

The Brief Abstinence Test: Effects of Continued Incentive Availability on Cocaine Abstinence

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This study compared the effects of 4 voucher incentive conditions of a brief abstinence test on continuous cocaine abstinence. In 3 conditions, cocaine-abusing methadone patients could earn \$100 for 2 days of cocaine abstinence; 2 of these conditions offered, on either a continuous or interrupted schedule, an additional \$300 for evidence of sustained abstinence over the next 9 days. In the 4th condition, no incentives were available. In incentive conditions, 70–80% of patients initiated abstinence, compared with 48% in the no-incentive condition. Both continuing reinforcement conditions produced higher rates of sustained abstinence than the single and no-voucher conditions. The study confirmed the utility of quantitative urine-testing methods combined with high valued incentives to promote cocaine abstinence initiation in methadone maintenance patients.

Cocaine use is typically observed in approximately 50% of methadone treatment applicants (e.g., Ball & Ross, 1991). Although some methadone patients cease or reduce cocaine use after entering treatment, a significant proportion maintain or increase their level of use (Grella, Anglin, & Wugalter, 1997). Continued cocaine use during methadone treatment is associated with a number of negative consequences, including poor clinical outcomes (Dunteman, Con-delli, & Fairbank, 1992; Kidorf, Stitzer, & Brooner, 1994), increased risk of HIV infection (Grella, Anglin, & Wugalter, 1995; Meandzija, O'Conner, Fitzgerald, Rounsaville, & Kosten, 1994), unemployment (Zanis, Metzger, & McLellan, 1994), and criminal activity (Hunt, Spunt, Lipton, Goldsmith, & Strug, 1986). Therefore, effective interventions for reducing cocaine use during methadone maintenance treatments are needed.

Research has shown that providing patients with tangible incentives contingent on objective evidence of drug abstinence

is an effective way of initiating and maintaining cocaine abstinence during methadone treatment. For example, in a study by Silverman and collaborators (1996), 47% of the polydrug-abusing methadone patients exposed to a voucher-based reinforcement intervention achieved between 7 and 12 weeks of sustained cocaine abstinence. However, many of the patients assigned to the voucher condition failed to stop their cocaine use for any substantial period of time. As discussed by Petry (2000), one factor contributing to these results may be the relatively low magnitude of the initial reinforcer (\$2.50 voucher) in their escalating voucher schedule, which for some patients may not be sufficient to compete with reinforcement derived from drug use. A second factor may be the behavioral response required to obtain reinforcement. Under standard qualitative urinalysis testing conditions, 2–5 days of abstinence may be necessary before a negative urine sample can be produced. Such an extended period of abstinence may be difficult for some patients to achieve, especially early in treatment.

Fortunately, the concrete and largely quantitative nature of abstinence reinforcement interventions make them amenable to empirically based development (Silverman et al., 1996). A recent study by Robles et al. (2000) sought to investigate two parameters of reinforcement contingencies, reinforcer magnitude and response requirement, on the initiation of cocaine abstinence in methadone patients. Their goal was to implement a procedure that would maximize initial response to a contingent reinforcement intervention and initiate cocaine abstinence in the largest possible proportion of patients. They used quantitative urinalysis to differentiate, within a 2-day window, between new cocaine use and carryover elevation of the cocaine metabolite benzoylecgonine from previous use (Preston, Silverman, Schuster, & Cone, 1997). Abstinence was defined as a 50% or greater reduction over 2 days in urine benzoylecgonine concentration or urine benzoylecgonine concentrations below the standard qualitative cutoff criterion of 300 ng/ml.

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The combination of a high magnitude reinforcer (\$100) and a low response requirement (2 days of abstinence) resulted in cocaine abstinence initiation in approximately 80% of the patients. In contrast, only 36% and 32% met these abstinence criteria during the week before and the week after the incentive intervention, respectively.

The results of the Robles et al. (2000) study are important for at least two reasons. First, they demonstrate the utility of using quantitative urinalysis testing to detect brief periods of abstinence. Second, their results indicate that high rates of brief abstinence can be achieved with a relatively simple procedure. The purpose of the current study was to replicate the brief abstinence test findings described above and to determine if abstinence initiated with a combination of high reinforcer magnitude and low response requirement could be sustained for longer periods of time by continuing to provide reinforcement for drug-free urines. Two variations of a continuing reinforcement procedure were tested that begin to explore the effects of omitting urines from the reinforcer delivery schedule versus offering reinforcement for each drug-free urine submitted.

Method

Sample Characteristics

Study participants were 40 cocaine-abusing methadone maintenance patients enrolled between September 1998 and May 1999 at the Behavioral Pharmacology Research Unit at Johns Hopkins University School of Medicine. These individuals were identified as opioid dependent prior to treatment entry and had submitted an opioid-cocaine-positive urine specimen during the screening procedure. Study participants were 41 ($SD = 6.6$) years old on average. Fifty-eight percent were African American, and 58% were male. They had completed 11.8 ($SD = 2.4$) years of education on average, and 80% were unemployed. At treatment entry, average self-reported days of heroin use was 25.5 ($SD = 8.7$) of the past 30 days, and mean days of cocaine use was 18 ($SD = 10$) of the past 30 days. All but 2 patients received *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; *DSM-IV*; American Psychiatric Association, 1994) diagnoses of current cocaine dependence based on the Structured Clinical Interview of *DSM-IV* Axis I Disorders (SCID; Spitzer, Gibbon, & Williams, 1986) interview data.

Methadone Induction

On their day of admission, participants provided informed consent for study participation and received their first methadone dose. Initial dose was 30 mg, and this was increased by 10 mg per day until the target maximum dose of 100 mg was reached. Methadone doses were not disclosed to patients or study staff in contact with them.

4-Week Baseline

During the second through fifth weeks of treatment, after the methadone dose had been stabilized, urinalysis results were monitored to identify patients with high rates of cocaine use. Patients were considered eligible for study participation if 3 of the last 12 and 2 of the last 6 urine samples they provided during the baseline phase were positive for cocaine. Forty-six patients met these

criteria and were enrolled in the study. Six of these participants dropped out during the study, 2 after their first study condition, 3 during or after their second study condition, and 1 after his third study condition. There was no systematic relationship between dropout and the study condition in effect.

Standard Treatment

Throughout the 4-week baseline and 6-month study, patients received weekly individual and group counseling and daily methadone at a dose of 100 mg per day. Urine samples were collected, under observation, on Mondays, Wednesdays, and Fridays. Take-home methadone doses were allowed only on holidays and for emergencies (e.g., to attend funerals). Patients were terminated from treatment and the study if they missed 3 consecutive dosing days. At the end of the study, all patients underwent a 90-day methadone detoxification during which their methadone dose was gradually reduced to 0 mg. Participants were encouraged to and helped to find treatment elsewhere during this time.

Experimental Design

We used a within-subject design. Each study participant was exposed to four different voucher schedules, presented in counter-balanced order and separated by 4-week washout periods. Each experimental phase began on a Monday and lasted 11 days. The four voucher schedules are shown in Table 1. The single-voucher condition replicates procedures used in the Robles et al. (2000) study; a single \$100 voucher incentive was available for 2 days of cocaine abstinence. The continuous and interrupted voucher schedules offered monetary reinforcement for more prolonged periods of abstinence. Following the initial reinforcement of 2-day abstinence (Monday to Wednesday) with a \$100 voucher, a total of \$300 in additional vouchers could be earned over 9 days. As shown in Table 1, the \$300 worth of incentives was divided across the subsequent urine-testing days in the continuous voucher condition, whereas in the interrupted condition, the reinforcement opportunity was omitted on Wednesday of the second week. The purpose was to determine whether patients could remain abstinent under an interrupted schedule in which one urine test was excluded from the reinforcement delivery protocol. In both of these latter conditions, payment was contingent on sustained cocaine abstinence; thus, once a participant submitted a cocaine-positive urine sample, voucher incentives were no longer available for the remainder of that experimental condition.

Participants were told on the first Monday of intervention phase weeks that they would earn vouchers if their urine-test results indicated that they had abstained from cocaine use, and the rules of the relevant intervention condition were explained. Thus, in the

Table 1
*Dollar Amounts Available to Participants by
Experimental Condition On Each Urine-Test Day*

Condition	Urine-test day					
	Mon 1 ^a	Wed 1	Fri 1	Mon 2	Wed 2	Fri 2
No voucher						
Single		100				
Continuous		100	100	67	67	67
Interrupted		100	100	100		100

Note. Mon = Monday; Wed = Wednesday; Fri = Friday.

^a Mon 1 was an instruction day.

single-voucher condition, patients knew that earnings were possible only for the first 2-day period, whereas in the continuous and interrupted conditions, patients knew that earnings were available for continuous abstinence beyond the first 2 days. Participants received no information on Monday of the no-voucher intervention phase. This was an oversight; inclusion of such instructions may have further clarified for participants the distinction between voucher and no-voucher study conditions. Each experimental phase was followed by a 4-week washout period during which standard methadone treatment continued but no voucher incentives were available. Patients continued to participate in subsequent experimental phases regardless of whether they had resumed cocaine use during the washout.

Abstinence Determination

During the experimental conditions, all urine specimens were sent to a certified commercial laboratory for quantitative urinalysis testing. Cocaine metabolite concentrations (benzoylecgonine) were measured by Fluorescence Polarization Immunoassay. The assays were performed with Axysm Immunoassay reagents (Abbott Laboratories, Abbot Park, IL) on an Axysm instrument according to the manufacturer's recommended procedures. The linear range for cocaine metabolite assay was 30–5,000 ng/ml. Specimens that contained concentrations of cocaine metabolite above 5,000 ng/ml were diluted with Axysm reagent buffer until results fell within the linear range of the assay. For quantitative testing, a 50% reduction from the previous value in urinary benzoylecgonine concentration or a specimen containing 300 ng/ml or less of benzoylecgonine was considered evidence of recent cocaine abstinence. Quantitative urine-testing methods and abstinence criteria were the same as those used by Preston, Silverman, Schuster, and Cone (1997). Urine samples were also tested on-site using Enzyme Multiplied Immunoassay Test (EMIT) technology, which detects negative samples with benzoylecgonine concentrations of 300 ng/ml or less. This yielded a qualitative outcome (drug positive vs. negative).

Procedures for Awarding Vouchers

Vouchers were awarded for objective evidence of cocaine abstinence. Vouchers had monetary value that could be used to purchase goods and services in the community. Patients did not receive cash. Rather, all purchases and payment for services were made by research staff. Because urine specimens were sent to an outside laboratory for testing, study patients received feedback on their voucher earnings for Monday–Wednesday intervals on Friday and for Wednesday–Friday and Friday–Monday intervals on the next Wednesday. Earnings could be carried over from one study condition to another.

Measures

The primary outcome measure was number of consecutive days of documented cocaine abstinence (50% reduction in benzoylecgonine concentration or concentration of 300 ng/ml or less) for each participant, with Monday–Wednesday and Wednesday–Friday intervals designated as 2 days of abstinence and Friday–Monday interval designated as 3 days of abstinence. Analysis of longest duration of abstinence was conducted in two ways: (a) duration of abstinence initiated on the first day of each 2-week condition and (b) longest duration of abstinence initiated at any point within each 2-week condition. In either case, longest duration of abstinence could range from 0 to 11 days. Number of urine specimens

submitted with benzoylecgonine concentration of 300 ng/ml or less, which indicates cocaine abstinence by the less sensitive qualitative criteria generally used in drug abuse treatment, was analyzed as a secondary outcome.

Data Analysis

Missing data (9 urine samples out of 960 expected) were replaced as cocaine positive. We used Cox proportional hazards analysis, stratifying on participant (France, Lewis, & Kay, 1991), to examine the effects of study condition on continuous abstinence duration using quantitative abstinence criteria. This is a survival analysis procedure suitable for use with a within-subject design. The survival analysis with quantitative data assesses specific efficacy of the interventions that were designed to initiate abstinence at the first time point and to sustain abstinence throughout the testing period. Post hoc tests (McNemar test of planned comparisons) examined group differences in the survival function at several discrete time points.

Analyses of other variables were conducted using one-way (longest duration of abstinence) or two-way (cocaine-negative urine specimens by qualitative criteria) repeated measures analysis of variance (ANOVA). Qualitative urine-test results were analyzed using point abstinence rather than survival analysis because abstinence rates were expected to increase over time for those who remained abstinent during sustained incentive procedures. To characterize the greater sensitivity of quantitative versus qualitative urine-testing methods, the percentage of participants meeting abstinence criteria at each time point under the two testing methods was analyzed in a three-way repeated measures ANOVA that included urine-test method, study condition, and urine-testing time point as within-subject factors.

Results

Rates of Cocaine Abstinence

Figure 1 shows the percentage of participants who initiated and maintained abstinence during each experimental condition. Survival analysis indicated a significant effect of condition on the percentage of participants initiating and sustaining abstinence during the 11-day intervention, $\chi^2(3, N = 40) = 9.25, p < .03$. The figure indicates that 70–80% of the patients showed evidence of cocaine abstinence over the first 2 days of the intervention (Monday–Wednesday) when a \$100 incentive could be earned. In contrast, only 48% of these patients showed evidence of initial abstinence on the first Wednesday of the no-voucher condition. In planned comparison testing on Day 1 (Wednesday), the percentage of participants abstinent in the single-voucher (80%), continuous (73%), and interrupted (70%) conditions all differed significantly from the percentage abstinent in the no-voucher (48%) condition but did not differ significantly from one another. By the second test day (Friday), the percentage of participants remaining abstinent in the single-voucher group had fallen to 28% and was no longer significantly different from the percentage abstinent in the no-voucher condition (30%). During the two conditions in which vouchers could be earned for remaining abstinent after the first Wednesday (continuous and interrupted), abstinence rates remained higher than in the single- and no-voucher conditions throughout the interventions. However,

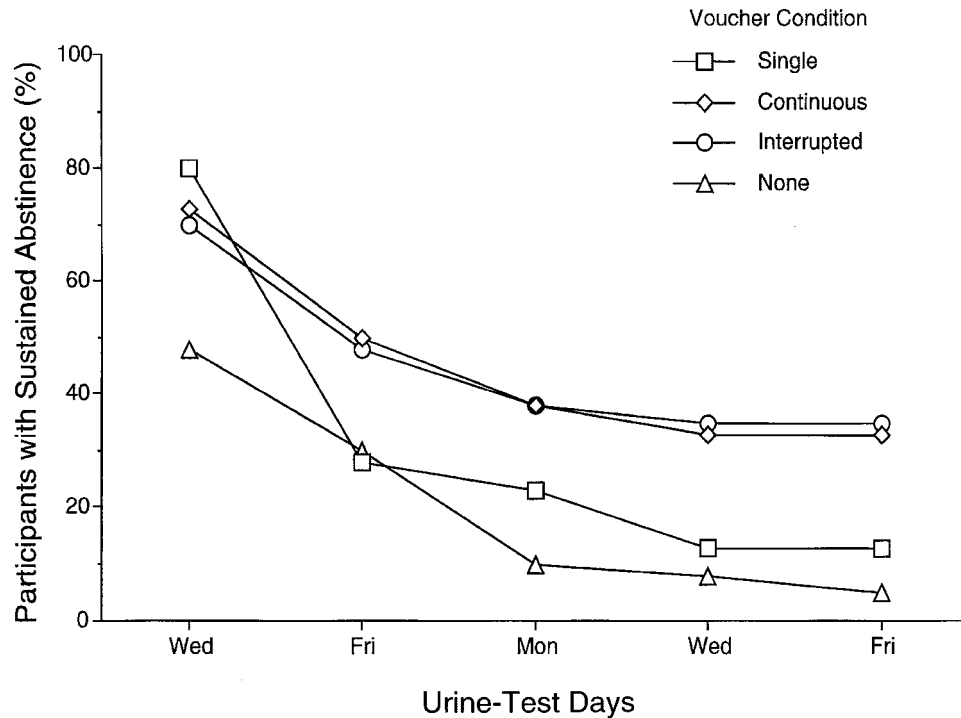


Figure 1. Percentage of participants ($N = 40$) with continuous abstinence for four study conditions tested in random order using a within-subject design and separated by 1-month washout periods. Participants received instructions on Monday (Mon) of the first week (not shown). First data point represents the percent with urinalysis evidence of 2-day cocaine abstinence sustained from Mon to Wednesday (Wed; benzoylecgonine concentration decrease of more than 50% or absolute concentration of 300 ng/ml or less). Subsequent points indicate percentage of participants continuing to meet urinalysis abstinence criteria on each subsequent urine-test day. Fri = Friday.

these rates fell gradually from 70% and 73% of participants abstinent on the first Wednesday to 33% and 35% remaining abstinent by the final Friday test day. This compares with 13% and 5% of participants continuously abstinent during the single- and no-voucher conditions, respectively. Planned comparison tests revealed that abstinence rates at the end of the intervention were significantly higher for both the continuous and interrupted conditions than for the single- and no-voucher conditions. Neither continuous and interrupted nor single- and no-voucher conditions differed significantly from each other.

Longest Duration of Abstinence

As shown in Figure 2, when longest duration of abstinence was calculated from Day 1 of the intervention, mean abstinence duration was 2 ($SEM = .47$) days for no-voucher, 3.2 ($SEM = .55$) days for single-voucher, and 4.9 ($SEM = .73$) and 4.8 ($SEM = .76$) days for continuous and interrupted voucher conditions, respectively, $F(3, 117) = 7.3, p < .001$. Post hoc testing revealed that both the continuous and interrupted conditions had significantly longer durations of initial abstinence than the no-voucher condition but did not differ significantly from each other or from the single-voucher condition.

Similar results were seen for longest duration of abstinence initiated at any point during the intervention. The overall effect of study condition was significant, $F(3, 117) = 5.7, p < .002$. Mean longest abstinence duration was 4.0 ($SEM = .50$) and 3.8 ($SEM = .37$) days in the single- and no-voucher conditions, respectively, whereas these values were 5.6 ($SEM = .66$) and 5.8 ($SEM = .63$) days in the continuous and interrupted voucher conditions, respectively. Both the continuous and interrupted conditions differed significantly from single- and no-voucher conditions but did not differ from each other.

Table 2 shows patterns of abstinence initiation across study days. Among participants who initiated any abstinence in a given condition, 60%–70% initiated their longest duration of abstinence at the start of the study intervention in the three conditions in which vouchers could be earned, whereas this was true for 37% of participants under the no-voucher condition. The next most prevalent abstinence initiation time point was Friday of the first intervention week. That is, an abstinence judgment was made on the basis of comparison of urine results from the first Friday and the second Monday of intervention. This pattern was especially prevalent in single-voucher (32% of those initiating any abstinence) and no-voucher (39% of those initiating

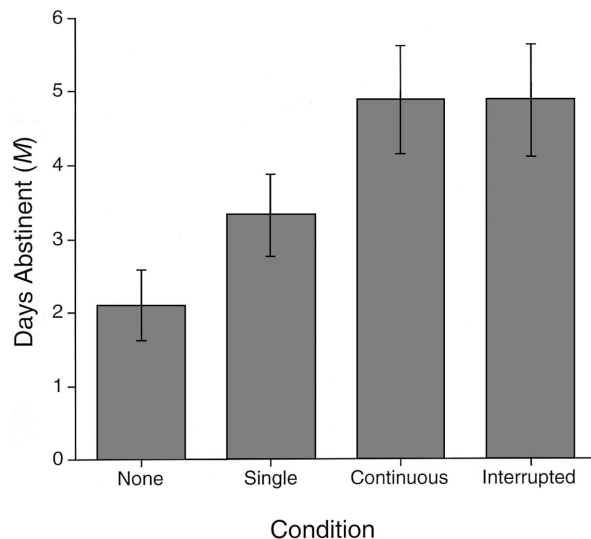


Figure 2. Mean (\pm SEM) longest duration of abstinence for each of the four test conditions. Data shown are for abstinence episodes initiated at the start of each intervention condition. Two days of abstinence was assigned when participants met urinalysis abstinence criteria on Monday–Wednesday and Wednesday–Friday testing intervals; 3 days of abstinence was assigned when criteria were met over the Friday–Monday testing interval.

abstinence) conditions, and was typically associated with the minimum abstinence duration of 3 days (i.e., abstinence did not extend beyond the Monday assessment).

Abstinence by Qualitative Testing Criteria

Figure 3 shows the percentage of urine specimens testing cocaine-negative by the qualitative cutoff (< 300 ng/ml) at each urine-testing time point. An ANOVA revealed a significant effect of condition, $F(3, 117) = 3.5, p < .02$; time, $F(5, 195) = 6.5, p < .001$; and a Condition \times Time interaction, $F(15, 585) = 2.7, p < .003$. Approximately 20% of participants were abstinent on Monday of each study condition, before the intervention was introduced. In the no-voucher condition, the percentage testing cocaine-negative by qualitative criteria fluctuated unsystematically between 15% and 27% across urine-testing time points. For the single-voucher condition, the percentage abstinent rose to 37% on the first Wednesday test day, then fluctuated between 17% and 25% for the remainder of the intervention. In contrast, the percentage of participants testing abstinent rose gradually from 20% on the first Monday to 43% and 48% in the continuous and interrupted conditions, respectively, on the second Monday test day, with abstinence rates for these groups then declining only slightly through the remainder of the study intervention. On the second Monday of the intervention period, the percentage of participants abstinent in both continuous (43%) and interrupted (48%) conditions was significantly different from the abstinence rate in the no-voucher condition (15%). However, no other post hoc differences were significant.

Quantitative Versus Qualitative Testing Outcomes

An ANOVA revealed a highly significant effect of urine-testing method, $F(1, 39) = 133, p < .001$. Across all study conditions and time points, participants tested abstinent on 52% of occasions under the quantitative testing criteria versus 31% of occasions under qualitative (EMIT) testing. This difference in abstinence by urine-test method was seen under all four study conditions: Test \times Condition, $F(3, 117) = 1.33, ns$. However, there was a significant Test \times Time interaction, $F(5, 195) = 16.7, p < .001$. Under qualitative testing, approximately 30% of participants tested abstinent at each point (range = 29–35%). In contrast, percents abstinent with quantitative testing were 68%, 49%, 54%, 43%, and 45% across the 5 time points included in the analysis. Post hoc testing revealed that results from the two testing methods were significantly different only at the first (Wednesday) and third (second Monday) time points.

Discussion

This study replicated previous observations (Robles et al., 2000) that indicated that a brief abstinence test, using a combination of high reinforcer magnitude and low response requirement, can motivate cocaine abstinence initiation in a high percentage of methadone maintenance patients. Specifically, 70–80% of participants in the current study displayed evidence of abstinence over the first 2 days of an intervention when a \$100 voucher could be earned for evidence of cocaine abstinence based on quantitative urinalysis testing, as compared with 48% in the no-voucher condition. Furthermore, the current study extends previous observations by showing that abstinence initiation can be repeatedly observed in the same group of participants over multiple applications of the voucher intervention. The importance of identifying effective abstinence initiation procedures is highlighted by recent studies showing that exposure to reinforcement for the initiation of cocaine abstinence is subsequently associated with higher rates of cocaine abstinence when more demanding response requirements are introduced (Preston, Umbricht, Wong, & Epstein, 2001) or when incentives are later removed (Higgins, Badger, & Budney, 2000).

Table 2
Percentage of Participants Initiating Longest Duration of Abstinence on Each Urine-Test Day

Condition ^a	Urine-test day				
	Mon 1	Wed 1	Fri 1	Mon 2	Wed 2
No Voucher (<i>n</i> = 38)	37	13	39	8	3
Single (<i>n</i> = 37)	62	3	32	3	0
Continuous (<i>n</i> = 36)	69	14	14	3	0
Interrupted (<i>n</i> = 40)	60	10	18	5	8

Note. Mon = Monday; Wed = Wednesday; Fri = Friday.

^a Sample size includes only those who achieved a minimum of 2 days abstinence at any time during the study condition.

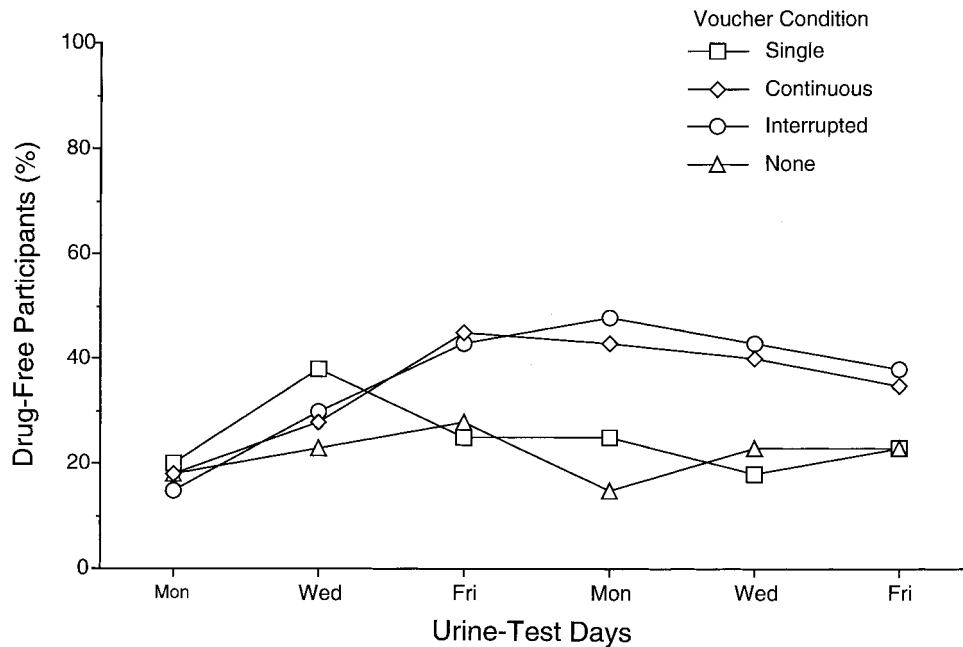


Figure 3. Percentage of participants ($N = 40$) with urine benzoylecgonine concentration of 300 ng/ml or less at each urine-testing occasion. Data are shown for four study conditions tested in random order using a within-subject design and separated by 1-month washout periods. Participants received instructions on Monday (Mon) of the first week; incentives were delivered at each subsequent test point on the basis of evidence of 2-day (first Mon–Wednesday [Wed]; single-voucher condition) or continuous (continuous and interrupted voucher conditions) abstinence detected at each subsequent urine-testing point. Fri = Friday.

We used quantitative urinalysis testing throughout the study to detect cocaine use and identify periods of brief abstinence. Although significant effects of incentive conditions were seen with the more conservative and conventional qualitative testing (Figure 3), our results nevertheless indicate that far fewer instances of abstinence would have been detected if only qualitative testing had been used to determine reinforcer delivery. Thus, the use of quantitative procedures represents an important technical innovation because it allows for more sensitive detection of brief periods of abstinence and therefore more widespread exposure of deserving patients to potentially beneficial reinforcers. Other studies have extended the use of quantitative testing to investigate the effects of altering the response required to obtain reinforcement. For example, recent studies have evaluated the use of shaping procedures, whereby reinforcers are provided contingent on evidence of reductions in drug use rather than abstinence (e.g., Elk et al., 1995; Preston et al., 2001). Shaping procedures have not been widely implemented in the treatment of drug use. However, quantitative testing may provide the methodology needed to investigate potentially useful shaping procedures.

Data from the longest duration of abstinence measure suggest that the incentive interventions synchronized abstinence attempts, since the majority of longest abstinence episodes began on the first day of the study intervention (Table 2). However, in the single-voucher and no-voucher

conditions, there was also a relatively high prevalence of 3-day abstinence outcomes detected on Monday of the second week, when drug use had not been checked since the previous Friday (Table 2). Given that drug use over the weekend seems likely, this pattern suggests that some undetected use may have occurred and that the 2-day interval originally recommended by Preston and colleagues (1997) gives more accurate outcomes in quantitative testing to detect new drug uses. Future studies will need to evaluate the accuracy and reliability of abstinence judgments based on 2- versus 3-day testing intervals by collecting additional urines during the longer interval.

The current study also extends previous observations by showing that continuing cocaine abstinence incentives over 11 days resulted in more sustained abstinence than was observed under conditions in which incentives were withdrawn (single-voucher) or absent (no-voucher). This conclusion is reflected in the significantly different abstinence survival curves, shown in Figure 1, as well as in longest duration of abstinence measure shown in Figure 2. By the end of the intervention, 34% of study participants had remained abstinent on average in the two conditions in which incentives were available throughout, as compared with 9% of the same participants who remained abstinent on average in the two conditions in which incentives were absent or withdrawn. It is possible that even higher rates of sustained abstinence would have been observed in the con-

ditions in which reinforcement was available during the entire intervention period if different reinforcement schedules, such as an escalating schedule, had been used (Higgins et al., 1993; 1994; Roll & Higgins, 2000; Roll, Higgins, & Badger, 1996; Silverman et al., 1996). Another factor potentially affecting outcome is immediacy of reinforcement. Because we used off-site quantitative testing, feedback and reinforcement were generally delayed for several days. Better outcomes under all incentive conditions may have been observed if reinforcement had been delivered more immediately after urine collection.

In the current study, the continuous and interrupted schedules produced virtually identical findings; abstinence rates did not decline during the interrupted schedule, despite the temporary removal of the incentive. It is possible that the timing of the interruption accounts for the similar findings, in that patients who remained abstinent into the second week of the intervention were more likely to continue abstinence despite an interruption in the schedule. Nevertheless, these results are consistent with other studies suggesting that schedules delivering intermittent reinforcement may be effectively used in abstinence incentive protocols. For example, in a study by Petry, Martin, Cooney, and Kranzler (2000), patients earned the chance to draw from a bowl to win prizes of varying magnitudes available under a probability schedule when they submitted negative breath alcohol samples and completed steps toward achieving their treatment plan goals. Treatment retention and alcohol abstinence rates were higher for patients enrolled in the voucher program relative to standard treatment controls. The use of intermittent reinforcement schedules warrants further research because intermittent schedules have been found to generate high rates of behavior in preclinical studies. Furthermore, intermittent and variable delivery schedules may better approximate the types of schedules that exist in the natural environment.

Although the brief abstinence procedure does appear to facilitate the initiation of abstinence, it is important to note that relatively high rates of relapse were observed. Specifically, abstinence rates declined by 35–40 percentage points over the 11-day intervention despite the continuing availability of substantial monetary reinforcers. The pattern of results suggest that the brief abstinence test may prove useful in future investigation of factors that promote sustained abstinence. For example, one feature of the schedules used in the current study is the large reinforcers offered for initial periods of abstinence. Some drug abusers may consider \$100 an adequate amount of money to meet their current needs and as a result may be less motivated to work for additional money. The brief abstinence model could be used to study the interaction between start-up bonuses and schedules of reinforcement designed to promote sustained periods of abstinence (e.g., Silverman et al., 1998). The current results also suggest that the reinforcement procedures needed to sustain abstinence may differ from those required during the initiation of abstinence. Future studies could also investigate the effects of relapse-prevention strategies, whether psychosocial, behavioral, or pharmacological, when used in conjunction with the brief abstinence test.

In conclusion, the current study replicated previous research (Robles et al., 2000) with the brief abstinence test, and used an efficient within-subject design to compare multiple versions of the intervention. Over 70% of patients exposed to the brief abstinence test were able to initiate at least 2 days of cocaine abstinence. The study extends previous observations by demonstrating that higher rates of sustained abstinence are achieved when incentives are continued past the first 2 days, relative to conditions in which incentives were discontinued or absent. Finally, the study provides some support for the use of interrupted schedules of voucher delivery. The findings have utility for understanding the impact of amounts and schedules of reinforcement on abstinence behavior. Furthermore, the fact that relapse was observed despite the continuing availability of substantial monetary reinforcement suggests that the brief abstinence test could also be used as a model to investigate parameters of incentive procedures or other relapse-prevention interventions that could result in even higher rates of sustained abstinence.

References

- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.
- Ball, J. C., & Ross, A. (1991). *The effectiveness of methadone maintenance treatment*. New York: Springer-Verlag.
- Duntzman, G. H., Condelli, W. S., & Fairbank, J. A. (1992). Predicting cocaine use among methadone patients: Analysis of findings from a national study. *Hospital and Community Psychiatry*, 43, 608–611.
- Elk, R., Schmitz, J., Spiga, R., Rhoades, H., Andres, R., & Grabowski, J. (1995). Behavioral treatment of cocaine-dependent pregnant women and TB-exposed patients. *Addictive Behaviors*, 20, 533–542.
- France, L. A., Lewis, J. A., & Kay, R. (1991). The analysis of failure time data in crossover studies. *Statistics in Medicine*, 10, 1099–1113.
- Grella, C. E., Anglin, M. D., & Wugalter, S. E. (1995). Cocaine and crack use and HIV risk behaviors among high-risk methadone maintenance clients. *Drug and Alcohol Dependence*, 37, 15–21.
- Grella, C. E., Anglin, M. D., & Wugalter, S. E. (1997). Patterns and predictors of cocaine and crack use by clients in standard and enhanced methadone maintenance treatment. *American Journal of Drug and Alcohol Abuse*, 23, 15–42.
- Higgins, S. T., Badger, G. J., & Budney, A. J. (2000). Initial abstinence and success in achieving longer term cocaine abstinence. *Experimental and Clinical Psychopharmacology*, 3, 377–386.
- Higgins, S. T., Budney, A. J., Bickel, W. K., Foerg, F., Donham, R., & Badger, M. S. (1994). Incentives improve outcomes in outpatient behavioral treatment of cocaine dependence. *Archives of General Psychiatry*, 51, 568–576.
- Higgins, S. T., Budney, A. J., Bickel, W. K., Hughes, J. R., Foerg, F., & Badger, G. (1993). Achieving cocaine abstinence with a behavioral approach. *American Journal of Psychiatry*, 150, 763–769.
- Hunt, D. E., Spunt, B., Lipton, D., Goldsmith, D. S., & Strug, D. (1986). The costly bonus: Cocaine-related crime among methadone treatment clients. *Advances in Alcohol and Substance Abuse*, 6, 107–122.

- Kidorf, M., Stitzer, M. L., & Brooner, R. K. (1994). Characteristics of methadone patients responding to take-home incentives. *Behavior Therapy*, 25, 109-121.
- Meandzija, B., O'Conner, P. G., Fitzgerald, B., Rounsaville, B. J., & Kosten, T. R. (1994). HIV infection and cocaine use in methadone maintained and untreated intravenous drug users. *Drug and Alcohol Dependence*, 36, 109-113.
- Petry, N. M. (2000). A comprehensive guide to the application of contingency management procedures in clinical settings. *Drug and Alcohol Dependence*, 58, 9-25.
- Petry, N. M., Martin, B., Cooney, J. L., & Kranzler, H. R. (2000). Give them prizes and they will come: Contingency management for treatment of alcohol dependence. *Journal of Consulting and Clinical Psychology*, 68, 250-257.
- Preston, K. L., Silverman, K., Schuster, C. R., & Cone, E. J. (1997). Assessment of cocaine use with quantitative urinalysis and estimation of new uses. *Addiction*, 92, 717-727.
- Preston, K. L., Umbricht, A., Wong, C. J., & Epstein, D. H. (2001). Shaping cocaine abstinence by successive approximations. *Journal of Consulting and Clinical Psychology*, 69, 643-654.
- Robles, E., Silverman, K., Preston, K. L., Cone, E. J., Katz, E., Bigelow, G. E., & Stitzer, M. L. (2000). The brief abstinence test: Voucher-based reinforcement of cocaine abstinence. *Drug and Alcohol Dependence*, 58, 205-212.
- Roll, J. M., & Higgins, S. T. (2000). A within-subject comparison of three different schedules of reinforcement of drug abstinence using cigarette smoking as an exemplar. *Drug and Alcohol Dependence*, 58, 103-109.
- Roll, J. M., Higgins, S. T., & Badger, G. J. (1996). An experimental comparison of three different schedules of reinforcement of drug abstinence using cigarette smoking as an exemplar. *Journal of Applied Behavior Analysis*, 29, 495-505.
- Silverman, K., Higgins, S. T., Brooner, R. K., Montoya, I. D., Cone, E. J., Schuster, C. R., & Preston, K. L. (1996). Sustained cocaine abstinence in methadone patients through voucher-based reinforcement therapy. *Archives of General Psychiatry*, 53, 409-415.
- Silverman, K., Wong, C. J., Umbricht-Schneiter, A., Montoya, I. D., Schuster, C. R., & Preston, K. L. (1998). Broad beneficial effects of cocaine abstinence reinforcement among methadone patients. *Journal of Consulting and Clinical Psychology*, 66, 811-824.
- Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1986). *Structured clinical interview of DSM-IV Axis I disorders*. New York: New York State Psychiatric Institute.
- Zanis, D. A., Metzger, D. S., & McLellan, A. T. (1994). Factors associated with employment among methadone patients. *Journal of Substance Abuse Treatment*, 11, 443-447.

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