Rohde 2010; Reback et al. 2012; Reback, Fletcher, Shoptaw, & Mansergh 2015). The larger randomized controlled trial compared HIV risk behaviors (days of methamphetamine use, episodes of sex while on methamphetamine, and CAI with different partner types) among participants in three nested methods of text message delivery targeted to out-of-treatment MSM: 1) interactive text messages transmitted by Peer Health Educators plus automated text messages (TXT-PHE); 2) automatic text messages without peer interaction (TXT-Auto); and, 3) a weekly assessment (AO) with no texted prevention

messages (Reback, Fletcher, Swendeman, Metzner, 2018). This randomized text-messaging trial found that at follow-up, participants in all three treatment arms reported fewer episodes than they had at baseline of methamphetamine use, sex while on methamphetamines, and CAI with casual male partners. Participants in the two text-messaging interventions also reported fewer episodes of CAI with main male partners and the TEXT-Auto participants reported fewer CAI with anonymous male partners (Reback et al., 2018).

Given that text-messaging interventions are scalable, portable, and private, the public health impact of an efficacious text-messaging intervention to reduce methamphetamine use and HIV sexual risk behaviors could be profound. The purpose of this paper was to determine the costs to the healthcare sector, in 2014 adjusted dollars, for benefits achieved through the application of theory-based, interactive text messages, with and without real-time interactive peer text conversations, among non-treatment seeking, methamphetamine-using MSM.

2. MATERIAL AND METHODS

2.1 Participants

MSM between the ages of 18 and 65 who reported 1) having used methamphetamine within the previous three months; and, 2) engaging in CAI (insertive or receptive) with a non-primary partner within the previous three months, were enrolled in the study between March 2014 and January 2016 (N = 286). Potential participants also had to own a personal cell phone with unlimited texting service, be willing and able to charge it daily, and be willing and able to provide informed consent and comply with study requirements. Potential participants were deemed ineligible if they were currently in or seeking methamphetamine abuse treatment, or were determined to have a more serious psychiatric condition that was beyond safe enrollment (e.g., active psychosis; suicidal ideation).

Participants who met all study eligibility criteria were administered an informed consent form and then completed an Audio Computer Assisted Self Interview baseline assessment. Following the baseline behavioral assessment, participants were screened for HIV, other sexually transmitted infections and recent drug use. Follow-up assessments were administered at 8-weeks (intervention completion), and at 3-, 6-, and 9-months post-enrollment. All research activities occurred in Los Angeles County, California. Study procedures were approved by the Friends Research Institute Institutional Review Board and the University of California, Los Angeles Institutional Review Board. Further details regarding study procedures and intervention methods, and demographics of the population are reported elsewhere (Reback et al., 2018).

2.2 Interventions

Participants were randomly assigned to one of three arms:

TXT-PHE (n = 94): Peer Health Educators (PHE) engaged in bidirectional interactive text-messaging conversations with participants; participants in this arm also received five automatically transmitted unidirectional text messages a day, as well as a once weekly assessment on methamphetamine use and HIV sexual behaviors in the previous seven days.

TXT-Auto (n = 99): Participants in this arm only received the five automatically transmitted unidirectional text messages a day and the once weekly assessment on methamphetamine use and HIV sexual behaviors in the previous seven days.

AO (n = 93): Participants in this only received the once-weekly assessment on methamphetamine use and HIV sexual behaviors in the previous seven days.

Total participant follow-up rates were 84% at intervention completion (i.e., eight weeks), 90% at 3-months follow-up, 86% at 6-month follow-up, and 93% at 9-month follow-up.

2.3 Measures

2.3.1 Outcomes—Information on methamphetamine use and HIV-related sexual risk behaviors were gathered with the Behavioral Questionnaire – Amphetamine (BQA) (Twitchell, Huber, Reback, & Shoptaw 2002). As reported in Reback et al. (2018) the outcomes assessed were:

1. Number of self-reported days of methamphetamine use in the previous 30 days;

2. Number of episodes of sex while on methamphetamine in the previous 30 days;

3. Number of self-reported episodes of CAI with any partner type in the previous 30 days;

Risk behaviors were reported at 8 weeks, 3, 6, and 9 months following baseline. We interpolated for the months not specifically reported to obtain an estimate of the total number of risks acts over the nine months and converted this to an average number of risk behaviors per month from baseline to month 9 by dividing by 9. This monthly average was subtracted from the figure reported in the baseline for risk behaviors over the prior month to measure incremental improvement in outcomes.

2.3.2 Costs—The cost of delivering the intervention in each of the study arms was collected retrospectively using a modification of the template developed by the Joint United Nations Program on HIV/AIDS (UNAIDS 2000). Costs were considered from the point of view of the health care system. Monthly costs were calculated based on program expenditures in each of the three arms during the period from February 1, 2014 and January 31, 2015, which reflected steady state costs of the on-going program. Facilities costs, other office and medical costs, and the costs for the Program Director were obtained from administrative records. In the base case these costs are evenly split among the three study arms. The costs for the Program Director included salary, benefits, and retirement contributions. Benefits and retirement costs were calculated as .369 of wage bill (based on PHEs plus Program Director). A sensitivity analysis did not allocate facility or Program Director costs to the AO intervention, which required little administrative oversight. Research-specific costs (e.g., incentive payments) were excluded from total costs. All cost data were price-adjusted back to year one of the study (2014), using the medical care component of the consumer price index. Table 1 details the components of cost.

Participants in each of the arms received text messages at different rates. The cost of the text messaging platform was allocated based on the proportions of scheduled weekly messages

received in each arm. In each of the text arms (i.e., TXT-PHE and TXT-Auto) participants received 5 messages a day, 7 days a week plus 1 weekly assessment text. The AO arm received 1 text-message survey every week. Thus, 73 messages were sent weekly—36 to each of the two text arms and one to the AO arm. The AO arm received 1/73 of all text messages (=1.4%). The remaining 98.6% of costs of sending the messages were split between the two text arms (49.3% each).

Costs specific to the TXT-PHE arm also included the wages, benefits, and retirement contributions for the Peer Health Educators. Benefits and retirement costs were calculated as .369 of wage bill. The monthly cost of Peer Health Educators was $7,167.90. Data were not available on larger societal costs, such as the costs incurred by participants for other services/agencies/institutions such as incarceration or health care costs. The participants' opportunity costs of participation were also not included, but were minimal.

In order to calculate intervention cost per participant, we first calculated the monthly average costs for each arm by dividing its total monthly cost by the average number of participants per month. TXT-PHE averaged 9.2 participants per month; TXT-Auto averaged 10.2 and AO averaged 8.6 participants per month. Monthly cost per participant was multiplied by 2 to account for the two month enrollment period.

2.4 Analysis

This analysis examines the relative cost effectiveness of each study arm across the three outcomes. In their reporting of the primary outcomes, Reback et al., (2018) found statistically significant reductions in all three intervention arms between baseline and both the 8 week and 9 month assessments in number of self-reported days of methamphetamine use in the previous 30 days. Findings also demonstrated significant reductions in the number of self-reported episodes of sex in the previous 30 days while under the influence of methamphetamine, such that participants in the TXT-Auto arm reduced these episodes to a greater extent than the AO arm. Participants in the TXT-PHE arm demonstrated significantly fewer episodes of CAI, with larger reductions occurring with non-main partners.

Within each arm, we calculated ratios of intervention cost per enrollee to average monthly reductions in risk acts per enrollee relative to baseline reports. The Incremental Cost-Effectiveness Ratio (ICER) for the TEXT-Auto arm compared to the AO arm was calculated as the difference in the per capita cost between the TEXT-Auto arm and the AO arm, divided by the difference in reductions in risk behaviors over time between the two (Neumann, Sanders, Russell, et al. 2017; Gold, Siegel, Russell, & Weinstein, 1996). The ICER in this study is a measure of the incremental cost of reducing CAI, for example, by using TXT-Auto relative to the less costly AO. The ICER is not reported when the more costly intervention is clearly dominated because it achieves fewer reductions in risk behaviors than the less costly alternative.

The robustness of the findings was tested by calculating the impact on the ICER under the alternate assumptions about cost. We also tested the effect of using reported risk behaviors at 9 months versus using average monthly risk behaviors based on estimate for each of the nine months.

3. RESULTS

Table 1 summarizes the cost calculations for the base case. The monthly cost of the intervention was $16,001 in the TXT-PHE arm, $8,833 in the TXT-Auto arm, and $5,983 in the AO arm in the base case.

Table 2 shows the monthly cost per enrollee and the intervention cost/enrollee over the 2 month duration of the intervention, based on average monthly enrollment in each arm. In the base case, the average intervention cost per participant in the TXT-PHE arm ($3,478) was double the mean cost in the TXT-Auto arm ($1,732). The AO arm averaged costs of $1,391. Over the 2-month intervention, the incremental cost of adding a Peer Health Educator to the texting-only intervention (i.e., the TXT-PHE arm) was $1,746 and the incremental cost of adding more frequent messaging (i.e., the TXT-Auto arm) to the AO arm was $341 in the base case. Reallocating the costs for the Project Director and facilities raised the cost of the two texting arms and reduced the cost of the AO arm. The second sensitivity test, which allocated 75% of these costs to the TXT-PHE arm lowered the cost of the TXT-Auto arm.

As reported in Reback et al., (2018), at both 8 weeks and 9 months following baseline, participants in all three intervention arms reported fewer days of methamphetamine use, episodes of sex on methamphetamine, and CAI than they had at baseline. This is reflected in Table 3, which presents estimates of the difference between baseline reports and the reports of average monthly risk activities over the 9 months following baseline.

The amount of the reduction varied across intervention arms, with the TXT-PHE arm being totally dominated by the other arms. That is, for each behavior considered, participants in at least one other intervention arm reported greater reductions in risk compared to baseline that the TXT-PHE arm, while the TXT-PHE arm had the highest costs. ICER is only appropriate for non-dominated comparators, so results for the TXT-PHE arm are not included. The differences between the TXT-Auto and AO groups were less consistent. The AO group reported greater declines in days of methamphetamine use, but the TXT-Auto group experienced greater decreases in CAI.

Table 3 also shows the cost of achieving these reductions. The average intervention cost associated with reducing an instance of methamphetamine use was $541 in the TXT-Auto group and $357 in the AO arm. The two arms had similar costs for reducing an episode of sex on methamphetamine, but the TXT-Auto arm was associated with substantially lower costs per episode of CAI averted ($142 vs. $449). The sensitivity analysis that split overhead costs equally between TXT-PHE and TXT-Auto showed slightly higher costs for TXT-Auto relative to AO in reducing CAI, but TXT-Auto proved to be less costly under the assumption that facility costs were weighted more heavily on the TXT-PHE arm. The sensitivity analysis that used the report of risk behaviors at month 9, rather than the average over 9 months moderated some of the outcome effects, but showed the same pattern as the base case—the TXT-Auto arm was associated with lower costs to reduce instances of sex on methamphetamine and of CAI, but had greater costs per day of reduced methamphetamine use.

In the base case, the cost per participant in the TXT-Auto averaged $341 more than for AO participants ($1,732 - $1,391). Dividing this cost difference by the difference in reductions in CAI of 9.1/month represents the added cost for every one unit decrease in CAI using TXT-Auto rather than AO. The ICER for differences in reductions in episodes of sex on methamphetamine (which did not differ significantly from zero) was $426, but the ICER for CAI was $37.

4. DISCUSSION

Project Tech Support2 enrolled non-treatment seeking MSM with high rates of methamphetamine use, engagement in sex while using methamphetamine, and engagement in CAI with male partners. More than two-fifths were HIV positive (41%), a rate consistent with samples of MSM engaged in high rates of methamphetamine use (Shoptaw & Reback, 2007) and, thus, present a prime target for risk reduction intervention (Finlayson et al., 2011).

As noted in the primary outcomes article (Reback et al., 2018) and summarized here, the primary results of this randomized controlled trial found little evidence that either text intervention arm (TXT-PHE or TXT-Auto) yielded superior results to the AO arm in reducing methamphetamine use. All three arms evidenced reductions in days of methamphetamine use and, relatedly, episodes of sex while using methamphetamine. However, in regards to HIV sexual risk behaviors, there was evidence that the two text intervention arms (TXT-PHE and TXT-Auto) significantly outperformed the AO arm.

Interactive text-messaging with Peer Health Educators did not reduce risk behaviors more than automated text messaging. The TXT-PHE arm was dominated by the TXT-AUTO arm and, therefore, did not justify the added cost. TXT-PHE also faced added cost and logistical challenges related to hiring and training staff, especially in the face of staff turnover. This conclusion is consistent with the higher cost per outcome achieved in the TXT-PHE arm.

Results indicate that simple attentional control methods (i.e., the AO arm) may be sufficient to reduce problematic methamphetamine use behaviors among non-treatment seeking MSM who are receptive to reducing or eliminating their methamphetamine use via a low-intensity texting intervention. However, the greatest declines in risk behaviors occurred in the monthly incidence of CAI. The TXT-Auto arm was associated with reductions in CAI at a lower cost than the AO arm ($142 vs. $449). Although the base case cost of the TXT-Auto arm was $341 more than in the AO arm, participants in the TXT-Auto arm reported 9.1 fewer episodes of CAI per month relative to baseline. This yielded an incremental cost of $37.47 for reducing one episode of CAI per month, a cost that public health decision makers may be willing to pay.

These findings have important public health implications, given the low cost and high scalability of such a text-based intervention delivery method. Further research may look to data collection methods that implicitly increase ongoing self-monitoring, such as daily diaries, ecological momentary assessments, or (as in this study) weekly timeline follow-back style text-based assessments.

4.1 Limitations

The results from this cost-effectiveness analysis must be interpreted in light of the limitations of the parent study, which was limited by the lack of a sampling frame of non-treatment seeking MSM; enrollment into the study involved voluntary self-selection, which may have introduced biases. Further, data were collected in a large metropolitan city in the southwestern United States, and results may thus not be generalizable to MSM living in rural areas or in areas where community norms regarding gay culture and/or methamphetamine use may differ. Risk behaviors were assessed at 8 weeks, 2, 3, 6, and 9 months. Therefore intermediate values had to be interpolated to obtain estimates for the entire 9 month period. However, results based solely on the 9 month report were fully consistent with the 9 month averages. We also lack evidence on changes in risk behaviors after 9 months, but the consistency between the ninth month report of behavioral risks and the 9 month average may signal a longer run effect of the intervention. Persistent effects of the intervention over time would improve its estimated cost-effectiveness. Additionally, the study did not collect biomarkers of viral load among the HIV-positive participants, as it is recognized that an undetectable viral load greatly impacts transmission, which affects costs. As such, we had to rely upon the self-reported data on CAI as a measure of HIV sexual risk. And, although not a limitation, it is important to note that this study was conducted before PrEP was widely available; PrEP uptake, adherence and persistence also has a large impact on the costs associated with HIV sexual risk behaviors. However, both viral load suppression and PrEP use do not protect against the transmission of other sexually transmitted infections and their associated cost implications. Results are also not generalizable to MSM who are actively seeking treatment for their methamphetamine use, or to MSM unfamiliar with, or without access to, current mobile phone technology.

5. CONCLUSIONS

Adding Peer Health Educators who engaged in bidirectional interactive text-messaging conversations with participants in addition to an automated unidirectional text message intervention was not found to be cost-effective. Reback et al., (2018) found automated delivery of theory-based text messages could augment weekly self-monitoring assessment to increase positive outcomes, especially HIV sexual risk behavior outcomes. The cost-effectiveness analysis found that the cost-effectiveness ratios of adding automated text messaging (TXT-Auto) to weekly assessments only (AO) was below $40 per episode of CAI measured 9 months following the intervention, which may be cost effective for application among some populations at particularly high risk for HIV transmission. Lower-risk populations may find optimal outcomes from weekly self-monitoring assessments.

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Highlights

- Cost effectiveness of text-message delivery for reductions in meth use & HIV risks

- Cost analysis captured total costs of delivering the interventions by 3 study arms

- Automated, unidirectional text-messages delivery were most cost effective

- Adding Peer Health Educators for interactive messaging was not cost effective

- Findings are critical for scalability & implementation in resource-limited settings

Table 1:

Monthly Costs by Intervention Arm

	TXT-PHE	TXT-Auto	AO	Total
Program Director	$2,038	$2,038	$2,038	$6,112
Supplies				
Software	$132	$132	$132	$397
Office supplies				$348
Computer acquisition				$49
Facilities Costs	$2,128	$2,128	$2,128	$6,384
Rent				$3,135
Utilities				$419
Maintenance				$546
Copier				$149
Insurance				$1,721
Telephone				$414
Other and Medical	$1,525	$1,525	$1,525	$4,575
Incentives				$0
Local Travel/Mileage				$19
Lab Fees				$3,952
STI Tests				$487
UA Kits				$116
HIV Tests				$0
Other Office	$78	$78	$78	$233
Printing				$92
Postage				$13
IT Support				$86
Subscriptions/Conf Dues				$0
Website				$42
Peer Health Educators	$7,168	$0	$0	$7,168
Text Messaging Platform	$2,933	$2,933	$83	$5,950
Total Monthly Cost	$16,001	$8,833	$5,983	$30,817

Table 2:

Intervention Costs—Base Case and Sensitivity Estimates

	TXT-PHE	TXT-Auto	AO
Base Case			
Total Monthly Cost	$16,001	$8,833	$5,983
Av. Monthly Enrollment	9.2	10.2	8.6
Monthly Cost/Enrollee	$1,739	$866	$696
Intervention Cost/Enrollee	$3,478	$1,732	$1,391
Sensitivity Test 1			
Project Director	$4,584	$4,584	0
Facilities	$4,788	$4,788	0
Alternate Monthly Cost	$18,083	$10,915	$1,817
Alternate Monthly Cost/Enrollee	$1,966	$1,070	$211
Intervention Cost/Enrollee	$3,932	$2,140	$422
Sensitivity Test 2 (75%, 25%)			
Project Director	$6,876	$2,292	0
Facilities	$7,182	$2,394	0
Alternate Monthly Cost	$21,207	$7,791	$1,817
Alternate Monthly Cost/Enrollee	$2,305	$764	$211
Intervention Cost/Enrollee	$4,610	$1,528	$422

Table 3:

Reductions in Risk Behaviors and Cost/Reduction by Intervention Arm

	TXT-PHE	TXT-Auto	AO
Reductions in days of methamphetamine per mo. per enrollee, averaged over 9 mo.	−3.2	−3.2	−3.9
Reductions relative to baseline in days of methamphetamine per mo. per enrollee, averaged over 9 mo.	−2.6	−3.8	−3.0
Reductions relative to baseline in days of methamphetamine per mo. per enrollee, averaged over 9 mo.	−9.3	−12.2	−3.1
Intervention cost/ enrollee base case costs	$3,478	$1,732	$1,391
Intervention cost/ enrollee- sensitivity 1	$3,931	$2,140	$422
Intervention cost/ enrollee- sensitivity 2	$4,610	$1,528	$422
Cost/reduced risk behavior – base case costs			
Methamphetamine use	*NA*	$541	$357
Sex on methamphetamine	*NA*	$456	$464
CAI	*NA*	$142	$449
Cost/reduced risk behavior – sensitivity 1			
Methamphetamine use	*NA*	$669	$108
Sex on methamphetamine	*NA*	$563	$141
CAI	*NA*	$175	$136
Cost/reduced risk behavior – sensitivity 2			
Methamphetamine use	*NA*	$478	$108
Sex on methamphetamine	*NA*	$402	$141
CAI	*NA*	$125	$136
Reductions days of methamphetamine per mo. per enrollee at mo. 9	−3.3	−3.7	−4.6
Reductions relative to baseline in days of methamphetamine per mo. per enrollee, at mo. 9	−2.5	−4.4	−2.8
Reductions relative to baseline in days of methamphetamine per mo. per enrollee, at mo. 9	−8.4	−12.9	−3.2
Cost/reduced risk behavior – mo. 9 base costs			
Methamphetamine use	*NA*	$468	$302
Sex on methamphetamine	*NA*	$394	$497
CAI	*NA*	$134	$435