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Contingent Vouchers and Motivational Interviewing for Cigarette Smokers in Residential Substance Abuse Treatment

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Abstract

Residential drug treatment provides an opportunity to intervene with smokers substance use disorders (SUD). A randomized controlled clinical trial compared: (1) Contingent Vouchers (CV) for smoking abstinence to Noncontingent Vouchers (NCV), crossed with (2) Motivational Interviewing (MI) or Brief Advice (BA), for 184 smokers in SUD treatment. During the voucher period, 36% of carbon monoxide readings indicated smoking abstinence for those receiving CV versus 13% with NCV ($p < .001$). Post-treatment point-prevalence abstinence rates were low (3–4% at each follow up), with more abstinence when CV was combined with MI (6.6% on average) than with BA (0% on average). No differential effects on drug use or motivation to quit smoking occurred. Thus, CV had limited effects on long-term smoking abstinence in this population but effects were improved when CV was combined with MI. More effective methods are needed to increase motivation to quit smoking and quit rates in this high-risk population.

Keywords

contingent vouchers; contingency management; financial incentives; motivational interviewing; brief advice; smoking cessation' substance use disorders; point-prevalence abstinence; nicotine dependence; motivation to quit smoking

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1. Introduction

Smokers with substance use disorders (SUD) smoke more heavily than do smokers in general (e.g., Compton, Thomas, Stimson & Grant, 2007; Moliterno et al, 1994; Roll et al, 1996). Smokers with SUD have synergistic health risks (Castellsague et al., 1999; Pelucchi, Gallus, Garavello, Bosetti, & La Vecchia, 2006), and more alcohol dependent smokers die from tobacco than from the alcohol use disorder (AUD) (Hurt et al., 1996; Hurt & Patten, 2003; Zacny, 1990). Smoking cessation trials enrolling people with SUDs during substance treatment had very limited success in affecting smoking (e.g., Bien & Burge, 1991; Joseph, Willenbring, Nugent, & Nelson, 2005; Kalman et al., 2001; Monti, Rohsenow, Colby, & Abrams, 1995; Prochaska, Delucchi & Hall, 2004). Improving ways to help smokers with SUD to quit smoking is important for their health.

While SUD treatment provides a window of opportunity for smoking intervention, low motivation to quit smoking within 6 months is a major barrier to cessation in this population (Burling, Ramsey, Seidner, Kondo, 1997; Flach & Diener, 2004; Irving, Seidner, Burling, Thomas, & Brenner, 1994; Martin, Rohsenow, MacKinnon Abrams & Monti, 2006; Monti et al., 1995; Richter, Gibson, Ahluwalia & Schmelze, 2001; Sees & Clark, 1993; Seidner, Burling, Gaither, & Thomas, 1996). Since low pretreatment motivation predicts low success for smoking cessation in smokers with SUD (Rohsenow, Martin, Tidey, Monti, & Colby, 2013), treatments designed to enhance motivation may be particularly relevant for these smokers. Methods of motivating smoking abstinence include Motivational Interviewing (MI; Miller & Rollnick, 1991, 2002), Brief Advice (BA; Manley, Epps, Husten, Glynn, & Shopland, 1991), and contingent vouchers (CV) for smoking abstinence (Higgins et al., 2004).

MI uses an empathic nonconfrontational therapist style, emphasizes the client's personal responsibility and choice about change, and provides objective feedback about the effects of the substance on the client (in most studies), advice to change, and advice about methods available for making change. Controlled studies of MI for smoking have had mixed results. MI or a similar motivational counseling in general practice settings resulted in more point-prevalence abstinence than did various types of BA (Butler et al., 1999; Soria, Legido, Escalano, Yeste, & Montoya, 2006). Meta-analyses concluded that MI is more effective for adult smoking cessation than other counseling methods but with a small effect (2.3% more smokers abstinent) (Heckman, Egleston, & Hofmann, 2010; Hettema & Hendricks, 2010). Among adults not seeking to quit smoking (thus similar to smokers with SUD), "motivational advice" produced more quit attempts compared to no treatment although it was not more effective than smoking reduction counseling with nicotine replacement (Carpenter, Hughes, Solomon, & Callas, 2004).

BA refers to a standardized procedure involving brief advice to quit smoking and brief coping skills training using methods designed to increase motivation (e.g., Glynn & Manly, 1990). BA is recommended for low motivation smokers in primary care settings in clinical practice guidelines (Coleman, 2004; Fiore et al., 2000; Hollis, Lichenstein, Vogt, Stevens, & Biglan, 1993; Katz, Muehlenbruch, Brown, Fiore, & Baker, 2004; Manley et al., 1991). Across studies, smokers in general show a 30% increase in odds of quitting with BA (Fiore

et al., 2000; Rigotti, 2002). BA versus MI for methadone-maintained smokers showed about 5% abstinent at 6 months with either approach (Stein et al., 2006). Our previous clinical trial compared MI to BA for tobacco cessation among smokers in residential SUD treatment (Rohsenow et al., 2014). The smokers with more pretreatment drug use days who received BA were the only ones with abstinence at 12 months (7% versus 0%), perhaps because the strong direct message to quit smoking used in BA is more consistent with the strong messages about abstinence provided in SUD treatment than the MI message that change is up to them. Furthermore, BA increased post-treatment motivation to quit smoking more than did MI. Therefore, the next logical approach for this research program was to determine whether another method of increasing abstinence could enhance the effects of either BA or MI for smokers with SUD.

CV based smoking treatments provide vouchers for tangible incentives (money or merchandise) contingent on abstinence or reduction in smoking to a target level. CV methods have long been known to increase smoking abstinence in the general population (reviewed in Higgins, Tidey & Rogers, 2009; later study by Secades-Villa, García-Rodríguez, López-Núñes, Alonso-Pérez, & Hernández-Hermida, 2014), although most of these were laboratory analogue studies. Generally subjects return to regular smoking when CVs are withdrawn in studies relying on CV without counseling (Ledgerwood, Arfken, Petry & Alessi, 2014; Robles et al., 2005; Stitzer et al., 1986; Stitzer & Bigelow, 1982, 1983, 1985) so there is a need to incorporate CV into cessation counseling.

Ten published studies have investigated CV for smoking abstinence among smokers with SUD, mostly smokers receiving pharmacologic treatment for opiate dependence (reviewed by Sigmon & Patrick, 2012). In general, CV significantly increased smoking abstinence while the incentives were in place, but not for long after incentives were terminated (Alessi & Petry, 2014; Alessi, Petry & Urso, 2008; Dunn et al., 2008, 2010; Hunt et al., 2010; Robles et al., 2005; Shoptaw et al., 1996, 2002; Wiseman et al., 2005). Very few of these studies included behavioral counseling: these included brief smoking skills training (Robles et al., 2005), brief behavioral support (Alessi & Petry, 2014), and relapse prevention training (Shoptaw et al., 2002). Since CV is particularly effective at increasing abstinence early in treatment, it may have complementary effects with counseling approaches that build motivation during the treatment and thereby extend the effects of CV past the end of the incentive period (e.g., Carroll et al., 2006). Therefore, we conducted the first fully-powered randomized trial to investigate the effects of CV for smoking abstinence combined with counseling to increase motivation and coping skills among patients with SUD so as to see if effects of CV will persist after vouchers when combined with methods to increase intrinsic motivation.

The primary purpose of the study was to evaluate the hypothesis that CV, compared to non-contingent vouchers (NCV), when combined with either MI or BA, would increase the likelihood of tobacco abstinence among smokers with SUD, both while the contingencies are in place and during the 12-month follow-up period. While there is no theoretical reason for BA to be more or less effective than MI in increasing smoking abstinence, BA was more effective than MI for smokers with SUD in our previous study (Rohsenow et al., 2014). We also investigated several possible moderators of treatment effects: number of drug use days

(per Rohsenow et al., 2014); initial motivation to quit smoking (Rohsenow et al., 2013); nicotine dependence (using minutes to first cigarette per Transdisciplinary Tobacco Research Center, 2007); and gender. No effects on substance use during follow up were expected but were investigated due to concerns in the treatment provider community about effects of smoking cessation on sobriety (Monti et al., 1995; Prochaska, 2010).

2. Materials and Methods

2.1 Participants

2.1.1 Site—The clinical site was a state-funded inner-city 28-day residential substance abuse treatment program with state-wide catchment (The Providence Center, Residential Services program). The program was abstinence-oriented and provided SUD education in a group format based on 12-Step models, with outpatient aftercare available, with about 30 inpatients at a time. Smoking cessation was not addressed by the program and smoking was allowed outdoors at breaks. In-service training with clinical staff explained the benefits of smoking cessation for people with SUD. We had been conducting smoking treatment studies with SUD patients there for a number of years already. Any patient could receive our smoking self-help materials without participating in our research.

2.1.2 Eligibility Criteria—A trained research therapist determined eligibility and diagnosis. Patients were eligible if they met current DSM-IV SUD criteria (see 2.4.3), smoked at least 10 cigarettes per day for the past 6 months, and were not engaged in smoking treatment. Patients were excluded if they were psychotic, actively suicidal, terminally ill, cognitively impaired (unable to understand informed consent when tested on comprehension; none were excluded for this), or could not read. Recruitment occurred from June 2002 to June 2006. Recruits were told the study would provide “informational sessions about smoking” without requiring cessation and would offer payments either for reduced smoking followed by abstinence, or just for providing breath samples for 19 days, and that after the 19-day voucher period, they would receive free nicotine replacement for up to 8 weeks.

2.2 Overview of Procedures

The design was a 2 (CV vs. NCV) by 2 (MI vs. BA) randomized controlled clinical trial in which participants were randomized to one of four groups: CV + MI, CV + BA, NCV + MI, NCV + BA. Stratified random assignment, using urn randomization (Stout et al., 1994), was done on the first day of the voucher period while stratifying for gender, nicotine dependence severity (median split) based on the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991), and motivation to change smoking (median split) as assessed by the Smoking Contemplation Ladder (CL; Biener & Abrams, 1991) score. The median split for FTND and the Smoking Contemplation Ladder were based on medians from a previous study with participants from the same clinical site (Rohsenow et al., 2014). Follow ups were at 1, 3, 6 and 12 months with CO or cotinine confirmation. To ensure adequate follow-up rates detailed contact information was collected at baseline, the costs of transportation to an agreed upon interview location was covered by

the study, some reminders were sent, and participants consented to designate a significant other as a locator if we lost contact with the participant.

2.3 Interventions

2.3.1 Procedures applying to both MI and BA—Both MI and BA were provided in four sessions: at baseline (the day before starting the voucher period) and 7, 14 and 19 days after the first session. Both interventions were fully manualized and audiotaped. All participants were informed of free access to nicotine replacement therapy (NRT; transdermal nicotine patch or nicotine gum; doses per product insert) for up to 12 weeks after the first 3 weeks if medically eligible, smoking cessation pamphlets, and hard candy (chewing gum not allowed on site). NRT was not offered during the 19-day active treatment period so as not to confound the assessment of CV vs. NCV, as those in the CV condition would more likely to use NRT, and so participants would not have any incentive to drop out of CV early to get access to NRT. To prevent diversion, participants were required to turn in their used gum or blister pack to receive the next day's dose, and to put on the patch in staff presence.

2.3.2 Motivational Interviewing—MI used a motivational therapist style with assessment feedback, as recommended by Miller & Rollnick (1991), provided from a computer-generated personalized feedback report that we programmed. The initial session (45 min) involved discussing pros and cons of smoking, the health risks associated with their carbon monoxide (CO) level, the costs of smoking relative to their income, their smoking rate compared to state and national norms, the relationship of smoking to alcohol use and to sobriety, and their barriers to change (Asher et al., 2003) with corrective information (since more barriers are associated with lower motivation, Martin, Rohsenow, MacKinnon, Abrams, & Monti, 2006). Patients chose goals and methods from a menu of suggestions, and were provided with their choice of a variety of smoking cessation pamphlets. At additional sessions at 7, 14 and 19 days after the first session (15–30 min each), patients were asked about progress toward their own stated goals, barriers and ways to overcome barriers, successes (focusing on self-efficacy), and revised goal preferences. The last session discussed coping with the transition off of the contingencies.

2.3.3 Brief Advice—BA to promote motivation to quit used AHRQ-recommended methods (Manley et al., 1991; Hollis et al., 1993), adapted for SUD recovery issues. In the initial session (15 min), therapists assessed smoking rate and interest in quitting, directly advised patients to stop smoking now during SUD treatment for their health, assisted by giving advice about useful methods (quit date, nicotine replacement, support from family/friend, community resources, groups on site), and asked them to set a quit date within the next 2 weeks. If patients expressed concern about effects on sobriety, they were given corrective information. Patients were given a consumer guide for smoking cessation and were encouraged to select from a variety of nationally available published pamphlets on smoking cessation (e.g., effects on children, smoking and food, handling withdrawal, etc.). Additional sessions at 7, 14 and 19 days after the first session (10–15 min each) checked on progress toward smoking cessation, engaged in problem-solving around barriers (including concerns about effects on substance use, adapting the measure by Asher et al., 2003), noted successes in accomplishing goals in terms of methods they should continue using, repeated

direct advice to quit smoking for their health, and reminded them of methods available including the pamphlets. The last session discussed coping with the transition off of the contingencies.

2.3.4 Therapists and monitoring—Interventions were provided by one of three research therapists (two masters' level and one Ph.D.), with each conducting both types of treatment. Therapists received 30 hours of training in MI including supervised role-plays and practice with the treatment manual, conducted by the first author who had received 2-day MI training from Steven Rollnick (one of the original developers of MI). Training in BA involved 10 hours of training and role-played practice. Treatment session audiotapes (15% of initial sessions, 10% of additional sessions) were reviewed in weekly group supervision with the treatment coordinator and a psychologist trained in MI, and rated for MI style and adherence to the manual (see 2.4.4), with immediate feedback to therapists to prevent drift.

2.3.5 Contingent Voucher procedures—Vouchers were provided during a 5-day reduction phase plus a 14-day abstinent phase. CO monitoring used an EC50 Micro III Smokerlyzer® (Bedfont Scientific Ltd, Kent UK). We encouraged patients to use this opportunity as a way to start a lifetime of tobacco abstinence. Research staff explained the procedures in detail and provided a written handout explaining the contingencies.

Baseline phase: Breath CO was collected for two mornings between 8:00 and 8:15 AM, and the average of the two readings was used as the baseline CO level.

Reduction phase: Breath CO level was collected each morning between 8:00 and 8:30 a.m. for 5 days. Participants received a printed voucher with a monetary value of $2 per test for a 25% reduction from baseline CO level, $4 for 50% reduction, and $6 for a 75% or greater reduction.

Abstinence phase: Breath CO level was collected each morning between 8:00 and 8:30 a.m. and each afternoon between 5:30 and 6:00 p.m. for the next14 days. An escalating schedule of payments provided increasing levels of payments in vouchers for each successive CO level that showed abstinence (CO reading ≤6 ppm, per Cummings & Richard, 1988; Lamb et al., 2010) ranging from $3 for the first sample to $16.50 for the 28th consecutive abstinent breath sample, and with $10 bonuses provided every time three consecutive readings showed abstinence. Whenever a breath sample did not meet the criterion for abstinence, the participant earned no voucher and the payment schedule reverted to the initial $3 level, then after three consecutive abstinent samples the schedule returned to the payment level at which the reset occurred. This component was designed to support efforts to regain abstinence following a lapse. Participants who completed all 19 days of samples and missed no more than three of the scheduled breath tests earned a voucher for a $40 bonus (total possible = $433).

2.3.6 Noncontingent Voucher procedures—In NCV participants could earn the same payments per day for 19 days as those randomized to CV, simply for providing breath samples as scheduled. The NCV condition controls for the effects of receiving vouchers, providing daily breath samples to be analyzed for CO level, and degree of interaction

between patient and research staff. Participants provided breath samples on the same schedule as those in the CV group, and the identical system of records, vouchers and merchandise certificates were used for payments.

2.3.7 Vouchers and payments—In addition to printed vouchers participants received, staff maintained a log of vouchers earned in case of loss of vouchers. Vouchers were redeemed for merchandise certificates to popular area stores any day the participant requested them (usually when leaving on pass or providing them to family, both only available on weekends). Merchandise certificates were deposited in their accounts at the treatment agency weekly to protect them from theft while participants were in residence.

2.4 Assessments

2.4.1 Assessment procedures—Research interviewers blind to treatment condition conducted all assessments. Follow-up interviews, in person, were about 1, 3, 6 and 12 months after the initial session. Participants were given a breath alcohol test (per Sobell and Sobell, 1986) using Alco Sensor IV by Intoximeters; none had a breath alcohol reading > .02 g/dL. Follow-up interviews were conducted away from the clinical site after discharge, and all were assured that clinical staff would not be informed of the information provided, per Sobell and Sobell (1986). Participants received $35, $40, $45, and $50 in merchandise certificates for the 1, 3, 6, and 12 month interviews, respectively, and $15 in merchandise certificates at each follow-up for completing the interviews within 14 days of the due date. Significant others (family member or close friend) received $15 per assessment for their time and travel.

2.4.2 Outcome measures—A Timeline Followback interview (Brown et al., 1998; Ehrman & Robbins, 1994; Sobell & Sobell, 1980) was used at baseline (for 6 months pre-admission) and follow ups (for the period since the previous interview) to collect daily data on smoking, alcohol, and other drugs, scored for number of days of use and number of cigarettes and drinks per day. The primary smoking outcome measure during follow-up, 7-day point-prevalence abstinence, was confirmed with a CO level ≤4 ppm and salivary cotinine level ≤ 15 ng/ml (Cropsey et al., 2014; Hughes et al., 2003; Lamb et al., 2010). (CO was used within-treatment; cotinine was used at follow-ups except if the person was using nicotine replacement when CO needed to be used instead.) Urine drug screens (On Trak® test cups for screening confirmed with EMIT, gas chromatography and mass spectrometry) were conducted at follow-up. To count as abstinent from drugs, both self-report and urine drug screen must have been negative. A significant other was interviewed about the patient's substance use to make participants believe that we could check the validity of their answers, but since such reports do not increase validity, they were not used as data (per Sobell & Sobell, 1986). Alcohol abstinence self-reports were accepted since there is no valid way to confirm them given the short half-life of alcohol and unreliability of significant other reports as confirmation. (See section 2.5.2 for handling missing data and data imputation methods.)

2.4.3 Individual difference measures—Current SUD diagnoses were made using the criteria of the Structured Clinical Interview for DSM-IV-Patient version (First, Spitzer, Gibbon, & Williams, 1995), administered by trained research interviewers. Other individual

difference measures at baseline included a smoking history questionnaire, breath CO, and the Fagerström Test for Nicotine Dependence (FTND; Heatherton, Kozlowski, Frecker, & Fagerström, 1991) from which minutes to first cigarette was obtained. Responses to the 5-question stage of change algorithm (Prochaska & DiClemente, 1992) were given to research therapists to help them tailor their motivational approach in the session. MI feedback forms included current number of cigarettes per day (with current annual cost to them), CO level at baseline (with health interpretations), and information from the following measures: Smoking Temptations Questionnaire (Velicer, DiClemente, Rossi, & Prochaska, 1990), Nicotine and Other Substance Interaction Expectancy Questionnaire (Rohsenow, Colby, Martin, & Monti, 2005), Barriers to Quitting Smoking in Substance Abuse Treatment (BQS-SAT; Asher et al., 2003), revised to change “alcohol” to “alcohol or drugs”.

2.4.4. Process and treatment delivery measures—At baseline and 1-month, participants completed the Smoking Contemplation Ladder (CL; Biener & Abrams, 1991), a single 10-point fully-anchored scale from 1 (no interest in quitting) to 10 (I have quit smoking and will never smoke again). During treatment we recorded use of NRT, the number of CO readings less than 6 ppm in the voucher period, and length of stay per agency records.

Treatment supervisors endorsed the adequacy of six MI adherence items (whether the treatment provider adequately discussed ambivalence [pros and cons, goal discrepancies], discussed the feedback about smoking effects, explored barriers to change, provided summaries, discussed various goals, and discussed methods for change). Treatment sessions were rated by the treatment supervisors on 1 (not at all) to 5 (extensively) scales for five motivational style measures (arguing, demonstrating empathy, reflective listening, supporting self-efficacy, emphasizing personal responsibility for change). All ratings were done for both conditions.

2.5 Data Analysis Approach

2.5.1 Preliminary analyses—Analyses were conducted using IBM SPSS Statistics® for PC except that multiple imputation analyses were run using MIANALYZE procedures (SAS/STAT, 2013) and moderation analyses were run using PROCESS (Hayes, 2012). All variables were checked for assumptions of normality and outliers, and other assumptions underlying regression. (Log transformation was required only for number of heavy drinking days, number of drug use days at follow-up, and minutes to first cigarette. Untransformed values are presented for ease of interpretation.) All other requirements for GEE, regression, and analysis of variance were met. Treatment group differences in baseline characteristics, in length of treatment (program, study counseling, and contingency period), in number of days of NRT use, and in follow-up rates were examined with 2 X 2 (contingency type by counseling type) one-way analyses of variance (ANOVA) for continuous variables, 2-group (contingency type or counseling type) chi-square tests for dichotomous variables, and 2-group (counseling type MI vs. BA) one-way ANOVAs for supervisor ratings of therapist style.

2.5.2 Handling missing data—At follow-up, people with a CO > 4 ppm, cotinine > 15 ng/ml (if not using NRT), or missing CO or cotinine data, or with self-reported smoking were coded as having smoked with the following exception: if the participant was in prison, self-report was accepted since biological verification equipment was not allowed so lack of verification was unrelated to participant decision. People claiming abstinence from drugs but who had a positive, missing or contaminated drug screen were coded as having used drugs for that follow-up interval with the following exceptions: 1) If the participant was in prison (N = 5 MI + CV, N = 5 BA + CV, N = 4 MI + NCV, N = 4 VA + NCV), self-report was accepted since urine samples were not allowed so lack of verification was unrelated to participant decision (Brown et al., 2009). (Number of prisoners claiming abstinence: N = 2 at 3 mo., N = 1 at 6 mo., N = 3 at 12 mo.) Participants who died during follow-up (*n* = 1 for all follow-ups and *n* = 3 at 12 months) were coded as missing for outcomes after death.

Since positive imputation, while the standard for smoking research since most likely to reflect the true values (e.g., Higgins & Green, 2011), could lead to false positives, analyses were re-run using multiple imputation methods (per Higgins & Green, 2011) to provide sensitivity analyses (Rosenbaum, 2005). We imputed data for those missing verified abstinence, average cigarettes per day, or number of days that any drugs were used at each follow up. Multiple imputation provides a method for handling missing data where missing values are imputed for each missing variable to complete the data (Rubin, 1987). Multiple imputation was performed for the outcome variables using multiple linear or logistic regression plus a random component to produce the imputed values. One-hundred-fifty imputed data sets were generated to yield estimates that were better than 95% efficient (Rubin, 1987; Schafer & Graham, 2002). Separate regression analyses were performed using all 150 of the imputed data sets, and the final results represent the effect sizes averaged across the 150 sets of estimates. Since none of these sensitivity analysis results differed in significance level from the analyses without multiple imputation, analyses with multiple imputation are not presented.

General estimating equations (GEE; Zeger and Liang, 1986) models tested the effects of intervention condition on primary and secondary outcomes over time (1, 3, 6 and 12 month follow-up). In these models, the main effects of contingency type and counseling type examined whether outcomes differed over the follow-up period. The two-way interaction of contingency type by counseling type was entered on the second step along with the two-way interactions of contingency type by time, and counseling type by time. The interactions with time examined whether the time slope, or rate of change, differed by these factors.

2.5.3 Analyses of post-treatment outcome—Two post-treatment outcome measures for smoking were chosen: 7-day point-prevalence abstinence confirmed with CO and cotinine (per Hughes et al., 2003) and number of cigarettes per day (to detect reductions in smoking short of abstinence). Three substance use outcome variables were used: number of heavy drinking days (more than 6/4 standard drinks per day for men/women, per Flannery et al., 2002) log transformed during each follow-up period, number of drug use days log transformed during each follow-up period, and relapse to any heavy drinking or drug use over the 12 months. Analyses of the full intent-to-treat sample were conducted using 2 X 2 (contingency type by counseling type) GEE analyses. To follow-up significant interactions

of contingency type and counseling type, we examined the effect of counseling type at each level of contingency type using the Wald statistic as the basis for significance testing (Tabachnick & Fidell, 2013). Results were also analyzed for each time period separately to compare with other studies.

2.5.4 Within-treatment and process analyses—One within-treatment outcome and two process measures were chosen: number of readings with CO abstinent during the 14-day abstinence induction phase of the contingency period, use of NRT during months 2–3 of follow up, and pre-post change in CL. CO levels were analyzed with 2 X 2 (contingency type by counseling type) ANOVA during the contingency period. The CL scores were analyzed with 2 X 2 X 2 repeated measures (pretreatment, 1 month) ANOVA; and 2 x 2 contingency type by counseling type logistic regression was used for use of NRT during months 2–3 of follow-up.

2.5.5 Moderator analyses—Moderation analyses (to inform patient-treatment matching) were conducted with pretreatment nicotine dependence (fewer minutes to first cigarette pretreatment), pretreatment frequency of drug use days, gender, and initial motivation level using the CL as the moderator variables. (Initial motivation level was predicted only to differentially affect CV versus NCV response, since both types of counseling are designed to induce motivation equally.) The outcome variables used for the moderator analyses were confirmed 7-day smoking abstinence and average cigarettes per day. In moderator analyses, the potential matching variable was entered with either contingency type or counseling type in path analysis-based moderation models (per Hayes, 2012). The model entered the matching variable, contingency type or counseling type in the first step, and the 2-way interaction of treatment and matching variable on the second step. Significant interaction effects were followed with simple slopes tests.

3. Results

3.1 Sample Size and Attrition

Of 249 eligible patients, 234 (94%) consented, and 184 (79% of the consented) stayed at the site long enough to be randomized to treatment (the intent-to-treat sample). (See Figure 1 for flow chart.) Of these, 98 (53.3%) were assigned to MI, 86 (46.7%) were assigned to BA, 97(52.7%) were assigned to CV, and 87 (47.3%) were assigned to NCV; all received their assigned treatment. Mean number of days in the residential program was 43.6 ± 23.9 [S.D.] with no significant difference between conditions. Of 184 randomized to treatment, 1-mo follow-up was completed by 168 (91.3%), 3-mo follow-up was completed by 160 (87%), 6-mo follow-up was completed by 154 (83.7%), and 12-mo follow-up was completed by 139 (75.5%), with no significant differences by condition. One person who died before the first follow-up was not included in any analyses, resulting in n = 183 for analyses. Two-group ANOVAs or χ^2 analyses showed no differences between those who completed the follow-up versus those who did not complete the follow-up at each time on demographic variables (race, gender, age, education) or clinical variables (FTND, number of drinking days) except that those who completed the follow-up interview at 1 month were slightly younger (M = 34.1 ± 8.2 years) than those who did not (M = 38.6 ± 6.8; $t(182) = 2.09$, $p = .04$. Completion

of the CO collection during the contingency period and number of study counseling sessions attended did not differ significantly by treatment condition. Of those with follow-up data collected, CO data at follow-up was missing for 16.7% (N=28) at 1 month, 33% (N=53) at 3 months, 17% (N=26) at 6 months, and 18.7% (N=26) at 12 months. Collection of CO data during follow-up did not differ significantly by treatment condition, except at 6 month follow-up where 90% (N = 63) of those in BA provided CO and 77.4% (N = 65) of those in MI provided CO, $\chi^2 = 4.33$, $p = .04$. Interviews were conducted at prison/jail for 4.4% (N = 7) at 3, 7.9% (N = 12) at 6, and 11.6% (N = 16) at 12 months where no CO data collection was allowed, as noted above (section 2.5.1). No serious adverse events related to the study occurred.

3.2 Participant Characteristics

Participants' mean age was 34.5 ± 8.2 years; 83.2% (N = 153) were white, 9.2% (N = 17) were black, 7.5% (N = 14) were of other races; 6.6% (N = 12) were Hispanic; 44.6% (N = 82) were male; 10.9% (N = 20) were married or living with a romantic partner. In addition, participants' mean education level was 12.2 ± 1.7 years; 81.9% (N = 164) were unemployed in the week before entering treatment, and their mean legal income was $9,487 ± 13,619 in the past year. At pretreatment, participants showed a CO level of $M = 16.4 ± 7.4$ ppm; smoked $M = 22.3 ± 9.4$ cigarettes/day; had a mean FTND score of 5.28 ± 2.29, and had a mean (median) minutes to first cigarette of 33.0 (15.0) ± 44.6 minutes (median provided due to skewness). They had been smoking daily on average for 18.3 ± 8.4 years. The current drug or alcohol diagnoses were: 71.2% (N = 131) alcohol abuse or dependence, 73.9% (N = 136) cocaine abuse or dependence, 52.8% (N = 97) opiate abuse or dependence, and 37% (N = 68) marijuana abuse or dependence. Participants drank 6.3 ± 14.3 drinks per day, had heavy drinking on 23.1 ± 30.7% of days, and had used drugs 43.6 ± 37.1% of days during the 6 months pretreatment. Contingency type by counseling type ANOVAs or χ^2 analyses showed no differences between conditions for demographic variables or any pretreatment smoking or substance use variable. (See Table 1 for values by treatment condition. Untransformed values of the log-transformed variables are displayed to aid interpretation.)

3.3 Confirmation of Abstinence during Follow-up

Of people reporting 7-day abstinence from smoking at each follow-up, 8 out of 9 at 1 mo., 6 out of 6 at 3 mo., 5 out of 6 at 6 mo., and 8 out of 8 at 12 mo. were confirmed abstinent by cotinine or CO level. Of people reporting abstinence from drugs at each follow-up, 9.7% (13 of 134) at 1 mo., 11.3% (12 of 106) at 3 mo., 15% (18 of 122) at 6 mo., and 8.3% (9 of 109) at 12 mo. were identified as using drugs by urine screen.

3.4 Treatment Style and Adherence Ratings by Supervisor

Therapists were significantly more likely in MI vs. BA to discuss the following topics: increase ambivalence about smoking (93% of MI, 4% of BA sessions), provide assessment feedback (100% of MI, 0% of BA sessions), explore barriers to quitting smoking (100% of MI, 17% of BA sessions), provide summaries (100% of MI, 0% of BA sessions), discuss methods of quitting or preparing to quit (100% of MI, 58% of BA sessions), and discuss possible goals (100% of MI, 14.8% of BA sessions), all χ^2s > 19.58, all ps < .001. Therapist

style ratings did not differ significantly between treatment conditions for arguing, empathy, or reflective listening, but in MI therapists were more likely to support self-efficacy and emphasize personal responsibility (χ^2s from 3.82 to 11.08, *p*s < .05).

3.5 Treatment Outcomes

3.5.1 Smoking abstinence during abstinence contingency period by condition

—During the 14-day period when only abstinence earned vouchers in the CV condition, there was a main effect for contingency type on percent of CO readings indicating abstinence, $F(1, 180) = 26.78$, $p < .001$. There was no effect for counseling type or interaction between counseling and contingency type. In CV, on average 35.5% ± 35.3% (N = 10.0) of CO readings were abstinent compared to 12.9% ± 20.0% (N = 3.6) in NCV. In CV, 6.2% (N = 6) of participants were abstinent for all 28 readings compared to 1.0% (N = 1) in NCV, $\chi^2 = 3.18$, $p = .07$ (Fisher's exact test, 1-tailed). In MI, 3.1% (N = 3) participants were abstinent for all 28 readings compared to 4.7% (N = 4) in BA, $\chi^2 = .32$, *ns.* Total amount earned within-treatment was $92.61 in CV, $280.80 in NCV.

3.5.2 Smoking abstinence at follow ups by condition—Confirmed 7-day point-prevalence smoking abstinence averaged 4.4% (N = 8 out of 183) at 1 mo., 3.3% (N = 6 out of 183) at 3 and 6 months, and 4.3% (N = 8 out of 181, excluding 2 more people who died) at 12 months. The 2 X 2 GEE model (*N* = 183) identified no main effects for contingency type or counseling type, and no interaction effects with time. There was a significant contingency type by counseling type interaction, $B = -2.65$ ($SE = 1.33$), Wald χ^2 ($df = 1$) = 3.99, $p < .05$. Follow-up tests showed that within the CV condition there was a significant effect demonstrating higher overall 7-day point-prevalence smoking abstinence in those who received MI vs. BA, $B = 2.49$ ($SE = 1.08$), $OR = 12.10$, $CI = 1.46$ to 100.48, Wald χ^2 (df = 1) = 5.33, p <.05. For those who received CV, MI increased the likelihood of abstinence by 12 times compared to BA. (See Table 2 for details, and Figure 2).

3.5.3 Cigarettes per day by condition—The GEE model identified no main effect for treatment, contingency by counseling interaction, or interactions with time but did indicate a significant overall time effect, $B = 1.22$ ($SE = 0.24$), Wald χ^2 ($df = 1$) = 25.22, $p < .01$. Positive B-weights indicated a significant increase in cigarettes smoked per day over the 12 month follow-up period. Follow-up post-hoc Tukey tests found that 1-month cigarettes per day, $M = 10.3 \pm 6.4$, differed from 3 month, $M = 13.1 \pm 7.6$, 6 month, $M = 13.1 \pm 8.2$, and 12 month, $M = 14.4 \pm 9.1$ cigarettes per day (*p*s < .01). To test if cigarettes per day at follow-up were reduced compared to pretreatment, we added pretreatment cigarettes per day to the model. Collapsed across all treatments, average cigarettes per day at each follow-up were reduced when compared with pretreatment (*p*s < .001).

3.5.4 Moderator analyses—Moderation analyses on smoking abstinence during the post-treatment follow-up period entering pretreatment minutes to first cigarette, CL score, or number of drug use days as a factor were nonsignificant. Moderation analyses on cigarettes per day at follow-up entering pretreatment minutes to first cigarette, CL score or number of drug use days as a factor in the analyses were also nonsignificant. When minutes to first

cigarette was replaced with FTND, models were still nonsignificant. In analyses adding gender as a factor, no significant main or interaction effects were found for gender.

3.5.5 Substance use outcomes—The GEE models predicting number of drug use days and number of heavy drinking days identified no main effect for treatment, contingency by counseling interaction, or interactions with time but did indicate a significant time effect for drug use days, $B = .20$ ($SE = 0.02$), Wald χ^2 ($df = 1$) = 90.57, $p < .001$, and heavy drinking days, $B = .14$ ($SE = 0.02$), Wald χ^2 ($df = 1$) = 60.50, $p < .001$, both indicating an increase over the whole period between 1 and 12 months. Post-hoc Tukey tests were performed on the log transformed variables to determine specific time points during which change occurred; the means and standard deviations of the untransformed variables are presented for easier interpretation. Results found 1-month number of drug use days, $M = 1.00 \pm 4.15$, was lower than at 3, $M = 4.33 \pm 10.69$, at 6, $M = 9.13 \pm 18.47$, and at 12 months, $M = 24.01 \pm 38.52$, and 12 month drug use days was significantly greater than all other follow-ups. Post-hoc Tukey tests found that 1 month number of heavy drinking days, $M = 0.30 \pm 2.28$, was lower than at 3, $M = 2.20 \pm 7.40$, at 6, $M = 9.88 \pm 12.45$, and at 12 months, $M = 12.33 \pm 31.72$, and 12-month heavy drinking days was significantly greater than all other follow-ups. Pretreatment drug use days and heavy drinking days at each follow-up were still reduced compared to pretreatment when pretreatment values were added to the model (*p*s < .001).

Analyses of number of participants with any relapse to drug or heavy alcohol use were also non-significant except for a significant time effect, $B = -.81$ ($SE = 0.08$), Wald χ^2 ($df = 1$) = 102.13, $p < .001$. Follow-up post-hoc tests found that 1-month relapse to drug or heavy alcohol use, 10.1% of participants (N = 17 out of 168, 16 missing), differed from 3-month, 33.8% (N = 54 out of 160, 24 missing), 6-month, 44.2% (N = 68 out of 154, 30 missing), and 12-month, 64.0% (N = 89 out of 139, 45 missing) (*p*s <.01), and 12-month differed from 3-month and 6-month values (*p*s <.01).

3.6 Process Measures

3.6.1 Contemplation Ladder—There were no significant effects for counseling type, contingency type, time, or interactions with time on CL score in the repeated measures (pretreatment and 1 month follow-up) 2 X 2 X 2 ANOVA.

3.6.2 Use of NRT Months 2–3 of Follow-up—NRT patch or gum was used by 22.8% ($n = 42$) of patients on $M = 10.60 \pm 13.21$ days during the 2–3 month follow-up period. Logistic regression found no significant differences by condition for percent of participants who used any NRT, and ANOVA found no effects of condition on number of days used NRT.

3.6.3 Multiple imputation analyses—Analyses re-run with multiple imputation methods for missing values on verified abstinence, average cigarettes per day, or number of drug use days did not differ in terms of significance level from the analyses without multiple imputation so details of multiple imputation analyses are not presented.

4.0 Discussion

CV, MI and BA each produced low rates of abstinence in this population, with only 3–4% of participants confirmed abstinent at each point of the one year follow up. However, the best outcomes across the year occurred when CV was combined with MI, resulting in 5.7 to 7.5% (mean of 6.6%) of participants being confirmed abstinent from smoking at each interval over the year of follow up. Most smoking treatments for smokers in SUD treatment do not present 1-year outcomes and/or show no significant effects of the smoking treatment (e.g., Stein et al., 2006). While Alessi and Petry (2014) showed 16% of smoking men treated in residential SUD treatment not smoking at 24 weeks, the trial was small, no differences by CV versus no CV were seen, and no 12-month results were reported. The 12-month smoking abstinence rates reported by Rohsenow et al. (2014) for alcohol dependent smokers in residential SUD treatment without CV were only 2% (0% after MI, 4% after BA, 7% after BA if pretreatment drug use was high). Compared to the very limited existing results from randomized trials of smokers recruited early in SUD treatment, even the relatively low abstinence rates in the present trial show some benefit for combining CV with MI.

Thus, contingent financial incentives when combined with MI do work better than each approach alone to promote smoking abstinence for many smokers with SUD, although with considerable room for improvement. Results were not differential for people with higher or lower pretreatment nicotine dependence, motivation to change, or number of drug use days. These results are encouraging about the value of combining financial incentives with MI but indicate that stronger combinations of smoking treatments are still needed for this population. During the voucher period, CV had significant short-term effects on number of abstinent readings, but even these rates were relatively low, with only 6% of participants having continuous abstinence throughout the contingent voucher condition. Thus, finding ways to increase abstinence during the voucher period are needed for this population.

Without voucher-based treatment (i.e., in the NCV condition), MI and BA had equivalent effects on abstinence. This is consistent with our previous study (Rohsenow et al., 2014) showing no advantage for MI overall (about 2% were abstinent in each counseling condition at each follow-up). The advantage for BA for a subset of individuals with heavier drug use that was found in our earlier study was not replicated in the present study despite the greater frequency of pretreatment drug use in the present study. Given that MI is more costly in therapist training and time, the present results indicate that BA is recommended in SUD programs that are not using voucher-based smoking treatment as a low-cost way to promote long-term smoking abstinence in 2–4% of individuals. While smoking cessation rates are still low, BA adapted for SUD programs is quick and easy to administer and, multiplied by the number of programs, could have a beneficial health effect in this population overall.

No harmful effects on substance use were found, consistent with most other controlled studies (reviewed by Monti et al., 1995; later studies by Burling, Burling, & Latini, 2001; Carmody et al., 2012; Hurt et al., 1994; Kalman et al., 2001; Nieva, Ortega, Mondon, Ballbè, & Gual, 2011; Reid et al., 2008; Rohsenow et al., 2014). Treatment providers are often reluctant to recommend smoking cessation to patients in SUD treatment for fear of harm to recovery (Prochaska, 2010). The present findings, combined with reviews or meta-

analyses that showed increased probability of lasting alcohol and drug abstinence after smoking interventions were provided concurrent with SUD treatment (Baca & Yahne, 2009; Prochaska, Delucchi, & Hall, 2004), indicate that SUD treatment providers should be encouraged to incorporate smoking treatment into SUD programs. Providing smoking cessation treatment early in SUD treatment did not have any harmful effects on sobriety among patients recently abstinent from their substances of abuse across studies except in one study, and that involved a mandatory smoking cessation program imposed on patients (Joseph et al., 1993).

Future directions for developing treatments that combine financial incentives with motivational counseling methods may include comparing the efficacy and cost-effectiveness of prize-based CV versus standard voucher methods (e.g., Alessi & Petry, 2014). Furthermore, given that higher levels of withdrawal discomfort reported by smokers with SUD predict less smoking abstinence during and after CV (Rohsenow, Tidey, Kahler, Martin, Colby, & Sirota, 2015), combining CV treatments with pharmacotherapies that reduce craving or withdrawal discomfort may boost the effectiveness of CV, as has been shown in smokers with serious mental illness (Tidey, Rohsenow, Kaplan, Swift, & Reid, 2011).

Limitations

Participants did not need to be motivated for smoking cessation to engage in this program so the current results may underestimate the effectiveness of these treatments among smokers who are ready to quit smoking. However, the purpose was to use SUD treatment as a the window of opportunity to find ways to motivate these smokers to try to quit smoking. Given the low levels of motivation to quit smoking in this population in general (Flach & Diener, 2004; Monti et al., 1995), including less-motivated smokers in this study best mirrored the motivation characteristics of this population. The study was conducted at one low-income inner city SUD treatment agency, and results might be different with higher-income populations and agencies requiring private funding. No adjunctive pharmacotherapy was permitted during the voucher period due to concerns about confounding the investigation of CV versus NCV, so the current results may underestimate the effects of these treatments when combined with nicotine replacement or other pharmacotherapies for smoking cessation. Smokers with missing biological confirmation of smoking abstinence were considered to be smoking, but analyses using multiple imputation indicated that the method of imputation did not affect any results.

Conclusions

Although voucher-based smoking treatment combined with MI has modest effects on smoking abstinence over the year after contingencies are withdrawn in this population, abstinence rates were significantly better when combining CV with MI compared to CV with BA or compared to BA or MI without CV. Thus, CV plus MI may be worth implementing in SUD programs to promote smoking abstinence. For SUD programs that do not have the resources for CV, BA and MI have equivalent effects on abstinence so BA is recommended as less costly in terms of time and training. These behavioral treatments need to be investigated in combination with pharmacotherapies for smoking cessation, since

reducing the aversiveness of smoking cessation might make smokers with SUD more likely to engage in cessation attempts.

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Highlights

- We provided contingent vouchers for smoking abstinence for smokers in residential drug treatment.
- We also provided motivational interviewing or brief advice to quit smoking.
- More smoking abstinence occurred in treatment with contingent vouchers than without.
- In the following year, smoking abstinence was low, 3 to 4% of patients.
- Smoking abstinence was greater for people who got vouchers and motivational interviewing.

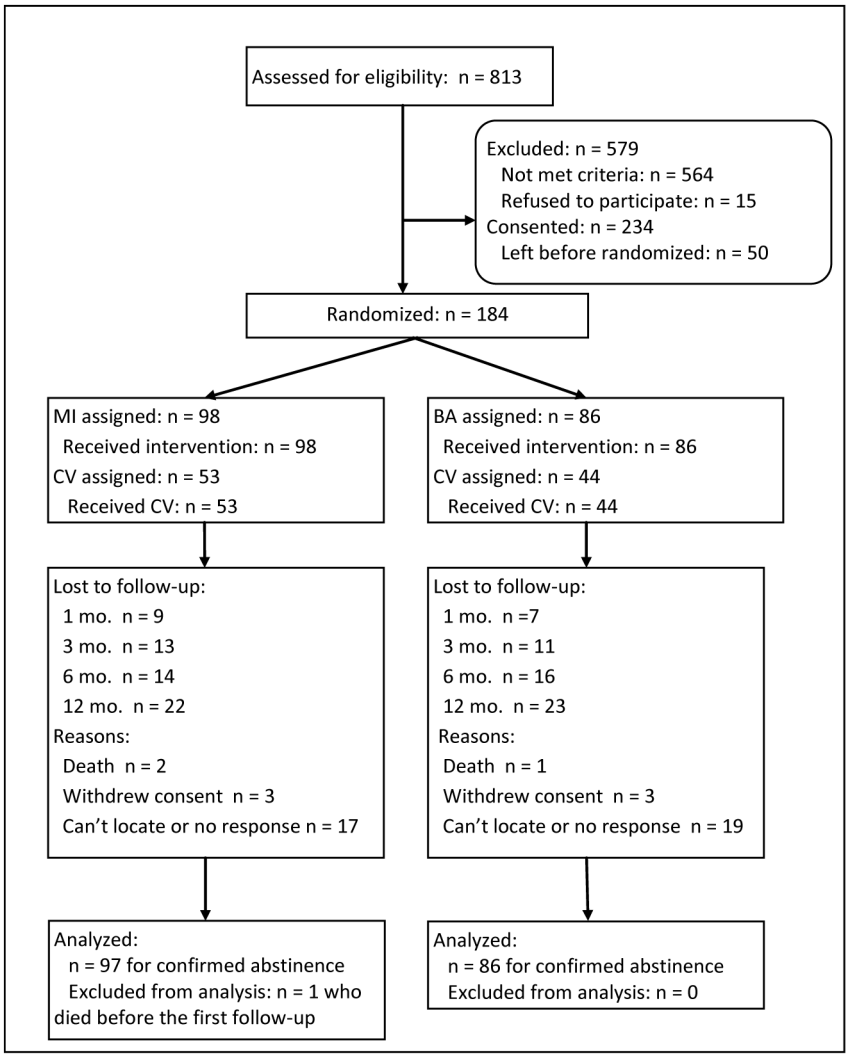

Figure 1.
Flow chart of recruitment and retention.

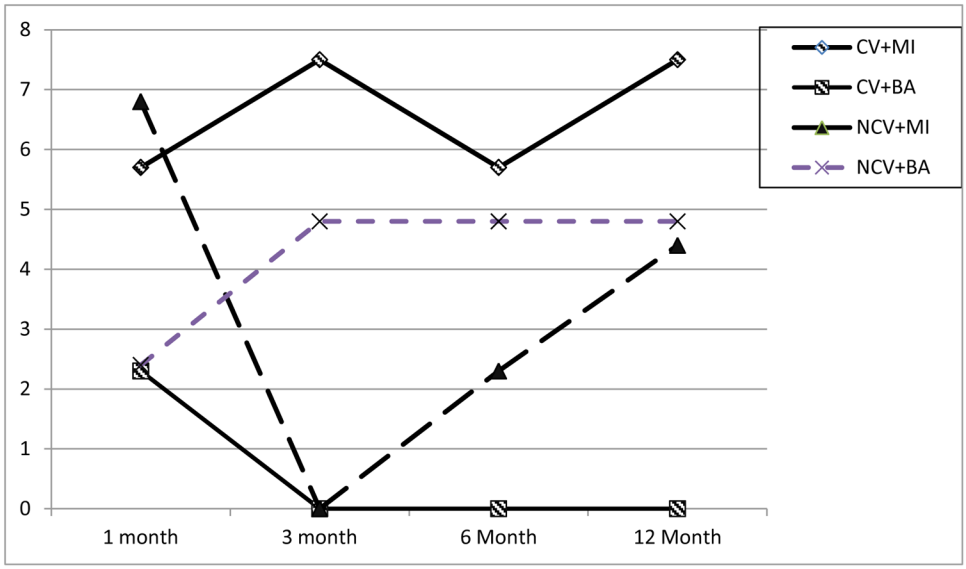

Figure 2.

Percent of participants confirmed abstinent from smoking at each follow-up period by assignment to Motivational Interviewing (MI) versus Brief Advice (BA) treatment and by CV (Contingent Vouchers) versus NCV (Noncontingent Vouchers) condition assignment. No main effects are significant. Standard errors are so small that standard error bars are not visible.

Table 1

Participant Pretreatment Characteristics by Treatment Condition.

Variable	MI Treatment Mean (SD) or %	BA Treatment Mean (SD) or %	CV Mean (SD) or %	NCV Mean (SD) or %
Age in years	33.5 (7.3)	35.7 (8.9)	34.1 (8.4)	34.9 (7.9)
Education (years)	12.1 (1.7)	12.4 (1.8)	12.0 (1.5)	12.4 (1.9)
Income yearly (legal)	$8,624 ($11,298)	$10,470 ($15,868)	$9,215 ($10,964)	$9,791 ($16,134)
Days in residential facility	44.4 (23.8)	42.6 (24.2)	41.9 (25.0)	45.4 (22.7)
CO level	16.0 (7.4)	16.9 (7.1)	16.5 (7.2)	16.4 (7.4)
Cigarettes/day	23.6 (10.2)	20.9 (8.2)	22.8 (9.4)	21.8 (9.3)
FTND	5.54 (2.44)	5.22 (2.10)	5.55 (2.29)	5.20 (2.30)
Minutes to first cigarette	31.7 (37.5)	34.4 (51.8)	32.1 (35.0)	34.0 (53.6)
Years smoked daily	17.8 (7.9)	19.0 (9.0)	18.3 (8.5)	18.4 (8.4)
Contemplation Ladder	4.93 (1.54)	5.19 (1.25)	5.01 (1.37)	5.09 (1.46)
% drinking days	22.0 (31.8)	29.6 (32.4)	27.2 (33.6)	23.8 (30.6)
% drug use days	47.9 (36.7)	38.8 (37.2)	45.4 (37.8)	41.8 (36.5)
Drinks per day	6.2 (17.1)	6.3 (10.4)	6.2 (12.3)	6.4 (16.4)
Race – white	82.7%	83.7%	82.5%	83.9%
Race – black	10.2%	8.1%	9.3%	9.2%
Race – other	7.1%	8.1%	8.2%	6.9%
Hispanic	6.2%	7.0%	5.2%	8.0%
Male	50.0%	38.4%	43.3%	46.0%
Married or living together	12.2%	9.3%	9.3%	12.6%
Unemployed pretreatment	85.7%	93.0%	90.7%	87.4%
Drug use disorder	90.8%	86.0%	90.7%	86.2%

MI = motivational interviewing, BA = brief advice, CV = contingent vouchers, NCV = noncontingent vouchers.

FTND = Fagerström Test for Nicotine Dependence total score

CO = expired carbon monoxide in parts per million

Table 2

Number of participants with 7-day confirmed point-prevalence smoking abstinence* at each follow-up within each treatment condition (Total *N*=183)

			1 Month		3 Month		6 Month		12 Month	
Condition		***N***	***N***	***%***	***N***	***%***	***N***	***%***	***N***	***%***
CV	MI	53	3	5.7	4	7.5	3	5.7	4	7.5
	BA	44	1	2.3	0	0	0	0	0	0
NCV	MI	44	3	6.8	0	0	1	2.3	2	4.5
	BA	42	1	2.4	2	4.8	2	4.8	2	4.8

CV = contingent vouchers; NCV = noncontingent vouchers; MI = motivational interviewing; BA = brief advice

* or reporting abstinence while in prison