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Exploring the Components of an Efficacious Computer Brief Intervention for Reducing Marijuana Use among Adults in the Emergency Department

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Abstract

Objective: To examine the efficacious components of a computer-delivered brief intervention (CBI) for reducing marijuana use among adults presenting to a low-income urban emergency department (ED), which a prior report found to decrease marijuana use at a 6-month follow-up.

Method: Participants were 237 ED patients reporting recent drug use (46% male; 54% African-American; mean age, 30.7) who were randomized to receive a CBI consisting of an interactive program guided by a virtual health counselor. The primary outcome was past 30-day marijuana use at 6-month follow-up assessed using the Timeline Follow-Back (TLFB). Intervention components related to change in marijuana use at 6 month follow-up examined in the current study included participant responses to items within five CBI domains that were rooted in motivational interviewing: goals for change, strengths, evoking-change (concerns about use and benefits of change), challenges, and tools for change.

Results: The evoking-change domain was related to significant reductions in marijuana use at 6 months ($B=-2.91$, $SE=1.10$, $p<.01$). Within this domain, items focused on concerns about family and friends were related to reductions in marijuana use of up to 5.5 fewer days of marijuana use in the past month ($B=-5.49$, $SE=1.63$, $p<.01$).

Conclusions: An ED-based brief intervention, delivered by computer, was effective in reducing marijuana use. Intervention components focused on perceived concerns about use and benefits of change in relation to family and friends were critical domains within a CBI associated with reductions in marijuana use at 6-month follow-up.

Keywords

brief intervention; computer; emergency department; marijuana; motivational interviewing; substance use

1. Introduction

Screening, brief intervention, and referral to treatment (SBIRT) approaches for substance use provide opportunities for early detection and can increase motivation to change and/or seek treatment (Babor et al., 2007). Hospital Emergency Departments (ED) are appealing settings for SBIRT because substance use problems are overrepresented among ED patients versus the general population, and because EDs provide access to low income and high-risk populations who may not routinely seek out other medical care (Cherpitel & Ye, 2008). However, translation of SBIRT into practice has lagged due to limited staff time and personnel barriers required to deliver brief interventions (BI) with fidelity (Del Boca, McRee, Vendetti, & Damon, 2017), as well as a lack of significant effects reported for some BIs for reducing drug use (Saitz et al., 2014).

Computer-delivered brief interventions (CBI) can address implementation barriers and have potential for dissemination, replication, and cost-effectiveness (Babor, et al., 2007; Blow et al., 2017), especially given the near ubiquitous access to tablets and smart phones (Pew Research Center, 2017). CBIs often employ Motivational Interviewing (MI) techniques, focusing on why change is needed (e.g., increasing motivation) and how to change (e.g., identifying tools) (Resnicow & McMaster, 2012). Several randomized controlled trials (RCTs) have tested the efficacy of ED-based CBIs for substance use, with the majority focused on alcohol (see Sundström, Blankers, & Khadjesari, 2017). However, marijuana is the most frequently used illicit substance in the United States, and while attitudes and laws around marijuana use are relaxing (Campbell, Twenge, & Carter, 2017), chronic marijuana abuse and dependence predict harmful outcomes, including unemployment and crime (Maier, Mannes, & Koppenhofer, 2017).

Two recent studies found that MI-based CBIs were effective in reducing marijuana use among adolescents in primary care (Walton et al., 2013) and adults seeking ED care (Blow et al. 2017). Consistent with the MI framework and a personalized medicine SBIRT approach, CBIs must be adaptable to meet preferences and needs of specific patient groups (Schinke & Schwinn, 2017). However, no studies have explored the specific components associated with intervention-related change within efficacious ED-based CBIs with the

exception of Walton and colleagues (2017), who found that identifying more strengths and strategies during an ED-based alcohol CBI predicted fewer alcohol consequences at a 3-month follow-up among risky drinking youth. In addition, a prior study examining the same data as the current study reported a cross-sectional association between patients in the CBI group identifying more benefits and tools of change and greater help-seeking intentions and confidence immediately after receiving the CBI (Bonar et al., 2014). However, this prior study was conducted only on the baseline data and data collected immediately after the CBI was implemented. It remains unknown which components within the CBI were related to greater reductions in marijuana use over time.

Despite the promise of digital interventions (Hoch, Preuss, Ferri, & Simon, 2016), no studies have identified specific components of interventions related to changes in marijuana use for effective marijuana-focused CBIs delivered in the ED. Thus, we examine the components of change within an efficacious CBI that predicted reductions in marijuana use at 6 month follow-up to inform future research that customizes intervention components to optimize outcomes. We focus on findings from secondary analyses of a MI-based CBI delivered in an ED, which was related to reduced marijuana use relative to enhanced care as usual (Blow, et al., 2017). The current study extends these prior findings by using a structural equation model (SEM) approach to explore within-session CBI components as predictors of reductions in marijuana use at the 6-month follow-up to understand potential components of intervention efficacy. We hypothesized that reductions in marijuana use among those receiving the CBI would be related to endorsing more items across five domains covered in the CBI that were informed by a MI-framework: goals, strengths, evoking-change (i.e., benefits vs. concerns), challenges, and tools. Subsequent analyses explored specific items endorsed within each domain in relation to marijuana use outcomes.

2. Methods

2.1. Study design

This paper presents data from a secondary data analysis of the HealthiER You RCT, which compared three conditions: CBI ($n=257$), Therapist BI ($n=257$) and Enhanced Usual Care (EUC) ($n=266$) for drug using adults in an urban ED. To evaluate the impact of a booster, participants were randomized after a 3-month follow-up assessment to receive an adapted motivational enhancement therapy (AMET) booster or enhanced usual care booster (EUC-B). Hence, the study employed a fully crossed, 3×2 factorial design [CBI, Therapist BI, or EUC-ED] $\times 2$ follow-up conditions (AMET, EUC-B). Follow-up assessments took place in the community at 3-, 6-, and 12-months post-ED. Follow-up staff delivering the 3-month condition were blinded to ED condition assignment. Procedures were approved by institutional review boards at the University of Michigan and Hurley Medical Center (HMC); a certificate of confidentiality was provided by the National Institutes of Health. Extensive details of the study design, inclusion/exclusion criteria, retention of participants, and primary outcomes are previously reported (Blow, et al., 2017; Bonar, et al., 2014).

2.2. Study setting and population

This RCT took place at HMC, a low-income urban, Level 1 trauma center in Flint, Michigan. Patients aged 18–60 years presenting to the ED were eligible for screening with recruitment between February 2011 and August 2012. Exclusion criteria included inability to consent (e.g., psychosis, medically unstable, police custody), seeking care for suicidal ideation or acute sexual assault, non-English speaking or illiterate, or severe hearing or visual impairment.

2.3. Procedure

Patients were identified using electronic medical records and approached by research assistants (RAs) in ED treatment and waiting areas to obtain consent for a 15-minute computerized screening survey (compensation \$1 gift). Those reporting past 3-month illicit drug use or misuse of psychoactive prescription drugs on the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST score ≥ 4 ; Humeniuk et al., 2008) were eligible and invited to complete a second stage consent, 30-minute surveys on tablets (optional audio), an RA-administered semi-structured interview (compensation: \$20), and urine drug screen (\$5). Participants were then randomly assigned via computerization and to one of three ED conditions: (1) a 30-minute therapist-delivered BI with computer guidance (TBI), (2) a 30-minute CBI, or, (3) EUC. Compensation was \$40 for the 3- and 6 month assessments, and \$50 for the 12-month assessment. As our study goal was to explore the efficacious components of the CBI, we focused only on participants within the CBI condition. The original outcomes study reported no significant effects of CBI on marijuana use at 3-month follow-up; thus, we focused on the 6-month assessment where the CBI was related to significant reductions in marijuana use (Blow, et al., 2017).

2.4. Measures

Demographic items were assessed using items from prior work (Blow, et al., 2017; Bonar, et al., 2014). To assess number of marijuana use days in the past 30 days, we used Timeline Follow-Back (TLFB) semi-structured interviews with daily calendars (Sobell & Sobell, 1992). To confirm any findings using an objective assessment of marijuana use, we also used data from the urine drug screen collected at baseline and 6-month follow-up.

The CBI was delivered via touchscreen tablet computers with audio headphones. The CBI included still images of actors streamed together and interactive questions and exercises. Participants first received a user tutorial and introduction by a virtual doctor comprised of still images and a recorded voice. Participants then selected one of 6 virtual health counselors (with a choice of race (African American, Hispanic or European American) and gender of the counselor) by touching their picture. The counselor's voice was then heard and varying streaming still images (silhouette overlaying an engaging screen of text) appeared throughout the CBI with the counselor introducing choices and activities on the computer. Short video vignettes were developed that streamed together images of actors in a community scene. Vignettes included a recorded voice of the character telling a personal story of drug use (fictional scenario). Actors reflected the minority and gender characteristics relevant for inner city multi-ethnic participants. Interactive exercises during the CBI included: (1) choosing pictures of relevant life areas and selecting goals, concerns,

benefits, change statement, challenges, tools/strategies and strengths; from which selections are saved and strategically displayed during later activities; (2) completing an importance ruler on a scale of 1 to 10; and, (3) viewing summarized content of previous selections in a visually dynamic design. This required active participation on exercise screens, combined with listening to strategic statements and summaries from the virtual health counselor in between exercises. The content included tailored feedback regarding drug use patterns, and completing exercises around identifying goals and values, concerns of drug use, benefits of changing use, personal strengths, and formulating a change plan specific to their identified stage of change (includes identifying challenges of avoiding use and tools/strategies towards change) (Blow, et al., 2017; Bonar, et al., 2014).

Our analyses focus on components of the CBI that were derived directly from the selections that the participant entered into the tablet during the intervention. This data was conceptualized across five domains (goals, strengths, evoking-change, challenges, and tools) rooted in MI theory, including engaging and focusing a client on change targets and evoking motivations for change (Miller & Rollnick, 2012). Within the intervention, patients navigated a series of screens presenting items from each domain (Supplemental Table 1). The goals domain covered three categories: social/family/friends, work/school/finance, and health. Strengths included two categories: personal and social strengths. The evoking-change domain assessed concerns about drug use and perceived benefits of change for three categories: social/family/friends, work/school/finance, and health. The challenges domain had categories for people/places/situations and feelings/thoughts. Finally, the tools to reduce drug use domain included five categories: tools for people/places/situations, feelings/thoughts, turning down using, finding other things to do, and finding supportive people. There was some variation in the number of items participants were required to select depending on the category (e.g., “pick all that apply” vs. “pick up to three”). Thus, to make meaningful comparisons between domains and categories, we created z-scores of the summed domain and category scores.

2.5. Analytic Strategy

To test the general and specific aspects of the intervention that equated to effective intervention components for reducing marijuana use, our analytic strategy proceeded in order of domains, to categories, to specific items (Supplemental Table 1). Retention was high at 6-month follow-up with self-reported marijuana use data available for 212 participants. For all models, we employed structural equation modeling in Mplus version 7.2 with full information maximum likelihood estimation and robust standard errors (Muthén & Muthén, 2014), allowing us to explore the *unique* effects of domains, categories, and items, controlling for baseline marijuana use, time spent completing the CBI, and covariance of predictors in each model, and account for the small amounts of missing data (Enders & Bandalos, 2001). To ensure that effects were not accounted for by other factors, we re-ran models accounting for race, gender, age, and education.¹ For post-hoc models to confirm our main findings using data from the urine drug screen (i.e., testing positive vs. negative for

¹We also re-ran models including assignment to adapted motivational enhancement therapy (AMET) booster or enhanced usual care booster (EUC-B); patterns of significant/non-significant results were unchanged (available on request).

marijuana), we used logistic regression in Mplus with Monte Carlo integration and full information maximum likelihood estimation and robust standard errors to account for missing data (Muthén & Muthén, 2014)

2.5.1. Aim 1: Which CBI domain predicts decreases in marijuana?—We conducted a single SEM to explore the effects of the five different domains of goals, evoking-change, challenges, tools, and strengths on reductions in marijuana use at 6 months.

2.5.2. Aim 2: Which category of items from the CBI predicts decreases in marijuana?—Second, we explored which categories within each domain were related to lower marijuana use at 6-months. We ran separate models for each of the five domains and applied a Bonferroni correction to account for multiple comparisons (corrected p -value of 0.01).

2.5.3. Aim 3: Which specific items from the CBI predict decreases in marijuana?—Finally, as simply examining the *total number* of items endorsed within domains could mask the impact of individual items, we carried out an *exploratory* analysis, to test the influence of individual items within each of the 18 categories from across the 5 domains (Supplemental Table 1).

3. Results

3.1. Demographic data and descriptives

Descriptive statistics for summed domains, category variables, and marijuana use variables are presented in Table 1. Endorsement rates of specific items within categories across the five domains are presented in Supplemental Table 1. Finally, participants' baseline demographic and substance use characteristics are presented in Supplemental Table 2 (also see Blow, et al., 2017).

3.2. Aim 1: Which CBI domain predicts decreases in marijuana?

Our first SEM explored the relationship between domain scores and marijuana use at 6-month follow-up, accounting for baseline marijuana use, time spent completing the CBI, and the covariance between predictors (Table 2). We found that higher evoking-change domain scores (i.e. higher scores represented more concerns about use and more perceived benefits of change) on reductions in marijuana use from baseline to 6 months ($B=-2.91$, $SE=1.10$, $\beta=-.24$, $p=.01$), but no significant effects of any other domain. Results were unchanged when we accounted for the following covariates in the model: age, gender, race, and education (Supplemental Table 3).

3.3. Aim 2: Which category of items from the CBI predicts decreases in marijuana?

Next, we explored five models to test the influence of categories within each domain. Within the evoking-change model, we found an effect of the number of family concerns on lower marijuana use at 6-months, controlling for time spent on the CBI and baseline marijuana use, which survived a Bonferroni correction ($B=-2.51$, $SE=0.94$, $p=.01$; Supplemental Table

4, Figure 1). No other category scores from the domains of goals, strengths, challenges, and tools were related to reductions in marijuana use (Supplemental Table 4).

3.4. Aim 3: Which items from the CBI predict decreases in marijuana?

We ran 18 exploratory models to test items from the five domains, accounting for baseline marijuana use and time spent on the CBI. Results from all 18 models are presented in Supplemental Table 5. The following items were significantly related to lower marijuana use at 6-months: (1) Within *work goals*, “Stay out of legal trouble” was related to 3 fewer days of marijuana use at 6-month follow-up ($B=-3.15$, $SE=1.55$, $\beta=-.12$, $p=.04$). (2) Within *tools*, endorsing the item, “volunteering to help others”, was related to more than 3.5 fewer days of marijuana use ($B=-3.74$, $SE=1.65$, $\beta=-.12$, $p=.04$). (3) Within *strengths*, the items “I’m determined and hard-working” ($B=-5.22$, $SE=1.85$, $\beta=-.20$, $p=.004$) and “I like overcoming new challenges” ($B=-6.67$, $SE=2.70$, $\beta=-.11$, $p=.02$) were related to 5.5–6.5 fewer days of marijuana use. (4) Within *family concerns*, endorsing the item, “family, friends or children don’t want to spend time with me” was related to 5.5 fewer days of marijuana use ($B=-5.49$, $SE=1.63$, $\beta=-.21$, $p=.001^2$). (5) Within *health concerns*, the item, “I feel depressed, stressed, angry, or guilty” was related to a 4-day reduction in marijuana use days ($B=-3.99$, $SE=1.55$, $\beta=-.16$, $p=.009$). (6) Within *health benefits*, endorsing “I will be able to do more physical activities” was related to a 3.5 day reduction in marijuana use days ($B=-3.63$, $SE=1.74$, $\beta=-.15$, $p=.04$). (7) Finally, within *family benefits*, the item “Get along better with family or friends” was related to a 3.5 day reduction in marijuana use days ($B=-3.30$, $SE=1.63$, $\beta=-.13$, $p=.04$).

Post-hoc confirmation of findings using urine drug screen test results—To confirm our main findings for evoking-change and family concerns using a more objective assessment of marijuana use, we re-ran models using data from a urine drug screen assessed at baseline and 6 months. Higher evoking-change domain scores were related to significantly lower odds of testing positive for marijuana at 6 months, accounting for baseline test results ($OR=.43$, 95% $CI = .22, .84$, $p<.001$). Within the evoking change domain, results were confirmed with the number of family concerns endorsed also related to significantly lower odds of testing positive for marijuana at 6 months, accounting for the baseline screen ($OR=.53$, 95% $CI = .31, .85$, $p<.001$).

4. Discussion

4.1. Overview of findings

Given the promise of technology for enhancing the reach of efficacious substance use interventions (Hoch, et al., 2016), we address a gap in the literature by reporting a novel exploration of the components of an intervention related to change within an efficacious CBI that reduced marijuana use among adults in the ED. In contrast to our hypothesis, only the “evoking-change” domain was related to reductions in marijuana use at 6-month follow-up. The importance of evoking-change is central to MI and prompts patients to explore, through

²The impact of endorsing this item on reductions in marijuana use survived a Bonferroni correction accounting for all 18 exploratory models tested (i.e., Bonferroni-corrected p value of .002)

decisional balance, the contradictory and uniquely personal elements of the conflict they feel around drug use behavior (Miller & Rollnick, 2012). Consistent with recent work cautioning against using a 2×2 decisional balance exercise, particularly with those who are ambivalent about change (Miller & Rose, 2015), our CBI included only two components of the decisional balance framework: (1) evoking *benefits* of change or reasons for move towards change (i.e. reducing or stopping drug use) and (2) evoking *concerns* reasons to move from the “status quo” (continued drug use). Our findings suggest that a virtual CBI therapist elicited concerns and benefits effectively to prompt reductions in marijuana use. Thus, greater emphasis on *evoking-change* components within CBIs for marijuana use may bring about favorable clinical outcomes.

4.2. Personalizing brief computer-based treatments

It was notable that the category of concerns expressed about family was an important ingredient of a CBI for reducing marijuana use, based on assessments via both self-reports of marijuana use and a urine drug screen. These findings are consistent with existing literature that has established the role of family and friends in intervening with and promoting desistance from substance misuse (Velleman, Templeton, & Copello, 2005). Our results suggest that an emphasis on modules within CBIs that focus on family and friends could further help to promote behavior change. Other specific items that promoted significant reductions in marijuana use were focused on reducing legal problems, identifying personal strengths (consistent with Walton et al., 2017), volunteering to help others, wanting to reduce feelings of depression and anxiety, and increasing physical activity. Of course, while our analyses of individual items must be considered exploratory, the results provide potential clues for personalizing future CBIs and partly explain some of the non-significant effects we found for the broader domain analyses (i.e., a focus on individual items provides a more optimized approach for understanding potential components of change). Thus, adaptation of CBIs could include the flexibility for expanded coverage of the topics identified by our results, consistent with the more natural flow of conversation that might occur in a face-to-face therapy sessions within the framework of the MI-based BI (Bonar, et al., 2014).

4.3. Limitations

Strengths of this investigation included sophisticated quantitative modeling to explore components of intervention effectiveness while accounting for autoregressive effects. However, our findings should be situated within the context of several limitations. First, replication is required of this single-site study. Second, results are limited to the sociodemographic characteristics of adults in our study, which largely mirror the Flint community, and may not be generalizable to other groups. At the same time, the diversity of the current sample is also a strength relative to prior studies of alcohol CBIs that have largely been tested among White college students (Sundström, et al., 2017). Third, although the focus on specific items within our CBI is novel and has the potential to be highly informative, these results should be considered exploratory, given the number of models conducted and potential for type I error (although a Bonferroni correction was used). Future multi-arm RCTs of different CBIs for reducing drug use are needed to explore the efficacy of different domains or items. Finally, although the focus of the current paper was on

marijuana use, future studies are needed to explore the effectiveness of CBIs for addressing polydrug use.

4.4. Conclusions

We provide insight into potentially salient elements of CBIs that influence meaningful reductions in marijuana use days of up to 6.5 fewer days per month. Optimizing efficacious marijuana interventions is especially important in light of changing marijuana policies that are increasing legal access to this already commonly-used substance. As scalable interventions that can reduce the public health burden of harmful marijuana use are urgently needed, future research should address what updates are needed to bring CBI content in line with changes in the laws, as well as how to personalize delivery based on key intervention components associated with behavioral outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Endorsing more concerns about family was related to a significant reduction in marijuana use from baseline to 6-month follow-up

Note. Scatterplot presents the partial regression plot of the association between endorsing more concerns about family and reductions in marijuana use at 6-month follow-up controlling for other categories within evoking change domain, marijuana use at baseline, and time spent on the CBI.

Table 1.

Descriptive statistics for category scores within the computer-delivered intervention and marijuana use variables at baseline and 6 month follow-up.

	<i>N</i>	<i>Min</i>	<i>Max</i>	<i>M</i>	<i>SD</i>
Domains					
Goals	229	1	12	5.86	2.97
Evoking-Change	181	6	24	12.19	5.77
Challenges	249	2	7	5.33	1.34
Tools	154	5	30	12.30	7.91
Strengths	246	2	9	6.99	2.28
Categories					
Work goals	242	0	4	1.99	1.18
Family goals	244	0	4	1.71	1.19
Health goals	238	1	4	2.06	1.16
Work concerns	227	1	4	2.05	1.19
Family concerns	208	1	4	1.67	1.05
Health concerns	227	1	4	1.97	1.21
Work benefits	240	1	4	2.23	1.32
Family benefits	229	1	4	1.83	1.11
Health benefits	239	1	4	2.24	1.27
People/places/situation challenges	250	1	4	2.64	0.81
Feelings/thoughts challenges	249	1	3	2.69	0.68
People/places/situations tools	239	1	4	2.31	1.27
Turning down use tools	165	1	4	1.70	1.07
Feelings/thoughts tools	241	1	8	3.11	2.38
Finding other things to do tools	240	1	9	3.29	2.58
Finding supportive people tools	229	1	5	2.12	1.36
Social strengths	247	1	4	3.19	1.18
Personal strengths	248	0	5	3.79	1.29
Self-reports of past 30-day marijuana use					
Baseline	250	0	30	13.38	11.64
6-month follow-up	212	0	30	12.44	12.04
Urine drug screen for marijuana		<i>N</i>		<i>N</i>	
Baseline	negative	52	negative	49	
	positive	170	positive	130	

Note. Each domain included instructions requiring participants to select a varying number of items depending on the category (e.g., “pick all that apply” versus “pick up to three”). To ensure comparability and establish unique effects of different domains or categories, we thus created z-scores of summed items within each domain and category. Z-scores were used in all subsequent analyses.

Table 2.

Higher endorsement of items with the evoking change domain was related to reductions in marijuana use from baseline to 6-month follow-up.

<i>Outcome – marijuana use at 6-month follow-up</i>				
<i>Predictors</i>	B	SE	β	<i>p</i>
Marijuana use at baseline	0.52	0.06	0.50	< 0.001
Time spent completing CBI	0.09	0.07	0.08	0.22
Goals	0.59	0.86	0.05	0.40
Evoking change	−2.91	1.10	−0.24	0.007
Challenges	0.40	0.78	0.03	0.60
Tools	1.14	0.94	0.09	0.22
Strengths	−0.61	0.90	−0.05	0.50