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Contingency management is efficacious and improves outcomes in cocaine patients with pretreatment marijuana use

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Abstract

Background—Marijuana use is common in patients seeking treatment for cocaine use. Nevertheless, few studies have examined effects of marijuana use on treatment outcomes in general, and even fewer with respect to contingency management (CM) treatment, which has been criticized for potentially increasing non-reinforced drug use.

Method—Data from three randomized clinical trials of CM versus standard treatment (ST) in cocaine-abusing patients were examined (Petry et al., 2004, 2005a, 2006a; $N = 393$) to assess effects of pretreatment marijuana use on outcomes. Patients were divided into two groups: (1) no self-reported marijuana use (No Pre-M; $n = 315$) and (2) any self-reported marijuana use (Pre-M; $n = 78$) in the 30 days pretreatment.

Results—CM was especially efficacious in enhancing retention in Pre-M patients such that retention nearly doubled among Pre-M patients assigned to CM versus those assigned to ST. In contrast, CM exerted only modest benefits on retention in No Pre-M patients. Pretreatment marijuana use was not related to during-treatment abstinence from cocaine, opioids, and alcohol, or abstinence at a Month 9 follow-up. However, CM treatment and longest duration of abstinence achieved during treatment were significant predictors of Month 9 abstinence. Pre-M patients also evidenced more improvements in drug problems over time when randomized to CM.

Conclusions—CM was especially efficacious in facilitating retention and improving severity of drug-related problems in those who used marijuana in the month before initiating treatment.

Keywords

contingency management; pretreatment marijuana use; during treatment marijuana use; outpatients; treatment outcomes

1. Introduction

Marijuana use is common in patients seeking treatment for cocaine dependence. Estimates indicate that between 20% and 59% of individuals seeking treatment for cocaine also use marijuana (Budney et al., 1993, 1996; Higgins et al., 2003, 2007; Lindsay et al. 2009; Miller et al., 1990). In a sample of 1183 individuals seeking treatment for cocaine (Lindsey et al., 2009), marijuana users were more likely to be female, Caucasian, and younger than non-

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marijuana users. Compared to their non-marijuana using counterparts, marijuana using cocaine-dependent patients also used cocaine and alcohol more frequently, and they reported greater medical, legal, and psychiatric problems.

Although marijuana using and non-marijuana using cocaine abusers clearly differ with respect to some demographic and psychosocial characteristics, relatively little research has examined the impact of marijuana use on treatment outcomes of cocaine abusers. Aharonovich et al. (2006) found that occasional marijuana use was associated with greater retention in a medication trial involving methylphenidate for treatment of attention deficit disorder and cocaine dependence. However, other studies (Rawson et al., 1986), including one large prospective trial (Aharonovich et al., 2005), reported that marijuana use is associated with greater likelihood of cocaine relapse. In general, patients who use multiple substances have poorer treatment outcomes than those who use just one drug (McLellan et al., 1994; Simpson et al., 1999). Because of their more severe psychosocial impairment and greater use of substances, marijuana using cocaine abusers may necessitate more intensive treatment than cocaine users without concurrent marijuana use.

One intervention that may be useful for patients initiating treatment with more significant psychosocial and substance use problems is contingency management (CM). CM interventions for substance use provide reinforcers for evidence of abstinence. Typically, reinforcers are vouchers exchangeable for retail goods and services or chances to win prizes of varying magnitudes. Numerous studies (Higgins et al., 1994, 2000, 2003, 2007; Petry et al., 2004, 2005ab, 2006a) and meta-analyses (Dutra et al., 2008; Lussier et al., 2006; Prendergast et al., 2006) demonstrate the efficacy of CM for reducing cocaine use. CM is efficacious across a wide range of cocaine using populations, including those with significant psychopathology and substance use problems (Gonzales et al., 2003; Ries et al., 2004; Roll et al., 2004), and CM may be particularly efficacious for patients who do not fare well in standard drug abuse treatment (Weinstock et al., 2007; Rash et al., 2008).

Budney et al. (1996) examined marijuana use and treatment outcomes in 186 patients participating in CM trials for cocaine dependence. Marijuana use before treatment entry was related to increased psychosocial impairment and substance use problem severity. However, marijuana use did not significantly impact retention or cocaine abstinence in the 95 patients who received CM. The patients who were not randomized to CM ($n = 91$) were excluded from the analyses, so this study did not address whether CM is of greater benefit than standard treatment in marijuana using versus non-using cocaine-dependent patients. Higgins et al. (2003) also examined main, but not interactive, effects of marijuana dependence on cocaine outcomes in patients who received CM and found no effect. However, the relatively small sample size may preclude the ability to detect more than a large effect size of marijuana use on cocaine outcomes.

The purpose of this study was to examine, in a larger sample, whether marijuana use at the time of treatment entry was related to outcomes across and within standard treatment and CM interventions. We conducted a retrospective analysis of three randomized trials (Petry et al., 2004, 2005a, 2006a) evaluating the efficacy of CM in cocaine abusing outpatients. We predicted that patients who reported marijuana use at time of treatment initiation would have more severe substance use and psychosocial problems than those without recent marijuana use. Given the benefits of CM in the three trials (Petry et al., 2004, 2005a, 2006a), we expected CM would improve outcomes overall, and we also examined whether marijuana use group interacted with treatment condition in terms of primary outcomes.

2. Method

2.1 Patients

Data were drawn from patients ($N = 393$) enrolled in one of three clinical trials on CM (Petry et al., 2004; Petry et al., 2005a; Petry et al., 2006a). Participants were patients recently admitted to one of four community-based outpatient substance abuse treatment programs. Across the trials, inclusion criteria were (a) at least 18 years old, (b) past-year cocaine abuse or dependence, and (c) able to comprehend study procedures. Exclusion criteria were (a) significant uncontrolled psychiatric problems (e.g., psychosis, mania, suicidality), and (b) in recovery for pathological gambling. The latter was included because prize-based CM has an element of chance, although no patients were excluded for this reason, and this intervention has not been associated with gambling problems in research to date (Petry et al., 2006b; Petry and Alessi, 2010). Patients provided written informed consent for study participation, and study procedures were approved by the university's Institutional Review Board.

2.2 Procedures

2.2.1 Original Trials and Current Study Intake—Retrospective analyses of data collected in three clinical trials comparing CM and standard treatment in patients with current cocaine dependence who were recently enrolled in outpatient treatment are presented. The primary aims of the studies were to compare the efficacy of (1) prize CM, a lower-cost prize CM condition, and standard treatment (Petry et al., 2004), (2) prize CM, voucher CM, and standard treatment (Petry et al., 2005a), and (3) CM-reinforced abstinence, CM-reinforced activities, and standard treatment (Petry et al., 2006a). The same outcomes were assessed using identical instruments, and assessments occurred at the same intervals across the trials. Because outcomes between CM conditions did not significantly differ in any study, CM conditions are combined for this study.

At study intake, urine samples were tested for cocaine and opioids using OnTrak Teststicks (Varian, Inc., Walnut Creek, CA), and a breath sample was tested for alcohol using an Alcosensor IV Alcometer (Intoximeters, St. Louis, MO). Past-year substance use diagnoses were assessed using checklists based on modules from the Structured Clinical Interview for *DSM-IV* (First et al., 1996). Severity of psychosocial problems was assessed using the Addiction Severity Index (ASI; McLellan et al., 1985), an instrument with demonstrated validity and reliability (Bovasso et al., 2001; Kosten et al., 1983; Leonhard et al., 2000). Composite scores are derived for 7 domains and range from zero to 1, with higher scores reflecting greater severity of problems. Days of marijuana use in the past 30 were recorded in the ASI-Drug section. The ASI was re-administered and samples collected at follow-up interviews 3, 6 and 9 months following intake.

2.2.2 Treatment Conditions—After determining eligibility, patients were randomly assigned to treatment conditions. A brief description of treatment conditions is provided below (See main study reports for full details; Petry et al., 2004; Petry et al., 2005a, Petry et al., 2006a). Across all trials, study procedures were in addition to standard outpatient services, as described below.

2.2.2.1 Standard Treatment (ST) included group therapy sessions on 3–5 days per week during the initial phase of treatment, and once per week for up to 12 months during aftercare. Group therapy included relapse prevention, coping and life skills training, HIV education, and 12-step involvement. Patients in the ST condition submitted up to 21 urine and breath samples that were tested for cocaine, opioids, and alcohol. The sample collection schedule was three times per week during study weeks 1–3 (e.g., Monday, Wednesday,

Friday), twice per week during weeks 4–6 (e.g., Monday, Thursday), and once per week during weeks 7–12.

2.2.2.2 Contingency Management (CM) patients received the same outpatient treatment services and study procedures described above. In addition, CM patients in all three studies were reinforced for urine and breath samples that tested negative for cocaine, opioids, and alcohol and/or completion of activities consistent with treatment goals. Each goal-related activity was reinforced when patients provided objective evidence of completion (e.g., receipt; see Petry et al., 2001). Schedules of reinforcement for abstinence and goal-related activities were independent, such that abstinence outcomes did not affect goal-related reinforcement and vice versa.

2.2.3 Data Analysis—Patients were divided into two groups based on self-reported days of marijuana use in the 30 days before study intake [no pretreatment marijuana use (No Pre-M; $n = 315$) versus any pretreatment marijuana use (Pre-M; $n = 78$)]. Patients in the No Pre-M group and Pre-M group were compared on demographics, baseline variables, treatment condition (ST, CM), and study (Petry et al., 2004; Petry et al., 2005a; Petry et al. 2006a) using t -tests and chi-squared tests as appropriate. Parametric tests were used for variables normally distributed or otherwise, because t -tests are robust to departures from normality when the sample size is large (Lumley et al., 2002).

Multivariate Analysis of Variance (MANOVA) was used to examine the relationship between pretreatment marijuana use group and the primary treatment outcomes: (1) weeks retained in treatment, (2) longest duration of sustained cocaine, opioid and alcohol abstinence (LDA), and (3) the percent of negative urine/breath tests, during the intervention. LDA was defined as the greatest number of weeks in a row of consecutive negative samples. Samples that tested positive for cocaine, opioids, or alcohol broke the chain of abstinence. Although the number of urine/breath tests scheduled was equivalent across studies, actual number submitted differed ($p = .00$); therefore, percent of negative samples was calculated with number of samples submitted in the denominator. Weeks in treatment, LDA and percent of negative tests were significantly and moderately correlated ($r = 0.50 - 0.74$, $p = .00$), supporting the use of multivariate tests. Independent variables included were pretreatment marijuana use group (0 versus >0 days of marijuana use in the 30 days pretreatment), treatment condition (ST or CM), baseline urine/breath test result (positive or negative for cocaine, opioids, and alcohol), and study (Petry et al., 2004, 2005a, 2006a). Other variables (age, marital status, years of education, DSM opioid dependence diagnosis, and ASI Psychiatric scale scores) were excluded because of no significant association with the dependent variables. First, a full factorial model was run. Interactions that were not statistically significant and those that were not clinically relevant were removed from the final multivariate test. Interactions retained were pretreatment marijuana use group $\times$ treatment condition and study $\times$ treatment condition.

Logistic regression evaluated Month 9 abstinence (cocaine, opioids, and alcohol). Pretreatment marijuana use group and treatment condition were covariates, along with LDA because it is a strong predictor of long-term abstinence (Higgins et al., 2000; Petry et al., 2005a). Analyses were conducted twice, first with missing samples omitted from the analysis and second with missing samples coded positive. The same variables were retained and significant using the two methods. The analysis with missing samples coded positive is presented.

Latent growth models examined changes in ASI Drug scores over time (baseline and Months 3, 6, and 9). The procedure included the following models: 1) intercept only, 2) linear growth (slope coding: 0, 3, 6, and 9), 3) latent basis growth (slope coding: 0, 1, with

remaining time points freely estimated), and 4) conditional model (best fitting growth model with predictors pretreatment marijuana use group, treatment condition, and their interaction added). All models used a maximum likelihood estimator with robust standard errors, using all available data at each assessment. We examined models for evidence of poor model specification and assessed fit using the model chi-square tests, Satorra and Bentler (2001) scaled chi-square difference tests, root-mean-square error of approximation (RMSEA; Browne and Cudeck, 1993), and the standardized root-mean-square residual (SRMR). Growth modeling was conducted using Mplus (version 4.2; Muthén and Muthén, 1998-2006); other analyses were conducted using SPSS v. 15.

3. Results

3.1 Baseline and Demographic Variables

Baseline and demographic data by pretreatment marijuana use group are depicted in Table 1. Individuals who reported past 30-day marijuana use at baseline ($n = 78$) reported using on a median (interquartile range) of 4.0 (1.0 – 15.5) days out of the past 30 days. Patients in the Petry et al. (2004) study were more likely to report pretreatment marijuana use; those in the Petry et al. (2005a) study were more likely to report no use. Compared to those in the No Pre-M group, Pre-M patients were more likely to be younger, never married, and opioid dependent, and to have a positive baseline opioid or cocaine test and greater ASI Drug and Psychiatric composite scores.

3.2 Primary Treatment Outcomes

Significant multivariate effects of treatment condition, study, treatment condition X study, and baseline urine/breath test results emerged on the primary treatment outcomes. There was a trend towards a main effect of pretreatment marijuana use group on primary outcomes [$F(3, 381) = 2.40, p = .07, \eta^2_p = .02$]. After controlling for aforementioned significant effects, there was a significant multivariate interaction of pretreatment marijuana use group by treatment condition on primary outcomes [$F(3, 381) = 3.44, p = .02, \eta^2_p = .03$]. Follow-up univariate tests indicated a significant effect on weeks retained [$F(1, 383) = 4.2, p = .04, \eta^2_p = .01$]. CM was associated with increased retention regardless of pretreatment marijuana use. However, the extent to which retention was increased in the CM condition compared to the ST condition was particularly pronounced in the Pre-M group (Table 2). Effects of pretreatment marijuana use group by treatment condition were not significant for percent of negative tests ($p = .81$) and LDA ($p = .95$).

ⁱTreatment condition had a significant omnibus effect on outcomes [$F(3, 381) = 7.50, p = .00, \eta^2_p = .06$], with significant univariate effects on weeks retained [$F(3, 383) = 21.12, p = .00, \eta^2_p = .05$] and LDA [$F(3, 383) = 17.09, p = .00, \eta^2_p = .04$]. CM patients gained, on average (*SD*), an extra 2.5 (0.54) weeks of treatment and 2.18 (0.52) LDA weeks compared to ST patients (p 's = .00). Study was also associated with outcomes [$F(6, 762) = 6.72, p = .00, \eta^2_p = .06$], with a univariate effect on percent of negative tests [$F(2, 383) = 7.4, p = .001, \eta^2_p = .04$] and LDA [$F(2, 383) = 6.9, p = .003, \eta^2_p = .03$]. Percent of negative urine/breath tests was on average (*SD*) 9.8% (2.7%) and 8.7% (2.7%) percent higher in the 2006a and 2005a studies, respectively, compared to the 2004 study (p 's = .00). LDA was on average (*SD*) 1.6 (.5) and 1.4 (.5) weeks longer in the 2005a study versus the 2004 and 2006a studies, respectively (p 's = .00).

For the multivariate study X treatment condition effect [$F(6, 762) = 5.38, p = .00, \eta^2_p = .04$], there was a univariate effect on weeks retained [$F(2, 383) = 4.1, p = .02, \eta^2_p = .02$] and percent of negative samples [$F(2, 383) = 8.1, p = .00, \eta^2_p = .04$]. Weeks retained in the ST condition and CM condition was on average (*SD*) 4.1 (.7) and 7.7 (.5) weeks in the 2005a study, 4.1 (.7) and 7.3 (.5) weeks in the 2006a study, and 5.7 (.7) and 6.4 (.5) weeks in the 2004 study, respectively. Percent negative samples in the ST and CM condition was on average (*SD*) 54.4% (3.3%) and 67.8% (2.2%) in the 2004 study, 74.9% (3.6%) and 66.9% (2.3%) in the 2006a study, and 69.1% (3.7%) and 70.5% (2.3%) in the 2005a study.

Finally, baseline sample result also impacted outcomes, [$F(3, 381) = 118.3, p = .00, \eta^2_p = .48$], with univariate effects on percent negative samples [$F(3, 381) = 343.3, p = .00, \eta^2_p = .47$] and LDA [$F(3, 381) = 41.45, p = .00, \eta^2_p = .10$]. Patients who tested negative for cocaine, opioids, and alcohol at baseline achieved a mean (*SD*) of 49.9% (2.7%) more negative tests and 3.4 (.5) more LDA weeks than patients who tested positive.

3.3 Long-term Substance Use Outcomes

The percent of patients who completed the Month 9 follow-up was 71.4% ($n = 225$) and 59.0% ($n = 46$) in the No Pre-M and Pre-M groups, respectively ($p = .03$). The percent of samples negative for cocaine, opioids, and alcohol (with missing samples coded positive) at Month 9 as a function of pretreatment marijuana use group and treatment condition are presented in Table 2. Step 1 with pretreatment marijuana use group and treatment condition was not significant [$\chi^2 (2, N = 393) = 1.13, p = .57$]. The second step entering LDA into the model was significant [$\chi^2 (1, N = 393) = 56.05, p = .00$], as was the overall model [$\chi^2 (3, N = 393) = 57.18, p = .00$, Nagelkerke $R^2 = 0.18$]. The overall model had an acceptable goodness of fit (Hosmer and Lemeshow $\chi^2 (7) = 9.55, p = .22$), with an overall percentage of 69.5% of cases accurately classified. Significant predictors were treatment condition and LDA. Being in the CM condition was associated with an increase in the odds of testing negative at the 9 Month follow-up by a factor of 1.91 [95% CI: 1.18 – 3.10, Wald $\chi^2 (1) = 6.89, p = .01$]. Further, every 1 week increase in LDA was associated with an increase in the odds of testing negative at Month 9 by a factor of 1.22 [95% CI: 1.16 – 1.29, Wald $\chi^2 (1) = 49.0, p = .00$].

3.4 Long-term Marijuana Use and ASI Drug Scores

At baseline, 80% ($n = 315$) of participants reported no marijuana use in the 30 days pretreatment. In assessing changes in marijuana use over time, the percent of participants collapsed across treatment condition who reported no use in the past month (of those who completed the follow-up) was 71.8% ($n = 282$) at Month 3, 64.1% ($n = 252$) at Month 6, and 61.8% ($n = 243$) at Month 9. In patients who reported any marijuana use, the median (interquartile range) was 2 (8) at Month 3, 2 (13.5) at Month 6, and 3 (10.5) days at Month 9. The percent of participants who reported no marijuana use in the past month at each time point is presented in Table 2 as a function of pretreatment marijuana use group and treatment condition.

In terms of ASI-Drug scores, the latent basis model provided the best fit: nonlinear ASI Drug score model (with ASI baseline score residual variance fixed to 0), model scaled $\chi^2 (3) = 4.261, p = 0.23, RMSEA = 0.03, SRMR = 0.04$. Means and variances for the intercept and slope of the respective independent model were significant ($p > .05$). The significant *intercept* mean and variances suggest that participants experienced significant drug-related problems at baseline, with considerable variability in baseline severity between participants. The *slope* parameters suggest that on average ASI Drug score decreased significantly over time and that variability in the rate of change was present among participants. Growth was nonlinear; the majority of change occurred between baseline and Month 3 with subsequent change (although significant) below what would be expected given a linear trajectory.

Using the ASI-Drug score latent basis model, we examined whether pretreatment marijuana group, treatment condition, and the interaction of these variable predicted the latent growth factors. Pretreatment marijuana group and the pretreatment marijuana group and treatment condition interaction term significantly predicted the intercept and slope factors. These predictors were positively associated with the intercept growth factor; however, the associations with the slope were negative. Results suggest that baseline ASI-Drug scores were highest in the Pre-M group, and that the Pre-M group experienced greater decreases (improvement) in ASI-Drug scores over time relative to the No Pre-M group. The significant interaction indicates that those in the Pre-M group achieved greater improvements in ASI-Drug scores when randomized to the CM conditions.

4. Discussion

This paper presents a retrospective analysis of the effect of pretreatment marijuana use on outcomes in three clinical trials of CM for cocaine-abusing patients. Past-month marijuana use varied 1-30 days in patients who used within the month before treatment but was relatively low overall. Pretreatment marijuana use was significantly associated with younger age, never married, testing positive for cocaine, opioids, and/or alcohol at baseline, being opioid dependent, and having greater severity of drug and psychiatric problems.

CM protected against attrition in the Pre-M group. Patients who had recently used marijuana before initiating treatment and who received CM remained in treatment approximately 3.5 weeks longer than those who received ST. Patients with no recent marijuana use who received CM stayed in treatment about 1.5 weeks longer compared to those who received ST. This benefit of CM on retention was evident in our sample with relatively low frequency of marijuana use. The clinical importance of enhanced CM treatment in marijuana users may (or may not) be more salient in patients with greater frequency of use or marijuana dependence.

Pretreatment marijuana users had more severe drug use problems at baseline, and they experienced a greater improvement in those problems over time relative to non-pretreatment marijuana users. Budney et al. (1996) similarly found more psychosocial impairment in pretreatment marijuana users. In the present study, this effect was likely due to decreased marijuana use from baseline to Month 3 in the Pre-M group. By contrast, frequency of use increased in the No Pre-M group over time. About a third of No Pre-M patients reported some days of marijuana use over the follow-up period. Others have noted a similar effect in terms of alcohol use at baseline and during treatment in marijuana-dependent treatment patients, with heavier drinkers decreasing use and lighter drinkers increasing use during treatment (Kadden et al., 2009). The change in proportion of marijuana users in this study, and in magnitude of drinking in the Kadden et al. (2009) study, may be attributed to a regression towards the mean effect. Although frequency of any marijuana use increased during the follow-up period, rates of marijuana use remained relatively low compared to those reported in other studies of cocaine abusers (Budney et al., 1993, 1996; Higgins et al., 2003, 2007; Lindsay et al. 2009; Miller et al., 1990).

Some clinicians have expressed concern that CM treatment that reinforces abstinence from one or a subset of substances may increase use of non-reinforced substances. This was not the case in this sample. Marijuana use did not increase in those receiving CM relative to standard treatment regardless of pretreatment marijuana use. A majority of CM patients were not marijuana users at baseline or follow-up, and about half of Pre-M patients reported no days of use at the end of treatment. Although the sample size was relatively small in some subgroups, these results suggest that there is no detrimental effect of CM versus ST on marijuana use.

Our results differ somewhat from those of Budney et al. (1996) and Higgins et al. (2003), which found no effect of marijuana use or dependence on retention or cocaine treatment outcomes. The Budney et al. (1996) study restricted analyses to patients who were assigned to CM, so it did not examine treatment condition by marijuana use group effects. Similarly, the Higgins et al. (2003) study only evaluated main effects of marijuana dependence, not interaction effects with treatment condition. Another study (Epstein and Preston, 2003) in methadone-maintained patients randomized to standard treatment or CM likewise failed to find main or interactive effects of objective indicators of marijuana use on treatment outcomes, including retention. It is possible that differences between studies are related to differences in the operational definition of marijuana use (e.g., self-reported past 30-day use

versus urinalysis testing) or the period examined (pretreatment versus during treatment). Lack of an effect of marijuana use on retention in the Epstein and Preston (2003) study may also be related to treatment setting, in that methadone programs suffer from less attrition than outpatient drug-free settings. No studies found an effect of marijuana use on other drug use outcomes.

Limitations of this study include lack of objective indicators of marijuana use, only examining marijuana use over a 30-day pretreatment period, and only using frequency of use as the measure of marijuana use problems. In addition, although acceptable, follow-up rates could have been higher and differed by pretreatment marijuana use group. Another limitation is that only 20% of patients reported any pretreatment marijuana use. This rate of use is on the low end of the range reported elsewhere (Budney et al., 1993, 1996; Higgins et al., 2007; Lindsay et al., 2009; Miller et al., 1990; USDHHS, 2008). Underreporting of marijuana use can be high in certain populations (Ghitza et al., 2007) and may depend on consequences (e.g., increased testing) of use in the clinical setting. In this study, no consequences were imposed on self-reports of marijuana or other drug use, and any reports of use to the research staff were not shared with clinical staff at the clinics. Further, patients knew that study urines were not tested for marijuana. Still, the possibility that perceived or real knowledge of consequences may have produced some underreporting cannot be ruled out.

This is one of the first studies to evaluate main and interactive effects of marijuana use, a common clinical concern, and CM treatment on outcomes. It adds to the literature that reinforcement of abstinence from specific drugs does not increase use of other substances (e.g., Kadden et al., 2009). Strengths of this study are that the sample size was large, and patients were recruited from three studies conducted across 4 community-based clinics, enhancing generalization. Further, analyses focused on objective outcomes of substance use, and during-treatment outcomes were available on 100% of the patients.

In sum, these data suggest that patients seeking treatment for cocaine use who also use marijuana may particularly benefit from CM in terms of retention. Without CM, these patients withdrew from treatment relatively quickly. For longer-term outcomes, pretreatment marijuana users who received CM experienced decreased severity of drug-related problems over time. Consistent with past research, LDA predicted long-term abstinence, and CM predicted long-term abstinence independent of its effects on LDA. Clinical conclusions are that CM may be one option to abate the attrition and increased severity of drug-related problems that might otherwise be observed in marijuana-using cocaine abusers. Future research is needed to examine the impact of greater severity of marijuana use on treatment outcomes.

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Table 1**Baseline and Demographic Characteristics by Pretreatment Marijuana Use Group**

Variables	No Pretreatment Marijuana Use	Pretreatment Marijuana Use	Statistic (<i>df</i>)	<i>p</i>
N	315	78		
Treatment Condition			$\chi^2 (1) = 0.053$	.82
Standard Treatment	29.5 (93)	28.2 (22)		
Contingency Management	70.5 (222)	71.8 (56)		
Study			$\chi^2 (2) = 7.29$	.03
Petry et al. (2004)	27.9 (88)	41.0 (32)		
Petry et al. (2005b)	39.0 (123)	24.4 (19)		
Petry et al. (2006a)	33.0 (104)	34.6 (27)		
Age (mean, <i>SD</i>)	36.9 (7.8)	33.1 (8.5)	$t (391) = 3.72$	.00
Male Gender	50.8 (160)	47.4 (37)	$\chi^2 (1) = .282$	.60
Race			$\chi^2 (5) = 2.94$	.71
African American	52.1 (164)	53.8 (42)		
Caucasian	33.7 (106)	38.5 (30)		
Hispanic	12.4 (39)	6.4 (5)		
Native American	0.3 (1)	0.0 (0)		
Asian	0.3 (1)	0.0 (0)		
Other	1.3 (4)	1.3 (1)		
Marital Status			$\chi^2 (6) = 16.3$	.01
Never Married	51.7 (163)	60.3 (47)		
Remarried	1.0 (3)	0.0 (0)		
Widowed	1.6 (5)	0.0 (0)		
Separated	10.5 (33)	5.1 (4)		
Divorced	19.4 (61)	6.4 (5)		
Married	11.4 (36)	19.2 (15)		
Cohabiting	4.4 (14)	9.0 (7)		
Employed			$\chi^2 (3) = 6.35$	.10
Full-time	43.2 (136)	55.1 (43)		
Part-time	23.5 (74)	11.5 (9)		
Unemployed	25.7 (81)	26.9 (21)		
Other	7.6 (24)	6.4 (5)		
Income (mean, <i>SE</i>)	\$8,855 (\$709)	\$12,796 (\$2,447)	$t (90.3) = -1.55$	.13
Years of Education (mean, <i>SD</i>)	11.6 (1.78)	11.6 (1.56)	$t (391) = .14$	.89
Negative Baseline Toxicology Test (opioids, cocaine, alcohol)	86.0 (270)	62.8 (49)	$\chi^2 (1) = 22.13$	.00
DSM-IV Alcohol Dependence	54.3 (171)	47.4 (37)	$\chi^2 (1) = 1.18$	.28
DSM-IV Cocaine Dependence	85.7 (270)	84.6 (66)	$\chi^2 (1) = 0.06$	.81
DSM-IV Opioid Dependence	21.0 (69)	10.3 (8)	$\chi^2 (1) = 5.49$	.02
Addiction Severity Index Scores				

Variables	No Pretreatment Marijuana Use	Pretreatment Marijuana Use	Statistic (<i>df</i>)	<i>p</i>
(mean, <i>SD</i>)				
Alcohol	0.22 (0.22)	0.27 (0.25)	<i>t</i> (108) = -1.80	.07
Drug	0.14 (0.08)	0.23 (0.09)	<i>t</i> (105) = -7.93	.00
Medical	0.22 (0.33)	0.24 (0.35)	<i>t</i> (391) = -0.54	.59
Employment	0.74 (0.29)	0.70 (0.31)	<i>t</i> (391) = 0.97	.33
Legal	0.13 (0.20)	0.14 (0.22)	<i>t</i> (391) = -0.37	.71
Family/Social	0.18 (0.22)	0.22 (0.25)	<i>t</i> (108) = -1.05	.30
Psychiatric	0.26 (0.23)	0.34 (0.26)	<i>t</i> (391) = -2.59	.01
# Urine/Breath Samples Provided	11.27 (5.91)	10.53 (5.99)	<i>t</i> (391) = 1.00	.32

Notes. Values denote percent (*n*) unless otherwise indicated. CM = Contingency Management; DSM-IV = Diagnostic and Statistic Manual of Mental Disorders, Revision IV. The full sample (*N* = 393) was used in all comparisons. Changes in *df.* reflect use of tests that correct for heterogeneity of variance.

Table 2

Primary and post-treatment outcomes by baseline marijuana use group and treatment condition

	<u>No Pretreatment Marijuana Use</u>		<u>Pretreatment Marijuana Use</u>	
	ST	CM	ST	CM
<u>Primary treatment outcomes</u>				
<i>N</i>	93	222	22	56
Retention in treatment (weeks)	5.6 (0.4)	7.0 (0.3)	3.7 (0.8)	7.3 (0.5)
Longest duration of abstinence from cocaine, opioids and alcohol (weeks)	2.4 (0.4)	4.6 (0.3)	2.5 (0.8)	4.6 (0.5)
% (<i>n</i>) Negative samples for cocaine, opioids and alcohol	67.5 (2.2)	70.3 (1.6)	64.8 (4.2)	66.5 (0.3)
<u>Long-term substance use and ASI outcomes</u>				
Month 9 % (<i>n</i>) of negative samples for cocaine, opioids and alcohol (missing coded positive)	76.3 (45)	70.4 (100)	76.9 (10)	73.3 (22)
% (<i>n</i>) with no past 30-day marijuana use				
Month 3	79.6 (74)	75.2 (167)	45.5 (10)	55.4 (31)
Month 6	73.1 (68)	67.1 (149)	40.9 (9)	46.4 (26)
Month 9	65.6 (61)	66.7 (148)	40.9 (9)	44.6 (25)
<u>ASI Drug scores</u>				
Baseline	.13 (.01)	.14 (.01)	.19 (.20)	.25 (.01)
Month 3	.09 (.01)	.10 (.01)	.09 (.02)	.11 (.01)
Month 6	.08 (.01)	.09 (.01)	.11 (.03)	.08 (.01)
Month 9	.07 (.01)	.08 (.01)	.06 (.02)	.08 (.01)
<u>ASI Psychiatric scores</u>				
Baseline	0.26 (0.02)	0.26 (0.02)	0.35 (0.06)	0.34 (0.03)
Month 3	0.22 (0.03)	0.17 (0.01)	0.17 (0.05)	0.25 (0.03)
Month 6	0.22 (0.03)	0.17 (0.02)	0.12 (0.05)	0.16 (0.03)
Month 9	0.19 (0.03)	0.13 (0.01)	0.10 (0.05)	0.17 (0.03)

Note. Values represent unadjusted means (*SE*) unless otherwise noted. ST = Standard Treatment; CM = Contingency Management.