See commentaries by Chen and Hamner p941

Multicomponent Smoking Cessation Treatment Including Mobile Contingency Management in Homeless Veterans

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ABSTRACT

Introduction: Smoking rates are 80% among persons who are homeless, and these smokers have decreased odds of quitting smoking. Little is known about relapse rates among homeless smokers. More information is needed regarding both quit rates and innovative methods to treat smoking cessation among homeless smokers. Web-based contingency management (CM) approaches have been found helpful in reducing smoking among other difficult-to-treat smoker populations but have been generally limited by the need for computers or frequent clinic-based carbon monoxide (CO) monitoring. This open pilot study builds on a web-based CM approach by evaluating a smartphone-based application for CM named mobile CM (mCM). The study was conducted from January 1, 2013–April 15, 2014.

Method: Following a 1-week training period, 20 homeless veteran smokers (≥ 10 cigarettes daily for 1 year or more and a CO baseline level ≥ 10 ppm) participated in a multicomponent smoking cessation intervention including 4 weeks of mCM. All smokers received 4 smoking cessation counseling sessions, nicotine replacement, and bupropion (if medically eligible). Participants could earn up to $815 ($480 for mCM, $100 for CO readings showing abstinence [ie, 6 ppm or less] at posttreatment and follow-up, and $35 for equipment return).

Results: Mean compensation for the mCM component was $286 of a possible $480. Video transmission compliance was high during the 1-week training (97%) and the 4-week treatment period (87%). Bioverified 7-day point prevalence abstinence was 50% at 4 weeks. Follow-up bioverified single assessment point prevalence abstinence was 55% at 3 months and 45% at 6 months.

Conclusions: Results of this open pilot study suggest that mCM may be a useful adjunctive smoking cessation treatment component for reducing smoking among homeless veterans.

Trial Registration: ClinicalTrials.gov identifier: NCT01789710

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Studies have indicated that smoking rates are high among homeless individuals (80%).[1,2] Research conducted in a sample of 98 homeless smokers found that 67% suffered from current smoking-related symptoms, and 46% reported current smoking-related health problems.[3] There is evidence that homeless smokers are interested in quitting. Okuyemi and colleagues[4] reported that nearly 76% of the homeless smokers had plans to quit smoking within the next 6 months. Unfortunately, available evidence suggests that homeless smokers have been unsuccessful in reducing or quitting smoking. In a study following 754 chronically homeless adults, 48% of the smokers reported that they were trying to limit their smoking, and 75% reported that they had discussed smoking cessation with a health care professional; however, there were no significant reductions in smoking status at the 1-year follow-up.[2] There are few studies evaluating smoking cessation among homeless smokers, as they are often excluded from smoking cessation clinical trials.[5]

Rates of smoking are generally higher among individuals with multiple psychiatric disorders,[6] and persons who are homeless are more likely to have multiple psychiatric disorders.[7] Homeless veterans are 4 times as likely to have a diagnosis of nicotine dependence compared to veterans who are not homeless,[8] independent of their increased risk for other substance-use disorders.

Contingency management (CM) is an intensive behavioral intervention that has demonstrated efficacy in other difficult-to-treat smokers,[9] including drug-dependent individuals,[10,11] individuals with low motivation to quit,[12,13] and individuals with other psychiatric comorbidity.[14–16] Contingency management has been used to reduce drug use across a wide range of substances including cocaine, alcohol, marijuana, methamphetamine, and cigarettes.[17] Whereas drug-seeking behavior is thought to be maintained by the immediate physiological and psychological consequences of the drug (ie, reinforcement), CM aims to reduce drug taking through the reinforcement of an incompatible behavior (ie, abstinence). Most CM approaches provide positive reinforcers (eg, money, vouchers) contingent on abstinence measured via biological assay. Carbon monoxide (CO) has been recommended as 1 of the biological measures to verify smoking abstinence.[18] Contingency management may be a useful treatment component to increase quit rates among homeless smokers.

Widespread implementation of CM has been limited by the burden inherent in in-person bioverification of abstinence 2–4 times daily.[19] Because of this burden, alternative strategies for abstinence verification have been examined. Several studies have

Clinical Points

- Veterans who are homeless can quit smoking but will most likely need more intensive intervention (including counseling, pharmacotherapy, and behavioral intervention) to quit successfully.
- The use of technology, in this case, mobile contingency management, is feasible among the homeless veteran population and may contribute to successful short and long abstinence from cigarettes.

shown that internet-based verification of smoking cessation is a useful, effective, and less burdensome CM strategy.[20–23] Typical Internet-based verification of smoking cessation involves use of an Internet-ready computer, a web-ready camera, and a portable CO breath monitor. Participants provide self-bioverification by uploading video recordings of their CO readings (filmed via web camera) directly to a secure website. Similar methods have been used in several studies to date.[21–23]

We developed a smartphone application that allows a participant to follow similar procedures, thus, making mobile CM (mCM) even more portable, potentially more feasible, and less expensive. A preliminary study utilizing this approach in a sample of smokers with posttraumatic stress disorder (PTSD) demonstrated a 4-week bioverified quit rate of 82% for the mCM condition and 45% for controls.[24] Three-month self-report quit rates were 50% in the mCM group and 18% in the control group. The current study was designed to evaluate the feasibility of mCM within a smoking cessation intervention among homeless veteran smokers. It was hypothesized that the multicomponent smoking cessation treatment incorporating mCM would result in higher than usual quit rates among homeless smokers.

METHOD

Study Participants

Following institutional review board (IRB) approval of the study, 25 homeless smokers were screened for study inclusion. Participants were included if they (1) were currently homeless or homeless more than twice in the past-year period, (2) smoked at least 10 cigarettes daily for at least 1 year and had a CO level at the baseline session of at least 10 ppm, (3) were eligible for US Department of Veterans Affairs (VA) care, (4) were between the ages of 18–70 years, and (5) were willing to make a quit attempt. Potential participants were excluded if they (1) were pregnant (due to contraindications to nicotine replacement therapy [NRT]), (2) used forms of nicotine other than cigarettes (different treatment modalities required to treat other forms of nicotine), (3) were medically unstable (not optimal time for quit attempt), (4) produced a positive drug screen (may have affected ability to carry out study procedures), or (5) had uncontrolled diabetes, seizure disorder, or eating disorder (contraindications to bupropion use). Any participant with diabetes, seizure disorder, or an eating disorder who wished to participate in the study without using bupropion was allowed to do so. Current use of medication for depression or asthma required clearance from a participant's primary care physician in order to use the study NRTs. All participants (N = 20) had current primary care physicians.

Homelessness was defined according to VA guidelines as (1) living in a shelter, institution providing temporary residence, or a public or private place not designed for regular sleeping accommodation; (2) imminent loss of housing; and (3) other federal definitions including a) a long-term period without permanent housing, b) instability as evidenced by frequent moves, or c) expectation to continue in unstable housing due to factors such as chronic disabilities.[25]

Participants were evaluated for PTSD utilizing the Clinician-Administered PTSD Scale (CAPS)[26] and for other Axis I disorders utilizing the Structured Clinical Interview for the *Diagnostic and Statistical Manual of Mental Disorders,* Fourth Edition, Text Revision (SCID).[27] Five individuals were excluded from participation (1 for current substance abuse or dependence based on the SCID, 1 for being an ineligible veteran, and 3 for CO levels being too low).

Multiple diagnostic raters performed SCID evaluations over the course of the study. Each rater was trained using a standardized training method that included the review of a series of 8 instructional videos regarding SCID administration, observation of real-life SCID administration by a trained interviewer, and co-rating training with a trained interviewer. In addition, each rater completed diagnostic ratings on 7 video-recorded SCID interviews, and from these ratings, interrater reliability scores for reliability of diagnoses were high, with $\kappa = 0.96$. Finally, regular clinical supervision and consultation were provided to raters.

Demographic and Smoking Measures

Participants completed a demographic form that included questions about age and years of education, several measures of smoking characteristics including the Fagerström Test for Nicotine Dependence (FTND),[28] and a measure to discern years they had smoked, age they first smoked, and number of cigarettes smoked daily. Participants also provided a baseline CO reading. These were used as sample descriptors.

Intervention

Homeless smokers participated in mCM to assist in a smoking cessation attempt by uploading videos bioverifying abstinence indicated by CO readings ≤ 6 ppm.[29] Counseling and medications were also provided. Following informed consent and screening, participants were asked to complete a total of 7 laboratory visits, 1 brief telephone session, and 5 weeks of CO monitoring. All sessions were conducted in the Traumatic Stress and Health Research Laboratory located in the Durham, North Carolina Veterans Affairs Medical Center. Table 1 provides a timeline with a brief description of each of the study components.

The first contact was a screening appointment during which the CAPS, SCID, and demographic and smoking

Table 1. Intervention Design

Contact	Tasks	Timepoint
1 (laboratory visit)	• Consent • Screening (clinical interviews, questionnaires) • Urine sample, saliva (spit) sample, and breath sample taken	Day 1
2 (laboratory)	• Counseling session • Questionnaires • Start bupropion SR 150 mg for days 1–3 and increase to 300 mg on days 4–45 • Set target quit date (midnight before session 4)	Week 2
3 (laboratory)	• Counseling session • Receive equipment training • Begin practice carbon monoxide (CO) monitoring for 1 week	Week 3
4 (laboratory)	• Quit day • Counseling session • Begin abstinence CO monitoring • Begin NRT (nicotine patches) • Begin use of "rescue" NRT (nicotine gum, lozenges, or inhaler)	1 week after session 3 (quit date)
5 (phone)	• Counseling session • Continue abstinence CO monitoring • Reduce NRT dose • Continue use of "rescue" NRT	2 weeks after session 4
6 (laboratory)	• Breath and saliva sample provided • Return equipment • Reduce NRT dose • Continue use of "rescue" NRT	2 weeks after session 5
7 (laboratory)	• Breath and saliva sample provided • End NRT use if abstinent from smoking	2 weeks after session 6
8 (laboratory)	• Questionnaires • Breath and saliva sample provided	1 month after session 7
9 (laboratory)	• Questionnaires • Breath and saliva sample provided • End bupropion and NRT if still using	3 months after session 7

Abbreviations: CO = carbon monoxide, NRT = nicotine rescue treatment.

questionnaires were administered by the study coordinator. In contact 2, participants completed the first of 4 counseling treatment sessions for smoking cessation. The four 20-minute counseling sessions were based on standard cognitive-behavioral therapy (CBT) techniques shown to be efficacious for smoking cessation, were consistent with the Public Health Service Clinical Practice Guidelines,[30] and were based on the manual used in a large-scale PTSD smoking cessation trial.[31] During this second contact, participants began bupropion SR 150 mg on days 1–3 with an increase to 300 mg on days 4–45. Contact 2 occurred 1–3 weeks following contact 1 depending on the timeliness of the response from the individual's physician providing clearance for the participant to be prescribed study medications.

In contact 3, participants completed the second of 4 CBT treatments and set a quit date. Participants were provided with a mobile phone equipped with a video camera and a CO monitor for use in the mCM intervention. Participants were trained to use the equipment to video record themselves taking a CO reading, display the results, and then upload the videos to a secured website that was accessible only by the research team members. At this contact, participants began 1 practice week of CO monitoring.

In contact 4, the quit date, participants completed the third of 4 CBT treatments, began NRT, and began abstinence monitoring. The primary outcome measure to determine quit was a CO reading of ≤ 6 ppm. Participants monitored breath CO twice per day, with at least 8 hours between each

Table 2. Potential Compensation for Monitoring and Abstinence

Week	Day	First CO Reading	Second CO Reading	Bonus	Weekly Totals
3	1–7	$1.00	$1.00		Up to $14.00
4	1	$1.00	$1.25		
	2	$1.50	$1.75		
	3	$2.00	$2.25		
	4	$2.50	$2.75		
	5	$3.00	$3.25	$5.00	
	6	$3.50	$3.75		
	7	$4.00	$4.25		Up to $41.75
5	1	$4.50	$4.75		
	2	$5.00	$5.25		
	3	$5.50	$5.75	$5.00	
	4	$6.00	$6.25		
	5	$6.50	$6.75		
	6	$7.00	$7.25		
	7	$7.50	$7.75		Up to $90.75
6	1	$8.00	$8.25	$5.00	
	2	$8.50	$8.75		
	3	$9.00	$9.25		
	4	$9.50	$9.75		
	5	$10.00	$10.25		
	6	$10.50	$10.75	$5.00	
	7	$11.00	$11.25		Up to $144.75
7	1	$11.50	$11.75		
	2	$12.00	$12.25		
	3	$12.50	$12.75		
	4	$13.00	$13.25	$5.00	
	5	$13.50	$13.75		
	6	$14.00	$14.25		
	7	$14.50	$14.75		Up to $188.75

Abbreviation: CO = carbon monoxide.

Table 3. Sample Characteristics (N = 20)

Characteristic	Contingency Management
	Mean (SD)
Age, y	54.7 (7.0)
Years of education	12.6 (1.8)
CAPS score	47.2 (34.6)
Fagerström score	3.6 (1.1)
Baseline CO reading	20.9 (10.0)
No. cigarettes per day	21.1 (8.5)
Years smoking	34.8 (12.9)
Age first smoked, y	16 (4.3)
	N (%)
Male	18 (90)
Minority	16 (80)
Married	0 (0)
Veteran	20 (100)
Living in subsidized housing	3 (15)
Living in homeless shelter	7 (35)
Living in automobile	1 (5)
Living in transitional housing	5 (25)
Living temporarily with friends/family	4 (20)
Employed	2 (10)
Unemployed	16 (80)
Retired	2 (10)
Lifetime disorders	
No disorders	2 (10)
Posttraumatic stress disorder	12 (60)
Major depressive disorder	10 (50)
Panic disorder	1 (5)
Obsessive-compulsive disorder	1 (5)
Generalized anxiety disorder	1 (5)
Social phobia	1 (5)
Schizophrenia	4 (20)
Bipolar disorder	3 (15)
Dysthymia	1 (5)
Eating disorder	1 (5)
Alcohol abuse	2 (10)
Alcohol dependence	12 (60)
Drug abuse	5 (25)
Drug dependence	12 (60)

Abbreviations: CAPS = Clinician Administered PTSD Scale, CO = carbon monoxide.

monitoring activity. Participants were compensated for each CO reading that indicated abstinence (ie, ≤ 6 ppm), and the reinforcement schedule was progressive with a reset contingency (see reinforcement schedule in Table 2). The reset was to $1 and increased 25 cents with each subsequent abstinence reading. A progressive reinforcement schedule was chosen because progressive reinforcement (compared to fixed reinforcement) has been shown to produce higher smoking cessation rates.[32]

Standard NRT was administered to all participants (21 mg for the first 2 weeks of the quit attempt, 14 mg for next 2 weeks, and 7 mg for last 2 weeks). Any participant who was identified as a heavy smoker during the prequit treatment phase (via CO readings > 30 ppm) received 42-mg nicotine patches to use on their quit day, continued the 42-mg dose for the first week of the postquit period, and reduced the dose to 21 mg at the second week. Recent research has suggested that for heavy smokers (ie, smokers with CO readings higher than 30 ppm), smoking cessation efficacy is greater when high-dose (42 mg) nicotine patches are used,[33] and the side effect profile for heavy smokers using a 42-mg patch compared to those using the 21-mg patch is low.[33] Participants were provided with detailed information regarding patches, which included a rationale for using the patches, proper placement, when to use them, possible side effects, and how to report side effects to research staff. One participant's patch dose was reduced from 21 mg to 7 mg due to negative side effects.

On the quit date, participants chose 1 form of acute administration NRT, ie, rescue method, and were instructed to use it as needed to reduce cravings during the postquit period. Rescue method options included nicotine gum (2 mg) or nicotine lozenge (2 mg). Participants could request to switch rescue method if the original method was found unsuitable (eg, gum sticking to dentures).

The fifth contact, which occurred 2 weeks after contact 4, was via telephone. Participants completed the final CBT for smoking cessation, which included a relapse prevention focus. During this contact, the study coordinator checked for any problems with monitoring, patch use, and/or bupropion use. In contact 6, which occurred 2 weeks after session 5, CO monitoring ceased, and study equipment was returned.

Contact 7, which occurred 6 weeks after quit date, was a laboratory visit during which abstinence was bioverified by a CO reading. Participants returned to the laboratory for 3- and 6-month follow-up visits during which they provided information about smoking behavior since the last contact. Abstinence was bioverified by a CO reading.

Participants could earn up to $815 ($480 for mCM, $100 for verified abstinence at the 3 follow-up visits, and $35 for equipment return) and were paid by mailed check at the end of contact 6 (screening appointment and 4 CBT treatments) and again after each follow-up contact. All study participants were able to provide an address where they had arranged to receive mail (eg, home of a relative, post office box). With regard to financial incentives, the local IRB recommended that we address the issue of potential undue influence prior to study approval. In designing this research intervention, careful consideration was given to minimizing the risk of undue influence. The study was designed such that compensation was provided only to those participants who obtained and maintained smoking abstinence. The IRB determined that the financial incentives were not unduly coercive.

All participants were prescribed the nicotine patch and an NRT rescue method, and 55% (n = 11) were prescribed bupropion. Six participants (30%) were not prescribed bupropion due to concurrent hepatitis C (a contraindication to bupropion use), a rate consistent with the reported hepatitis C rate among homeless individuals (27%).[34]

RESULTS

Participant characteristics are described in Table 3. The sample comprised mostly males, and more than 50% of the sample met criteria for comorbid lifetime PTSD, major depressive disorder (MDD), and lifetime alcohol and/or substance dependence. Rates of psychiatric comorbidity were similar to previously reported rates, except for PTSD and MDD. Rates of PTSD were higher (60%) in the study participants than in the Vietnam-era veteran population who

Table 4. Intervention Components

Intervention	Contingency Management (N = 20), N (%)
Prescribed bupropion	11 (55)
Bupropion compliance	73%[a]
Prescribed NRT patch	20 (100)
NRT patch compliance	57%[a]
NRT rescue	
Gum	4 (20)
Lozenge	14 (70)
Gum + lozenge	2 (10)

[a]Compliance was calculated based on self-reports of how much bupropion and NRT had been used out of how much was provided at each session throughout the study.
Abbreviation: NRT = nicotine rescue treatment.

have the highest reported veteran PTSD rates of any other wartime era (28.9%).[35] Depression rates were also higher in the study group (50%) than previously reported rates among homeless veterans (24%).[2] The mean FTND score was in the low dependence range (with a range from very low to medium dependence). No participants were married at study enrollment, consistent with previously reported marital rates among homeless smokers.[2]

Adherence to the timing and procedures for videos during the initial baseline week (mean = 97%) and treatment phase (mean = 87%) was excellent. Self-reported medication adherence was 57% with NRT and 73% among those prescribed bupropion. Table 4 provides use and compliance of the intervention components. Using an intent-to-treat statistical analysis approach[36] (ie, quit rates were based on all enrolled participants rather than those who completed the treatment) and based on a CO of ≤ 6 ppm for each assessment across the last 7 days of treatment,[31] the quit rate at 4 weeks (end of treatment) was 50% (n = 10). Compensation was found to be strongly correlated to abstinence ($P < .0001$); however, this was expected due to the study design, which included compensation being provided if abstinent. No other significant correlates were identified, most likely due to the small sample size. Table 5 provides the average weekly compensation for monitoring and abstinence. Compensation during treatment ranged from $0–$480, and mean compensation was $286.

As indicated by bioverified assessments at each follow-up, abstinence was 50% (10/20) at end of treatment, 55% (11/20) at 3-month follow-up, and 45% (9/20) at 6-month follow-up. During the initial follow-up period, 2 additional participants reported that they were able to quit after the treatment period because stressors contributing to their inability to quit had dissipated; these additional quitters increased the 3-month quit rate to 55% (11/20). Abstinence fell to 45% (9/20) at 6 months. Consistent with intent-to-treat analyses, participants who did not complete the study (n = 7) were counted as smoking at the posttreatment and follow-up assessments.

DISCUSSION

In this open pilot study, which utilized a multicomponent treatment that included an intensive behavioral intervention, mCM, 50% (10/20) of homeless smokers were bioverified to quit at posttreatment. The 3-month (55%; 11/20) and 6-month (45%; 9/20) follow-up quit rates were similar and indicated that most who quit were able to maintain abstinence at 6 months. Psychiatric comorbidity in the cohort was high, which is consistent with a previously reported rate,[8] and suggests that the intervention is useful in homeless smokers with a range of psychiatric problems.

Table 5. Average Weekly Compensation for Monitoring and Abstinence

Week	Potential Weekly $ Totals	Actual $ Earned Mean (SD)
3	Up to $14.00	$12.85 ($3.44)
4	Up to $41.75	$30.01 ($18.84)
5	Up to $90.75	$55.20 ($33.00)
6	Up to $144.75	$66.25 ($53.82)
7	Up to $188.75	$84.57 ($63.62)

Although we did not directly examine ease of use with regard to the mCM procedures, feasibility of mCM as part of a multicomponent smoking cessation intervention among veteran homeless smokers was high, as measured by compliance (92%) and participant retention (55%; 11/20) at 6-month follow-up. All study equipment sets (ie, phone, CO monitor, and carrying case) were returned except for 1; 1 participant's equipment was stolen along with other belongings. There was no screening for ability to use a smartphone, Internet, or technology. However, no participants were unable to learn study procedures, suggesting that this intervention may be utilized with most homeless veteran smokers.

The clinical implications of the current study include: (1) homeless smokers (with multiple psychiatric disorders), with intensive intervention, can quit smoking; (2) homeless smokers may need more intensive intervention in order to quit and maintain abstinence; and (3) homeless smokers can be reliably taught to use technology to assist in their quit attempts, be responsible for the equipment, maintain frequent contact with the provider, and be compliant with smoking cessation medications. The clinical implications for this study most likely apply to other vulnerable smoker populations including low-income smokers and smokers with psychiatric disorders.

This pilot study is limited by the small sample size and the lack of a comparison condition. In the study, we excluded participants who were actively abusing other substances in order to potentially interpret negative results (eg, perhaps participants failed to quit because of other active substance misuse). Given the positive result in terms of smoking cessation rates, reasonable next steps might be to evaluate this multicomponent smoking cessation treatment with homeless veterans who are abusing other substances. In a meta-analysis of individuals who were trying to abstain from other substances,[37] successful smoking cessation was associated with reduced relapse with other substances. That meta-analysis challenges the notion that it is important for individuals to quit only 1 harmful substance at a time. Results are limited to US Department of Veterans Affairs users and may be less favorable in health systems in which pharmacotherapy and smoking cessation counseling are less readily available.

Despite the limitations, these pilot results suggest that mCM is feasible and may contribute to increases in initial and long-term quit rates as part of a multicomponent smoking cessation intervention for smokers who are homeless. Mobile contingency management may provide a portable method and sufficient incentive to assist these smokers through cravings, particularly early in the quit period. Given the demonstrated feasibility and observed quit rates associated with this pilot study, a larger randomized clinical trial utilizing a comparison group of mCM with 1-year bioverified follow-up for smoking cessation among homeless veterans is warranted.

Drug names: bupropion (Wellbutrin, Aplenzin, and others).

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