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Short communication

Enduring effects of a computer-assisted training program for cognitive behavioral therapy: A 6-month follow-up of CBT4CBT☆,☆☆

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ABSTRACT

Objectives: To evaluate the durability of effects of a computer-assisted version of cognitive behavioral therapy (CBT) as treatment for substance dependence through a 6-month follow-up.
Methods: Following a randomized clinical trial in which 73 individuals seeking outpatient treatment for substance dependence in an outpatient community setting were randomized to either standard treatment-as-usual (TAU) or TAU with 8 weeks of biweekly access to computer-based training for CBT (CBT4CBT), participants were interviewed 1, 3, and 6 months after the termination of study treatments.
Results: Sixty of the 73 participants were reached for follow-up (82%); follow-up rates and availability of data were comparable across treatment conditions. Random regression analyses of use across time indicated significant differences between groups, such that those assigned to TAU increased their drug use across time while those assigned to CBT4CBT tended to improve slightly. The durability of the CBT4CBT effect remained even after controlling for treatment retention, treatment substance use outcomes, and exposure to other treatment during the follow-up period.
Conclusions: Computerized CBT4CBT appears to have both short-term and enduring effects on drug use.

1. Introduction

Cognitive behavioral therapy (CBT) has a comparatively strong level of empirical support among substance use disorders (Carroll and Onken, 2005; DeRubeis and Crits-Christoph, 1998; Dutra et al., 2008; Irvin et al., 1999) and its effects appear to be particularly durable. For example, a 1-year follow-up of cocaine-dependent individuals treated with CBT indicated that they continued to make significant reductions in use, even after controlling for exposure to other treatments (Carroll et al., 1994). This 'sleeper' effect has since been replicated in several studies (Carroll et al., 2006; Epstein et al., 2003; Rawson et al., 2002). However, despite strong empirical support for CBT, it is still rarely implemented in community-based settings. Among the barriers to the implementation of CBT in clinical settings are the relative complexity of the approach itself; high caseloads resulting in limited opportunities for clinicians to provide individual therapy to patients; the time and cost of training as well as the high rates of turnover among substance use clinicians; and the relative lack of established CBT training programs and ongoing supervision for clinicians. To address this issue, we developed a six-module, multimedia computer-based version of CBT ("CBT4CBT") and conducted a randomized clinical trial demonstrating its efficacy as an adjunct to standard outpatient treatment among a heterogeneous group of drug-dependent individuals (Carroll et al., 2008). During the 8-week treatment period, participants assigned to the CBT4CBT condition had significantly longer periods of abstinence and submitted significantly fewer drug-positive urine specimens than those assigned to TAU.

However, an important and rarely studied question regarding computer-assisted training methods is the durability of their effects. If the emerging promise of computer-assisted treatments (Tumur et al., 2007) is to be realized, it is crucial that these approaches be demonstrated to have clinically meaningful and sustained effects. The few existing studies evaluating the durability of effects from computer-assisted treatment have been positive, but limited by loss to follow-up and reliance on self-reported outcomes (Andersson et al., 2005; Spek et al., 2008; Wright et al., 2005). In this report we describe main outcomes from a 6-month follow-up study of a randomized clinical trial of CBT4CBT. Based on the existing literature supporting the durability of CBT effects (Carroll et al., 1994), the primary hypothesis was that individuals assigned to CBT4CBT

☆ A CONSORT diagram for the trial can be viewed by accessing the online version.
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would maintain reduced frequency of substance use and submit fewer positive urine toxicology screens than those randomized to TAU.

2. Methods

2.1. Participants

Participants were recruited from individuals seeking treatment at a community-based outpatient substance abuse treatment provider in Bridgeport, CT. Participants were English-speaking adults who met DSM-IV criteria for any current substance dependence disorder. Exclusion criteria were minimized to facilitate recruitment of a clinically representative group of individuals seeking treatment in community settings. The CONSORT diagram,[1] 77 of the 155 individuals screened were determined to be eligible, provided written informed consent as approved by the Yale University School of Medicine, and were randomized to either TAU or CBT4CBT plus TAU. Of the 73 individuals who were exposed to treatment, 43% were female, 46% were African American, 34% were European-American, 12% were Hispanic, and 6% were Native American. Most (77%) were unemployed, and 75% had completed high school. Most (59%) reported cocaine use as their primary substance use problem, followed by alcohol (18%), opioids (16%) and marijuana (7%). Multiple substance use was common, as 80% of the sample reported using more than one type of substance.

2.2. Treatments

All participants were offered standard treatment (TAU), which typically consisted of weekly individual and group sessions. Those randomized to CBT4CBT4 were also provided biweekly access to the computer program in a small private room within the clinic. The multimedia CBT4CBT consists of six lessons, or modules, the content of which was based closely on a NIDA-published CBT manual (Carroll, 1998). The first module ("Introduction to CBT and the Functional Analyses") provided a brief explanation of how to use and navigate the program. Following completion of the first module, participants could choose to access the five remaining modules (coping with craving, refusal skills, problem solving skills, recognizing and challenging cognitions, decision making skills) in any order they wished, and repeat any information, section, or module as many times as they wished (Carroll et al., 2008).

2.3. Follow-up procedures, assessments, and analyses

Participants were interviewed before treatment, during treatment, at the 8-week treatment termination point and at follow-up evaluations conducted 1, 3, and 6 months after the end of treatment by an independent clinical evaluator. The primary outcome measures were frequency of substance use (operationalized as the percentage of treatment days the participant reported using alcohol or any illegal drug) and results of urine toxicology screens (number of drug-positive samples collected). The Substance Abuse Calendar, which is similar to the Timeline Follow Back (Fals-Stewart et al., 2000), was administered at each assessment point to collect detailed self-reports of drug and alcohol use on a day by day basis from randomization to the final day of follow-up.

We attempted to follow all 73 participants who initiated treatment, regardless of whether they completed the treatment phase of the protocol. Follow-up was naturalistic, and thus we did not seek to control or restrict participants' treatment involvement after they completed the 8-week protocol. Therefore, participants were free to continue treatment at the clinic, where the modal form of treatment was supportive group drug counseling therapy.

Participant self-reports of drug use were verified through urine toxicology screens that were obtained at every assessment visit. Of 145 urine specimens collected during the follow-up period, 95 were matched to a time period corresponding with the self-report. Of these, the majority were consistent with self-report in that only 16 (16.8%) were positive for drugs in cases where the participant had denied recent use (positive for cocaine, $n = 9$, marijuana, $n = 2$, and opioids, $n = 8$). This rate was comparable with the rate of discrepant self-report from the main phase of the trial (15%). Breathalyzer samples were also collected at each visit; none indicated recent alcohol use.

The principal analytic strategy for analyzing the follow-up data was random effects regression analyses (Bryk and Raudenbush, 1987) on frequency of drug use by month (28-day period), using the last 4 consecutive weeks of data provided by each participant during the active phase of treatment as the intercept. To evaluate the effect of protocol treatment retention, substance use outcomes within treatment, and exposure to treatment during the 6-month follow-up period on outcome, these variables were also added to the model as covariates.

[1] This diagram can be viewed with the online version of this paper at http://dx.doi.org by entering doi:xxxxxxxx.

3. Results

3.1. Follow-up sample

Of the 73 who were exposed to their study treatment, 60 were followed at least once. There were no significant differences by condition in rates of follow-up, data availability or length of time covered during the follow-up (mean 154.4 days for CBT4CBT and 146.6 for TAU, $F(1) = 0.51$, $p = .48$). One participant in the TAU condition died during the follow-up period. There were no significant differences between those who were reached for follow-up and those who were not reached in terms of baseline demographic or substance use-related variables. However, compared to the 60 participants reached for follow-up, the 13 participants not reached had completed significantly fewer weeks of the study protocol (6.1 versus 4.1, $F(1) = 8.8$, $p = .004$).

3.2. Treatment involvement during follow-up

During the 6-month follow-up period, 38% of those reached received some psychiatric treatment, 75% received some form of substance abuse treatment, and 12% had been arrested. However, intensity of involvement in any of these activities was fairly low, as participants reported they attended an average of 2.3 days of outpatient drug treatment, 1.5 days of inpatient treatment, and 5.8 days of self-help per month, and less than 1 day of any psychiatric treatment per month with no significant differences in the in the frequency or intensity of these events by treatment condition.

3.3. Relationship of within treatment outcomes to substance use during follow-up

As expected, there were fairly strong and consistent relationships between within-treatment substance use and outcome during the follow-up. For the sample as a whole, the percentage of drug-negative urine specimens collected during treatment was significantly correlated with the longest period of consecutive abstinence during follow-up ($r = 0.42$, $p < .01$). Similarly, those who attained longer consecutive periods of abstinence within treatment had significantly longer periods of abstinence during follow-up ($r = 0.55$, $p < .01$). For the participants randomized to CBT4CBT, the number of CBT4CBT modules started had a significant positive relationship with maximum days of abstinence during the follow-up ($r = 0.49$, $p = .02$).

3.4. Drug use during follow-up by treatment condition

As shown in Fig. 1, which presents estimated means of days of drug use by month by treatment, those assigned to CBT4CBT tended to continue to reduce their drug use slightly across the follow-up period, while those assigned to TAU tended to increase their frequency of drug use. Random effects regression analysis indicated no significant effects for group ($t = 0.1$, $p = .92$) or time ($t = .70$, $p = .48$), but a significant group by time effect ($t = 2.2$, $p = .03$). When treatment retention ('days retained in treatment') was added to the model as a covariate, the covariate was significant ($t = -3.2$, $p = .003$) and indicated that overall, participants who were retained in protocol treatment reported fewer days of drug use during follow-up. The group by time effect remained significant ($t = 2.3$, $p = .025$) suggesting that the sustained improvements following CBT4CBT compared with TAU remained significant even after accounting for treatment exposure. Similarly, when maximum consecutive duration of abstinence was added to the model, the covariate was again significant ($t = -2.9$, $p = .005$) indicating overall better outcome during follow-up for those participants who had achieved longer periods

Table 1
Substance use outcomes during follow-up by treatment condition.

Variable	Treatment condition[a]							
	CBT4CBT		TAU		Analysis			
	Mean	S.D.	Mean	S.D.	F or χ^2	d.f.	p	d
Percent days abstinence from all drugs	87.3	24.0	82.4	25.4	0.7	58	.41	.20
Longest maximum consecutive days abstinence all drugs	102.0	60.1	72.5	54.7	3.9	58	.05	.54
Percent drug-free urine specimens, 1 month follow-up	76.2		48.1		3.9	1	.05	
Percent drug-free urine specimens, 3 month follow-up	75.0		60.0		1.2		.27	
Percent drug-free urine specimens, 6 month follow-up	61.9		46.2		1.2	1	.28	

[a] CBT4CBT = computer-assisted cognitive behavioral therapy (n = 26), TAU = treatment as usual (n = 34).

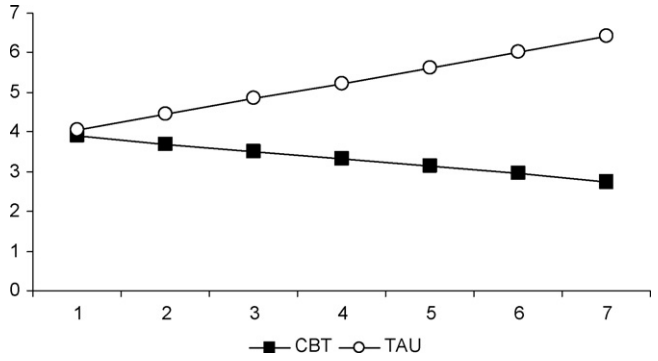

Fig. 1. Days of any drug use by month (treatment endpoint to end of 6-month follow-up) and treatment condition, estimates from random regression analyses.

of abstinence within the 8-week treatment period. The group by time effect remained significant as well (t = 2.4, p = .015). Finally, when 'total days of substance abuse treatment during follow-up' was added to the same model as a covariate, the covariate was not significant, indicating that level of exposure to substance use treatment during follow-up was not strongly associated with drug use outcomes during this period. Again, the group by time effect favoring CBT4CBT over TAU remained statistically significant even after controlling for exposure to treatment (t = 2.2, p = .03).

Table 1 presents results of urine toxicology screens and self-reported drug use and results of urine toxicology screens at each follow-up by treatment condition. Across groups, participants reported they were abstinent for 84% of days throughout the follow-up, but group differences were not statistically significant. Those assigned to CBT4CBT reported a significantly higher period of consecutive abstinence from all drugs during the follow-up period (102 versus 72.5 days, F = 3.9, p = .05). Moreover, those assigned to CBT4CBT were significantly more likely to submit a drug-negative urine specimen at the 1-month follow-up (76% versus 48%, F = 3.9, p = 0.05). At the 3-month and 6-month follow-ups, those assigned to CBT4CBT submitted a higher proportion of drug-free urine specimens, although the difference was not statistically significant at these points.

4. Discussion

This 6-month follow-up of a computer-assisted training program in CBT for addictions demonstrated that the CBT4CBT program was associated with enduring benefit detectable up to 6 months after the end of treatment. Evidence for the enduring efficacy of CBT4CBT relative to standard treatment was detectable not only in self-report but also through biological measures (urine specimens at 1 month). Participants assigned to CBT4CBT tended to maintain or increase the gains they had achieved during treatment, while those assigned to the TAU condition tended to increase their substance use over the follow-up interval. Moreover, although length of abstinence attained during treatment as well as retention in treatment were both significantly associated with better drug use outcomes during follow-up, the positive effects for CBT4CBT over time remained significant even after controlling for these variables.

These data thus provide comparatively strong support for the durability of effects from computer-assisted CBT, in that they were obtained even after controlling for important prognostic indicators. They are also, to our knowledge, the first to demonstrate enduring effects on computer-assisted CBT on a behavioral indicator of outcome (urine specimens). Although 82% of the treatment-exposed sample was reached for at least one follow-up, a limitation of this study is incomplete data at some follow-up points. However, the random regression models used here reduce, to some extent, the statistical problems usually associated with missing follow-up data in that use of these models enabled utilization of all available data (Gibbons et al., 1993; Nich and Carroll, 1997). Furthermore, we evaluated the follow-up data carefully and ruled out several possible sources of bias (e.g., differential contribution to the dataset by treatment condition and other participant characteristics). Because CBT4CBT was evaluated as we anticipated it may be used in drug abuse treatment settings, that is, as an adjunct to standard treatment, we did not control for level of exposure to treatment overall. Finally, another limitation of this and any naturalistic follow-up study is uncontrolled exposure to non-study treatments. Although a large proportion of participants reported some exposure to substance use or psychiatric treatment during follow-up, such exposure was typically abbreviated and did not appear to have a strong influence on drug use outcomes during follow-up.

Conflict of interest

Drs. Carroll and Rounsaville are members of Applied Behavioral Research, which produces clinician training materials unrelated to the CBT4CBT program. The Yale University Office of Cooperative Research has filed a provisional patent application for the program. Drs. Ball, Martino, Nich and Babuscio have no conflicts to declare.

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Contributors: Drs. Carroll, Ball, Martino, Nich and Rounsaville designed the study and carried out the protocol. Dr. Carroll, Ms. Nich and Tabuscio conducted the data analysis. Dr. Carroll wrote the first draft of the article and all authors have reviewed and approved the final manuscript.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.drugalcdep.2008.09.015.

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