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Contingency Management for Smoking Cessation in Adolescent Smokers

Suchitra Krishnan-Sarin, Amy M. Duhig, Sherry A. McKee, Thomas J. McMahon, Thomas Liss, Amanda McFetridge, and Dana A. Cavallo
Yale University School of Medicine

This pilot study evaluated the use of contingency management (CM) procedures in combination with cognitive–behavioral therapy (CBT) for smoking cessation in adolescents. Twenty-eight treatment-seeking adolescent smokers participated in a 1-month, school-based smoking cessation program and were randomly assigned to receive either CM with weekly CBT or CBT alone. In the CM + CBT group, biochemical verification of abstinence was obtained twice daily during the first 2 weeks, followed by daily appointments during the 3rd week and once every other day during the 4th week. Participants were monetarily reinforced for abstinence on an escalating magnitude schedule with a reset contingency. At the end of 1 week and 1 month of treatment, abstinence verified using quantitative urine cotinine levels was higher in participants in the CM + CBT group (1 week: 76.7%; 1 month: 53.0%) when compared with the CBT-alone group (1 week: 7.2%; 4 weeks: 0%). These preliminary results provide a strong initial signal supporting the utility of CM techniques for smoking cessation in adolescents and demonstrate the feasibility of implementing such a program in a school setting.

Keywords: contingency management, smoking cessation, adolescents, high school, tobacco

Nicotine dependence is a chronic, relapsing disorder that typically emerges during adolescence, prior to 18 years of age. Epidemiological evidence suggests that many of these adolescent smokers have moved beyond the initiation stage and are interested in quitting smoking. According to the 2000 National Youth Tobacco Survey (Morbidity and Mortality Weekly Report, 2001), 61% of current adolescent smokers reported wanting to quit smoking, whereas 59% reported they had made a quit attempt in the past 12 months. Despite these high rates of interest in quitting, there are few empirically supported smoking cessation strategies for adolescent smokers, and most existing programs have low participation and success rates (Backinger & Leischow, 2001; Sussman, 2002). A recent review by an expert panel concluded that although the few valid research studies suggested some potential for cognitive–behavioral therapy, much more quality research is needed to develop interventions for tobacco cessation in youth (Backinger et al., 2003; McDonald, Colwell, Backinger, Husten, & Maule, 2003). The adolescent onset of nicotine dependence underscores the need to develop intervention strategies that could be applied prior to the establishment of entrenched, lifelong patterns in adulthood.

Contingency management (CM) approaches, in which desired behaviors (e.g., abstinence from recent drug use) are directly reinforced, have been successfully used in behavioral therapies research for substance use to retain patients in treatment and foster stable periods of abstinence (Higgins & Silverman, 1999, Petry et al., 2001). CM interventions for substance use have three basic requirements: they must (a) obtain objective evidence of abstinence from drugs, (b) provide tangible reinforcers (money, goods, privileges) when the target behavior is demonstrated, and (c) withhold the reinforcer when the target behavior does not occur (see review by Petry, 2000).

CM techniques have been used to successfully reduce tobacco use in non-treatment-seeking (Burling, Stitzer, Bigelow, & Russ, 1982; Roll, Higgins, & Badger, 1996; Schmitz, Rhoades, & Grabowski, 1995; Stitzer & Bigelow, 1985) as well as in treatment-seeking (Crowley, MacDonald, Zerbe, & Petty, 1991; Paxton, 1980; Rand, Stitzer, Bigelow, & Mead, 1989; Shoptaw, Jarvik, Ling, & Rawson, 1996) adult smokers. However, despite the promise of CM for smoking cessation in adult smokers, there has been a paucity of research on CM as a treatment for adolescent smokers. There have been no randomized controlled trials, but two preliminary studies have yielded positive findings. A small study by Weissman, Glasgow, Biglan, and Lichtenstein (1987) with treatment-seeking adolescents involving reinforcement for gradual reduction followed by cessa-

Suchitra Krishnan-Sarin, Amy M. Duhig, Sherry A. McKee, Thomas J. McMahon, Thomas Liss, Amanda McFetridge, and Dana A. Cavallo, Department of Psychiatry, Yale University School of Medicine.

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Correspondence concerning this article should be addressed to Suchitra Krishnan-Sarin, Department of Psychiatry, Yale University School of Medicine, S-208, Connecticut Mental Health Center, 34 Park Street, New Haven, CT 06519. E-mail: suchitra.krishnan-sarin@yale.edu

tion of tobacco use indicated a beneficial effect in male but not female smokers. Corby, Roll, Ledgerwood, and Schuster (2000) conducted a controlled feasibility study that employed a within-subject reversal design using a schedule of escalating magnitude of reinforcement with a reset contingency (Higgins et al., 1991; Roll et al., 1996) in nontreatment-seeking adolescent tobacco users. Results indicated that when adolescents were monetarily reinforced for not smoking, there was an increase in both the total number of CO specimens indicating abstinence (CO $<$ 8 ppm) and the number of consecutive CO specimens indicating abstinence.

Given the preliminary evidence supporting the utility of CM in reducing tobacco use in adolescents, we sought to develop and conduct preliminary efficacy testing of an approach that combined CM with cognitive–behavioral therapy (CBT) versus CBT alone as an initial Stage I treatment development pilot study (in accordance with the stage model of behavioral therapies research; Rounsaville, Carroll, & Onken, 2001) for smoking cessation in adolescent smokers. The choice of CBT as the control condition was based on a recent review by McDonald and colleagues (2003) that suggested some promise for CBT as a smoking cessation approach for young smokers. Because a major hurdle for implementing abstinence-linked CM is the requirement for multiple daily breath CO testing to verify abstinence, we increased the feasibility of this program by implementing it in a school-based context to enhance convenience and access to adolescent smokers. We used breath CO testing and urine dipsticks to determine daily abstinence in the CM + CBT condition. However, for the primary outcome of this study, we used quantitative weekly urine cotinine levels at 1 week and 1 month, as suggested by Mermelstein and colleagues (Mermelstein et al., 2002).

Method

Participants

Adolescent smokers between 14 and 18 years of age who reported being interested in quitting smoking were recruited from high schools in New Haven County. Recruitment was conducted during lunch and study hall periods in the school cafeterias. Information about the study was transmitted by informational flyers distributed during recruitment sessions and posters in the school hallways. Through these various mechanisms, adolescents were informed that the study involved (a) treatment-seeking smokers, (b) random assignment to treatment, (c) earning money to quit smoking, (d) daily appointments, and (e) parental permission for participation. Interested adolescents either called a telephone number provided on the flyers and posters or signed up for the study during the recruitment sessions. Adolescents expressing interest in quitting smoking were contacted by phone, and the project was discussed in detail with the potential participant and a parent. If a parent or adolescent declined to participate, the phone call was terminated. Smokers who reported smoking at least 10 cigarettes per day for the past year were screened for further participation and invited to come to our clinic with their parent for an eligibility screening session.

Procedure

During the eligibility session, signed permission from the parent and assent from adolescents 14–17 years of age was obtained; adolescents who were 18 years old signed a separate consent form. At this session, biochemical verification of smoking status was obtained using breath CO levels (Micromedical Micro CO meter, Microdirect Inc., Lewiston, ME) and quantitative urine cotinine levels (Graham Massey Analytical Labs; Shelton, CT). Participants also received a psychological evaluation by a clinical psychologist to exclude those with a current diagnosis of major depressive disorder (MDD) in order to avoid precipitation of an MDD episode (because a history of MDD in adult smokers is known to predict the reoccurrence of MDD after smoking cessation treatment; Tsoh et al., 2000). Although attention-deficit/hyperactivity disorder (ADHD) is a common diagnosis of adolescent smokers, a formal evaluation of ADHD was not conducted. The protocol was approved by the Yale Institutional Review Board and by the local school boards and/or principals.

Counseling procedures. Adolescents participated in a 1-month smoking cessation program in which all participants received weekly individually oriented CBT-based smoking cessation intervention (Duhig, Cavallo, McKee, McMahon, & Krishnan-Sarin, 2003; modified from Monti, Kadden, Rohsenow, Cooney, & Abrams, 2002; U.S. Department of Health and Human Services, 1992). All participants received a "preparation to quit smoking" session 2–7 days prior to their quit date. At this time, adolescents were randomly assigned to receive CM + CBT or CBT alone. During this session they were advised about the risks of continued smoking and benefits of quitting smoking and were assisted with developing a quit plan and setting a quit date. Handouts adapted for adolescents from established materials from the National Cancer Institute and American Cancer Society were provided. During the 1-month treatment period they received weekly counseling, consisting of modules addressing high-risk situations and self-monitoring, coping with cravings and urges, problem solving and refusal skills/assertiveness, and coping with lapses. The weekly counseling sessions took place on Days 7, 14, 21, and 28 of their quit attempt. The therapy was provided by PhD-level therapists.

Verification of abstinence. Abstinence was determined and reinforced using multiple daily breath CO readings and once daily urine cotinine readings. CO levels were measured using a Micromedical Micro CO meter, which is a precision instrument for detecting CO in exhaled breath. CO is known to have a half-life of 4 hr and is measured in the range of 0–500 ppm. This instrument produces no cross-sensitivity to hydrogen or other positrons. CO levels were assessed twice a day in the 1st and 2nd weeks (between 8 a.m. and 10 a.m. and between 1 p.m. and 3 p.m.), once a day in the 3rd week, and once every other day in the 4th week (between 1 p.m. and 3 p.m.). A CO reading of less than 8 ppm was considered negative; this criterion has been used in previous studies by other investigators (Heil, Tidey, Holmes, Badger, & Higgins, 2003; Javors, Hatch, & Lamb, 2005; Roll & Higgins, 2000).

Semiquantitative NicoMeter immunoassay test strips (ITS; Jant Pharmacal Corporation, Encino, CA) were used to determine cotinine levels on a daily basis. These strips use gold-coated particles and a series of avidity traps to allow for quantitation of cotinine. The test is performed by placing the dipstick in 0.5 in. of urine for 10 min. The dipstick has six levels: 0 = 0–100 ng/μl, 1 = 100–250 ng/μl, 2 = 250–1,000 ng/μl, 3 = 1,000–2,000 ng/μl, 4 = 2,000–5,000 ng/μl, 5 = 5,000–10,000 ng/μl, 6 = greater than 10,000 ng/μl. Urine cotinine dipstick levels were assessed daily in the afternoon, and abstinence was defined as a urine cotinine level less than the level on the earlier day in the 1st week

and no more than 100 ng/μl (Level 1 on the ITS) during following weeks. The ITS have been shown to have moderate sensitivity and specificity when compared with quantitative gas-chromatography/mass-spectrometry measurements of urine cotinine (Karnes, James, March, Leyden, & Koller, 2001). Verification of abstinence began on the adolescent's quit day.

CM procedures. Abstinence determination/reinforcement appointments were conducted by research assistants. All weekday appointments (including therapy sessions) were conducted in the school nurse's office, where we obtained breath CO levels and urine samples for cotinine measurements. Appointments were conducted either before or after school, in between classes, or during homeroom periods; participants were not allowed to miss class to participate. Weekend appointments were conducted at public locations like fast food restaurants, libraries, and other sites that were easily accessible to both the research assistant or therapist and the participant and where biochemical measurements could be obtained.

Participants in the CM + CBT group were reinforced for abstinence on a schedule of escalating magnitude of reinforcement with a reset contingency (Higgins et al., 1991; Roll et al., 1996). They received $1 for the first CO level that was below 8 ppm and increments of 25 cents for each consecutive negative CO level; they also received $5 for providing a urine sample that was negative for cotinine (using the urine dipstick) each day. If either the breath CO level or urine cotinine sample was positive, the adolescent was not paid for that appointment, and the payment for the next appointment was dropped back to the $1 level; both measures had to indicate nonsmoking to be reinforced and considered abstinent. An initial subset of the CM + CBT group (n = 4) were reinforced on a slightly modified schedule in the 1st week, with assessments conducted thrice per day (8–10 a.m., 3–5 p.m., and 8–10 p.m.): These participants received $2.50 for the first CO level that was negative and increments of 50 cents for each consecutive negative CO; they also received $8 per day for a negative urine cotinine sample. The third CO sample was dropped from the protocol to increase study feasibility due to scheduling difficulties with the 8–10 p.m. appointment.

Adolescents in the CM + CBT group could receive up to $313.75 for staying abstinent during the 1-month program. Adolescents in the CM + CBT and CBT-alone groups received $20 for participating in each weekly therapy session. Adolescents in the CBT-alone group were also required to provide urine and breath samples on a daily basis and were paid $5 for attending these appointments, regardless of abstinence status. Two of the 11 participants in the CBT-alone group did not receive daily appointments, because these appointments were added to the study design after the individuals had completed study participation.

Study outcomes. The primary outcome was point-prevalence abstinence rates at 1 week and 1 month as determined by self-reports and verified by quantitative urine cotinine levels (gas chromatographic techniques; Graham Massey Analytical Lab, Shelton, CT). Quantitative urine cotinine levels of less than or equal to 100 ng/μl were considered abstinent. Comparisons between groups were made using chi-square analyses, which included all participants who had received the "preparation to quit" session. Participants who dropped out or missed multiple appointments were counted as treatment failures. A single missed appointment was coded as abstinent if abstinence was verified at the appointments before and after the missed session.

Results

Twenty-eight (19 male and 9 female) adolescents, with an average age of 17.5 (SD = 1.8) years, participated in the pilot project; 11 received CBT alone and 17 received CM + CBT. Participants smoked an average of 12.9 (SD = 2.4) cigarettes per day, with average urine cotinine levels of 1,029 (SD = 205) ng/μl and average Fagerstrom Test of Nicotine Dependence (Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991) scores of 3.8 (SD = 1.5), indicating a moderate level of dependence. There were no group differences on these tobacco measures.

Adolescents in the CM + CBT condition attended an average of 2.45 counseling sessions; those in the CBT-alone condition attended an average of 2.38 sessions. In the CBT-alone group, 5 adolescents completed treatment until Week 4, and the other 6 participants dropped out of treatment at various times: n = 2 during Week 1, n = 3 during Week 2, and n = 1 during Week 3. In the CM + CBT condition, 11 adolescents completed treatment until Week 4, and the other 6 participants dropped out of treatment at various times: n = 4 during Week 1, n = 1 during Week 2, and n = 1 during Week 3.

Weekly point-prevalence abstinence rates (verified by quantitative urine cotinine levels) indicated that at the end of the 1st week there were significant differences, $\chi^2(1, N = 29) = 12.13$, $p < .001$, between the rates of abstinence in the CBT + CM (13/17, or 76.5%) and CBT-alone (1/11, or 7.2%) groups. These differences were still significant at the end of 4 weeks of treatment, $\chi^2(1, N = 29) = 8.58$, $p < .001$, with 9/17 (53%) participants in the CBT + CM condition versus 0/13 (0%) participants in the CBT-alone condition remaining abstinent throughout the entire trial. Figure 1 presents weekly point-prevalence abstinence rates in both groups. The urine cotinine levels obtained at weekly appointments on the participants who stayed in treatment reflected the above abstinence rates. Specifically, for the CBT-alone group, the average cotinine level at baseline was 1,145 (SD = 165), at Week 1 was 676 (SD = 98), and at Week 4 was 1,243 (SD = 300). In contrast, in the CM +

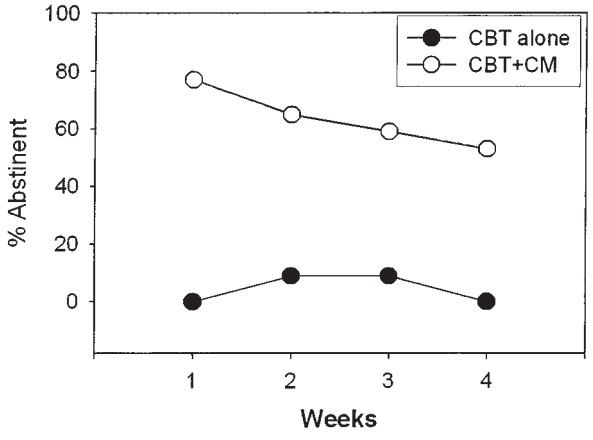

Figure 1. Point-prevalence abstinence rates in adolescent smokers participating in a 1-month smoking cessation program and receiving either contingency management (CM) in combination with cognitive–behavioral therapy (CBT; n = 17) or CBT alone (n = 11).

CBT group, the average cotinine level at baseline was 955 ($SD = 245$), at Week 1 was 85 ($SD = 45$), and at Week 4 was 43 ($SD = 35$).

Discussion

The results of this preliminary pilot study suggest that the use of CM techniques in combination with CBT may significantly enhance smoking quit rates in a high-risk adolescent population. Notably, no smokers achieved end-of-treatment abstinence when provided CBT alone, emphasizing the importance of the inclusion of CM techniques.

An advantage of our program is that it was designed to be school based, which significantly enhanced its feasibility. Anecdotally, we found that students appeared to like the CM approach, did not mind attending appointments in school, and did not object to providing urine and CO samples for abstinence assessments. We also found the local high schools to be remarkably enthusiastic to the idea of conducting the research study and helping their students quit smoking. In addition, we encountered minimal difficulties with conducting the multiple daily study appointments in the local high schools and with obtaining informed consent from the parents of the participants.

A limitation of this preliminary study is the small sample size and the minor procedural differences in subsets of the participants, which could not be examined statistically due to the small sample size. These reflect minor changes in procedures necessitated to adapt CM and CBT to be applied in the school setting and are in keeping with the Stage I, developmental nature of this project (Rounsaville et al., 2001).

The generalizability of this intervention remains to be determined. One issue relates to its future application. For example, should school personnel conduct this program, it may need to be modified, as weekend abstinence assessments may be an impediment. Second, the use of active parental permission, which required that the parents of the adolescents be aware of their smoking habit, influenced who chose to sign up for the study. Although we did not keep accurate records on this issue, there were many adolescents who expressed interest in joining the study but declined to participate because of this requirement. Ongoing studies are using a waiver of parental permission to further enhance the feasibility and generalizability of this school-based intervention. For this procedure, parents of all students (smokers and nonsmokers) within each school receive a letter explaining the study and are asked to inform the school if they do not want their child to participate; otherwise, permission is considered to be granted. Third, students knew they could earn money for achieving abstinence during the 1-month treatment study in the CM group or, in the case of the CBT-alone group, could earn money for study participation. Whether adolescent smokers enrolled in the study because they wanted to quit smoking or simply earn money remains to be determined. If adolescents were motivated to enroll in this study exclusively for money, maintenance of improvement in smoking cessation treatment outcomes could be adversely affected upon removal of contingencies. Ongoing research by our group will examine longer term abstinence outcomes to determine whether initiation of abstinence using CM in combination with the smoking cessation and refusal skills taught through CBT help adolescent smokers maintain abstinence over and beyond the treatment period.

In summary, this preliminary study indicates that CM techniques, with their focus on immediate abstinence, may significantly enhance quit rates in adolescent smokers and can be instituted in a school-based context. Further evidence that these techniques might be attractive to adolescents comes from focus groups in which adolescent smokers reported that money, small enticements, and short sessions were features that would draw them to a smoking cessation program (Balch, 1998). Therefore, we conclude that further investigation is warranted to confirm these preliminary results and develop this innovative smoking cessation intervention for adolescent smokers.

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