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Treatment Outcomes of a Multi-Component Mobile Health Smoking Cessation Pilot Intervention for People with Schizophrenia

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Abstract

Objective: The objective of this study was to investigate the feasibility and acceptability of a multi-component mobile contingency management (CM) pilot intervention for smoking cessation for people with schizophrenia.

Methods: This intervention included mobile contingency management (i.e., monetary compensation for bioverification of abstinence through using a phone app), cognitive behavioral therapy (CBT), and pharmacotherapy for smoking cessation. This intervention was compared to an intensive treatment comparison (ITC), which contained all components except the CM. Participants were bioverified with carbon monoxide and saliva cotinine at a 6-month follow-up session.

Results: In this pilot, the treatment group did not differ from the intensive treatment comparison at any time point. However, measures of treatment feasibility and acceptability indicated that smokers with schizophrenia were able to navigate the CM phone application and adhere to the protocol, demonstrating the potential utility of mobile interventions in this population.

Conclusions: Despite lack of long-term abstinence for participants, adherence to the mobile application intervention indicates the potential for future investigation of mobile smoking cessation treatments for people with schizophrenia.

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Disclosures

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Introduction

Among substance use disorders, nicotine dependence and its complications lead to the most annual deaths due to substance misuse in the US—over 480,000 (U.S. Department of Health and Human Services, 2014). These fatalities are not equally represented across the US population, as nicotine dependence is overrepresented among certain populations. One population disproportionately affected are people with schizophrenia. People with schizophrenia have higher smoking rates (62-85%; Chapman, Ragg, & McGeechan, 2009; Ziedonis et al., 2008), increased rates of nicotine dependence (50-90%; Ziedonis, Kosten, Glazer, & Frances, 1994), and smoke more heavily (29-46%; smoking >20 cigarettes per day) than the general population (de Leon & Diaz, 2005). Nicotine dependence increases risk of cardiovascular disease, diabetes, and mortality in all smokers; because individuals with schizophrenia smoke at higher rates they are at a greater risk of cardiovascular disease, diabetes, and mortality (Hennekens, Hennekens, Hollar, & Casey, 2005). Smoking and its deleterious effects provide an explanation (in part) for the life expectancy disparity of 28.5 years between people with schizophrenia and the general population (Olfson, Gerhard, Huang, Crystal, & Stroup, 2015). As smoking increases health risks, smoking cessation decreases risk for the aforementioned complications and consequences. In fact, for people with schizophrenia, Bobes and colleagues (2010) determined that smoking cessation led to a 90% decrease in 10-year cardiovascular events. The continued overrepresentation of people with schizophrenia among smokers is not a result of people with schizophrenia not wanting to quit, as their rate of quit attempts are comparable to the general population (McClave, McKnight-Eily, Davis, & Dube, 2010). Instead, people with schizophrenia are less likely to achieve and maintain a successful quit attempt (de Leon & Diaz, 2005; McClave et al., 2010). This would suggest that current smoking cessation programs are not as successful for this population, leading to the necessity of approaches to increase smoking cessation in smokers with schizophrenia.

Currently, rates of long-term abstinence among smokers with schizophrenia are low (Cather, Pachas, Cieslak, & Evins, 2017). Meta-analysis of bupropion and bupropion combined with a transdermal nicotine patch reported 6-month abstinence rates of 20% and 12-month rates of 12% (Evins et al., 2007; Tsoi, Porwal, & Webster, 2013). One novel addition to bupropion and nicotine replacement therapy (NRT) would be behavioral treatment. Among substance use disorders, contingency management (CM) is an intensive behavioral treatment often utilized to achieve initial abstinence. CM is a behavioral neuroeconomic application that provides tangible incentives for verified abstinence (Glimcher & Rustichini, 2004; Potenza, Sofuoglu, Carroll, & Rounsaville, 2011).

Two previous studies have investigated CM with smokers diagnosed with schizophrenia. Tidey and colleagues (2011) compared CM versus combined bupropion and nicotine replacement treatment. Compared to the combined treatment, CM was significantly more effective in decreasing cigarettes per day; neither intervention resulted in smokers quitting. In a second trial to investigate efficacious smoking cessation interventions for smokers with schizophrenia, Gallagher et al. (2007) compared CM with NRT, CM without NRT, and a minimal intervention. Verified by a phased weekly, once every 2 weeks and then once monthly appointments to the clinic to provide a carbon monoxide reading, abstinence

rates (as defined by a single CO reading of ≥ 10 ppm) among both CM groups (43% with NRT and 37% without NRT) were significantly higher than the minimal intervention (8%). However, cotinine verification (which evaluates nicotine use in the past 7 days) produced vastly different results (CM with NRT 2%; CM without NRT 7%; minimal intervention 5%). Given the infrequent schedule of the CM and carbon monoxide verification, the disparity between validation techniques suggested participants were able to smoke during the week and quit overnight when an upcoming CM appointment was required. The payment structure for CM is described in Table 1.

Beyond the critiques of verification of abstinence, there are concerns about the long-term effects of CM, particularly when the incentives are removed (Volpp et al., 2009). Numerous studies have not found a significant difference in long-term effects between controls and CM interventions after the contingencies were removed (Higgins, Davis, & Kurti, 2017). However, CM may serve as an important approach in helping smokers with schizophrenia achieve short-term abstinence. CM has also been shown to be effective in retaining difficult-to-treat populations, allowing extended exposure to concomitant treatment components (e.g., NRT, bupropion, cognitive behavioral therapy, etc.). With initial reduction and tangible incentives, participants have reported increased self-efficacy (Romanowich, Mintz, & Lamb, 2009), a potentially important factor in the maintenance of a quit attempt. These benefits suggest an application of CM could contribute to short-term smoking abstinence for people with schizophrenia.

Our group used a successive cohort design to iteratively develop a multicomponent mobile health smoking cessation intervention (Wilson et al., 2018). The intervention included mobile contingency management (mCM; i.e., financial compensation for confirmed abstinence from smoking), pharmacotherapy for smoking cessation, and cognitive-behavioral counseling sessions that included counseling on relapse prevention. Two cohorts ($N = 13$) were utilized to refine the intervention. Qualitative methodologies were utilized to incorporate for participant, therapist and consultant feedback. Metrics of patient engagement included treatment adherence (40% in Cohort 1 and 63% in Cohort 2). Both participants and therapists reported that the intervention was helpful. Over one third of participants self-reported abstinence at post-treatment. The finalized treatment manual and procedures were named iCOMMIT and were utilized in the pilot RCT. The purpose of the current pilot trial was to compare iCOMMIT to a control condition wherein all treatments components were utilized except mCM (called intensive control [ITC]) among smokers with schizophrenia measuring: 1) acceptability and feasibility; 2) smoking cessation knowledge; and 3) the feasibility of recruitment, randomization and retention procedures in a pilot randomized clinical trial comparing iCOMMIT to an intensive treatment comparison (ITC; i.e., all components except for contingency management) for improving short-term and long-term smoking abstinence.

Methods

Beginning in 2015-2017 participants were recruited from various settings within a Southeastern metropolitan area. Eligible participants were between 18-70 years old and met the following criteria: a) have smoked for at least one year; b) currently smoked

at least 10 cigarettes daily; c) fluent in conversational English; d) willing to make a smoking cessation attempt; and e) met criteria for schizophrenia, schizoaffective disorder or another psychotic disorder as determined by the Structured Clinical Interview for DSM-5 diagnosis (SCID-5). (First, Williams, Karg, & Spitzer, 2015). Exclusion criteria included the following: a) a history of myocardial infarction within the past 6 months; b) contraindication to NRT with no medical clearance from a primary care provider or the study physician; c) unwilling to quit other forms of nicotine (e.g., cigars, pipes, or chewing tobacco); d) are pregnant; e) met criteria for current mania; f) currently enrolled in another study; g) current incarceration or inpatient psychiatric hospitalization. Written informed consent was obtained prior to any study procedures. A study coordinator reviewed the consent with participants and described all study procedures were approved by the Duke University Institutional Review Board. Smokers were randomized in a 2:1 ratio to iCOMMIT versus an intensive treatment comparison (ITC). Block randomization was used with random block sizes of three or six, with the number of blocks and sequence developed by the study statistician. The study coordinator was blinded to the randomization sequence. One participant was withdrawn at the end of the screen, prior to randomization, as they did not have the literacy required to complete study procedures such as completing questionnaires and using the mCM application. Thirty-four participants were randomized. Of these, 27 completed at post-treatment, 23 completed three-month follow-up and 18 completed the 6-month follow up. Individuals who were lost to follow-up were considered smokers.

Participant characteristics

Forty-two participants were screened and 35 were enrolled in the randomized control trial. Participants included 28 males (80%). Twenty one participants identified as African American/Black, 5 identified as White, 8 identified as more than one race, and one participant identified as American Indian/Alaskan Native. No participants identified as Hispanic. Fourteen participants identified as being single, never married (40%), 15 divorced (43%), 5 married (14%), and one separated (3%). Mean age was 48.2 ($SD = 9.9$).

Of those enrolled, 15 were diagnosed with schizophrenia (44%), 18 with schizoaffective disorder (53%), and 1 with psychotic disorder not otherwise specified (3%). Symptoms of psychosis were measured at baseline and follow-up visits. The Scale for the Assessment of Positive Symptoms (SAPS; Andreasen, Arndt, Miller, Flaum, & Nopoulos, 1995) was used to measure severity of positive psychotic symptoms. The Clinical Assessment Interview for Negative Symptoms (CAINS; Kring, Gur, Blanchard, Horan, & Reise, 2013) was used to measure negative symptomatology. The CAINS is divided into two subsections, motivation and pleasure items, and expression items. Participant baseline characteristics for the SAPS and CAINS is described in Table 3.

Multi-Component Mobile-Enhanced Treatment for Smoking Cessation (iCOMMIT)

Multi-Component Mobile-enhanced Treatment for Smoking Cessation (iCOMMIT) is a smoking cessation treatment that combined mobile technology with behavioral, cognitive-behavioral, and pharmacologic approaches. The components of the intervention included the following: 1) behavioral therapy in the form of mobile contingency management (mCM) designed to increase early abstinence rates; 2) pharmacotherapy for smoking cessation

(including nicotine replacement therapy [NRT] and bupropion); and 3) five sessions of guideline-based cognitive-behavioral smoking cessation counseling designed to increase coping skills specific to smoking cessation. Participants had the choice as to whether they preferred their first session as a home visit or by telephone. All remaining counseling sessions were conducted by telephone.

mCM Component.—iCOMMIT participants received monetary compensation based on their own reduced CO readings (< 6 ppm). The smartphone-based application through which we provided CM allowed participants to generate a video recording of themselves blowing into a handheld CO monitor. They logged in to a secure website via the smartphone application interface that includes pages tailored to each participant, uploaded the video recordings via encrypted network connections, and received reinforcement information all through a mobile smart phone. If participants missed several uploads, they were contacted by a study coordinator to provide technical support. The CO reading was used to determine smoking abstinence and the web application automatically calculated the compensation earned by the participant and sends that information to the patient's phone (actual monetary payment was given at the end of the treatment and monitoring phase [6 weeks]). Payment was issued as checks which would take several weeks to process and be received by the participant, as institutional procedure. As the payments would not be temporal to the mCM because of this, payment was given in one sum at the end of the monitoring. iCOMMIT participants received training in use of the smart phone and CO monitor. Participants were instructed to provide video recordings of CO readings using an Apple iPhone or a Droid MAXX 2. The CO breath monitor was a hand-held battery-operated instrument that measures CO in ppm, and provided an LED reading of CO levels. For each video recording, participants were asked to 1) begin a recording using the iPhone or a Droid MAXX 2; 2) show the initial zero CO reading to the camera; 3) video record their face while holding their breath during the monitor's countdown; 4) audibly blow slowly into the CO monitor while on camera; and 5) show the final CO reading to the camera.

Participants practiced data collection in the baseline session and for one week prior to their quit date to ensure they could effectively complete mCM procedures. They were instructed to take two readings per 24-hour period, with at least 8 hours between each sample. Video recordings were uploaded to a secure server via the app. Through the app, participants could see personalized information regarding their monetary reinforcement earned. Study coordinators monitored validity and compliance on a daily basis and offered feedback to ongoing participants regarding compensation. See Table 1 for the schedule of incentives.

The study team used AES-256 encryption protocols to ensure all video uploads and participant data were transferred through encrypted network connections. The web application passed checks for vulnerabilities including SQL injection, Code Injection, XSS, and RFI vulnerabilities. The site was accessible only to participants and study staff via 512-bit SHA-2 hashed passwords.

Pharmacotherapy.—Pharmacotherapy was offered to all study participants, but not required for study participation. The pharmacotherapy was chosen prior to meta-analyses indicating varenicline was efficacious for smokers with schizophrenia (Tsoi, Porwal,

& Webster, 2013). The study physician provided all pharmacotherapy and screening for pharmacotherapy. All study participants (who assented and for whom it was not contraindicated) were prescribed bupropion, which they started 2 weeks prior to their quit day (150 mg/daily for days 1-7 and 300 mg/daily [administered in two daily doses]). Because bupropion has been shown to improve long-term quit rates in smokers with schizophrenia, 11 participants were asked to continue bupropion for 6 months following the quit date and were provided with enough of the medication to do so. Participants who started bupropion but did not quit during the intervention were not prescribed bupropion through the 6-month follow up. Contraindications for bupropion were assessed by the study physician. Varenicline was offered as an alternative if participants did not quit on their initial quit date due to its efficacy for smokers with schizophrenia (Tsoi, Porwal, & Webster, 2013). For participants who switched to varenicline, there was a washout period for bupropion and then varenicline was prescribed (0.5 mg once per day for three days, 0.5 mg twice per day for four days, then 1 mg twice per day for up until 6-month follow-up).

NRT was also offered as part of this multi-component treatment. NRT is recommended as a first line treatment in clinical practice guidelines (Fiore, Bailey, Cohen, Goldstein, & Gritz, 2000) and theoretically could minimize potential effects of nicotine withdrawal on neurocognitive functioning (e.g., sensorimotor gating) in smokers with schizophrenia (Ziedonis et al., 2008). Smokers were prescribed the NRT patch and one nicotine rescue method (e.g., nicotine gum, lozenge). Because the polycyclic aromatic hydrocarbons of tobacco smoke can affect the metabolism of some antipsychotic medications (e.g., olanzapine, clozapine, haloperidol, fluphenazine), resulting in reduced medication blood levels (Desai, Seabolt, & Jann, 2001) patients were monitored for increased medication side effects during the trial. Coordinators and counselors asked about any side effects at all study contact points to indicate any adverse events.

Cognitive-Behavioral Counseling.—The study team had developed a five-session guideline-based CBT smoking cessation therapist manual and a participant workbook for iCOMMIT (Wilson et al., 2019) which was given to both groups. The content of the manual and workbook were adapted from the manual used in a large-scale PTSD smoking cessation trial (McFall et al., 2010), and was tailored to the current population based on consensus-based clinical practices. The counseling intervention was provided to participants by trained masters'- and bachelors'-level clinicians. All therapists attended a half-day training meeting, during which they were trained by a Ph.D.-level staff psychologist with specialized training in behavioral change psychology (ED). Two therapists (one masters'-level counselor and one doctoral-level psychologist) provided the counseling across the two cohorts, and they attended weekly group supervision meetings with the PI and treatment refinement team to review critical points in counseling sessions, discuss cases, and receive ongoing consultation.

Intensive Treatment Comparison (ITC)

The intensive treatment comparison (ITC) included all the iCOMMIT all components except for the mobile contingency management. Participants received five session phone CBT.

However, these participants did not have a study phone to use, as in the contingency management group, so they completed CBT sessions using their personal phones.

Measures of Treatment Feasibility and Acceptability

Treatment feasibility was measured using a questionnaire that was completed by the therapist about the participant (e.g., “The topics the participant and I discussed were appropriate to his/her needs right now.” The total possible score was 35 on a 5-point Likert scale ranging from 1 (*completely disagree*) to 5 (*completely agree*). The measure also contained a write in section for additional feedback about that week’s session. Treatment acceptability was measured using a questionnaire at each contact (aside from baseline) assessing 8 self-reported items (e.g., “The skills I learned today were helpful.”). The total possible score was 40 on a 5-point Likert scale ranging from 1 (*completely disagree*) to 5 (*completely agree*).

Measure of Smoking Cessation Knowledge

Participants’ knowledge of smoking cessation treatment was examined using a 16-item questionnaire with true/false responses (range 0-16). The questionnaire queried about participants’ knowledge of tobacco smoking and skills used in quitting smoking with specific content in the following areas: 1) health risks of continued smoking (e.g., “Smoking is a major cause of heart disease.” –[true]); 2) health benefits of quitting smoking (e.g., “If you smoke for more than 30 years, the damage is done, and you will not receive much benefit from quitting smoking.” –[false]); 3) quit smoking terms and strategies (e.g., “A smoking “trigger” is defined as a life-threatening health consequence of smoking, like cancer or lung disease.” –[false]); 4) uses of NRT (e.g., “Nicotine patches can be used to reduce cravings to smoke, but they will not reduce nicotine withdrawal symptoms.” –[false]); and, 5) quit smoking facilitators and inhibitors (e.g., “Quitting smoking is stressful, so during that time it is best not to add to your schedule by increasing enjoyable activities.” –[false]).

Smoking Abstinence

The primary clinical end-point was self-reported prolonged abstinence (defined as no cigarette use during the follow-up period) and bioverified prolonged abstinence at a 6-month follow-up. Bioverification included saliva cotinine and CO. Secondary outcomes included 7-day and 30-day point prevalence abstinence. For the iCOMMIT participants, twice daily CO measures were utilized to determine abstinence in the last week of treatment as well as in the last two weeks of monitoring only. Abstinence was determined to be CO 6 ppm with two allowed lapses during the week. Measures of recruitment (proportion screened versus enrolled), randomization (dropouts immediately upon randomization), and retention (proportion of treatment completers) were calculated to assess feasibility of the study procedures.

Feasibility and acceptability among smokers with schizophrenia was calculated these across the iCOMMIT and intensive treatment comparison (ITC) participants. Feasibility was measured using the sum of 7 Likert-scale self-report items measured at each contact (aside

from baseline), up to 8 times per participant. Acceptability was measured using the sum of 8 Likert-scale self-reported items at each participant contact.

Results

Feasibility and Acceptability

Multilevel modeling, which accounted for clustering of observations within participants, was used to model these summed scores by treatment arm. No differences between iCOMMIT participants ($M = 32.91$, $SE = 0.51$) and ITC participants ($M = 32.94$, $SE = 0.59$) were detected for feasibility ratings, $F(1, 26) = 0.00$, $p = .97$. The mean score for both groups was 4.7 (between somewhat and completely agree). Across groups the clinicians', feasibility ratings were high (4.67, 0.03).

Multilevel modeling was also used to model acceptability as a function of treatment arm. No differences between iCOMMIT participants ($M = 37.41$, $SE = 1.01$) and control participants ($M = 37.63$, $SE = 1.47$) in acceptability, $F(1, 22) = 0.01$, $p = .91$ were detected. The total possible score was 40, and the mean score for iCOMMIT participants was 4.67 (between somewhat and completely agree). For the ITC group, the mean score was 4.70 (between somewhat and completely agree).

Smoking Knowledge

Participants' knowledge of smoking cessation treatment was examined using number of correct responses submitted to a 2 (iCOMMIT vs. ITC) X 2 (pre-intervention vs. post-intervention) ANOVA. No main effects for treatment arm, $F(2, 32) = 0.88$, $p = .42$, or time, $F(1, 22) = 0.85$, $p = .37$, were observed. The interaction of group X time was also not significant, $F(1, 22) = 0.19$, $p = .66$. Knowledge scores in the ITC group improved by 0.37 points ($SD = 1.28$, $p = .77$) and in the iCOMMIT group's knowledge improved by 1.06 points ($SD = 0.88$, $p = .25$). The means and standard deviations were as follows: Baseline, iCOMMIT ($M = 10.00$, $SD = 2.98$); ITC ($M = 10.77$, $SD = 2.77$); and post-treatment iCOMMIT ($M = 11.06$, $SD = 2.77$); ITC ($M = 11.14$, $SD = 2.79$).

Abstinence was measured through CO and saliva bioverification, as well as through 7-day and 30-day point prevalence (Table 1). At post-treatment, in the iCOMMIT group 9.5% ($n = 21$) had both 7- and 30-day point prevalence abstinence post-treatment. In the ITC, 7.7% ($n = 13$) had 7- and 30-day point prevalence abstinence. At 6 months, in the iCOMMIT group 19.0% ($n = 21$) had 7-day and 4.8% had 30-day point prevalence abstinence post-treatment. In the ITC, 15.4% ($n = 13$) had 7- and 30-day point prevalence abstinence. Saliva cotinine was analyzed at the 6-month follow up. In the iCOMMIT group, 14.3% ($n = 21$) were bioverified abstinent, and in the ITC 15.4% ($n = 13$) were bioverified abstinent.

Discussion

Though developed with therapist and participant perspectives in a successive cohort design, during the RCT pilot the combined mCM and CBT treatment, iCOMMIT, failed to differ from the intensive treatment comparison condition at any time point. In addition, ratings of acceptability, feasibility, and smoking cessation knowledge failed to differ statistically

between the two groups. These pilot results suggest that the addition of mCM to intensive smoking cessation treatment did not significantly enhance quit rates among smokers with schizophrenia.

Utilization of varenicline was not a required inclusionary criterion. As a result, only one participant of the 34 elected to use it. Varenicline has been shown to support smoking cessation, even among persons with schizophrenia (Kishi & Iwata, 2015). Yet, participants reported that their current (schizophrenia) medication regimen affected their willingness to add another prescription. Mandating varenicline might have increased abstinence rates among the participants overall; however, it would have likely negatively affected the recruitment and retention of smokers with schizophrenia in the pilot study (i.e., participants would have not consented to participate in the trial if they were required to assent to varenicline).

Though the long-term abstinence outcomes failed to be statistically significant, participants of iCOMMIT demonstrated a willingness, marked by high acceptability ratings and adherence, to use the mCM app and send twice-daily CO measures. This study outcome indicated that smokers with schizophrenia were able to navigate smart phone applications and adhere to technological procedures of abstinence verification, supporting the use of mobile technology to support smoking cessation in this population. The high adherence to the app procedures is consistent with other recent work in this population (Ferron et al., 2017).

Additionally, 6-month abstinence biochemically verified rates appeared to be higher than self-report abstinence at post-treatment in both groups. This may be due to intensive treatment, other than that of the mCM, received by both groups. The ITC group received pharmacotherapy options as well as the CBT sessions, and that may have had an effect on prolonged abstinence rates.

Limitations

This pilot study had multiple limitations. First, the study was limited by a small sample size of 34 participants. Additionally, therapists were not blind to participant condition assignment. Only one participant was willing to use varenicline, meaning that we are unable to form any conclusions about the effect of varenicline. As this was a multi-component treatment, it is also impossible to determine which, if any, of the treatment components determined the smoking cessation effect (other than mCM, which was varied across the two conditions). There was heterogeneity in terms of pharmacotherapy that was received in both groups, but as not all participants opted to take pharmacotherapy, it was not feasible to analyze those that did as a subgroup. Finally, there was no post-treatment assessment in the ITC, while the iCOMMIT group had bioverified data at post-treatment because of the mCM. Since the purpose of the study was to primarily evaluate long-term abstinence, a formal post-treatment assessment was not completed. In this study, 63% of participants in the iCOMMIT group were bioverified (with CO < 6 ppm) quit at post-treatment (compared to 9.5 % at the 3-month follow-up). However, it could not be determined whether the mCM component improved short-term abstinence over and above the ITC group because the ITC group did not complete a post-treatment assessment.

Implications

Despite these limitations, the study holds noteworthy implications for smoking cessation treatment intended for people living with schizophrenia who smoke cigarettes. Participants in iCOMMIT showed high initial abstinence through mCM; whether it was greater than the ITC is unknown (because of a lack of post-treatment assessment in this group). It will be important in future studies to increase the focus on increasing quit rates and relapse prevention. Additional approaches such as weekly group sessions, increased facilitator and participant contacts, follow-up over the course of a year with various reinforcers, varenicline in the post-treatment period, use of low or no nicotine cigarettes, and the allowance of multiple quit attempts, may enhance both short- and long-term quit rates. Future research should consider maximizing treatment components that have shown both initial success and maintained abstinence in other difficult-to-treat smoker populations. Further, it could be useful in future research to add ecological momentary assessment to evaluate affect, craving, and other potentially clinically relevant information.

Conclusion

The results of this pilot study suggested that addition of mobile CM to an intensive smoking cessation treatment failed to improve long-term smoking abstinence rates among smokers with schizophrenia. Despite the lack of group differences for smoking abstinence, iCOMMIT participants' adherence, reported acceptability/feasibility of mCM and high post-treatment quit rates indicated a potential for continued investigation of smart phone application utilization for smoking cessation programs designed for smokers with schizophrenia.

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References

- Andreasen NC, Arndt S, Miller D, Flaum M, & Nopoulos P (1995). Correlational studies of the Scale for the Assessment of Negative Symptoms and the Scale for the Assessment of Positive Symptoms: An overview and update. *Psychopathology*, 28, 7–17. [PubMed: 7871123]
- Bobes J, Arango C, Garcia-Garcia M, & Rejas J (2010). Healthy lifestyle habits and 10-year cardiovascular risk in schizophrenia spectrum disorders: An analysis of the impact of smoking tobacco in the CLAMORS schizophrenia cohort. *Schizophrenia Research*, 119(1), 101–109. doi:10.1016/j.schres.2010.02.1030 [PubMed: 20219322]
- Cather C, Pachas G, Cieslak K, & Evins A (2017). Achieving smoking cessation in individuals with schizophrenia: Special considerations. *CNS Drugs*, 31(6), 471–481. doi:10.1007/s40263-017-0438-8 [PubMed: 28550660]
- Chapman S, Ragg M, & McGeechan K (2009). Citation bias in reported smoking prevalence in people with schizophrenia. *Australian & New Zealand Journal of Psychiatry*, 43(3), 277–282. doi:10.1080/00048670802653372

- de Leon J, & Diaz FJ (2005). A meta-analysis of worldwide studies demonstrates an association between schizophrenia and tobacco smoking behaviors. *Schizophrenia Research*, 76, 1351–1357.
- Desai HD, Seabolt J, & Jann MW (2001). Smoking in patients receiving psychotropic medications. *CNS Drugs*, 15(6), 469–494. doi: 10.2165/00023210-200115060-00005 [PubMed: 11524025]
- Evins AE, Cather C, Culhane MA, Birnbaum A, Horowitz J, Hsieh E, ... Goff DC (2007). A 12-week double-blind, placebo-controlled study of bupropion SR added to high-dose dual nicotine replacement therapy for smoking cessation or reduction in schizophrenia. *Journal of Clinical Pharmacology*, 27(4), 380–386. doi:10.1097/01.jcp.0b013e3180ca86fa
- Ferron JC, Brunette MF, Geiger P, Marsch LA, Adachi-Mejia AM, & Bartels SJ (2017). Mobile phone apps for smoking cessation: Quality and usability among smokers with psychosis. *JMIR Human Factors*, 4(1), e7. [PubMed: 28258047]
- Fiore MC, Bailey WC, Cohen SJ, Goldstein MG, & Gritz ER Treating tobacco use and dependence. Clinical Practice Guideline, Treating Tobacco Use and Dependence. Clinical Practice Guideline (2000). Rockville, MD.
- Gallagher SM, Penn PE, Schindler E, & Layne W (2007). A comparison of smoking cessation treatments for persons with schizophrenia and other serious mental illnesses. *Journal of Psychoactive Drugs*, 39, 487–497. [PubMed: 18303706]
- Glimcher PW, & Rustichini A (2004). Neuroeconomics: The consilience of brain and decision. *Science*, 306(5695), 447–452. doi:10.1126/science.1102566 [PubMed: 15486291]
- Hennekens CH, Hennekens AR, Hollar D, & Casey DE (2005). Schizophrenia and increased risks of cardiovascular disease. *American Heart Journal*, 150(6), 1115–1121. doi:10.1016/j.ahj.2005.02.007 [PubMed: 16338246]
- Higgins ST, Davis DR, & Kurti AN (2017). Financial incentives for reducing smoking and promoting other health-related behavior change in vulnerable populations. *Policy Insights from the Behavioral and Brain Sciences*, 4(1), 33–40. doi:10.1177/2372732216683518
- Kishi T, & Iwata N (2015). Varenicline for smoking cessation in people with schizophrenia: Systematic review and meta-analysis. *European Archives of Psychiatry and Clinical Neuroscience*, 265(3), 259–268. [PubMed: 25283510]
- Kring AM, Gur RE, Blanchard JJ, Horan WP, & Reise SP (2013). The Clinical Assessment Interview for Negative Symptoms (CAINS): Final development and validation. *The American Journal of Psychiatry*, 170(2), 165–172. doi:10.1176/appi.ajp.2012.12010109 [PubMed: 23377637]
- McFall MJ, Saxon AA, Malte CC, Chow BD, Bailey SP, Baker GM, ... Lavori P undefined. (2010). Integrating tobacco cessation into mental health care for posttraumatic stress disorder: A randomized controlled trial. *JAMA*, 304(22), 2485–2493. doi: 10.1001/jama.2010.1769 [PubMed: 21139110]
- McClave AK, McKnight-Eily LR, Davis SP, & Dube SR (2010). Smoking characteristics of adults with selected lifetime mental illnesses: Results from the 2007 National Health Interview Survey. *American Journal of Public Health*, 196, 116–121. doi:10.2105/AJPH.2009.188136
- Potenza MN, Sofuoglu M, Carroll KM, & Rounsaville BJ (2011). Neuroscience of behavioral and pharmacological treatments for addictions. *Neuron*, 69(4), 695–712. doi:10.1016/j.neuron.2011.02.009 [PubMed: 21338880]
- Olfson M, Gerhard T, Huang C, Crystal S, & Stroup T (2015). Premature mortality among adults with schizophrenia in the United States. *JAMA Psychiatry*, 72(12), 1172–1181. doi:10.1001/jamapsychiatry.2015.1737 [PubMed: 26509694]
- Romanowich P, Mintz J, & Lamb RJ (2009). The relationship between self-efficacy and reductions in smoking in a contingency management procedure. *Experimental Clinical Psychopharmacology*, 17(3), 139–145. [PubMed: 19586228]
- Tidey JW, et al. (2011). Effects of contingency management and bupropion on cigarette smoking in smokers with schizophrenia. *Psychopharmacology*, 217(2), 279–287. [PubMed: 21475970]
- Tsoi DT, Porwal M, & Webster AC (2013). Interventions for smoking cessation and reduction in individuals with schizophrenia. *Cochrane Database of Systematic Reviews*, 2, CD007253. doi:10.1002/14651858.CD007253.pub3

- Volpp KG, Troxel AB, Pauly MV, Glick HA, Puig A, Asch DA, ... Audrain-McGovern J (2009). A randomized, controlled trial of financial incentives for smoking cessation. *New England Journal of Medicine*, 360, 699–709. doi:10.1056/NEJMsa0806819
- Wilson SM, Thompson AC, Currence ED, Thomas SP, Dedert EA, Kirby AC, ... & Beckham JC (2019). Patient-informed treatment development of behavioral smoking cessation for people with schizophrenia. *Behavior therapy*, 50(2), 395–409. [PubMed: 30824254]
- Ziedonis D, Hitsman B, Beckham JC, Zvolensky M, Adler LE, Audrain-McGovern J, ... Riley WT (2008). Tobacco use and cessation in psychiatric disorders: National Institute of Mental Health report. *Nicotine & Tobacco Research*, 10(12), 1691–1715. doi:10.1080/14622200802443569 [PubMed: 19023823]
- Ziedonis D, Kosten TR, Glazer WM, & Frances RJ (1994). Nicotine dependence and schizophrenia. *Hospital & Community Psychiatry*, 45(3), 204–206. [PubMed: 7910577]

Table 1.

Reinforcement schedule for contingency management component in the iCOMMIT group

	Days Pre Quit	1 st CO	2 nd CO	Bonus	Total
Practice Weeks	1 to 21	\$1.00			\$21.00
	Days Post Quit	1 st CO	2 nd CO	Bonus	Total
Week 1	1	\$5.00	\$5.00	\$5.00	
	2	\$5.00	\$5.00	\$5.00	
	3	\$5.00	\$5.00	\$5.00	
	4	\$2.50	\$2.60		
	5	\$2.70	\$2.80	\$5.00	
	6	\$2.90	\$3.00		
	7	\$3.10	\$3.20		up to \$72.80
Week 2	8	\$3.30	\$3.40		
	9	\$3.50	\$3.60		
	10	\$3.70	\$3.80	\$5.00	
	11	\$3.90	\$4.00		
	12	\$4.10	\$4.20		
	13	\$4.30	\$4.40		
	14	\$4.50	\$4.60		up to \$60.30
Week 3	15	\$4.70	\$4.80	\$5.00	
	16	\$4.90	\$5.00		
	17	\$5.10	\$5.20		
	18	\$5.30	\$5.40		
	19	\$5.50	\$5.60		
	20	\$5.70	\$5.80	\$5.00	
	21	\$5.90	\$6.00		up to \$84.90
Week 4	22	\$6.10	\$6.20		
	23	\$6.30	\$6.40		
	24	\$6.50	\$6.60		
	25	\$6.70	\$6.80	\$5.00	
	26	\$6.90	\$7.00		
	27	\$7.10	\$7.20		
	28	\$7.30	\$7.40		up to \$99.50
Week 5 & 6	29-42	up to \$25 each week			
TOTAL POSSIBLE mCM PAYMENT					up to \$388.50

Note. Cumulative column indicates payment for videos only (baseline monitoring) and payment accrued for continuous abstinence to that point.

mCM = mobile contingency management.

Table 2.

Smoking cessation outcomes

Smoking Cessation Outcomes (%)		
	iCommit (n = 21)	ITC (n = 13)
3 month		
7-day point prevalence abstinence	9.5	7.7
30-day point prevalence abstinence	9.5	7.7
6 month		
7-day point prevalence abstinence	19.0	15.4
30-day point prevalence abstinence	4.8	15.4
Saliva cotinine	14.3	15.4

Table 3.

Participant Demographics and Baseline Characteristics

	iCOMMIT (<i>n</i> = 21)	ITC (<i>n</i> = 13)	Total (<i>N</i> = 34)
<i>Age, Mean (SD)</i>	49.2 (10.3)	46.8 (9.9)	48.2 (9.9)
<i>Race (N, %)</i>			
Black/African American	13 (62%)	8 (62%)	21 (62%)
White	3 (14%)	1 (8%)	4 (12%)
More than one race	4 (19%)	4 (30%)	8 (24%)
Amer. Ind./AK native	1 (5%)	0 (0%)	1 (2%)
<i>Diagnosis (N, %)</i>			
Schizophrenia	13 (62%)	2 (15%)	15 (44%)
Schizoaffective disorder	7 (33%)	11 (85%)	18 (53%)
Psychotic Disorder, NOS	1 (5%)	0 (0%)	1 (3%)
<i>Psychotic Symptoms Mean (SD)</i>			
SAPS	20.6 (15.9)	30.0 (26.7)	23.3 (20.7)
CAINS MAP	10.0 (6.1)	15.0 (7.8)	11.9 (7.0)
CAINS EXP	3.5 (3.6)	5.4 (5.1)	4.9 (4.1)
<i>Smoking Mean (SD)</i>			
FTND	5.8 (1.6)	6.7 (2.8)	5.9 (2.3)
Cigarettes per day	14.0 (6.7)	25.2 (14.8)	17.6 (11.7)

Note. SAPS = The Scale for the Assessment of Positive Symptoms; CAINS = The Clinical Assessment Interview for Negative Symptoms; MAP = Motivation and Pleasure subscale; EXP = Expression subscale; FTND = Fagerstrom Test for Nicotine Dependence.