Contingency Management Interventions for Treating the Substance Abuse of Adolescents: A Feasibility Study

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This article reports on the feasibility of using a contingency management intervention with adolescent smokers that has proven efficacious in adult substance abuse treatment. The study used 8 adolescent participants in an A (1 week)–B (1 week)–A (1 week) reversal design. During the baseline phases, no contingencies were placed on cigarette smoking, and adolescents received money noncontingently. During the experimental intervention week, adolescents received payment contingent on not smoking. The magnitude of reimbursement available during the baseline and intervention phases was equated. Results indicated that the contingency management intervention was effective in reducing smoking, both in terms of increasing the total number of abstinences and consecutive abstinences. In addition, changes in adolescents' affective states during smoking cessation were found. Anxiety, depression, anger, and fatigue were reported, and these negative states ceased once smoking resumed.

Tobacco use is the single most preventable cause of death in the United States (Centers for Disease Control and Prevention [CDC], 1992). By 1992, use of tobacco had led to more fatalities than those caused by alcohol, cocaine, crack, heroin, homicide, suicide, car accidents, fires, and AIDS combined (Cherner, 1990). Despite the recent classification of nicotine as an addictive substance and the public awareness of the health hazards associated with smoking, nearly 50 million Americans continue to smoke (CDC, 1999). Approximately 80% of tobacco use occurs for the first time among youths under 18 years of age (CDC, 1998). For example, 60% of smokers began smoking before age 14, and 77% were regular smokers by age 20, suggesting that adolescent smoking leads to regular cigarette use in adulthood. Although smoking initiation rates among adults dropped significantly from 1944 to 1988 following the emergence of antismoking public health campaigns, the rate of initiation of smoking did not change for young men aged 15 to 20 years of age and actually increased for young women in the same age group (Gilpin et al., 1994). By contrast, smoking initiation among young adults aged 21 to 24 declined sharply once the health consequences of smoking were first made public, and these rates continued to drop steadily through the late 1980s (Gilpin et al., 1994). These trends in smoking initiation and current smoking prevalence among adolescents suggest that knowledge of the health consequences of smoking alone is not an effective deterrent to smoking initiation and regular use among adolescents. Current estimates of adolescent smoking indicate at least two thirds of all adolescents have smoked at least one cigarette by age 18, 15% smoke every day, and 11% of high school seniors smoke at least 10 cigarettes per day (Johnston, O’Malley, & Bachman, 1998a; 1998b; Stanton, Lowe, & Gillespie, 1996). Smoking among substance-abusing adolescents in outpatient psychiatric clinic samples was reported to be even higher at 85% (Myers & Brown, 1994).

A total of 4.1 million, or 18.3%, of adolescents aged 12 to 17 are current smokers (Substance Abuse and Mental Health Services Administration [SAMHSA], 1996). Youths who are current smokers are about nine times as likely to use illicit drugs and drink heavily as nonsmoking youths (Everett, Giovino, Warren, Crossett, & Kann, 1998; SAMHSA, 1996). Compared with nonsmokers, current adolescent smokers are significantly more likely to report use of illicit substances and alcohol (Everett et al., 1998). Among adolescents who are current smokers, 64% reported a desire to stop smoking and 55% had tried to stop smoking in the past year (Stanton et al., 1996). Withdrawal symptoms have been frequently reported among adolescent smokers (Stanton et al., 1996).

Although enormous strides have been made in the treatment of adult substance abuse, relatively scant attention has been paid to the development of innovative treatment modalities for adolescents. The smoking cessation literature reveals consistent factors related to poor outcome with smoking cessation efforts with adolescents. These factors include high levels of baseline smoking low levels of motivation to quit smoking (Sussman, Dent, Severson, Burton, & Flay, 1998), and low levels of self-efficacy (Engels,
The present study was conducted to assess the feasibility of using contingency management interventions in the treatment of adolescent cigarette smoking specifically, and other substance abuse, generally. Contingency management treatment of substance abuse is based on the observation that drug use is a form of operant behavior that is partly maintained by the reinforcing effects of the drug (Bigelow & Silverman, 1999). Considerable research has shown that the likelihood of using drugs decreases when alternative reinforcers are available and accessible within the environment (Carroll, Lac, & Nygaard, 1989; Higgins, Roll, Wong, Tidey, & Fanton, 1999; Nader & Woolverton, 1991). Contingency management procedures have proven effective in treating substance abuse in many different populations such as methadone-maintained inner-city cocaine abusers, rural, primary-cocaine abusers with no opiate dependence, and individuals with obstructive pulmonary disease (Crowley, MacDonald, Zerbe, & Petty, 1991; Higgins et al., 1994; Shotpaw, Jarvik, Ling, & Rawson, 1996; Silverman et al., 1996). Furthermore, the use of a number of substances has been demonstrated to be amenable to modification via contingency management interventions (e.g., benzodiazepines, Stitzer, Bigelow, & Liebson, 1979; cocaine, Higgins et al., 1994; nicotine, Stitzer, Rand, Bigelow, & Mead, 1986; alcohol, Liebson, Tommasello, & Bigelow, 1978; opioids, Kidorf, Stitzer, Brooner, & Goldberg, 1994). The potential impact of contingency management interventions for treating the substance abuse of adolescents, however, remains untested.

A fundamental question in addressing the feasibility of using contingency management interventions to treat adolescent substance abusers is whether their substance use is sensitive to contingent environmental consequences. The relatively extensive literature demonstrating the efficacy of contingency management for promoting behavior change in diverse populations (e.g., Ullman & Krasher, 1965) and the efficacy of applied behavior analytic techniques for promoting other types of behavior change among adolescents (e.g., Ervin, DuPaul, Kern, & Friman, 1998) suggest that it would be. However, to our knowledge, no studies have been published addressing the use of modern contingency management interventions in the treatment of adolescent substance abuse. The proposed study was designed to address experimentally whether monetary reinforcement could be used to promote short-term abstinence from cigarette smoking in adolescents. This study was conducted strictly as a feasibility test. The primary question is whether abstinence from cigarette smoking in this population could be increased via contingent positive reinforcement, and not whether we could provide effective treatment for smoking cessation to study participants.

The tactic of using cigarette smoking as a model of substance abuse for experimentally examining issues related to contingency management interventions is well established (e.g., Roll, Higgins, Steingard, & McGinley, 1998; Stitzer & Bigelow, 1984; Stitzer et al., 1986). Our position is that feasibility studies of the type reported here represent a pragmatic use of resources and provide useful initial information around which subsequent clinical trials may be designed.

Method

Participants

Study participants were recruited through the use of newspaper advertisements, by referral from treatment and community agencies, and by word of mouth. Eight participants completed the study (5 boys and 3 girls). Two participants (both male) withdrew from the study for unknown reasons prior to any experimental manipulations. Inclusion criteria were current cigarette use, an initial carbon monoxide (CO) reading of at least 18 parts per million, and the absence of any psychiatric diagnosis as confirmed by the Lifetime Schedule for Affective Disorders and Schizophrenia for Adolescents (K-SADS-L; Puig-Antich & Chambers, 1994). Fagerstrom scores are a putative measure of nicotine dependence and were collected during the initial interview. These scores can range from 0 to 11, with higher scores indicating more severe nicotine addiction (Fagerstrom & Schneider, 1989). In addition, participants were required to reside within a 20-minute radius of the clinic to ensure their access to the clinic prior to and after school. Finally, eligible participants could not be actively contemplating smoking cessation at the initiation of the study. This study was approved by the Wayne State University Pediatric Institutional Review Board for Human Subjects.

Eight participants (3 girls and 5 boys) completed the study; the average age was 17 (range, 15–19). On average, participants reported smoking 19 cigarettes a day prior to participation in the study (range, 15–25), the average CO level at the time of initial contact was 21 (range, 18–28), and the average Fagerstrom score 5.8 (range, 2–9).

Procedure

Prior to enrollment in the study, prospective participants and a legal guardian met with one of the primary investigators. During this meeting, informed consent was obtained from both the participant and his or her guardian. A smoking history and psychiatric interview were conducted with participants, and an expired CO level was obtained. The expired CO level indicates recent smoking and is obtained by having the participant blow through a small hand-held sensor. In addition, observed urine samples were periodically collected (consent meeting, each of the three Fridays of study participation, and 2-week follow-up). These urine samples were analyzed by immunoassay (EMIT) for illicit drug use (cannabis, cocaine, heroin, and barbiturates). Illicit drug use was monitored as it may be associated with changes in cigarette smoking (Melilo, Lukas, & Mendelson, 1985; Roll, Higgins, & Tidey, 1997; Schuster, Lucchesi, & Emley, 1979). This study was conducted using a within-subject reversal design (ABA). The first and third weeks of the study consisted of baseline phases, whereas the second week consisted of an intervention phase. A follow-up session was conducted 2 weeks after the end of the second baseline period. This design permits the use of smaller sample sizes (e.g., Johnston & Penny packer, 1993; Roll et al., 1998).

During the first week (Baseline 1), participants were encouraged to use their willpower to try to stop smoking. During this phase participants visited the laboratory twice daily Monday through Friday before school (7:30 a.m.–9 a.m.) and after school (3 p.m.–5 p.m.). At each of these visits an expired breath sample was collected for CO analysis. Participants filled out the Profile of
Mood States (POMS; McNair, Lorr, & Droppleman, 1971) on the Friday afternoon visit. Participants were paid $4 for each CO provided, regardless of their CO levels. There were 10 trials during the baseline phase and a total of $40 available for study compliance during this phase.

During the second week (intervention phase) participants visited the laboratory twice daily Monday through Friday. These visits occurred before school (7:30 a.m.-9 a.m.) and after school (3 p.m.-5 p.m.). CO specimens were collected at each of these visits, and the POMS was filled out as in the baseline week described earlier. During this phase participants were once again encouraged to use their willpower to quit smoking. However, during this phase a contingency management intervention was put in place such that participants only received payment if their CO levels were ≤ 8 ppm, indicating recent abstinence from cigarettes (Roll & Higgins, 2000). Payment was made available according to the following schedule of reinforcement: Participants earned $1 for their first CO reading of ≤ 8 ppm. For each additional, consecutive CO reading of ≤ 8 ppm, participants received an additional $.50 (for example, the next payment would be $1.50, then $2, and so on). In addition, whenever participants produced five consecutive CO readings of ≤ 8 ppm, they received a $3.75 bonus plus their regularly scheduled payments. CO readings > 8 ppm or failure to submit a scheduled breath sample, reset the value of reinforcement back to $1, from which escalation could again proceed according to the same schedule. All money earned was paid in cash immediately after a CO reading was obtained. The total amount received by a participant who remained abstinent on all 10 trials of the intervention week was $40. This schedule of escalating payment was adapted from one used previously to study contingency management interventions with cigarette smokers (Roll & Higgins, 2000; Roll, Higgins, & Badger, 1996; Roll et al., 1998).

The third week (Baseline 2), was an exact replication of Week 1. At the end of the study, participants received a $25 bonus for completing the study. It is important to note that the amount of reinforcement (i.e., money) available each week was the same (i.e., $40). Thus, differences observed in smoking behavior between weeks cannot be attributed to the magnitude of reinforcement, but must be attributed to the contingency placed on abstinence during the intervention phase.

Participants were contacted 2 weeks following the termination of the study and CO and urine samples were collected. Participants received $5 for providing these samples.

Data Analysis

Results of this study were analyzed with a one-way repeated measures analysis of variance (ANOVA) to examine any influence of the intervention on total number of abstinences (i.e., CO ≤ 8 ppm), number of consecutive abstinences, POMS scores, and mean CO levels. CO readings from afternoon visits during the baseline and intervention phases were used in the analysis of mean CO level because they were collected at approximately the same time of day as intake and follow-up CO measures. This was done in order to control for the potential influence of time of day on cigarette smoking. Planned post hoc comparisons were conducted across the different phases when indicated by the presence of a significant result in the ANOVA to detect specific between-phase differences. Missing specimens were entered into the data analysis as 8 ppm. This happened only once for one participant. Throughout, results were considered significant when \( p < .05 \).

The total number of CO specimens indicating abstinence (i.e., number of specimens < 8 ppm) changed systematically during the study, \( F(2, 21) = 74.848, p < .05 \). Mean total numbers were 0.88 during the first baseline condition, 9.63 during the intervention condition, and 7.50 during the second baseline condition. In planned comparisons, the mean numbers of CO specimens indicating abstinence during the intervention condition differed from the first \( (p < .05) \) but not the second \( (p > .05) \) baseline conditions. The two baseline conditions also differed \( (p < .05) \), see Figure 1.

Likewise, the number of consecutive abstinences changed systematically during the study, \( F(2, 21) = 16.739, p < .05 \). The mean total number of consecutive abstinences were 0.38 during the first baseline condition, 9.50 during the intervention condition, and 5.00 during the second baseline condition. In planned comparisons, the mean numbers of CO specimens indicating abstinence during the intervention condition differed from the first \( (p < .05) \) but not the second \( (p > .05) \) baseline conditions. The two baseline conditions also differed \( (p < .05) \), see Figure 2.

Mean CO levels also changed systematically during the study, \( F(4, 35) = 21.186, p < .05 \). They were 20.75 ppm at intake, 16.93 during the initial baseline condition, 4.30 ppm during the intervention condition, 8.95 ppm during the second baseline condition, and 21.75 ppm at follow-up. In planned comparisons, the mean CO level was significantly lower during the intervention condition than during any of the other conditions (all, \( p < .05 \)). There were no significant differences between intake, Baseline 1, and follow-up readings (all, \( p > .05 \)); however, the follow-up reading was significantly higher than the Baseline 2 reading \( (p < .05) \), see Figure 3.

Several of the POMS measures also changed significantly during the study, including positive mood, \( F(2, 21) = \)

![Figure 1](show the graph of mean total abstinences during the study, including positive mood. CO = carbon monoxide.)
Discussion

These results demonstrate that an intervention that is based on delivering reinforcement contingent on drug abstinence and that has been effective in reducing substance abuse in adults can also successfully reduce cigarette smoking in adolescents. The total number of abstinences and the number of consecutive abstinences were greater during the intervention condition than during the initial baseline condition. Interestingly, the effects of the intervention seemed to linger during the second baseline. A failure to recover baseline is not without precedent when using a reversal design such as the one employed in this study to examine issues related to contingency management (Roll et al., 1998; Silverman et al., 1996). It is noteworthy that all of the participants did not participate during the same 5-week period, suggesting that the failure to recover baseline is not
the result of some uncontrolled extraneous factor. Similarly, mean CO levels did not return to initial baseline levels during the second baseline phase, presumably because of a carryover effect from the intervention phase, but they did so by the follow-up assessment. Taken together, these data suggest that the delivery of reinforcement, contingent on abstaining from cigarettes, is effective in reducing cigarette smoking among adolescents.

Although this study was not conducted to examine treatment strategies in smoking cessation per se, it does suggest that contingency management techniques may be efficacious as a smoking cessation intervention for adolescents. These techniques may also provide incentive to quit smoking for adolescents who are initially unsure about wanting to quit.

In addition to being a potentially clinically efficacious intervention, contingency management techniques may be highly cost effective. The total amount of money paid out to the adolescent participants in the present study was less than $150 per participant for the 6-week period. This amount is clearly negligible compared with the cost of continued smoking for adolescents and for the health care system, which might be heavily used by these nicotine-dependent individuals following years of chronic smoking.

The use of cash (as opposed to vouchers) has often been criticized as having the potential to facilitate drug use during or after the contingency payment. The use of cash incentives did not facilitate smoking or other drug use during the intervention phase or after the intervention at the 2-week follow-up period of the present study, as confirmed by CO readings and urine test results.

Mood changes following smoking cessation and a nicotine withdrawal syndrome among adolescents have not been systematically documented. This may be a function of the difficulty in getting adolescents to quit smoking in the first place. The mood changes exhibited by the adolescents in the present study corresponded with smoking cessation in the expected direction, that is, negative mood increased and positive mood decreased significantly during the intervention week and returned to baseline levels once the adolescents resumed smoking. These findings suggest the presence of a nicotine withdrawal syndrome in adolescents. Contingency management interventions such as those described in this report are known to be compatible with pharmacotherapy. Further, combined behavioral-pharmacological approaches are advocated for the treatment of nicotine dependence. Thus, future studies could investigate how a combination of the transdermal nicotine patch or bupropion, along with contingency management, might further reduce the nicotine withdrawal syndrome and improve the efficacy of smoking cessation interventions for adolescents.

The results of this study also indicate that it may be fruitful to investigate the effectiveness of contingency management with other forms of substance abuse among adolescents. Contingency management procedures have proven effective in treating substance abuse in many different populations and in curtailing the use of a number of substances. In light of the promising results of this study, clinical trials assessing the efficacy of contingency management interventions for treating substance abuse in adolescents appear warranted.

References


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