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Voucher-based incentives for cigarette smoking reduction in a women's residential treatment program

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Participants were women (N=16) living with their children in a residential substance abuse treatment facility. In this within-subjects repeated measures study, a 1-week baseline was followed by a 4-week intervention and a 2-week follow-up (same as the baseline). The intervention consisted of exposure to an educational video and a smoking cessation workbook, brief individual support meetings, and an escalating schedule of voucher-based reinforcement of abstinence. Throughout the study, three daily breath samples (8 A.M., noon, and 4 P.M.) were collected Monday through Friday to determine carbon monoxide (CO) concentration. In addition, urine cotinine (COT) was assessed on Monday mornings to monitor weekend tobacco use. Participants received vouchers of escalating value for CO-negative breath and COT-negative urine samples. Positive samples reset the voucher value. Significantly more negative tests were submitted during the intervention than during baseline and follow-up. The intensive behavioral intervention evaluated in this study produced a substantial reduction in cigarette smoking, and 25% of participants remained abstinent 2 weeks after the intervention was suspended. Nevertheless, the percentage of CO-negative samples submitted during the follow-up returned to baseline levels. While retaining many real-world characteristics, residential treatment facilities provide important opportunities for smoking cessation treatment and research.

Introduction

Smoking is the leading cause of preventable morbidity and mortality in the United States, with smoking-related diseases claiming more than 440,000 lives annually. Nationwide, the Centers for Disease Control and Prevention (CDC) have estimated annual medical care costs attributable to smoking (or smoking-related disease) at US$68 billion annually. In addition, the value of lost earnings and loss of productivity is estimated to be another US$82 billion per year (CDC, 2002).

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Epidemiological data show that more than 70% of all adult smokers would like to quit (CDC, 2000). However, smoking cessation is a difficult process, and only 2%–10% of smokers are able to quit on their own on a given cessation attempt. Nevertheless, the rate of success can be increased significantly by pharmacological and psychosocial interventions (Fiore et al., 2000; Stitzer, 1999). State-of-the-art smoking cessation programs are estimated to be more cost-effective than other medical interventions such as mammography or hypertension screening (CDC, 2000). Thus, making treatment for tobacco dependence available to anyone motivated to quit is recommended (Fiore et al., 2000; Wetter et al., 1998).

An estimated 25% of the U.S. population smokes (CDC, 2002). However, cigarette smoking is much more prevalent in substance-abusing patients, psychiatric patients, and institutionalized individuals. For example, in this institution's substance abuse treatment programs, approximately 85% of the patients smoke at intake, a prevalence rate consistent

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with the literature (e.g., Haustein, Haffner, & Woodcock, 2002; Roll, Higgins, Steingard, & McGinley, 1998; Schmitz, Rhoades, & Grabowski, 1995; Shoptaw, Jarvik, Ling, & Rawson, 1996; Srinivasan & Thara, 2002; Wiseman & McMillan, 1998; Zickler, 2000).

Because they have a high prevalence of smokers, residential treatment environments provide invaluable opportunities for smoking cessation research and treatment (Conners, Bradley, Whiteside-Mansell, & Cron, 2001; Falkowski, 2003; Metsch et al., 1995; Whiteside-Mansell, Crone, & Conners, 1999). In contrast to inpatient hospital settings, many residential programs have physical and social treatment environments that closely resemble the patients' own environment, thus affording opportunities to observe relatively normal patterns of smoking and other behavior. Furthermore, compared with outpatient facilities, residential programs provide opportunities to implement intensive treatment interventions through extended daily access to the patients and their living environment.

Evidence indicates that treating nicotine dependence simultaneously with other addictions decreases the overall risk of relapse. As Falkowski (2003) suggests, becoming and remaining abstinent from one drug requires the attainment of skills that also apply to abstaining from all addictions. Thus it seems reasonable that patients attempting to quit smoking in residential programs may benefit from the support they receive from qualified staff regarding addiction, withdrawal, cravings, and relapse.

In outpatient settings, reinforcement of abstinence has proved to be highly effective in reducing the use of cocaine (Higgins et al., 1991, 1994; Silverman, Svikis, Robles, Stitzer, & Bigelow, 2001), opioids (Silverman et al., 1996), marijuana (Budney, Higgins, Radonovich, & Novy, 2000; Sigmon, Steingard, Badger, Anthony, & Higgins, 2000), and tobacco (Heil, Tidey, Holmes, Badger, & Higgins, 2003; Higgins et al., 2002, 2003; Roll & Higgins, 2000; Roll et al., 1998; Shoptaw et al., 1996; Stitzer & Bigelow, 1983, 1984; Tidey, O'Neill, & Higgins, 2002). For example, Tidey and colleagues (2002) demonstrated a significant decrease in the level of smoking in schizophrenic outpatients when they received contingent payments for carbon monoxide (CO)-negative breath samples. In that study, the experimenter visited patients three times per day to collect the samples and rewarded CO-negative tests with cash on an escalating schedule similar to that developed by Higgins et al. (1991). All patients were exposed to three counterbalanced experimental conditions: Contingent rewards plus a nicotine (21-mg) patch, contingent rewards plus a placebo patch, and noncontingent rewards plus a placebo patch. In their sample of relatively heavy smokers, both of the contingent reward conditions produced similar decreases in expired CO concentrations, which were significantly lower than those obtained at baseline. By contrast, the noncontingent rewards plus placebo group did not differ from baseline.

In a more recent study, Heil and colleagues (2003) extended those results by showing a significant decrease in expired CO of normal, non-treatment-seeking adults living in the community when they received contingent payments for CO-negative samples. That study showed systematic changes in self-reported nicotine withdrawal symptoms, reflecting the observed decrease in expired CO.

Following earlier research, we hypothesized that essential elements of an effective voucher-based reinforcement program, such as frequent and objective verification of abstinence, immediate reinforcement, differential reinforcement of prolonged abstinence, and loss of reinforcement opportunities as a consequence of use (Higgins et al., 1991), could be effectively implemented in a residential treatment setting. In the present exploratory study, we assessed the feasibility and potential efficacy of an intensive voucher-based smoking cessation treatment for women living with their children in a residential substance abuse treatment facility.

Method

Study sample

The study was conducted at the University of Arkansas for Medical Sciences Center for Addictions Research, Education and Services (Arkansas CARES). Arkansas CARES is a residential program that admits mothers with their children and pregnant women who abuse alcohol and other drugs. During the standard 4- to 6-month substance abuse treatment that comprised the duration of the study, patients lived with their children in cottages shared with six or seven other families. Smoking was restricted to designated areas outdoors and was prohibited in all buildings and in the presence of children. In addition, all patients were required to attend one weekly smoking cessation group session. Under these conditions and after a 30-day period of adaptation to the residential setting, patients who reported smoking 10 or more cigarettes per day were invited to participate in the study. All Arkansas CARES patients were contacted: 16 completed the study; one did not qualify, three were lost to follow-up, and two were administratively discharged from the substance abuse treatment program before completing the study. Table 1 summarizes the characteristics of the study sample.

All study participants signed and received a copy of the consent form approved by the institutional review board of the University of Arkansas for Medical Sciences. In addition, at intake,

Table 1. Study sample (N=16).

Sample characteristic	*n*	Mean (*SEM*)
Race		
White	9	–
Black	7	–
Age (years)	–	32.6 (1.33)
Years of education	–	11.4 (0.5)
Number of children	–	2.27 (0.3)
Cigarettes per day	–	15.27 (3.7)
Years as a smoker	–	15.4 (2.26)
Previous attempts to quit	–	0.5 (0.19)
Longest previous abstinence (days)	–	112.3 (73.1)
Fagerström Tolerance Index	–	6.31 (0.42)
How much do you want to quit smoking?		
I don't want to quit smoking	0	–
I am thinking about quitting	2	–
I am ready to quit	14	–
Primary drug of abuse		
Stimulants	10	–
Alcohol	3	–
Opiates	2	–
THC	1	–
CES-D		
High symptomatology	13	–
On daily bupropion		
75 mg	1	–
150 mg	9	–

Note. CES-D, Center for Epidemiological Studies Depression Scale.

experimenters gave all patients a detailed explanation of the study procedures, answered their questions, and provided them with a written guide on what to expect during the three phases of the study.

Procedures

Immediately after signing the consent, all participants completed an intake questionnaire, the Center for Epidemiological Studies Depression Scale (CES-D; Hann, Winter, & Jacobsen, 1999; Radloff, 1977), and the Fagerström Tolerance Questionnaire (Fagerström & Schneider, 1989).

Throughout the study, participants were asked to go to an experimental station three times each weekday (at 8 A.M., noon, and 4 P.M.) to provide breath samples. The experimental station was in the building where participants attended classes and group therapy meetings. Breath samples were tested for CO concentration using Bedfont Scientific Ltd. 's (Rochester, England) piCO Smokerlyzer monitors. Experimenters followed the sample collection procedure recommended by the CO monitor manufacturer: (a) Participants were instructed to inhale and hold their breath for 15 s and (b) then they were instructed to blow into the monitor with constant pressure for 5 s. CO concentrations of 7 parts per million (ppm) or less were counted as CO-negative. In addition, on Mondays (8 A.M.) participants were asked to provide a urine sample that was immediately tested for the presence ($\geq$200 ng/ml) of cotinine (COT) using QuickScreen rapid nicotine test kits (Craig Medical Distribution, Inc., Vista, California). Qualitative urine test results were available 3–5 min after the samples were collected.

Throughout the study, participants were eligible to receive vouchers with monetary value for providing urine and breath samples. (The conditions under which patients received the vouchers are described below.) The vouchers were printed on distinctive letter-size paper as soon as the test results were available. It took approximately 2 min to collect each breath sample, enter the data, and print the voucher. Printed on each voucher was the name of the participant, date and time of the test, test results, and monetary value of the voucher. Once earned, the value of a voucher could not be lost, and the cumulative value of the vouchers earned during the week was redeemed with a bank check on Friday afternoons. Participants could earn a total of US$823 during the study's three phases, with an additional $100 bonus at the end of the study for providing at least 90% of the scheduled samples.

Throughout the study, meeting with the experimenters three times each weekday for CO testing provided ample opportunities for participants to ask questions, to comment, and to receive feedback on their efforts to quit smoking. The experimenters regularly prompted participants to ask their questions and comment regarding their attempts to quit or remain abstinent, and responded positively, conveying support for their efforts. No formal record was kept of these interactions.

Experimental design and data analysis

The present study followed a within-subject repeated measures design. For each participant, a 1-week baseline was followed by a 4-week intervention and a return to baseline conditions for 2 weeks. On the last day of each experimental phase, participants were reminded that new treatment conditions were to go into effect the following week.

During the first week of the study, participants provided 15 breath samples, receiving a $5 voucher for each sample regardless of the CO concentration. On day 3, participants watched the 17-min anti-smoking video *Women and Tobacco: Seven Deadly Myths* (CDC, 2000) followed by a 1-hr session during which the experimenters presented and discussed the tips to quitting described in J. A. Flock's (1995) *Ready to Quit* manual. All participants received a copy of the manual and were encouraged to follow it and to approach the experimenters whenever they had questions or comments.

During the 4-week intervention phase, study participants were exposed to an escalating schedule of voucher-based reinforcement of smoking reduction. In this phase, participants were required to provide three consecutive negative samples to earn their first voucher (worth $3); subsequently, they earned a voucher for each consecutive negative sample. Voucher value increased by $0.50 with each consecutive negative sample ($3.50, $4.00, $4.50, etc.), to a maximum of $10 per sample. However, providing a positive sample or failing to provide a scheduled sample reset the voucher value to zero, and three consecutive negative samples were again necessary to earn a $3 voucher and reinstate the escalating schedule. In addition to the escalating voucher schedule, patients received $10 bonuses after providing mutually exclusive series of three consecutive negative samples while the voucher value was less than $10, and $20 bonuses for providing a COT-negative urine sample on Monday mornings during the intervention phase. For Monday morning samples to be counted as negative, both the CO and COT tests had to be negative. The value of earned bonuses was added to the corresponding voucher and redeemed with that week's total earnings. Baseline conditions were reinstated during the last 2 weeks of the study.

The concordance between CO-positive breath samples and COT-positive urine results was 100% for samples taken on the same occasion. As expected, given the 17-hr half-life of COT and the much wider detection window of the urine COT test (up to 48 hr) compared with the breath CO test, not all CO-negative samples were associated with COT-negative specimens on Monday mornings. Breath samples could test negative if a participant had not smoked in the last 12 hr, but urine specimen tests detected use over the weekend. Thus, as described earlier, for Monday morning screens to be counted as negative, both the CO and COT tests had to be negative.

During this study, bupropion was prescribed to treat comorbid clinical depression as determined by a comprehensive psychiatric evaluation conducted before enrollment in the smoking cessation study. However, bupropion alone has been shown to be efficacious in reducing cigarette smoking at doses similar to or larger than those received by some of the study participants (Dale et al., 2001; Hayford et al., 1999; Hays et al., 2001; Hurt et al., 1997). Therefore, to assess the contributions of the medication and the behavioral intervention to the overall effects, individual mean CO concentrations, and individual percentages of negative breath and urine samples were compared using repeated measures two-way analysis of variance (ANOVA) with treatment phase and bupropion prescription as factors.

Of scheduled samples, 9.5% were not collected, mainly because of patient illness or program-related absence from the study site. To assess the impact of the missing data, abstinence test results were analyzed in two ways: By replacing missing values with positive values, and by replacing missing values with interpolated values. With the latter technique, a missing value was interpolated as positive if either the previous or the following sample was positive or missing, or if both samples were positive or missing. Because analyses using both replacement methods yielded essentially similar results, we report the more conservative missing-as-positive approach.

Results

Figure 1 shows the percentage of negative samples submitted in each treatment phase by all participants;

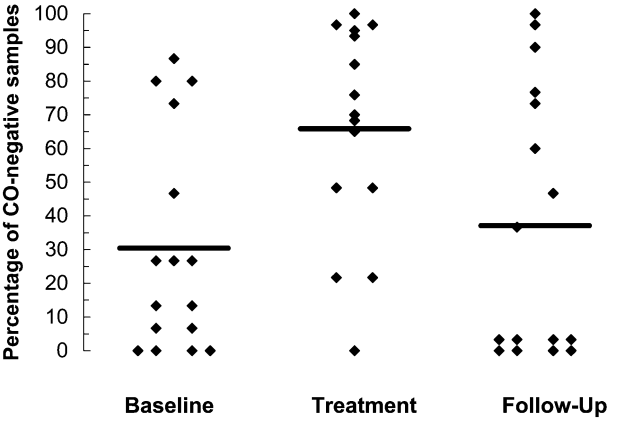

Figure 1. Percentage of CO- and COT-negative samples submitted in each treatment phase. Filled diamonds represent individual means, and bars represent sample means. Significantly more negative samples were submitted during the intervention (65.89%) than during baseline (30.42%) and follow-up (37.10%; both $p<.05$).

filled diamonds represent individual means, and bars represent sample means. A two-way repeated measures ANOVA of the percentage of negative samples with treatment phase (baseline, intervention, follow-up) and bupropion prescription (yes or no) as factors, showed significant effects of the treatment phase, $F=10.27$, $df=14, 2, 1$, $p<.001$, but not bupropion prescription, $F=2.4$, $df=14, 2, 1$, $p=.144$, or the interaction ($p=.535$). A post hoc analysis (Tukey's HSD) revealed that more negative samples were submitted during the intervention (65.89%) than during baseline (30.42%) and follow-up (37.10%; both $p<.05$). However, differences between baseline and follow-up were not statistically significant.

Figure 2 shows the timeline of breath samples collected (three per day) for all study participants. Each square represents a CO-negative sample; missing squares (solid lines) represent CO-positive or missing samples. Most participants (75%) provided more negative samples during the intervention than during baseline. Of the 16 participants, four (25%) submitted mostly negative samples during the intervention and follow-up (#3, #8, #10, and #16); one participant (#1) did not provide a single negative sample during the study.

In this homogeneous group of smokers, none of the characteristics assessed at intake (Table 1) were significantly associated with abstinence from smoking during the study. Study completers earned an average of $536.23, or 58% of the total possible.

Discussion

The intensive smoking cessation intervention evaluated in this exploratory study significantly reduced the number of CO-positive samples submitted during the treatment phase. Average breath CO concentration during the intervention dropped to below 8 ppm, the established abstinence reinforcement criterion.

Although 25% of participants approached complete abstinence during the follow-up, the overall group reduction in this phase was not significantly different from baseline. Informal reports suggest that several participants sought to become abstinent during the baseline in an attempt to start earning vouchers early in the intervention phase.

To manage depression symptoms, 10 study participants received bupropion hydrochloride (75–150 mg/day) during the study. Bupropion, however, has been shown to be effective in reducing cigarette smoking at doses between 100 and 300 mg/day (Dale et al., 2001; Hayford et al., 1999; Hurt et al., 1997). Therefore, it was necessary to statistically assess the contribution of the medication to the observed effects. Our analysis did not reveal a significant effect of taking daily low doses of bupropion; this finding, however, may have been related to low statistical power in assessing the effects of bupropion with a small sample size.

Neither nortriptyline nor nicotine replacement was prescribed to participants during the study, and patients were required to report all concurrent medications to the residential treatment staff. Although we made no deliberate attempt to check if our participants used nicotine replacement during the study beyond the Monday morning COT tests, we had no indication that they had used replacement.

The study did not assess the level of individual participation during the educational session and brief meetings. However, because the level of participation may correlate positively with treatment outcome, future studies should explore this variable.

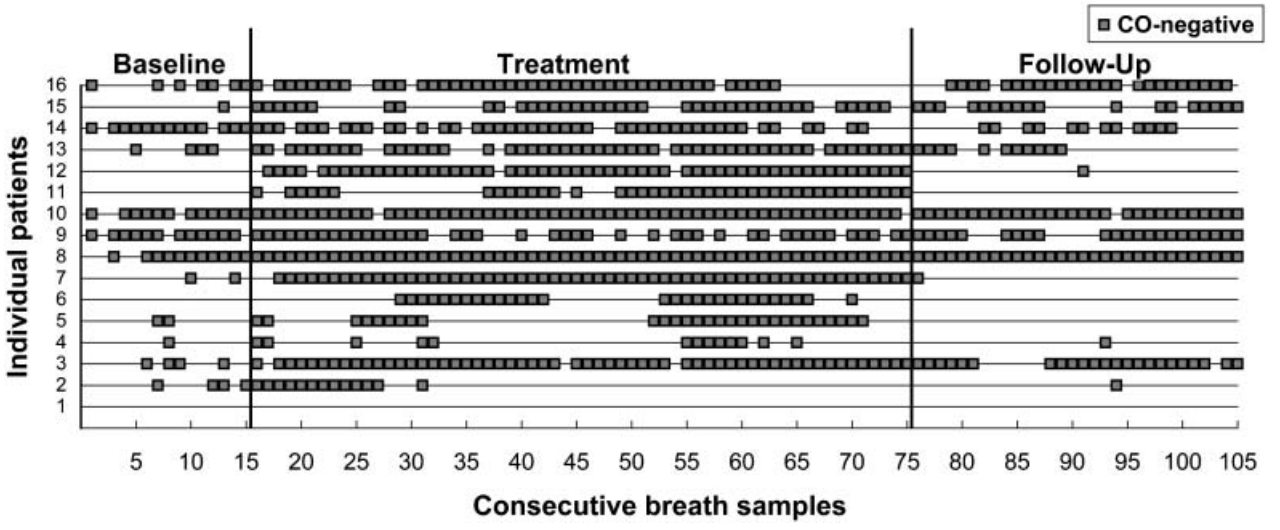

Figure 2. Timeline of all breath samples collected during the study. For individual participants, each square represents a CO-negative sample; missing squares (solid lines) represent CO-positive or missing samples.

For the study, we set the CO concentration cutoff limit for negative samples at 7 ppm or less, instead of the 11 ppm or less suggested by the monitor's manufacturer. From our observations and participants' casual reports, we believe the more stringent concentration cutoff value effectively reduced the proportion of false positive results without otherwise affecting the test. Even lower values (i.e., 3–5 ppm) could still be adequate for intensive interventions, when participants are not normally exposed to high concentrations of environmental CO (e.g., second-hand smoke or heavy traffic). Nonetheless, during the study, two participants who had remained smoke-free unexpectedly submitted breath samples with CO concentrations consistent with recent smoking (11 and 15 ppm). The patients, however, reported having spent the morning doing laundry and denied having smoked. At the experimenter's suggestion, their house was checked for possible CO contamination. A gas company technician promptly responded and tracked the CO leak to a damaged clothes dryer exhaust, which was repaired immediately. This unexpected event suggests that in addition to installing CO detectors and regularly checking possible CO sources in the buildings, it may be valuable to periodically test breath CO concentration in vulnerable patients and children living in institutional settings.

Residential treatment settings such as Arkansas CARES permit the evaluation of intensive and complex treatment interventions while retaining some important real-world characteristics. For example, women in this study lived with other smokers, and were responsible for preparing and serving meals, doing laundry, cleaning the house, keeping doctors' appointments, assisting their children with school assignments, and the like. Thus they were exposed to many of the same day-to-day stressors and triggers for relapse that occur in nonclinical environments. Simultaneously, the residential setting made it possible to systematically collect the majority of the scheduled breath and urine samples, and to make observations and interact with participants as needed.

Although the percentage of CO-negative samples during the intervention was twice as large as that of the baseline, it returned to baseline levels when the monetary contingency was removed. Even so, 25% of participants remained mostly abstinent through the follow-up phase, which may be an important outcome, given that the sample consisted of substance abuse patients who did not seek tobacco cessation treatment before their participation in the study. The long-term and cumulative effects of the quit attempt motivated by this intervention are unknown (Carpenter, Hughes, & Keely, 2003), but clearly more research is needed on how to prevent relapse once abstinence from smoking has been achieved.

The focus of the present exploratory study was on the viability of an intensive cessation treatment in a residential setting. In addition, such treatment facilities provide important opportunities for long-term treatment and evaluation. Further research could explore the effects of a behavioral-pharmacological abstinence maintenance program incorporated into the residential treatment. For example, by participating in regular CO testing, abstinent patients may qualify for special privileges in daily residential living. Such privileges would increase opportunities for patients to become engaged in the program, extend treatment duration, and greatly reduce the overall cost of the tobacco cessation program, as well as possibly increasing the treatment's long-term efficacy significantly.

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