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Amount of earnings during prize contingency management treatment is associated with post-treatment abstinence outcomes

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Abstract

Contingency management (CM) treatments that provide patients with the opportunity to earn chances of winning prizes of varying magnitudes are becoming increasingly popular. In the CM literature, magnitude of reinforcement is linked with effect sizes, such that CM treatments that provide larger magnitude reinforcement are more efficacious than those that provide lower magnitude reinforcement. With prize CM, even when magnitudes of overall expected prize earnings are constant, some patients win more prizes than others. Thus, patients who win larger overall amounts of prizes during treatment may have better outcomes than those who win fewer prizes. This study evaluated the impact of overall amounts of prizes won on long-term abstinence outcomes. The dollar amount of prizes won during prize CM treatments was determined from 78 cocaine abusing methadone maintenance patients who were randomized to prize CM treatments in three clinical trials. Abstinence three months following the end of the CM intervention was the primary dependent variable. The dollar amount of prizes won during CM treatment was a significant predictor of submission of cocaine-negative urine samples and self reports of cocaine abstinence at the follow-up evaluation, even after controlling for other variables associated with long-term abstinence such as pre-treatment urinalysis results and longest duration of abstinence achieved during treatment. These results suggest that magnitudes of earnings during prize CM may impact outcomes and call for further experimentation of parameters related to the efficacy of prize CM.

Keywords

contingency management; methadone maintenance; cocaine

Contingency management (CM) is a highly efficacious treatment for substance use disorders in which patients earn reinforcers for evidence of behavior change. In a recent meta-analysis, Dutra et al. (2008) found CM to have the largest effect size of all psychosocial interventions. In CM interventions that award chances to win prizes ranging from \$1 to \$100 in value for submission of drug-negative urine samples (Ghitza et al., 2007; Lott & Jencius, 2009; Peirce et al., 2006; Petry, Alessi, Marx, Austin, & Tardif, 2005a; Petry, Alessi, Hanson, & Sierra, 2007; Petry, Martin, Cooney, & Kranzler, 2000; Petry, Martin, & Simcic, 2005b; Petry, Weinstock, Alessi, Lewis, & Dieckhaus, 2010; Petry et al., 2004, 2005c, 2006), a variable reinforcement schedule is employed. Each behavior (i.e., submission of a

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negative sample) is reinforced with an opportunity to win a prize, and sustained behavior change (i.e., successive negative samples) leads to greater opportunities to win prizes. Based upon the probabilities of winning prizes in each prize category and the total number of draws possible, patients can earn enough draws to win an arranged average maximum of \$300 to \$400 in prize earnings in most 12-week studies (Peirce et al., 2006; Petry et al., 2005abc, 2006, 2007). However, chance is operative within this reinforcement procedure. Among patients who sustain equivalent periods of abstinence, some patients will receive more prizes overall, with some receiving a greater than expected number of higher magnitude prizes, while others will receive few prizes despite earning the same number of draws.

Magnitude of reinforcement is clearly linked to efficacy in CM interventions (Dallery, Silverman, Chutuape, Bigelow, & Stitzer, 2001; Higgins et al., 2007; Lussier, Heil, Mongeon, Badger, & Higgins, 2006; Prendergast, Podus, Finney, Greenwell, & Roll, 2006; Silverman, Chutuape, Bigelow, & Stitzer, 1999), including this prize reinforcement approach. When lower magnitude prizes are provided, the system is less efficacious (Petry et al., 2004). Because of this well-established association between magnitude of reinforcement and outcomes in CM studies, draw outcomes may impact the efficacy of prize CM.

To date, only one study has evaluated the association between actual prize earnings and outcomes in this prize CM approach. Ghitza et al. (2008) examined the impact of probabilities of winning and subsequent abstinence. They found that the ratio between the number of prizes won divided by draws earned on any particular day was associated with the probability of submitting a drug negative urine sample at the next urine testing session. Thus, their data suggest that the chance procedure operative in prize CM may have an impact on short-term abstinence outcomes.

Although short-term abstinence is clearly important, engendering long-term abstinence is an important goal of substance abuse treatment. In this study, we sought to determine whether the overall amount of prizes won during participation in CM treatment was associated with abstinence at a follow-up evaluation conducted three months after CM ended.

Methods

Participants were drawn from individuals randomized to prize CM conditions in three clinical trials (N = 87; Petry & Martin, 2002; Petry et al., 2005b, 2007), each of which evaluated the effects of CM for treating cocaine abusing methadone patients. Inclusion criteria were similar across the three trials and included age of at least 18 years, past-year diagnosis of cocaine abuse or dependence, stable methadone dose for at least one month, and English speaking. Exclusion criteria were severe cognitive impairment, uncontrolled psychiatric disorders (e.g., psychosis, bipolar), and in recovery from pathological gambling. All participants provided written informed consent for participation, as approved by the University Institutional Review Board.

Of the patients included in this report, they were on average (standard deviation (*SD*)) 39.7 (7.5) years of age, received 11.0 (2.0) years of education, and earned \$8,158 (\$6,156) per year. Twenty-five patients (32.1%) were male. Racial/ethnic background was African American for 29 (37.2%), Caucasian for 16 (20.5%), Hispanic for 32 (41.0%), and the remainder listed other ethnicities. The average (*SD*) dose of methadone was 74.9 (30.8) mg per day. At study initiation, 47 (60.3%) of patients tested positive for cocaine using urine toxicology tests described below.

Assessments

Patients completed a baseline evaluation consisting of demographic information and the Addiction Severity Index (ASI; McLellan et al., 1985), which assesses self reports of days of substance use in the past month. Research assistants also collected urine samples that were screened for cocaine using OnTrak TesTstiks (Varian, Inc., Walnut Creek, CA). Three months after the treatment period ended, patients were asked to participate in a follow-up evaluation, which consisted of the ASI and provision of a urine sample. They received \$10-\$25 for the initial evaluation and \$15-\$25 for the follow-up. Across the three trials, 78 of the 87 patients (89.7%) randomized to prize CM completed a follow-up evaluation, and these 78 patients are the focus of this report.

Treatments

Following the baseline evaluation, participants were randomized to standard care or standard care plus CM using a computerized urn randomization program (Stout, Wirtz, Carbonari, & Del Boca, 1994). The original studies (Petry & Martin, 2002; Petry et al., 2005b, 2007) provide full details of the treatments. Because the present report is limited to patients assigned to a prize CM condition, the description below focuses on treatment components that were applied consistently across the trials.

Participation in the trials did not impact standard care, which comprised daily methadone doses, monthly individual counseling, and weekly group therapy (cognitive-behavioral therapy, HIV education, life skills training, psychoeducation, and 12-step-oriented treatment). In addition to standard care, patients in all trials submitted two or three observed urine samples each week for 12 weeks, with two to four days between each sample. Each sample was tested for cocaine, using onsite testing as described earlier.

In all three studies, participants assigned to the prize CM condition earned reinforcement for submission of cocaine-negative samples. Participants earned at least one draw from a prize bowl for each sample that tested negative for cocaine, and they also earned increasing draws for consecutive abstinence. When participants provided a cocaine positive sample (or refused to leave a sample or had an unexcused absence on a scheduled testing day), the number of draws earned was reset to one for the next negative sample submitted.

The prize bowl from which participants drew contained slips of paper that stated “good job” or one of three prize categories: “small,” “large” or “jumbo.” When patients drew a “good job” slip, they won no prize for that draw, and 50% of the slips of paper resulted in no prize. When patients drew a slip that stated “small” (about 44% of the slips in the bowl), they chose between a variety of prizes worth \$1 in value: fast food coupons, food items, toiletries, bus tokens, etc. Large prizes (about 6% of slips) were patients’ choice of movie theater or store gift cards, phone cards, pot and pan sets, hand held CD players, etc. One slip in the bowl was for a jumbo prize, worth up to \$100 (e.g., television, stereo). Slips were returned to the bowl after each draw so that probabilities remained constant. Slips were counted to ensure intended probabilities at least monthly throughout the studies, and a number of quality control procedures were applied to ensure that patients did not “cheat” the system. These included having patients roll up their sleeves and open their hands before and after drawing. No instances of cheating were suspected based on research assistant reports or examinations of patients’ prize winning patterns.

2.4 Data Analysis

Because urinalysis testing can detect cocaine use only over about a 3-day period, analysis of abstinence at follow-up, the primary dependent variable, was conducted in two manners. First, patients were coded as abstinent if they submitted a cocaine-negative urine sample at

the follow-up, indicating recent abstinence ($n = 41$ of 78, 52.6%). Secondly, a more conservative definition of abstinence was applied in which both submission of a cocaine-negative urine sample and no past month self-report of cocaine use on the ASI were utilized to code a patient as abstinent ($n = 21$ of 78, 26.9%). Of patients who submitted a cocaine-positive sample at follow-up, the vast majority ($n = 34$ of 37, 91.9%) admitted to cocaine use in the prior month.

Initially, treatment outcomes were compared between patients who were abstinent at the follow-up evaluation and those who were not. These analyses are presented for both definitions of abstinence described above. The main treatment outcome was longest duration of continuous abstinence achieved and defined as the greatest number of consecutive weeks (range = 0 to 12 weeks) of objectively verified abstinence from cocaine. As noted earlier, cocaine positive or refused samples, and unexcused absences on a scheduled testing day, broke the string of abstinence in all three trials.

For each patient, the total dollar amount of all prizes won throughout the 12-week treatment period was also recorded. Total dollar amount of prizes won relates in part to chance, but also—albeit not 1:1—to draws earned. Draws earned are directly associated with longest duration of abstinence achieved during treatment (see Treatment section; $r = 0.92$ in this sample). Analyses investigating the effect of total dollar amount of prizes won on long-term abstinence outcomes therefore controlled for longest duration of abstinence achieved during treatment.

Logistic regressions examined predictors of abstinence at the follow-up defined in both manners outlined above. Step 1 included variables previously associated with treatment outcomes (Higgins, Badger, & Budney, 2000a; Petry et al., 2005ab, 2006, 2007; Petry et al., 2010; Stitzer et al., 2007ab), including study, baseline urine toxicology result, and methadone dose, with the first two variables included as categorical variables and methadone dose as a continuous variable. In Step 2, the longest duration of abstinence achieved and the total cost of prizes won during CM treatment were added. In both steps, the variables outlined above were entered simultaneously. All analyses were conducted on SPSS (version 15), and $\alpha < .05$ was considered significant.

Results

Table 1 shows the proportion of patients in each study, along with the during treatment outcomes of patients classified as abstinent or relapsed at the follow-up evaluation. There was a trend toward greater rates of relapse in the Petry et al. (2005b) study relative to the other two studies (Petry & Martin, 2002; Petry et al., 2007). Although total number of urine samples submitted did not vary based upon abstinence status at follow-up, those who were abstinent at follow-up achieved longer durations of cocaine abstinence during treatment than those who were considered relapsed at follow-up, regardless of how relapse was defined. In addition, those who relapsed received a lower value of prizes during treatment than those who were abstinent at follow-up. The number of draws earned correlated with dollar amounts of prizes won ($r = 0.84$), but this correlation was not 1.00, and it indicated a 16% variation in prizes won per draws earned, or about 1 *SD* around the mean of expected dollar amounts of prize winnings.

A logistic regression analysis evaluated predictors of abstinence defined as submission of a cocaine negative toxicology screen at follow-up. Step 1 including study, baseline toxicology results, and methadone dose was significant in predicting submission of a negative sample at follow-up, $\chi^2(4) = 16.60$, $p = .002$, and correctly classified 67.9% of patients. With just this step included (top left section of Table 2), negative baseline toxicology results were

significantly associated with abstinence. Step 2, which added the during treatment variables of longest duration of abstinence and total amount of prizes won, was also significant, $\chi^2(2) = 19.10$, $p < .001$, and improved the model, $\chi^2(6) = 35.71$, $p < .001$, correctly classifying 79.5% of the participants. Results from the full model are shown in the lower left section of Table 2. When step 2 was included in the model, baseline toxicology results were no longer significant, but overall amount of prizes won during treatment was significantly associated with abstinence at follow-up. Each additional \$1 in prizes won was associated with a 1% increased probability of abstinence at the follow-up.

Results were similar when abstinence at the follow-up was defined by both submission of a negative sample and no self-report of cocaine use in the past month. Step 1 (top right section of Table 2) was significant in predicting abstinence, $\chi^2(4) = 15.79$, $p = .003$, and correctly classified 73.1% of the sample. Baseline toxicology results were significantly associated with follow-up outcomes. Inclusion of step 2 was significant, $\chi^2(2) = 7.18$, $p = .03$, and improved the model, $\chi^2(6) = 22.97$, $p < .001$, classifying 75.6% of the sample correctly. Again, only overall amount of prizes earned during treatment was significantly associated with abstinence at follow-up (Table 2; lower right hand columns). Again, every additional dollar worth of prizes won during treatment improved the probability of abstinence at follow-up by 1%.

Discussion

Data from this study show that the overall dollar amount of prizes won during CM treatment was significantly and consistently associated with abstinence at a follow-up evaluation. The actual monetary amount of prizes won related to abstinence at follow-up even after controlling for longest duration of abstinence achieved during treatment and baseline urine toxicology results, two consistently significant predictors of long-term abstinence in CM studies across multiple populations and settings (Higgins et al., 2000a; Petry et al., 2005ab, 2006, 2007). The fact that these two variables were not significant when amount of prizes won was included in the analyses suggests that overall dollar amount of prizes won is a strong and salient predictor of abstinence in prize CM treatments.

These results are consistent with prior research on CM, demonstrating that the more reinforcement the greater the efficacy of CM (e.g., Lussier et al., 2006). Studies have experimentally altered the maximum magnitude of reinforcement patients can earn by varying total amounts of vouchers possible (Dallery et al., 2001; Higgins et al., 2007; Silverman et al., 1999) or magnitudes of prize categories available (Petry et al., 2004). The present study finds that natural variations in the chance procedures associated with prize CM impact outcomes. Actual earnings varied, as would be expected, by about 1 standard deviation around the mean of anticipated earnings based on the number of draws earned. Patients who won larger amounts of prizes, even after controlling for longest duration of abstinence achieved (a proxy for number of draws earned), were significantly more likely to be abstinent at the follow-up evaluation.

These data also complement and extend those of Ghitza et al. (2008), who found that proportions of prizes won to draws earned on any given day were related to abstinence at the next testing session. However, their study did not examine post-treatment effects of CM on abstinence outcomes or overall magnitudes of earnings.

Contingency management, although highly effective in engendering abstinence during the period in which it is in effect, does not always improve long-term abstinence rates (e.g., Petry et al., 2005a, 2006; Rawson et al., 2002). Nevertheless, in other studies (Higgins et al., 2000b; Iguchi, Belding, Morral, & Lamb, 1997; Kosten et al., 2003) as well as two of the

trials from which these data were drawn (Petry & Martin, 2002; Petry et al., 2005b), CM interventions did lead to sustained abstinence, and longest duration of abstinence during treatment was significantly predictive of long-term cocaine abstinence. The present data add to the understanding of how long-term abstinence may be achieved, as patients who won greater amounts of prizes during treatment, even after controlling for longest duration of abstinence achieved (and indirectly number of draws earned), were significantly more likely than those who won lower amounts of prizes to maintain their abstinence after CM was discontinued.

Limitations of this study include that abstinence was measured three months after the CM treatment ended. Even longer-term abstinence is important to evaluate. Further, this study did not collect urine samples throughout the follow-up period, and self-reports were used to corroborate urinalysis results obtained at the follow-up and to classify abstinence after CM treatment. This study also only examined the impact of the overall amount of reinforcement, and it remains unclear whether winning greater proportions of prizes (and especially larger prizes) early in CM treatment relates to during treatment, as well as longer-term, abstinence outcomes. Such analyses will require large sample sizes as few patients receive many large magnitude prizes early in CM treatments, when the number of draws per negative sample is low. In addition, combining data across three clinical trials may be considered a limitation because it increases heterogeneity, but it also enhances generalization of the findings as the effects emerged across studies.

Despite limitations, this study shows that the total value of prizes won, while controlling for draws earned, is significantly associated with abstinence outcomes after CM is discontinued. One interpretation of this finding is that earnings ought not to be left to chance. The association between magnitude of reinforcement and outcomes is well established (Lussier et al., 2006), and providing certain and large reinforcers is likely to improve outcomes. However, a balance must be achieved between costs of reinforcers and the use of CM in clinical settings, in which resources are limited.

Another conceptualization of these results is that alterations in prize reinforcement parameters may improve outcomes while minimizing costs. For example, prize CM treatments that ensure patients who remain abstinent receive a large value prize at least every two weeks may be more efficacious than ones that leave large prize winnings totally to chance (on average every 17th draw earned). Such an approach would add relatively little to the costs of the procedure, as only during early periods of abstinence are the number of draws, and chances of winning large prizes, relatively low. Alternatively, variations in probabilities of winning prizes, especially the large magnitude prizes that add most to the average cost per draw, may enhance outcomes while maintaining relatively low procedural costs. Experimental manipulations of specific parameters of prize CM procedures await further investigation, but these results, in conjunction with those of Ghitza et al. (2008), indicate that a better understanding of how probabilities and earnings impact outcomes is important. As CM is growing in acceptability (Kellogg et al., 2005; Henggeler et al., 2007, 2008; Squires, Gumbley, & Storti, 2008), results from such studies may have substantial clinical implications for the design and dissemination of the most efficacious and cost-effective CM procedure for use in community settings.

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Table 1

Study and during treatment variables by abstinence status at follow-up

	Cocaine negative at follow-up (n = 41)	Cocaine positive at follow-up (n = 37)	Statistical test (df), p value	Cocaine negative and no self report of use at follow-up (n = 21)	Cocaine positive or self report of use at follow-up (n = 57)	Statistical test (df), p value
Study, n (%)	11 (26.8%)	6 (16.2%)	$\chi^2 (2) = 4.06, p = 0.13$	7 (33.3%)	10 (17.5%)	$\chi^2 (2) = 5.38, p = 0.07$
Petry & Martin (2002)	14 (34.1%)	21 (56.8%)		5 (23.8%)	30 (52.6%)	
Petry et al. (2005b)	16 (39.9%)	10 (27.0%)		9 (42.9%)	17 (29.8%)	
Petry et al. (2007)						
Number of urine samples provided during treatment	23.6 (2.8)	23.2 (4.7)	$t (76) = 0.39, p = 0.70$	24.0 (1.6)	23.1 (4.3)	$t (76) = 0.88, p = 0.38$
Longest duration of abstinence (weeks)	6.1 (4.1)	2.1 (3.8)	$t (76) = 4.52, p < .001$	7.0 (4.3)	3.2 (4.0)	$t (76) = 3.70, p < .001$
Total cost of prizes won	\$243 (156)	\$68 (109)	$t (76) = 5.68, p < .001$	\$271 (172)	\$119 (137)	$t (76) = 4.08, p < .001$

Values represent means (and standard deviations) unless otherwise indicated.

Table 2

Predictors of post-treatment abstinence

Abstinence defined by: A cocaine negative sample				A cocaine negative sample and no self reported use				
Variable	Beta (SE)	Wald, p value	Odds ratio	95% CI	Beta (SE)	Wald, p value	Odds ratio	95% CI
Step 1								
Study		2.54, p = .28				3.27 p = .20		
Negative baseline toxicology	1.65 (0.55)	9.10, p = .003	5.18	1.78–15.08	1.66 (0.59)	8.01, p = .01	5.27	1.67–16.64
Methadone dose	−0.01 (0.01)	1.23, p = 0.27			−0.01 (0.01)	0.63, p = .43		
Final model								
Study		2.28, p = .32				3.94, p = .14		
Negative baseline toxicology	1.12 (0.72)	2.43, p = .12			1.13 (0.68)	2.75, p = .10		
Methadone dose	−0.02 (0.01)	2.01, p = 0.16			−0.01 (0.01)	0.95, p = .33		
Longest duration of abstinence	−0.23 (0.14)	2.54, p = .11			−0.72 (0.13)	0.31, p = 0.58		
Prizes won (\$)	0.01 (0.01)	10.09, p < .001	1.01	1.01–1.02	0.01 (0.00)	3.86, p = .04	1.01	1.00–1.01