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Contingency Management Approaches for Adolescent Substance Use Disorders

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Abstract

Multiple interventions for treating adolescents with substance use disorders have demonstrated efficacy, but the majority of teens do not show an enduring positive response to these treatments. Contingency-management (CM) based strategies provide a promising alternative, and clinical research focused on the development and testing of innovative CM models continues to grow. This article provides an updated review on the progress made in this area since we last commented on the published literature in 2010¹. Areas covered include: controlled trials of treatment for adolescents referred to substance use treatment, innovative applications of CM to tobacco cessation among youth, analyses of moderators and mechanisms of CM treatment outcomes, the emerging literature on dissemination and implementation, and other literature suggesting a growing acceptance of CM as viable and effective intervention. The literature in this area continues to progress at a moderate pace, with many indicators of budding interest in the application of CM, and in finding cost effective models to enhance dissemination and implementation. As with other types of substance use disorder treatments, we need to continue to search for more effective models, focus on post-treatment maintenance (reduce relapse), and strive for high levels of integrity and fidelity during dissemination efforts to optimize outcomes.

Keywords

contingency management; adolescent; substance use; treatment; review

In 2010, we asserted that the research base for CM applications in adolescent substance use disorder treatment settings was only just emerging, however, the overwhelming positive

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evidence base from the adult treatment literature provided reason for high expectations¹. The adolescent literature in this area continues to progress at a moderate pace, with many indicators of budding interest in its application, and in finding cost effective models to enhance dissemination and implementation. Mixed findings have been reported, which are not unexpected given the struggle to find inexpensive, effective treatment models that could readily be adopted by the current health care system. Outcomes from other psychosocial interventions for adolescent substance use disorders clearly indicate that these problems are not easy to treat and that success rates have much room for improvement². As discussed in our prior review of the adolescent CM literature, the schedule of reinforcement (magnitude, timing and frequency) of a CM program is likely the most important determinant of its success in changing the target behavior. For example, greater magnitude and more frequent delivery of contingent reinforcement (incentives) as soon as possible after the target behavior occurs will usually engender better outcomes than lesser magnitude, delayed, and lower frequency delivery, yet enlisting higher magnitude and more frequent incentives has greater cost and requires more time and effort. Unfortunately, those seeking to utilize CM to enhance treatment outcome may err towards keeping costs down in this way, at the peril of reducing efficacy. As we update this literature, we highlight details of each CM program to alert the reader to the parameters (e.g., target, schedule of reinforcement) under study to facilitate more nuanced interpretations of the findings.

In this article, we first provide a review of recent controlled trials focused on adolescent substance use for teens referred to outpatient treatment. Second, we present a brief summary of the continued innovative applications of CM to tobacco cessation among youth. Investigations of predictors and mechanisms of the CM outcomes from treatment studies are summarized to highlight recent efforts to better understanding mechanisms and predictors of CM approaches, and how these may be used to effectively guide future research endeavors. We then discuss the emerging literature on dissemination and implementation of CM and the use of CM as platform or backbone treatment in experimental studies of novel interventions, which indicate growing recognition and acceptance of CM as a viable model for community treatment. We also provide a brief review of a few studies that illustrates the influence of CM research occurring in the area of adolescent substance use treatment and how it is being extended to or paralleled by new applications targeting other health behaviors or disorders.

Clinical Trials Testing CM for Substance Use Disorders

Six new controlled trials of adolescent CM have been published since 2010. We review outcomes from each in turn below, focusing on the intervention characteristics across the domains of inclusion/exclusion criteria, the platform intervention to which CM was added, whether the control condition included any contingent incentives, and whether parents of adolescents participated in the delivery of contingent incentives was or was not part of CM. In addition, we characterize the CM interventions along the dimensions recommended in our prior article: target of the intervention (e.g., abstinence), monitoring strategy, and the incentive schedule, magnitude and type (see Table 1).

First, there have been two negative trials, reporting no significant differences for youth receiving CM vs. a comparison condition. The smaller trial randomized 31 youth over 2.5

years into outpatient substance treatment as usual vs. a CM intervention.³ Youth met DSM criteria for a cannabis use disorder, and parents were not involved in the intervention. The usual care youth did receive attendance incentives using a fishbowl, with a maximum value of approximately \$200. In the CM condition the target behavior was abstinence from all tested substances (no attendance incentives), monitored by urine tests conducted twice a week for 10 weeks. The incentive schedule was escalating, with a reset contingency if use occurred, however incentives were not reinstated if abstinence recurred, and draws could be lost. A fishbowl prize cabinet incentive program was used, with pulls earning \$5.20 on average, a maximum of 112 pulls, and estimated maximum earnings of about \$580. There were no significant differences between CM and usual care youth in substance use outcomes, with youth in both conditions achieving a mean of about 5 consecutive weeks of abstinence. Potential explanation for finding no effect for CM might include the small sample size (N=15 per condition). In addition there may have been selection bias in the sample due to the very small percentage of youth treated at the agencies who elected to enroll in the study. These youth were likely not representative of treated youth generally, and based on the positive outcomes in both conditions, may have reflected a motivated, low problem sample likely to achieve positive outcomes regardless of additional interventions. Further, the CM schedule was generally more punitive than is typical in the instance of a lapse. Accumulated draws could be lost, and were not reinstated back to maximum levels if abstinence was regained.

The second study with negative results enrolled 60 youth and compared 10-week group Cognitive Behavior Therapy (CBT) with or without a CM intervention⁴. Youth were required to meet DSM cannabis use disorder criteria and have a positive urine sample for cannabis at intake. The requirement of a positive cannabis test at intake is not typical across studies, and may have resulted in an overall sample at higher than usual risk of poor treatment outcome. Parents were not involved in the intervention, and youth in the control condition received incentives yoked to youth in the CM groups. In the CM condition the target behavior was abstinence from all tested substances, monitored by urine tests conducted once a week for 2 weeks, then twice a week for 8 weeks. The incentive schedule was escalating, with a reset contingency if use occurred. A voucher program was used with maximum earnings of \$242. Overall, neither condition showed improvement in substance use based on weekly TCH positive urine drug tests, with 71% of youth positive for THC at the end of the intervention. Potential explanations for the lack of efficacy of CM in this trial include the low magnitude of incentives, no parental involvement, and restricting the sample to the most high-risk youth.

The first of the four positive trials published in the past 5 years compared juvenile drug court with or without a family CM (FAM-CM) intervention (N=104)⁵. All youth in drug court were eligible, and the majority met cannabis use disorder criteria (80%). The usual drug court condition did not receive attendance incentives. The CM target was abstinence from all substances tested, and monitoring involved urine tests weekly plus additional random tests. The CM portion of the intervention lasted 4 months on average, however, drug court participation including ongoing urine testing throughout the 9 month post-recruitment follow up period. The schedule was escalating, however earned points could not be redeemed for rewards when a urine test was positive and not until the 5th week. Points were deducted for

positive tests, Incentives were negotiated with the teen and parent and were provided both by parents (monetary and nonmonetary) and staff. Incentives started at 12 points per negative urine test (1 point = \$1), and escalated after the first four weeks of the program up to a maximum of 24 points per negative test. The total number potential earnings was not clearly defined, however, it appeared that the incentive system was designed so that the majority of incentives earned would be delivered by parents and not program staff, who had maximum of \$150 in their part of the program. Youth receiving CM had decreased odds of a THC positive test through the 9-month intervention relative to the drug court as usual control youth. At the 9-month assessment, 20% of the FAM-CM and 34% of the control youth tested positive for THC. Differences across conditions were not observed on self-report of substance use, with 30% of youth in both conditions reporting any days of use in the past 90 days. CM youth also significantly reduced general delinquency, and person and property offenses.

Our most recent study compared Motivational Enhancement Therapy/Cognitive Behavior Therapy (MET/CBT 5+7)^{6,7} to two CM conditions, CM with and without comprehensive parent training (PT) (N=153)⁸. This study followed up on our initial study comparing MET/CBT 5+7 + abstinence CM + PT to MET/CBT 5+7 + attendance CM in order to replicate the positive effects of CM on cannabis abstinence and to isolate the efficacy of PT. Youth were referred to outpatient substance use counseling, and all met DSM-IV diagnostic criteria for cannabis use disorder. The MET/CBT control condition received attendance incentives (\$5 per visit and provision of urine specimens; maximum = \$140), and results of urine tests were provided to parents. The CM target was abstinence from all substances tested, and monitoring involved twice-weekly urine tests for 14 weeks. There were two CM components: clinic and home based. The clinic-based schedule was escalating, with a reset, and maximum earnings were \$590. An additional fishbowl program provided incentives (gift cards) for early abstinence (1st 4 weeks of the program; pulls earned \$2.43 on average, 112 pulls maximum, estimated maximum earnings = \$135). For home-based CM, parents worked with the teen's therapist to develop a contingency contract specifying rewards and consequences to be implemented at home contingent on the results of the teen's urine test results. Parents also earned incentives for session attendance, and compliance with the youth substance contract procedure (fishbowl: pulls earned \$2.43 on average, 111 pulls maximum, estimated maximum earnings = \$270). In the CM+PT condition, parents received additional parent training focused on youth conduct problems more generally. Youth in either CM condition were more likely to achieve 4 weeks of continuous cannabis abstinence during treatment (48%) than were those who received MET/CBT only (30%). Between-condition differences were not maintained during 12-month follow up.

No additional benefit was observed for the comprehensive parent training, that is, no differences were observed between the two CM conditions. The failure of PT to improve outcomes may be due to several factors. First, therapist fidelity to the PT intervention was only moderate (although it was comparable to other studies in which the intervention showed positive effects). Second, the inclusion of some youth with low levels of conduct problems in the treatment sample may have limited the impact of PT. Third, the home-based CM delivered to those who did not receive PT is an evidence-based parenting intervention that focuses specifically on substance use. Therefore, the 2 CM conditions differ in the dose/

breadth of PT, including an exclusive focus on substance use versus a broader focus on conduct problems and family communication, including substance use. Thus, these results do not suggest that parenting interventions fail to improve outcomes relative to individual interventions. However, the findings do suggest that the addition of a broad-spectrum parenting intervention, as delivered in this study, focusing on conduct problems did not boost outcomes over and above home based CM focusing on substance use more specifically.

A third positive trial enrolled substance using youth leaving residential treatment (N=337) who met criteria for a past year substance use disorder (91% for a cannabis use disorder)⁹. Using a 2x2 design, youth were randomly assigned to usual continuing care services (UCC) vs. assertive continuing care (ACC) services and to CM vs. no CM. There were no incentives provided to youth who did not receive CM. CM targeted two behaviors: abstinence from all substances tested, monitored via weekly urine tests for 12 weeks, and documented participation in prosocial activities. The schedule was escalating, with a reset. A fishbowl system with a prize cabinet was used (\$2.55 per pull; 117 pulls maximum abstinence and 117 for activities; estimated maximum earnings = \$298 each for abstinence and activities). Parents did not participate in CM, however ACC involved parent/caregivers in 4 sessions focused on communication and problem solving. Youth receiving CM only and receiving ACC only had more days of abstinence from cannabis through the 9-month post treatment follow up compared to UCC. Outcomes for the CM+ACC condition were not significantly different from UCC, which the authors suggest may have resulted from the high demands in the combined intervention.

The final positive CM trial was conducted in a school setting (N=136) and enrolled youth referred by school personnel due to concern about substance use (88% met cannabis use disorder criteria)¹⁰. The platform intervention was 4 sessions of Motivational Interviewing (MI), which was followed by either a CM condition or no additional intervention (MI only). No incentives were provided to the MI only youth. One CM target was abstinence from all substances tested, with monitoring achieved by a 50% (random) chance of a saliva test (substances tested and window of detection not specified) for 4 weeks. CM youth also received incentives for self-reported abstinence or “change plan improvements”. A fishbowl system with fixed, non-escalating pulls (one pull for each target) was used (50% chance of winning \$5 gift card per pull; \$2.50 per pull; 6 pulls maximum; estimated maximum earnings appear to be \$15– \$25). Parents did not participate. Results indicated greater reductions in marijuana use days per month among CM than MI only youth, with significant differences between conditions at the end of the 8-week intervention period, but not at the 16-week follow up assessment.

These diverse CM interventions for substance using youth are challenging to summarize. They all highlight cannabis use as the primary clinical outcome, regardless of the method of recruitment or setting, likely reflecting the ubiquitous and frequent cannabis use patterns across samples of adolescents enrolled in general outpatient settings. All programs targeted abstinence using objective biological sampling measured typically once or twice per week. They also generally demonstrate short-term CM efficacy across highly diverse settings (school, clinic, juvenile justice, continuing care), platform interventions (many were

evidence based, ranging from 4 session MI to 14 weeks of MET/CBT) using varying types of incentives (fishbowl vs. vouchers), schedules (although most were escalating), and magnitude (~\$25 to \$725 total/~\$6 to \$50 per week).

No trial has tested the impact of CM magnitude (i.e., compared different magnitudes or schedules) for substance using youth. Neither of the two trials with negative findings involved parents, and both were conducted in outpatient treatment settings, while 2 of the 4 positive trials directly involved parents in the administration of CM at home. To date, no trial has systematically tested the independent or combined efficacy of clinic- vs. parent-based CM. It seems possible that both negative trials may reflect some recruitment bias, with one trial showing generally positive outcomes in all conditions across a small and highly select sample of perhaps highly motivated youth³, and the other showing poor outcomes across groups where youth were required to test positive for cannabis at baseline, a unique inclusion criteria not typical of CM studies and perhaps more severe than other comparable studies⁴. The best outcomes across studies were reported for youth with the lowest rates of baseline substance use, that is, those in juvenile drug court or those entering continuing care after residential treatment^{5,9}. Intermediate, less long lasting outcomes^{8,10} were reported for youth in outpatient and school-based settings. Finally, across studies, long-term reduction in use or abstinence among youth remains a serious challenge, even among those who show better post-treatment outcomes. The one study focused on continuing care suggests that including additional targets of CM such as engagement in specific types of prosocial activities together with targeting abstinence might better facilitate enduring change¹¹.

Moderators and Mediators

Several recent studies have tested moderators and mediators of adolescent CM interventions. Overall, the list of tested relations that failed to reach significance is longer than positive associations. For example, with the CM-FAM intervention integrated with juvenile drug courts, no demographic characteristics (age <16 years, gender, ethnicity) or psychiatric problems (presence of internalizing or externalizing disorder) showed main effects on treatment outcome, and did not interact with CM⁵. Similarly, demographic predictors (mandated treatment, psychiatric medications, living with both parents, receipt of additional services) did not predict outcomes or interact with CBT+CM⁴. One study has reported a moderating effect of disruptive behavior disorder diagnosis (DBD) on treatment outcome related to MET/CBT + attendance incentives vs. MET/CBT + abstinence-based CM¹². DBD positive adolescents generally reported a higher frequency of marijuana use across all assessment periods, but those who received abstinence-based CM showed a significantly greater reduction in frequency of marijuana use than those who received MET/CBT plus attendance incentives. Interestingly, among DBD negative – adolescents who received abstinence-based CM did not have significantly better marijuana use outcomes compared to MET/CBT+ attendance-based incentive. This may have been due to a ceiling effect; that is, DBD negative adolescents receiving the MET/CBT + attendance incentives had good marijuana outcomes, making it more difficult to demonstrate greater outcomes in with abstinence-based CM.

Several studies have tested treatment engagement, secondary targets (e.g., prosocial activities) or cognitive mechanisms. For example, in the study of CM and ACC, although both were associated with greater treatment engagement (attending 4 or more sessions in the first 6 weeks) and increased prosocial activities, neither mediated relations between treatment condition and outcome⁹ The school-based CM study discussed above tested engagement in external substance use treatment and self-reported use of temptation coping skills in high risk situations at the end of their trial as mechanisms¹⁰. The number of temptation coping strategies endorsed mediated relations between treatment condition and end of treatment cannabis use frequency, after controlling for baseline marijuana use frequency. Youth receiving CM reported more use of temptation coping, which in turn predicted fewer cannabis use days, despite receiving no direct instruction in using these strategies. Although youth receiving CM were more likely to engage in outside treatment, this engagement did not mediate the intervention effects.

Overall, findings generally indicate that CM appears efficacious across broad demographic groups of adolescents. Only one recent study reported greater CM efficacy among a subpopulation, youth with concurrent disruptive behavior disorders. Research is particularly limited on moderation of CM efficacy by cognitive characteristics among adolescents, such as delay discounting or other characteristics related to executive function, including self-regulation or emotion-regulation. Research on mechanisms of CM is similarly limited, but the study of the school-based intervention represents a notable exception¹⁰.

Applying CM to Tobacco Cessation

Our last review also highlighted the promising initial CM studies targeting tobacco cessation in a school-based setting which found that adding CM to CBT could substantially enhance cessation rates in the short term¹³. A subsequent 4-week, randomized trial designed to “dismantle” the effects of CM and CBT has since been published¹⁴. Youth (n=82) seeking cessation treatment in their school setting received either CM alone, CBT alone, or CM +CBT. Participants included 82 adolescent smokers seeking smoking cessation treatment. A greater percentage of CM+CBT and CM youth (36.7% and 36.3% respectively) than CBT alone (0%) were abstinent for seven days or more immediately preceding the end of treatment. One and three month post treatment assessment did not reveal any between-condition differences, but suggested a slower increase in tobacco use over time in the CM alone group. Secondary analyses of these data suggest that the significant main effect of CM appeared to be primarily accounted for by its robust positive impact on youth with higher levels of behavioral impulsivity or greater self-regulation deficit¹⁵. An additional analysis examined whether exposure to stressful life events or type of coping style interacted with type of treatment to predict tobacco abstinence outcomes¹⁶. Interestingly, greater use of behavioral coping skills predicted positive smoking outcomes among those who received only CM, and the converse was observed among those in the CM+CBT condition, that is, less use of behavioral coping predicted abstinence. Last in response to concerns about potential negative effects of providing monetary incentives in the CM conditions, this group assessed how youth spent their incentive earnings. Youth self-reports suggested that CM was not associated with increased spending on tobacco or other substances, and a generally,

those who earned the most incentives tended to increase spending on more prosocial goods or services¹⁷.

Another tobacco cessation trial evaluated a home-based CM protocol focused on reaching a high-risk adolescent sample with little access to treatment¹⁸. Following a similar internet-delivered protocol developed by Dallery et al. for adult smokers that was tested successfully in a prior study with 4 adolescents¹⁹, 62 youth received either contingent incentives based on carbon monoxide (CO) levels indicative of smoking abstinence (verified by video recordings from a CO monitor 3 times per day) or incentives for just submitting the videos on schedule with no contingency on CO levels. The innovative reinforcement schedule included shaping, abstinence, and thinning phases. The CO-based contingencies engendered greater decreases in CO across the 30-day trial, and those in this condition also maintained reductions during a 6-week post-treatment phase. Overall, the CM approaches to adolescent tobacco smoking have illustrated that systematically providing contingent incentives for smoking reduction and cessation has strong potential, certainly for motivating and engendering initial change. Reinforcement schedules that focus on reducing relapse, such as thinning or fading¹⁹, warrant more study to better achieve more enduring positive effects.

Dissemination and Implementation of CM for Adolescent Substance Use

Despite strong evidence in support of the effectiveness of CM interventions in adults and the increasing literature demonstrating positive effects with adolescents, dissemination and implementation of CM programs has been limited. During the past few years, research examining methods of dissemination and implementation of CM for adolescent substance use indicates that CM is fairly straightforward to teach and implement, and represents a relatively low cost intervention that can be integrated with other treatment models and readily adopted by a variety of organization types (e.g., substances use services, mental health provider services, and juvenile drug courts)^{20–24}. Below we summarize the excellent work being conducted in this area.

One study examined two implementation models for integrating CM with Multisystemic Therapy (MST) for cannabis using adolescents with 38 MST-trained providers²¹. One model included an intensive quality assurance system (i.e., manualized information, expert consultation, organizational support, and ongoing training) and a CM workshop, while the other model included the CM workshop only. Therapist adherence to CM was not significantly increased for providers who received the intensive quality assurance + workshop compared to those who received the workshop only, suggesting that a CM workshop alone may be sufficient for adequate integration of CM into a clinic providing MST. This study also found that across both implementation groups, higher therapist adherence to CM was associated with increased cannabis abstinence, reinforcing the importance of developing effective training models for increasing and maintaining provider adherence to CM.

Another study examined three implementation models for the integration of a CBT+CM intervention for adolescent substance use into community outpatient substance abuse treatment services with substance abuse and mental health practitioners²⁰. Three models, a

workshop and resources (WS+), WS+ with computer assisted training (WS+/CAT), and WS +/CAT with supervisory support (WS+/CAT/SS), were tested in 10 organizations across 161 therapists. No benefit was observed for the two more intensive training models compared to the less intensive WS+ model in terms of CM knowledge, CM use, and CM adherence. This again suggests that a workshop with additional resources was sufficient to facilitate adequate adoption of CM into public sector outpatient substance abuse treatment services.

Finally, one study examined strategies for implementing CM-FAM) into Juvenile Drug Courts (JDCs)²². Six JDCs, 104 families, 51 therapists and 74 JDC stakeholders, received either training in CM-FAM or continued with providing usual services. Outcomes supported the feasibility of implementing CM-FAM in the JDCs, and of note, CM-FAM trained therapists and stakeholders had more favorable perceptions of incentive-based interventions for substance use. This finding is critical because non-favorable perceptions of incentive-based interventions are a primary obstacle to the dissemination of CM into community treatment settings. Additional education about and exposure to CM interventions for providers and stakeholders might help to overcome this obstacle^{25,26}.

Other Indicators of Acceptance of CM Models

One sign of the growing recognition and utilization of CM interventions for adolescent substance use comes from clinical trials that choose to use abstinence-based or attendance-based CM as treatment platforms upon which to test the efficacy of other new behavioral or pharmacological treatments. For example, two published trials investigating the efficacy bupropion and N-acetylcysteine (NAC) for adolescent tobacco cessation and cannabis use, respectively, used study designs that involved between-condition comparisons of CM plus Medication vs. CM plus placebo. Although not clearly asserted, the rationale for the design likely included the contention that before using a medication in an adolescent population, one should determine if it increases efficacy compared to an optimal noninvasive, psychosocial intervention (i.e., CM). Similarly, CM has been used as the base treatment upon which to build and test a Sexual Risk Reduction intervention for substance using adolescents^{27,28}.

Another indicator of growing interest in using CM to enhance outcome comes from pilot or demonstration trials conducted in community clinics. Most recently, a report appeared evaluating a very low cost CM program that targeted attending substance use treatment sessions in an urban outpatient clinic²⁹. A quasi-experimental design (comparing attendance prior to vs. after implementation of the CM program) showed that those in the CM program attended significantly more sessions on average (79% vs. 61%), with expenditures for the CM program averaging approximately \$29 per participant or \$3 per session. Such demonstrations, although not well controlled, clearly show that clinical operations can readily modify CM to fit their programs, and suggest a growing interest in how to utilize CM to optimize outcomes.

CM Targeting Other Health Behaviors in Adolescents

Literature on CM interventions targeting adolescent substance use behaviors continues to expand, and just recently has extended its reach to other important adolescent health behaviors, such as weight loss or medication adherence. Although many health behavior theories (e.g., health belief model, social learning model, and theory of planned behavior) have foundations in learning theory, supporting the relevance of immediate and long-term contingencies for adolescent health behavior decision-making, the integration of CM with behavioral therapies for non-substance use health behaviors in adolescence has lagged behind.

Since 2010, there have been four pilot studies examining the use of CM for modifying adolescent health behaviors, including three studies targeting self-monitoring of blood glucose (SMBG) in adolescents with type 1 diabetes and one study targeting adolescent weight loss. Interestingly, the research groups who first applied CM methods to adolescent or adult substance use conducted all of these studies. Stanger et al.³⁰ reported positive findings for parent-led CM and clinic-based incentives for SMBG in conjunction with MET/CBT for increasing SMBG and improving glycemic control in youth with poorly controlled type 1 diabetes. Consistent with those findings, both Petry et al.³¹ and Riaff and Dallery³² conducted pilot tests of clinic-based incentives for SMBG, without any additional counseling or parent-led CM, and also found improvements in SMBG and glycemic control. Last, Hartlieb et al.³³ conducted a pilot test of CM combined with behavioral skills training (BST) to enhance adolescent weight loss, and found that parent-involved CM, but not adolescent-only CM, enhanced the effect of BST on youth weight loss.

Empirical support for the importance of incorporating parent-led and clinic-based CM interventions into treatments targeting the modification of adolescent health behaviors continues to grow^{34,35}. Future experimental and implementation efforts should continue to examine the effectiveness of CM for targeting a wide variety of adolescent health behaviors, with the hope that findings will generalize across behaviors and inform new interventions.

Future Directions

Continued and new avenues of CM research and exploration would appear to offer one promising path to the development of more effective programming for adolescents with substance use related problem. Here we briefly mention just two possibilities not yet addressed:

1. Exploration of neural mechanisms may provide alternative ways of thinking about the development and specification of CM-based interventions³⁶⁻³⁸. For example, exposure to CM might produce activation or connectivity changes in one or more neural networks involved with making behavioral choices including executive (top down) and motivational and emotional (bottom up) processes. Such changes might be directly related to CM or occur indirectly through effects of abstinence from substance use, which may also affect brain structure and function. The use of experimental methods including neuroimaging to identify

intervention effects on behavioral and motivational/emotional neural mechanisms should provide clues as to how to improve the effectiveness of CM or how to target these important neural systems through other interventions e.g., cognitive training to improve outcomes.

2. Utilization of technology has great potential to facilitate or enhance CM approaches to substance use and other health behaviors³⁹. Studies with adults have demonstrated how web-based delivery of CBT interventions can increase access to and reduce costs of delivery of integrated CBT and CM interventions, which reflect an optimal treatment combination⁴⁰. Similarly, the adolescent smoking cessation interventions reviewed above provide models for how technology can be used to support effective monitoring of target behaviors outside the clinic which can extend the reach and perhaps facilitate more effective CM programs¹⁸. Another example comes from our recent adolescent trial that used automated payments to debit cards to ease staff burden associated with providing the incentive earnings to participants⁸. The growing development and application of diverse technological devices and platforms to improve health behavior should provide a surplus of ideas and innovations for adapting and implementing CM-based programs to better address adolescent substance use problems.

Conclusions

CM-based models of intervention continue to garner attention from clinical researchers seeking to enhance the effectiveness of treatments for adolescent substance use disorders. Studies are searching for CM models that can either improve outcomes, enable more access to these interventions, or both. Findings to date generally provide positive support for the value of adding CM to established treatments or for providing a primarily CM-based approach. A few key observations from this body of work to keep in mind include the following:

1. No study has yet to provide a careful test of the efficacy of a parent-administered CM intervention that is not delivered in concert with an associated clinic-based CM program. If efficacious, such a home-based program might provide a transportable option that would be lower cost than typical clinic-based CM programs. That said, engaging regular parent participation in treatment and facilitating application of a structured home-based CM poses substantial challenges of its own.
2. The substantial variation in the parameters of CM programs under study (outcome target, magnitude of reinforcement, frequency of monitoring and reinforcement) should hopefully remind the reader that CM programs can vary greatly in many aspects, and each program must be evaluated on its own merits. Enough data have now accumulated from adult and adolescent treatment studies to indicate that the question to be asked is not whether

CM is an efficacious intervention model or not, but whether a particular CM program works and what specific parameters were employed.

3. CM programs, even the most effective tested to date, like all other interventions for adolescent substance use disorders have much room for improvement, particularly related to longer duration outcomes. Innovative CM models focused on maintaining treatment gains are sorely needed to address the ubiquitous problem of relapse.
4. The nascent literature on implementation of CM in new treatment settings and the integration of CM with other treatment models suggest that adoption of and adherence to CM can be accomplished via comprehensive workshops and resources, perhaps without intensive training and supervision. That said, CM interventions can vary substantially in complexity, so, again, the challenges for disseminating any one CM program may differ substantially from others. As with other treatment models, integrity and fidelity are essential to achieving good outcomes with CM, and thus should not be taken for granted.

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Key Points

1. The literature on the use of contingency management for reducing adolescent substance use continues to grow, and generally shows positive effects for enhancing outcomes during treatment.
2. As with other models of treatment, obtaining enduring effects post-treatment remains a challenge, and tests of innovative CM programs targeting maintenance are lacking.
3. Implementation research indicates strong interest in adoption of CM, and initial findings suggest that structured workshops can provide effective training for some types of programs.
4. Parameters of CM programs, such as the frequency and magnitude of contingent incentives, context of the contingency (home vs. clinic), target behavior, and selected population, should be clearly specified when evaluating and discussing the efficacy of CM interventions.

Table 1

Characterization of CM interventions

| Study/N | Inclusion Criteria/Setting | Platform | Control Incentives | Parent Participation in CM | CM Target | Monitoring Schedule | Incentive Schedule | Incentive Magnitude | Incentive Type | Trial Outcome |
|--------------------------------|--|---|--------------------|------------------------------|--|---|---|---------------------|---|---|
| Killeen et al., 2012 (N=31) | Cannabis use + diagnosis/Outpatient | Community care, 12-step, group | Yes | No | Abstinence | 2×/week UA for 10 weeks | Escalating with reset | \$583 ² | Fishbowl/prize cabinet | Negative: CM=control; both conditions improved Positive: CM>control; during treatment differences; not sustained to 12 month follow up |
| Kaminer et al., 2014 (N=60) | THC positive UA + cannabis diagnosis/Outpatient | 10 week group CBT | Yes | No | Abstinence | 1×/week UA for 2 weeks; 2×/week for 8 weeks | Escalating with reset | \$242 | Vouchers/Gift cards | Negative: CM=control; poor outcomes in both conditions Positive: CM>control; during treatment differences; not sustained to 12 month follow up |
| Stanger et al., 2015 (N=153) | Cannabis use + diagnosis/Outpatient | Individual Met/CBT 5+7 | Yes | Yes + incentives for parents | Abstinence | 2×/week UA for 14 weeks | Escalating with reset | \$725 | Vouchers/Gift cards + Fishbowl/gift cards | Positive: CM>control; during treatment differences; not sustained to 12 month follow up |
| Henggeler et al., 2012 (N=104) | Drug court (80% with cannabis diagnosis)/Outpatient | Usual drug court services | No | Yes | Abstinence | 1×/week UA + random tests for ~4 months | Escalating/ can't redeem points if not abstinent/no reset | \$150 | Vouchers/gift cards | Positive: CM>control; during treatment differences to 9 months of continued drug court involvement |
| Godley et al., 2014 (N=337) | Post residential treatment/past year substance use disorder (91% with cannabis diagnosis)/Home visits | Usual continuing care/Assertive Continuing Care | No | No ¹ | Abstinence + prosocial activities | 1×/week UA for 12 weeks + activity verification | Escalating with reset | \$298 ² | Fishbowl/prize cabinet | Positive: CM>control; effects sustained to 9 month follow up. |
| Stewart et al., 2015 (N=136) | Referral by school staff due to substance use/substance use in prior 3 months (88% cannabis use disorder)/School based | MI | No | No | Abstinence + self-reported abstinence or reduction (“change plan improvement s”) | 1×/week self report + 50% chance of saliva test for 4 weeks | Fixed with no reset | \$15 ² | Fishbowl/gift cards | Positive: CM>control; during treatment differences; not sustained to 2 month follow up |

¹ Parents participated in one of the comparison conditions (Assertive Continuing Care).

² Maximum earnings not presented in manuscript; amount extrapolated from information in manuscript

MET =Motivational Enhancement Therapy; CBT=Cognitive Behavior Therapy; MI=Motivational Interviewing; UA=urinalysis; CM=Contingency Management