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Alcohol use severity and age moderate the effects of brief interventions in an emergency department randomized controlled trial

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ABSTRACT

Background: The primary aim of this study was to examine the efficacy of two motivational interviewing-based alcohol brief interventions (BIs) among adults presenting to an emergency department (ED). The secondary aim was to evaluate moderators of intervention effects.

Methods: Participants were 750 ED patients reporting recent alcohol misuse. Participants were randomly assigned to: 1) computer-delivered BI (Computer BI), 2) therapist-delivered BI with computer guidance (Therapist BI-CG), or 3) control. The BIs focused on reduction of alcohol use and risk behaviors. The outcome measure was trajectories of alcohol consumption (measured by the AUDIT-C) across baseline, 3-, 6- and 12-month follow-up assessments, analyzed using latent growth curve modeling. Moderation of intervention effect by gender, age, and baseline alcohol use disorder severity was examined.

Results: Across the full sample (40% males, mean age = 35.8, SD = 12.3), there was an overall reduction in alcohol consumption across 12 months. The main effects of the Therapist and Computer BI were not significant relative to control. Moderation analysis revealed that the impact of Therapist BI-CG, relative to control, was greater on reductions in alcohol consumption in participants with moderate to severe symptoms of alcohol use disorder compared to those with mild symptoms. The effect of the Computer BI on alcohol use, relative to control, was greater among younger participants compared to older participants.

Conclusions: While no overall effect was shown, ED-based Therapist BI-CG with computer guidance may be effective among patients with moderate-severe drinking patterns, whereas Computer BIs may be more effective for younger participants.

1. Introduction

Alcohol is the most commonly used and abused substance in the United States and accounts for 1 in 10 deaths among adults between 20 and 64 years old (Center for Behavioral Health Statistics and Quality, 2016). Individuals with alcohol use problems are more likely to seek emergency department (ED) care than are non-users (Cherpitel and Ye, 2008; Fuda and Immekus, 2006; Vitale and van de Mheen et al., 2006), and as many as one in seven ED patients report heavy drinking (Roche et al., 2006). Between 2006 and 2014, the number of ED visits related to alcohol use increased 61.6% in the United States to approximately 5 million alcohol-related visits in 2014 at a cost of $15.3 billion (White et al., 2018).

The ED is an important portal for entry into the medical care system for those with Alcohol Use Disorders (AUD), and thus delivery of efficacious interventions for alcohol use problems that minimize demands

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on ED staff time and resources are of considerable interest to clinicians and researchers. Brief interventions (BIs) are a time-limited approach for providing advice, counseling, motivational enhancement, and/or behavioral skills to reduce substance use and its consequences (Babor et al., 2008). A sizable body of literature has accumulated evaluating the efficacy and effectiveness of alcohol BIs in EDs (Havard et al., 2008; Kohler and Hofmann, 2015; Landy et al., 2016; Platt et al., 2016; Schmidt et al., 2016; Woolard et al., 2011). There is general agreement that BIs in the ED result in statistically small, but clinically meaningful, effects on alcohol consumption and/or alcohol-related harm when compared to minimal-contact control conditions. When compared to other active treatment conditions, no particular advantages of BI content, modality, booster sessions, and other tailoring are evident (Moyer et al., 2002; Platt et al., 2016; Schmidt et al., 2016; Simioni et al., 2015). This suggests that low-intensity and even computer-delivered BIs are viable alternatives to in-person approaches in the ED (Schmidt et al., 2016).

Despite the inherently 'brief' nature of BIs, many real-world ED settings lack the infrastructure to adequately deliver, monitor, or sustain the implementation of BIs over time, particularly those delivered in-person which require ongoing training, supervision, and fidelity monitoring (Lang et al., 2007). Thus, computer-delivered BIs are of great interest because they require minimal personnel time. In addition, computer-guided, therapist-delivered interventions are appealing because they increase standardization and fidelity. Across settings, computer-delivered alcohol interventions can result in reductions in alcohol use relative to control conditions, and effect sizes are largely commensurate with in-person interventions when direct comparisons could be made (Carey et al., 2009; Donoghue et al., 2014; Rooke et al., 2010; Sundström et al., 2017). These computer-delivered interventions can be used as a stand-alone approach or as a clinician support tool to guide a therapist delivering an intervention (Blow et al., 2006; Duroy et al., 2016; Kypri et al., 2008; Maio et al., 2005; Neumann et al., 2006; Walton et al., 2010). The efficacy of computer-based and computer-guided BIs in adult ED populations is not firmly established (Schmidt et al., 2016), as the majority of computer-delivered alcohol intervention trials were conducted among young college student samples (Carey et al., 2012). Given the large number of efficacy trials of purely therapist-delivered BIs in the ED, a critical next step is to evaluate alternative BI modalities and moderators of treatment effects to determine which modalities (i.e., computer-delivered or therapist-delivered with computer guidance) work best and for whom.

1.1. Moderators of brief interventions

Examining the role of alcohol use severity as a moderator for BIs of different modalities is needed. Clinical guidelines suggest BIs are most appropriate for those with low/moderate alcohol use problems (Babor et al., 2008; Heather, 1995). As a result, individuals with very heavy alcohol use or dependence are frequently excluded from BI studies (Saitz, 2010). Therefore, it is notable that many BI trials in hospital settings demonstrate that those with higher alcohol use severity, and even alcohol dependence, respond better to in-person BIs than those with lower alcohol use severity (Academic ED SBIRT Research Collaborative, 2010; Barnett et al., 2010; Blow et al., 2009; Field and Caetano, 2010; Spirito et al., 2004). One study suggests that alcohol use severity and intervention modality interact such that individuals with mild AUD symptom severity respond better to low intensity interventions without therapist contact, while patients with more severe symptoms respond better to more intensive therapist-guided interventions (Baumann et al., 2018). Thus, additional research is needed.

Gender is frequently evaluated as a moderator of intervention response in BI research because AUD prevalence and severity is known to vary between men and women (Grant et al., 2015). Differences in treatment response may be expected based on higher perceived stigma related to alcohol use among women coupled with lower likelihood of treatment seeking among men in the general population (Green, 2006; Tuchman, 2010). However, gender differences in BI response are often null, inconsistent, or conflicting. Two past trials indicate women may respond better to in-person BI relative to minimal-contact or computer BIs (Blow et al., 2006; Carey et al., 2011), while others did not find any gender differences (Barnett et al., 2010; Becker et al., 2016), and still others found men benefit most from BIs (Choo et al., 2013; Woodruff et al., 2013).

Unlike gender, age is often overlooked in BI moderation analyses. Age may be related to treatment response for a number of reasons. Young adults are less likely to seek treatment for alcohol problems and often view heavy drinking as 'normal' (Grella et al., 2009). We are aware of only one BI study in the ED that evaluated age as a moderator among adults. This study found that younger women who received a BI that included a booklet and in-person brief advice reduced their heavy episodic drinking relative to older women and men (Blow et al., 2006). Furthermore, age may moderate the effect of technology-based BIs due to differences in computer literacy and comfort across the lifespan (Jensen et al., 2010; Tennant et al., 2015).

1.2. Aims of the current study

The primary aim of this randomized controlled trial (RCT) is to test a standardized alcohol BI evaluating the efficacy of two delivery modalities, therapist-delivered with computer guidance (Therapist BI-CG) and computer-delivered (Computer BI), compared to a control condition of enhanced usual care (EUC) among adults with heavy or problematic alcohol use presenting to an ED. The two modalities represent different options for future intervention delivery. The secondary aim of this RCT is to examine the influence of potential moderators (alcohol use severity, gender, and age) on alcohol use quantity and frequency. This study addresses several key questions raised in the previously published literature.

2. Material and methods

2.1. Setting and participants

The *Health ExplorER* RCT took place at Michigan Medicine (University Hospital) in Ann Arbor, Michigan, a Level 1 trauma center. Study procedures were approved by the University of Michigan's Institutional Review Board. Patients aged 21–65 presenting to the ED were eligible for screening and were recruited between February 2012 and May 2014. Patients were excluded if they presented to the ED with acute psychiatric problems (e.g., active psychosis), were not medically stable (e.g., unstable vital signs), were in police custody, could not provide consent (due to limitations in language, literacy, or cognitive ability), had previously refused participation, were screened for this study within 3 months prior, or were currently receiving alcohol treatment. Patients who were acutely intoxicated were recruited after they passed the Mini-Mental Status Exam. Those who refused participation provided information on gender and race (at baseline only) as well as reasons for refusal.

2.2. Procedure

The *Health ExplorER* RCT compared three conditions, the Computer BI, Therapist-Therapist BI–CG, and EUC control group, delivered to adults with heavy alcohol use and/or problems in the ED. Follow-up assessments took place at 3, 6, and 12 months post-ED visit. All study-eligible adult patients presenting to the ED were recruited to complete a computerized health screen. Research staff approached patients and described the study. Interested patients provided written informed consent and completed a self-administered 15-minute computerized health screen. Upon screen completion, participants were compensated with a gift valued at $1.00. Those participants who reported past 3-

month use of alcohol and had a past 3-month Alcohol Use Disorder Identification Test's consumption questions (AUDIT-C) score of > 3 for women or > 4 for men met eligibility criteria for the RCT (Bradley et al., 2003; Bush et al., 1998). Eligible patients interested in participating provided written informed consent. Breathalyzers were administered (compensated with $5 cash), and patients with Blood Alcohol Content over 0.10 were asked to repeat the breathalyzer test until their BAC was 0.10 or lower before the baseline interview commenced.

Enrolled participants first self-administered a 30-minute computerized baseline assessment (compensated with $20 cash card). After baseline completion, participants were assigned to 1 of 3 groups through computer randomization stratified by gender and alcohol use severity (AUDIT > 19) and informed of their study condition by the research assistant (N = 750). Upon completion of the assigned condition, participants self-administered a 3-minute post-intervention questionnaire.

2.3. Interventions

The interventions were based on the principles of Motivational Interviewing (MI; Miller and Rollnick, 2002) and addressed problematic alcohol use. The Computer BI and Therapist BI-CG presented parallel content. Both interventions included the following content: (a) introduction and overview, (b) identifying personal strengths and goals that don't involve alcohol or drug use, (c) tailored feedback on alcohol and drug use using data from participant's screening questionnaire, (d) comparison of participant's alcohol use to national gender-matched average, (e) benefits of change and concerns about alcohol use, (f) readiness to change assessment, (g) strategies and barriers related to changing and avoiding alcohol-related consequences, and (h) summary. Following the BIs, participants received a 4-page summary "change plan" booklet reviewing the intervention elements as well as a folder containing resource pamphlets (e.g., employment, housing, etc.).

The Computer BI was delivered via touchscreen tablet computers with audio headphones. The Computer BI format included a combination of images and interactive questions and exercises guided by a virtual health counselor. The participant had a choice of one of six virtual health counselors which were avatars of different genders, races, and ethnicities. The chosen virtual health counselor was presented as a still image that introduced topics through audio recordings and delivered tailored reflections based on participant's answers to questions. The Computer BI also included vignettes used to address benefits of change, challenges, and strategies using images of actors coupled with audio.

The Therapist BI-CG was delivered by one of eight Master's-level therapists trained in MI. The therapists used a touchscreen tablet computer to assist in guiding the session, display content from the assessments, aid adherence to the intervention protocol, and to collaboratively view the participant's pertinent goals, benefits of change, etc. All sessions were audiotaped, and a random sample (17%) of the therapist interviews were monitored for competency using the *Clinical Skill/Competence Scale* included in the Motivational Interviewing Treatment Integrity (MITI 3.0; Moyers et al., 2007). Ratings were consistent with an appropriate level of proficiency for Therapist BI-CG. Across clinicians, average MI adherence (weighted mean) was 97%, which falls within the proficiency threshold of 90% and the competency threshold of 100% (Moyers et al., 2007). The mean was weighted to account for the number of BI sessions delivered by the therapist. Feedback on MI proficiency and supervision was provided every other week by a master's or doctorate-level MI experts who are both members of the MI Network of Trainers.

The EUC condition received a 3 to 5-minute minimal information session during which a staff member reviewed a pamphlet that included information on community support groups, location of substance use treatment centers, mental health services, and suicide prevention hotlines. This pamphlet was also provided in the intervention condition.

2.4. Follow-up assessments

Participants were contacted for follow-up assessment at 3, 6 and 12 months after their initial ED visit. Follow-up assessments lasted about a half hour and were offered online, in-person at a research site, in-person at a community location, at a person's home, or over the telephone. More than two-thirds of the participants completed their follow-up assessment online. Participants completed a computerized survey at all follow-up assessments. Participants that completed 3- and 6-month assessments received $5 for confirming their plans to attend the appointment and $30 for completion of each survey. Participants that completed the 12-month assessment received $5 for confirming the appointment and $40 for completion of survey.

2.5. Measures

2.5.1. Self-reported demographic information

Demographic variables were self-reported and adapted from prior research and included questions about sex, race, age, income, and education (Blow et al., 2006).

2.5.2. Drug use

The National Institute on Drug Abuse Alcohol, Smoking, and Substance Involvement Screening Test (World Health Organization, 2002) assessed use of illicit drugs (i.e., marijuana, cocaine, inhalants, hallucinogens, methamphetamine, street opioids) and nonmedical use of prescription drugs (i.e., opioids, sedatives, stimulants) over the past 3 months.

2.5.3. Alcohol use

Participants completed the 10-item AUDIT (Saunders et al., 1993) modified to assess alcohol use in the past 3-months with items scored on a 5-point scale from 0-4. The primary outcome variable included in analyses was an alcohol consumption variable that represented quantity*frequency as measured by the first two items of the AUDIT. A score of 8 or more on the full AUDIT was used in moderation analysis to stratify lower-risk from higher-risk alcohol use problems (Babor et al., 2016; Conigrave et al., 1995).

2.5.4. Moderation

We focused our moderation analyses on three relevant demographic factors linked to persistence in risky alcohol consumption: (1) sex (female = 0, male = 1); (2) age (younger, 21–35 years old = 0, older, 36–65 years = 1, based on the mean age of the sample); and (3) severity of alcohol use problem severity (low, AUDIT score 4–7 = 0, high, AUDIT score 8 or more = 1).

2.6. Statistical analysis

All data were analyzed using SPSS version 24 and Mplus version. 7.2 (Muthen and Muthen, 1998–2012). An "intent-to-treat" approach was used to include all available data for all participants who were randomized regardless of whether or not they completed the intervention. Descriptive statistics were calculated for demographic and alcohol use variables for the total sample (N = 750) and for each study condition. Chi-square and Fisher's exact tests were used to evaluate differences across intervention groups and differences between patients who refused participation and those who participated. Means and standard deviations of the primary outcome, quantity-frequency of alcohol use (i.e., alcohol consumption), were calculated for baseline and follow-up periods of 3 months, 6 months, and 12 months.

To explore the rate of change in alcohol consumption, latent growth curve modeling (LGCM) in Mplus was used. LGCM represents a powerful way to account for individual differences in starting levels and change over time among individuals by modeling their specific trajectory in alcohol consumption over time (i.e., rather than comparing

"rank" or mean score at any one given time point). Alcohol consumption scores at baseline, 3-, 6- and 12-month follow-ups were used as indicators for latent intercept (i.e., starting levels) and slope (i.e., linear change) factors. First, intercept and slope were examined across the full sample. Second, intervention conditions (i.e., Computer BI or Therapist BI–CG, relative to the EUC group) were explored as predictors of linear change in alcohol consumption across time (i.e., predicting the slope factor). Third, interaction terms between intervention group (Computer BI or Therapist BI–CG, with EUC as reference) and sex, age, and severity of alcohol use (total AUDIT scores: higher severity ≥ 8) were explored as predictors of linear change in alcohol consumption across time. We explored moderators in two ways: moderators were each considered separately (i.e., separate models for sex, age, and severity of alcohol use) as well as in a single model exploring unique effects of all moderators while adjusting for their overlap. Note that the study design was powered to detect differences between the EUC group and each intervention group (Computer BI or Therapist BI–CG) but not between the two BIs. Power calculations were conducted for 80% power to detect an effect size of 0.25 (one quarter of a standard deviation) for continuous outcomes.

3. Results

3.1. Study enrollment

Fig. 1 shows the consort flow diagram for the study. In total, 1021 patients aged 21–65 presenting to the ED were eligible for screening. Patients who refused to participate in the study were significantly older, t (972) = 4.24, p < .001, and more likely to be of White race, Chi-square (1) = 21.91 p < .001), compared to those who participated in the study.

3.2. Characteristics of participants

The final study sample included 750 participants. These participants were randomized to three intervention groups: 252 to Computer BI, 248 to Therapist BI–CG, and 250 to EUC.

Sample characteristics at baseline among participants in the study are shown in Table 1. Study participants were as follows: age M = 34.77, SD = 12.31; 60% were female; 78% were White; 42% were married/living together; 22% were high school graduate/GED or less; 64% were employed; 30% had income < $20,000. In terms of alcohol and drug use characteristics, 47% of study participants had a score of 8 or more on the AUDIT, 41% used any illicit drugs or misused prescription drugs in prior 3 months, and of these 36% used marijuana. Chi square differences tests indicated that there were significant associations between subgroups used in our moderation analyses: men were more likely to be in the high alcohol problem use group (χ^2 = 51.14, df = 1, φ_c = 0.26, p < .001), and there were higher numbers of females in the younger age group (χ^2 = 3.24, df = 1, φ_c = 0.07, p < .05).

3.3. Primary outcomes

3.3.1. Descriptive statistics

Table 2 presents the means and standard deviations (SD) for alcohol consumption (i.e., quantity*frequency) at baseline and at 3-, 6-, and 12-month follow-ups across the whole sample and by group. Across the whole sample and the total follow-up period, alcohol consumption decreased significantly from baseline to 12-month follow-up for all conditions, including among participants in the control condition (all p < .001; Table 2).

3.3.2. Latent growth curve modeling

Fig. 2 displays the results from the latent growth curve model. There was a significant linear decrease in alcohol consumption across the whole sample as well as within each intervention group consistent with the descriptive statistics (see Fig. 2). A linear model was chosen as the best-fitting model, as there was no significant variance in the quadratic factor. We next explored the effects of each treatment condition on the linear rate of change in alcohol consumption using regression within a structural equation model. There were no significant effects of the Therapist or Computer BI conditions (relative to the control condition) on the slope factor for alcohol consumption (i.e., treatment condition was not significantly related to linear decreases in alcohol consumption) (see Table 3).

3.3.3. Moderation analyses

Following main effects analyses, we explored potential moderation of treatment effectiveness by baseline alcohol severity, age, and sex. In a regression model, we entered the main and interaction effects of each treatment condition and each moderator. We present findings from models that explored each moderator (i.e., alcohol severity, age, and sex) in separate models. However, results were similar when these were included in the same multivariate model (i.e., adjusting for the effects of all moderators simultaneously) (see Table 3). We found a significant interaction between baseline severity of alcohol use and the effectiveness of intervention condition for the Therapist BI–CG (B = -0.35, p = .04) but not of the Computer BI (B = 0.05, p = .77) (Table 3). To probe this significant interaction, we explored separate slopes for alcohol consumption for participants in the Therapist BI–CG condition who reported higher alcohol use severity symptoms versus participants with lower severity of symptoms at baseline (i.e., subgroup comparison) (Fig. 3). We found that even considering their higher baseline starting levels of alcohol consumption, the rate of change of alcohol consumption in the high-risk group was almost double that of rate of change in the low-risk group (Fig. 3).

We found a significant interaction between age group and treatment condition in relation to alcohol consumption linear change for the Computer BI (B = 0.41, p = .01) condition but not the Therapist BI–CG condition (B = 0.28, p = .10). We probed this significant interaction by exploring separate slopes for alcohol consumption among older versus younger participants in the Computer BI condition. We found a significant linear reduction in rate of alcohol consumption in the young group aged 21–35 years old but not in the older group aged 36–65 years old within participants in the Computer BI condition (see Fig. 4). Finally, moderation of treatment effectiveness by sex for the Computer BI (β = 0.08, p = .56) and Therapist BI–CG (β = -0.10, p = .44) conditions was not significant.

4. Discussion

In this trial of Therapist BI-CG and Computer BI compared to an EUC control condition, the results indicated participants in all conditions significantly decreased their alcohol consumption over time from baseline to 12-month follow-up. There was no significant overall effect of either treatment condition on linear reductions in alcohol consumption across follow-up. However, moderation analyses were significant. We found a significant interaction between baseline severity of alcohol use and the effectiveness of intervention condition for the Therapist BI-CG but not of the Computer BI. Participants in the Therapist BI-CG condition with higher severity of alcohol problems at baseline had an almost two-fold steeper decline in alcohol use over time relative to participants with higher severity of baseline alcohol problems in the EUC condition. We also found a significant interaction between age and the efficacy of the Computer BI but not the Therapist BI-CG. Younger participants (21–35 years-old) in the Computer BI condition had a steeper decline in alcohol use over time relative to younger participants in the EUC condition, while older participants (36–65 years-old) in the EUC condition had a steeper decline in alcohol use over time relative to the Computer BI.

The finding that severity of alcohol use moderated the effect of a

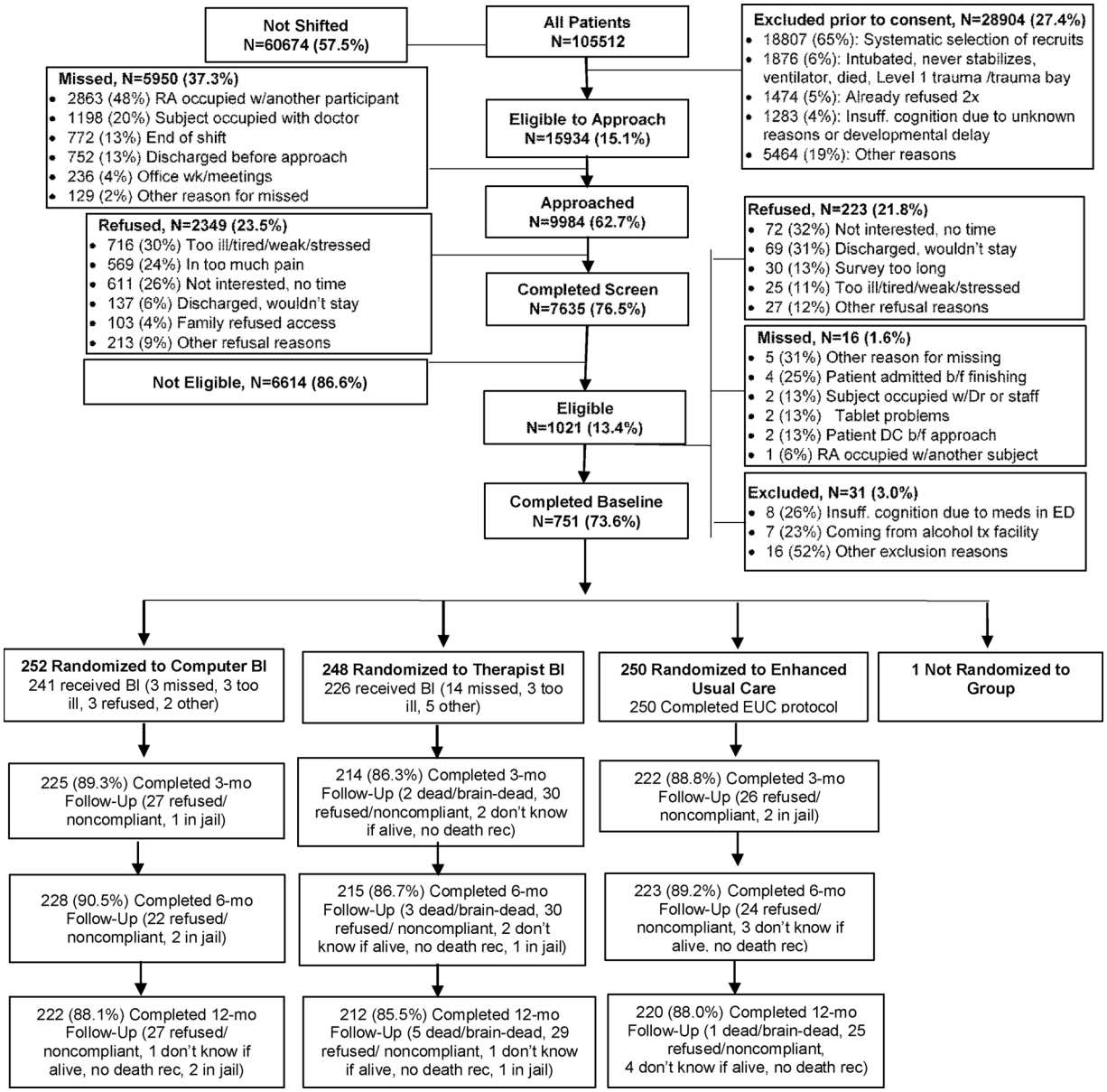

Fig. 1. Consort Flow Diagram (Feb 1 2012 – Sept 5 2014).

therapist-delivered alcohol BI compliments and extends a small number of studies that have reported similar outcomes. A number of studies have found that participants from ED and hospital settings with higher alcohol problem severity, and even alcohol dependence, respond more favorably to therapist-delivered BIs relative to participants with milder symptoms (Barnett et al., 2010; Baumann et al., 2018; Blow et al., 2009; Field and Caetano, 2010; Spirito et al., 2004). The current study provides evidence that BIs can, in some instances, reduce alcohol use among individuals who report heavy alcohol use despite lack of evidence in this domain from primary care settings (Saitz, 2010). With that said, future research is needed that considers a broader spectrum of AUD severity that includes a larger proportion of participants with clear evidence of alcohol dependence.

Computerized BIs offer several advantages in the ED setting: they can be administered quickly and easily, are highly standardized, and are cost effective relative to in-person interventions. To our knowledge, this is the first study to document age as a moderator of a Computer BI for alcohol. Our findings provide evidence that the use of computerized BIs may be effective among younger, but not older, participants. We found that the Computer BI was related to larger reductions in alcohol use relative to control condition among participants aged 21–35 years old. Importantly, however, older participants (36–65 years-old) in the EUC condition had a steeper decline in alcohol use over time relative to the Computer BI. The difference in response in the two age groups may reflect the fact that younger participants may have greater comfort and experience with computers and other health technology and therefore were more amenable and receptive to a therapeutic intervention delivered via computer. The efficacy of computer BIs for alcohol use among youth ages 14–20 lends support to this hypothesis (Cunningham et al., 2015). The greater relative reduction in alcohol use among older adults in the EUC condition relative to older adults in the computer BI condition underscores the importance of considering age when administering computer-based interventions. Gender did not significantly moderate the effects of the Computer or Therapist BI–CG. This differs from two past trials indicating that women may respond better to in-person BI relative to minimal-contact or computer BIs (Blow et al., 2006; Carey et al., 2011).

These findings should be interpreted in light of study limitations. While analyses evaluated alcohol use severity, some patients with severe alcohol problems were likely excluded from the study due to acute

Table 1
Baseline demographic and substance use characteristics.

Characteristics	Participants, No. (%)			
	Computer BI (n = 252)	Therapist BI-CG (n = 248)	EUC (n = 250)	Total (N = 750)
Age, Mean (SD)	35.2(12.4)	34.6(12.9)	34.5(11.6)	34.8(12.3)
Young Adults; 21-35 years-old	150(59.5)	160(64.5)	144(57.6)	454(60.5)
Sex				
Female	152(60.3)	150(60.5)	151(60.4)	453(60.4)
Male	100(39.7)	98(39.5)	99(39.6)	297(39.6)
Race				
White	188(74.6)	194(78.2)	199(79.6)	581(77.5)
Black	40(15.9)	37(14.9)	35(14.0)	112(14.9)
Other	24(9.5)	17(6.9)	16(6.4)	57(7.6)
Ethnicity				
Non-Hispanic	238(94.4)	233(94.0)	234(93.6)	705(94.0)
Hispanic	14(5.6)	15(6.0)	16(6.4)	45(6.0)
Marital status				
Married/Living together	114(45.2)	95(38.3)	107(42.8)	316(42.1)
Widowed/ Separated/ Divorced	35(13.9)	44(17.7)	31(12.4)	110(14.7)
Never married	103(40.9)	109(44.0)	112(44.8)	324(43.2)
Highest grade completed				
HS grad/GED or less	56(22.2)	49(19.8)	62(24.8)	167(22.3)
Any college	196(77.8)	199(80.2)	188(75.2)	583(77.7)
Employment status				
Unemployed	88(34.9)	95(38.3)	90(36.0)	273(36.4)
Employed	164(65.1)	153(61.7)	160(64.0)	477(63.6)
Household income[1]				
Less than $10,000	46(18.3)	35(14.1)	39(15.6)	120(16.0)
$10,000-$19,999	35(13.9)	35(14.1)	33(13.2)	103(13.7)
$20,000-$39,999	41(16.3)	47(19.0)	39(15.6)	127(16.9)
$40,000 or more	94(37.3)	100(40.3)	104(41.6)	298(39.7)
Alcohol and Drug Use[2]				
AUDIT score ≥ 8	98(38.9)	131(52.8)	125(50.0)	354(47.2)
Using Any Drugs	96(38.1)	116(46.8)	93(37.2)	305(40.7)
Marijuana	86(34.1)	102(41.1)	84(33.6)	272(36.3)
Other illicit drugs	25(9.9)	26(10.5)	19(7.6)	70(9.3)
Cocaine	11(4.4)	13(5.2)	8(3.2)	32(4.3)
Street Opioids	6(2.4)	4(1.6)	4(1.6)	14(1.9)
Hal/Inhal/Meth	16(6.3)	16(6.5)	11(4.4)	43(5.7)
Misusing Rx drugs	27(10.7)	20(8.1)	22(8.8)	69(9.2)

AUDIT = Alcohol Use Disorders Identification Test; SD = Standard Deviation; EUC = Enhanced Usual Care. Hal = Hallucinagens, Inhal = Inhalants, and Meth = Methamphtamine. Rx = Prescription. Drug use is defined as answering yes to using any drug class for non-medical reasons in the past 3-months.
[1] n = 102(13.6%) participants did not know or refused to answer.

Table 2
Alcohol consumption by Intervention condition and follow-up time point.

Intervention/Follow-Up	*n*	Quantity*Frequency Alcohol Use (i.e., consumption) Mean (SD)
Total sample		
Baseline	750	6.42 (3.85)
3-month	615	5.55 (4.21)
6-month	606	5.39 (4.14)
12-month	590	4.78 (3.83)
% change in mean, Baseline to 12-month		−.26***
Computer BI		
Baseline	252	6.1(3.9)
3-month	225	5.5(4.3)
6-month	226	5.3(4.4)
12-month	222	5.0(4.3)
% change in mean, Baseline to 12-month		−18.0***
Therapist BI-CG		
Baseline	248	6.6(3.8)
3-month	214	5.4(3.9)
6-month	215	5.4(4.1)
12-month	212	4.4(3.3)
% change in mean, Baseline to 12-month		−33.3***
Enhanced Usual Care		
Baseline	250	6.5(3.8)
3-month	222	5.8(4.4)
6-month	223	5.5(4.0)
12-month	220	5.0(3.8)
% change in mean, Baseline to 12-month		−23.1***

Note. The quantity and frequency scores are the product of the first two items of the AUDIT.
*** $p < 0.001$; SD = standard deviation.

intoxication in the ED or other medical or psychiatric comorbidities. When interpreting the general reductions in alcohol use across the follow-up, it is important to remember that study inclusion criteria ensured that the sample was elevated in terms of AUD symptoms at baseline, and some of the improvements may reflect regression to the mean (Finney, 2008). It is also possible that the extensive nature of the study assessments over the 12 months of the study encouraged all participants to consider their alcohol use and consequences and to make generally positive changes in total consumption, potentially hampering the ability to detect differences between conditions due to assessment reactivity (Sobell and Sobell, 1981) as well as natural change following an acute medical event. In addition, while we evaluated age as an intervention moderator, we did not include the full range of adult age, and thus results do not generalize outside of the 21- to 65-year-old age range. Conclusions from this study are specific to this sample's characteristics, setting, and intervention modalities and should not be generalized to other populations, treatment characteristics, or contexts. Power to detect significant findings was calculated for the overall between group intervention effect; thus, moderation analysis may not have been sufficient to detect effects, and therefore non-significant findings should be interpreted in light of this limitation. The ED setting has long been considered a 'teachable moment' to encourage a change in behavior.

This study has several methodological strengths including three follow-up time points, standardized intervention conditions monitored for fidelity, matched BI content across intervention conditions of different modalities, and high follow-up rates. The strengths ensured a more stringent test of all study aims by increasing fidelity of the intervention and assessments. More specifically, high follow-up rates reduced the likelihood that unbalanced attrition impacted moderation findings. Future studies are needed to potentiate the efficacy of brief interventions. This could include matching patient preference with delivery type (computer or therapist) and identifying other patient characteristics associated with response that can be used to tailor and optimize resource allocation of BIs in the broader context of personalized medicine. Additional research should disentangle why those with moderate to severe alcohol use problems benefit from therapist-guided interventions rather than computer-guided approaches using the same content. Future research could employ more sensitive measures of change in alcohol use (e.g., timeline follow-back calendar) to detect change among lower risk drinkers. Our research suggests that age or some measure of familiarity with computer, tablet, and smart phone technology may be an important factor in treatment tailoring. Given the number of BIs being developed for emerging technology platforms, evaluating age as a moderator is recommended for future research. Future studies should also identify which elements of BIs represent key intervention components and mechanisms of behavior change.

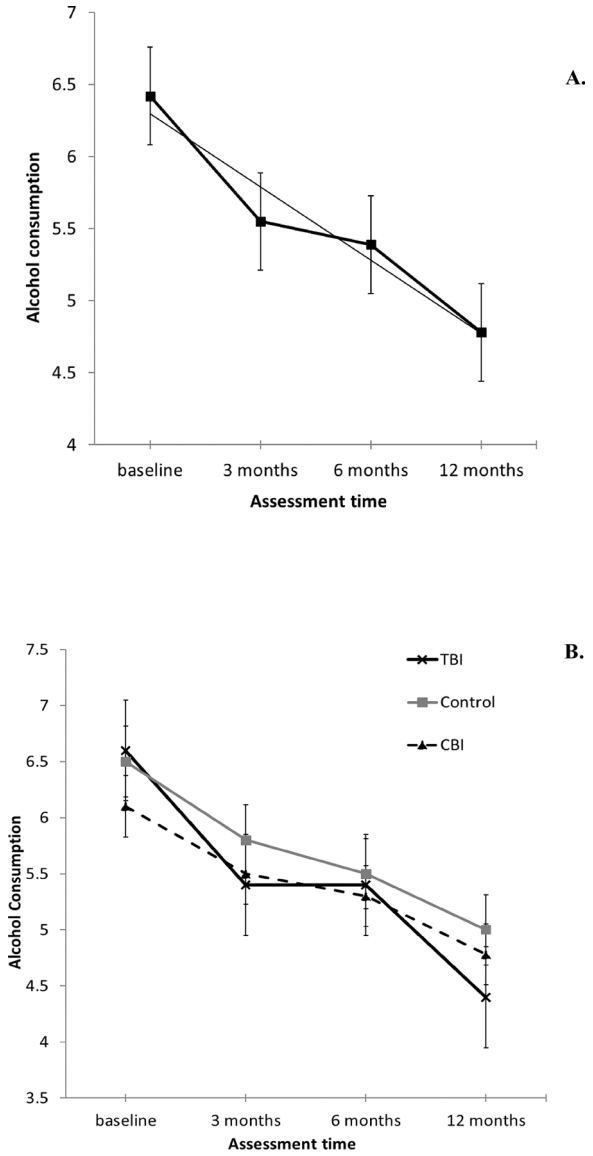

Fig. 2. Alcohol consumption decreased over time across the whole sample and within each treatment condition.
A. Whole sample B. Separated into treatment conditions
Note: Figure presents observed (thick black line) and estimated linear (thin line) change in alcohol consumption across follow-up, with standard error bars. Across the whole sample, there was a significant reduction in alcohol consumption across the study period (B = -0.35, SE = 0.04, $p < .001$). See Table 2 for estimates

Conflicts of interest

None to declare.

Role of the funding source

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Table 3
Separate regression analyses examining main and interactive effects of treatment condition and sex, severity, and age in separate models, and one joint model on the linear reduction in alcohol consumption across the study period.

Predictors	Linear decrease in alcohol consumption across follow-up		
	B	SE	*p*
Model 1 – Sex			
Computer BI vs. EUC	−0.03	0.11	0.77
Therapist BI-CG vs. EUC	−0.10	0.11	0.35
Male	−0.17	0.13	0.18
Male x Computer BI	0.12	0.17	0.50
Male x Therapist BI-CG	−0.14	0.17	0.44
Model 2 – Severity			
Computer BI vs. EUC	0.02	0.11	0.87
Therapist BI-CG vs. EUC	0.02	0.12	0.89
AUDIT severity (high vs. low risk)	−0.22	0.12	0.07
AUDIT severity x Computer BI	0.05	0.17	0.77
AUDIT severity x Therapist BI-CG	−0.35	0.17	0.04
Model 3 – Age			
Computer BI vs. EUC	−0.15	0.11	0.16
Therapist BI-CG vs. EUC	−0.26	0.11	0.02
Age (≥ 35 vs. 36-65)	−0.19	0.12	0.13
Age x Computer BI	0.41	0.17	0.01
Age x Therapist BI-CG	0.28	0.17	0.10
Model 4 – All moderators considered simultaneously			
Computer BI vs. EUC	−0.17	0.14	0.23
Therapist BI-CG vs. EUC	−0.08	0.14	0.58
Male	−0.10	0.13	0.42
AUDIT severity (high vs. low risk)	−0.21	0.12	0.09
Age (≥ 35 vs. 36-65)	−0.19	0.12	0.12
Male x Computer BI	0.07	0.17	0.68
Male x Therapist BI-CG	−0.08	0.18	0.66
AUDIT severity x Computer BI	0.03	0.17	0.85
AUDIT severity x Therapist BI-CG	−0.31	0.17	0.07
Age x Computer BI	0.40	0.17	0.02
Age x Therapist BI-CG	0.28	0.17	0.11

Note: BI = Brief Intervention; EUC = Enhanced Usual Care; Ref = reference group.

Contributors

All authors contributed to the manuscript, and the final manuscript has been reviewed and approved by all authors. Anne C. Fernandez contributed to analytic conceptualization, framing and interpreting findings, and drafting sections of the manuscript Rebecca Waller conducted outcome analysis and drafting sections of the manuscript. Maureen A. Walton was a Co-investigator involved in the design of the study and execution of the RCT, assisted with writing and critical scientific feedback, and consulted on analysis. Erin E. Bonar contributed to the clinical supervision of the RCT, assisted with data analysis, and contributed expertise to the manuscript. Rosalinda V. Ignacio was the senior data analyst who conducted descriptive analyses and assisted in writing the portions of the results section. Stephen T. Chermack was a Co-investigator on this study and assisted with intervention design as well as execution of the RCT, and contributed important scientific content to the manuscript. Rebecca M. Cunningham was a Co-investigator on this study and provided clinical guidance for the intervention delivery as well as contributed important scientific content to the manuscript. Brenda M. Booth was a Co-investigator on this study and provided clinical guidance for the intervention delivery and contributed to the manuscript. Kristen L. Barry was a Co-investigator involved in the design of the study and execution of the RCT contributed to the manuscript. Frederic C. Blow was the Principle Investigator for

Table 4
Alcohol consumption slopes within individual subgroups and treatment conditions based on significant interactions.

(1) Significant interaction between severity of alcohol problems and Therapist BI-CG condition

	Intercept			*Slope*		
	B	SE	*p*	B	SE	*p*
Therapist BI-CG(low severity)	4.58	0.15	< 0.001	−0.22	0.06	< 0.001
Therapist BI-CG(high severity)	8.10	0.38	< 0.001	−0.73	0.10	< 0.001
Control (low severity)	4.44	0.12	< 0.001	−0.22	0.06	< 0.001
Control (high severity)	8.29	0.36	< 0.001	−0.43	0.12	< 0.001

(2) Significant Interaction between age group and Computer BI condition

	Intercept			*Slope*		
	B	SE	*p*	B	SE	*p*
Computer BI (21-35 years old)	5.67	0.30	< 0.001	−0.34	0.09	< 0.001
Computer BI (36-65 years old)	6.26	0.37	< 0.001	−0.15	0.11	0.19
Control (21-35 years old)	6.36	0.30	< 0.001	−0.25	0.08	0.001
Control (36-65 years old)	6.21	0.36	< 0.001	−0.39	0.10	< 0.001

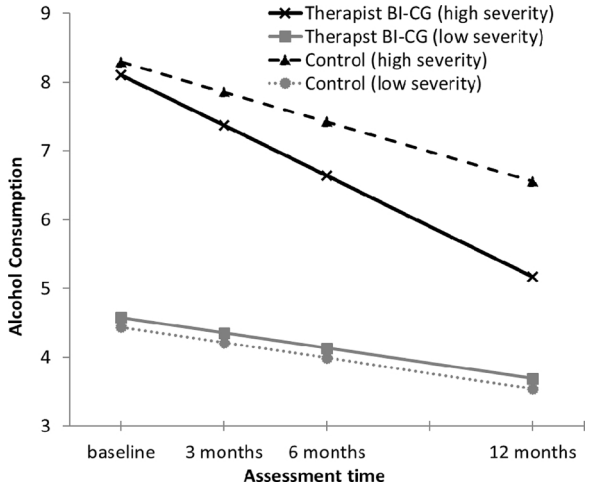

Fig. 3. A comparison of the effectiveness of the Therapist BI-CG relative to the control condition on the slope of alcohol consumption over time among participants with high alcohol use problems versus low alcohol use problems at baseline based on AUDIT scores.
Note: ** p < .01, *** p < .001, ns = not significant. The rate of decrease in the alcohol consumption of participants with high alcohol severity at baseline in the Computer Guided Therapist Brief Intervention (Therapist BI–CG) condition was almost double that of rate of change for participants with high alcohol severity in the control condition and more than three times that of the rate of change of participants with low alcohol severity who were in the Therapist BI–CG condition. See Table 4 for a complete presentation of intercept and slope factors across severity groups for the two conditions.

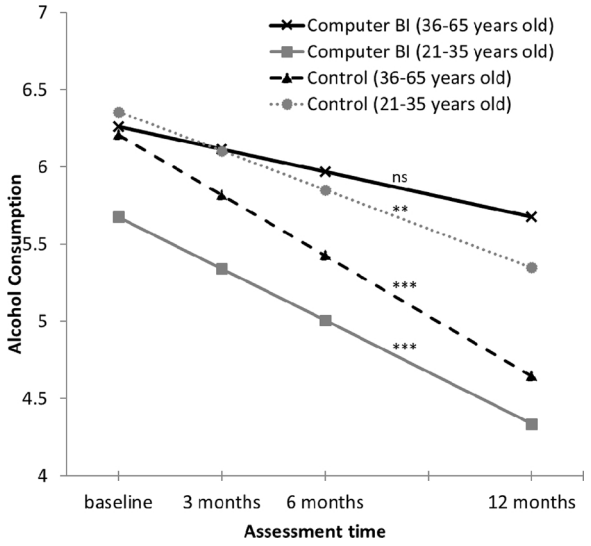

Fig. 4. A comparison of the effectiveness of the Computer BI relative to the control condition on alcohol consumption over time among younger participants (21–35 years old) and older participants (36–65 years old).
Note: ** p < .01, *** p < .001, ns = not significant. There was a significant reduction in the rate of alcohol consumption for participants aged 21–35 in the Computer Brief Intervention (BI) condition but not the older group aged 36–65 years old in the Computer BI condition. See Table 4 for a complete presentation of intercept and slope factors across age groups for the two conditions.

this RCT who designed the study and oversaw execution of the RCT, and assisted with all aspects of the study and manuscript.

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