Short communication

Predictors of outcome from computer-based treatment for substance use disorders: Results from a randomized clinical trial

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ABSTRACT

Background: Although empirical evidence for the effectiveness of technology-mediated interventions for substance use disorders is rapidly growing, the role of baseline characteristics of patients in predicting treatment outcomes of a technology-based therapy is largely unknown.
Method: Participants were randomly assigned to either standard methadone maintenance treatment or reduced standard treatment combined with the computer-based therapeutic education system (TES). An array of demographic and behavioral characteristics of participants ($N = 160$) was measured at baseline. Opioid abstinence and treatment retention were measured weekly for a 52-week intervention period. Generalized linear model and Cox-regression were used to estimate the predictive roles of baseline characteristics in predicting treatment outcomes.
Results: We found significant predictors of opioid abstinence and treatment retention within and across conditions. Among 21 baseline characteristics of participants, employment status, anxiety, and ambivalent attitudes toward substance use predicted better opioid abstinence in the reduced-standard-plus-TES condition compared to standard treatment. Participants who had used cocaine/crack in the past 30 days at baseline showed lower dropout rates in standard treatment, whereas those who had not used exhibited lower dropout rates in the reduced-standard-plus-TES condition.
Conclusions: This study is the first randomized controlled trial, evaluating over a 12-month period, how various aspects of participant characteristics impact outcomes for treatments that do or do not include technology-based therapy. Compared to standard alone treatment, including TES as part of the care was preferable for patients who were employed, highly anxious, and ambivalent about substance use and did not produce worse outcomes for any subgroups of participants.

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1. Introduction

Media technologies, such as the internet and mobile devices, have shown considerable promise in the delivery of behavioral therapies targeting problematic substance use (Chen et al., 2012; White et al., 2010). Recent systematic reviews and meta-analyses indicate that technology-mediated interventions are effective in the prevention, treatment, and recovery support of substance use disorders (SUDs; Marsch and Dallery, 2012; Moore et al., 2011; Riper et al., 2011). Benefits of technology-mediated health interventions include their ability to expand the reach and effectiveness of care and to enable higher fidelity in the delivery of evidence-based interventions (Bickel et al., 2008; Gustafson et al., 2011; Marsch and Dallery, 2012). Numerous randomized, controlled trials, such as the computer-based cognitive behavioral therapy program (Kiluk et al., 2010) and a web-based motivational interviewing and a motivational enhancement system (Ondersma et al., 2005, 2007) have provided growing empirical support for the efficacy and effectiveness of technology-mediated interventions for SUDs, including enhanced coping skill acquisition, risk recognition, and substance use reduction.

One of the most extensively studied technology-based interventions for SUDs is the therapeutic education system (TES), a fluency building behavioral intervention grounded in the community reinforcement approach (CRA) that has been shown to be efficacious in treating SUDs (Bickel et al., 2008; Marsch et al., 2014). The 65

interactive modules in the TES address problem solving, self-regulation and coping skills in order to assist individuals in implementing positive behavioral changes (Marsch et al., 2011, 2014).

In one recently published study conducted with opioid-dependent adults in methadone maintenance treatment, the authors found that replacing half of the standard counseling with the computer-based TES programs (referred to as reduced-standard-plus-TES hereafter) produced significantly greater rates of opioid abstinence over a one year follow-up period compared to standard alone treatment (Marsch et al., 2014). Despite the promising results, it is unknown whether including a computer-based TES as part of the care delivery model is still effective for various subgroups of opioid-dependent persons with different baseline characteristics. Opioid-dependent individuals with some characteristics may benefit from a computer-based therapy (Acosta et al., 2012; Cooney et al., 1991; Roman and Johnson, 2002), whereas persons with other characteristics (e.g., greater age, low education) may be served better with standard treatment. Systematic reviews affirm that baseline characteristics can moderate abstinence and study attrition outcomes in SUD treatment (Moore et al., 2011; Najt et al., 2011; White et al., 2010). To the best of our knowledge, only two studies have examined the predictive validity of baseline characteristics, such as cognitive functioning, in the context of technology-based interventions for SUDs (Acosta et al., 2012; Carroll et al., 2011).

Building upon the main outcomes among opioid-dependent participants who were randomized to computer-based TES as part of their care versus those who only received standard treatment (Marsch et al., 2014), we further examine how differently an array of demographic and behavioral characteristics of participants measured at baseline predict treatment outcomes. The characteristics examined in this paper are consistent with those that have been examined in substance abuse treatment research, allowing us to interpret our findings in relation to the broader context of the literature (Ciraulo et al., 2003; Marsch et al., 2005; Weekes et al., 2011).

2. Methods

2.1. Treatment random assignment

Eligible participants (N = 160, ≥ 18 years of age) recruited from a large methadone maintenance treatment (MMT) program, were randomly assigned to either (a) standard treatment or (b) reduced-standard-plus-TES condition in an intent-to-treat design. Demographics of the participants, eligibility criteria, general study procedures, and the CONSORT diagram are reported in Marsch et al. (2014).

Participants in the standard treatment condition received substance abuse counseling once a week for the first four weeks, and then every other week over the 52-week intervention period. The content of these sessions was largely similar to many other MMT programs, including discussion of current problems and treatment progress. Participants in the reduced-standard-plus-TES condition received the same standard counseling content offered by counselors to participants in the standard treatment condition during the first half of each scheduled counseling session, and spent the other half of their session using the computer-based TES program.

2.2. Urine drug testing

Participants were asked to provide urine samples to a research staff member at the study site on a weekly basis. Point-of-care qualitative urine test cups (Drug Test Systems, Dover, NH) were used to test for the presence of barbiturates, THC, cocaine, benzodiazepines, methamphetamine, opiates, methadone, oxycodone, and propoxyphene. Opioid abstinence was confirmed when all the urinalysis results for opiates, propoxyphene, and oxycodone were negative (Marsch et al., 2014).

2.3. Measures of baseline characteristics

Categorical baseline characteristics measured with multi-level responses, such as marital status, were dichotomized prior to the predictor analyses (Quinn and Keough, 2002). The Addiction Severity Index (McLellan et al., 1980) was used to measure substance use in the past 30 days, including sedatives, cocaine/crack, and alcohol intoxication. No use was coded as "0" and any use was coded as "1". Summated scores for the Beck Depression Inventory-II (BDI-II; Beck et al., 1996) and the Beck Anxiety Inventory (BAI; Beck and Steer, 1990) were calculated to assess participants' level of depression and severity of anxiety symptoms at baseline. The HIV/AIDS knowledge test (Marsch and Bickel, 2001) was modified into 25 items to measure HIV/hepatitis knowledge and sexual/drug risk behaviors (0 = no correct answers, 25 = a perfect score). Lastly, participants responded to the Stage of Change Readiness and Treatment Engagement Scale (SOCRATES 8A; Miller and Tonigan, 1996). The summated scores were transferred into decile scores for the recognition, ambivalence, and taking steps sub-scales, ranging from 10 to 90.

2.4. Statistical analyses

Generalized linear models (GLM) with logit link and binomial distribution were conducted to estimate the effect of the predictors on proportion-based binary responses for opioid abstinence (i.e., opioid-positive or -negative; Quinn and Keough, 2002). After examining the predictor effects within each study condition, the study condition was entered into the model with each predictor to explore an interaction effect between a given predictor and the study conditions. Cox proportional hazards regressions analyses were conducted to determine the unique contribution of each predictor on treatment retention within and across study conditions (Cox and Oakes, 1984).

3. Results

3.1. Predictors of opioid abstinence and retention within each study condition

For participants in the reduced-standard-plus-TES condition, eight variables (e.g., being Hispanic) predicted a higher percentage of weeks abstinent (Table 1). Five variables (e.g., more years of education) predicted a lower percentage of total weeks abstinent.

For participants in the standard treatment condition, only SOCRATES Taking Steps sub-scale scores predicted higher percentages of total weeks with opioid abstinence. Eight predictors (e.g., older age, being male, married and employed) revealed negative associations with percentage of total weeks with opioid abstinence.

Cox proportional hazards regression indicated that dropout rates decreased as one unit increased in the age of participants in the reduced-standard-plus-TES group (HR = .97, $p < .05$), but dropout rates increased when participants in both conditions were involved in risky drug injection behaviors in the past 30 days at baseline (HR = 1.88 for participants in the reduced-standard-plus-TES condition; HR = 1.98 for participants in the standard condition, $p < .05$).

3.2. Interaction effects: predictors of opioid abstinence and retention across conditions

Three predictors (employment status, BAI score and ambivalence score) showed significant interaction effects across study conditions on the outcome of opioid abstinence (Table 1). Being employed predicted significantly worse outcomes in the standard condition relative to the reduced-standard-plus-TES condition ($B = 0.30$, $p < 0.01$, $d = .11$). Higher BAI scores predicted better opioid abstinence for the reduced-standard-plus-TES condition participants by 0.06 ($p < 0.01$, $d = .57$) compared to those in the standard condition. Higher ambivalence scores predicted better opioid abstinence for the reduced-standard-plus-TES condition participants by 0.02 ($p < 0.01$, $d = .40$) compared to those in the standard condition.

Different dropout rates and patterns were observed in the hazard ratios across study arms as related to past 30 days cocaine/crack use at baseline. Participants who had used cocaine/crack in the past 30 days at baseline ($n = 76$) were more likely to drop out, especially approximately 30 weeks after the intervention started, when they were assigned to the reduced-standard-plus-TES condition compared to the standard treatment condition (Fig. 1A). For participants who had not used cocaine/crack in the past 30 days at baseline ($n = 84$), lower dropout rates emerged at approximately