Study Protocol

Official Title: Mechanisms for Alcohol Treatment Change [MATCH] Study

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Scientific Background

Young adulthood is a developmental period typically associated with escalating alcohol consumption and related risks [1]. Data from the 2019 US National Survey on Drug Use and Health [3] indicate that binge drinking (i.e. heavy episodic drinking), defined as four or more drinks for women and five or more drinks for men over any single occasion [4], increased from 23% at age 18 years to 42% by age 25 years. Immediate risks associated with binge drinking include poor school performance [5], interpersonal violence [6], motor vehicle accidents [7] and poisoning-related death [8].

Evidence-based interventions to reduce hazardous drinking in young adulthood could provide individual and public health benefits. Mobile digital behavioral interventions offer advantages to in-person behavioral interventions in their portability and automation, resulting in lower cost and ease of dissemination [9]. Mobile digital behavioral interventions may be especially useful for young adults, given their high personal ownership and use of smartphones [10]. One especially useful mobile communication modality for delivering behavioral support is text messaging. A recent meta-analysis of alcohol text message trials for young adult hazardous drinkers, including work from our group [11], found that text message interventions reduced self-reported binge drinking [−0.33 episodes per month; 95% confidence interval (CI) = −0.79, 0.12] and weekly alcohol consumption (−18.62 g per week; 95% CI = −39.61, 2.38) [12]. Although effects were small, they represent non-trivial population-level effects.

It remains unknown which behavior change techniques are needed to optimize intervention effectiveness, a critical step to understanding mechanisms of change and informing next-generation text message alcohol interventions [13]. Our group's alcohol text message intervention [11], which was informed by self-regulation theories [14] and the Theory of Planned Behavior [15], used two behavioral change techniques with the largest effect sizes in a meta-analysis of alcohol interventions [16]: self-monitoring and goal commitment, in addition to feedback on drinking behavior, to reduce young adult hazardous drinking. To examine which combination of behavioral change techniques was driving reductions in young adult hazardous drinking, we deconstructed our combined behavioral change techniques intervention (i.e. COMBO) into the following interventions: (1) TRACK (self-monitoring of drinking intentions, desire to get drunk and alcohol consumption) [17]; (2) PLAN (feedback on drinking intentions and desire to get drunk) [18]; (3) USE (feedback on drinking quantity consumed) [19]; and (4) GOAL (prompts to set a personal goal to limit drinking, tips to achieve the goal and feedback on goal success) [20].

Study Objectives

This study used a randomized controlled trial (RCT) design to examine the effects of PLAN, USE, GOAL and COMBO relative to an assessment control arm (i.e. TRACK) on reducing alcohol consumption at 3- and 6-month post-randomization among young adults with hazardous drinking in the emergency department (ED). The primary hypothesis, based on our prior studies [11, 22], was that there would be an ordered effect of the intervention in reducing the number of binge drinking days at 3-month post-randomization. That is, compared with the TRACK, (1) the combination of behavioral change techniques (i.e. COMBO) would show the greatest reductions in past month binge drinking days at 3-month follow-up and (2) component behavioral change

techniques (i.e. PLAN, USE and GOAL) would show intermediate reductions in past month binge drinking days at 3-month follow-up. We did not compare the four active conditions against each other. We explored intervention effects on secondary outcomes of binge drinking prevalence, drinks per drinking day and past month number of negative drinking consequences at 3- and 6-month follow-ups.

Study Design & Methods

The study was a parallel five-group individually randomized clinical trial that compared the efficacy of 12-week interventions utilizing different behavioral change techniques on reducing binge drinking at 3- and 6-month post-randomization among young adults with hazardous drinking. Assessor-blinded self-reported outcomes at 3 and 6 months were examined. The study was funded by the National Institute on Alcohol Abuse and Alcoholism (NIAAA). The study protocol was approved by the University of Pittsburgh Human Research Protection Office.

Participants who completed the baseline assessment were instructed to text a study telephone number within 24 hours. Only individuals whose telephone numbers matched the telephone numbers provided during the enrollment process were eligible. Once this match was recognized, participants received several texts welcoming them to the study and describing the 2-week run-in prior to randomization. During the 2-week run-in following the ED enrollment, on the 2 days in the week when participants typically drank alcohol (based on self-report data collected at baseline), subjects were prompted at 3 p.m. to report drinking plans and desire to get drunk, without receiving any directive feedback. This design feature of delivering messages on days when subjects typically drank was intended to ensure that we efficiently captured reports of drinking on days when it typically occurred. If no response was received within 2 hours, each text query was repeated once, and the response window closed after an additional 2 hours if no response was received. Only individuals who responded to at least 50% of the text queries and responded that they wished to continue participation with 'GO' at the end of the 2-week run-in were randomized to one of the five conditions. Randomization was performed by the software sequentially selecting a condition assignment in blocks of 10 from a randomization list generated a priori and concealed from participants and research staff throughout the trial.

The interventions were all delivered via an automated text messaging intervention for 12 weeks using software run by the Office of Academic Computing at the University of Pittsburgh Medical Center. We chose text messaging, given its ubiquity and preferential role for communication among young adults [17] as well as its proven effectiveness to deliver other health support [18]. Each intervention arm was designed to focus upon a unique component or combination of behavioral change techniques, as shown in Supporting information, Table S1 and as described in prior work [3]. The TRACK arm was intended to promote self-monitoring [17] of plans to drink, desire to get drunk and alcohol consumption and was identical to the run-in messaging. The PLAN arm was intended to challenge drinking expectancies [18] by providing feedback on drinking plans and desire to get drunk in addition to promoting self-monitoring. The USE arm was intended to modify post-drinking appraisals [19] by providing feedback on reported number of drinks consumed after their typical drinking day. The GOAL arm provided self-regulation support to limit alcohol consumption [20] by prompting drinking limit goal commitment [25], providing feedback on goal self-efficacy [26] and providing feedback on goal success to either bolster future goal striving [27] or reframe goal failure [28]. The COMBO arm combined all of the above behavioral change techniques [3].

Primary outcome

The primary outcome was the number of past month binge drinking days at 3-months post-randomization calculated from a 30-day time-line follow-back (TLFB) calendar [39]. Participants completed a web-based calendar and a visual reference displaying standard drink amounts and were asked to report their alcohol consumption by day. A standard drink was defined as 12 oz. of beer, 5 oz. of 12% table wine, 12 oz. of wine cooler or 1.25 oz. of 80-proof liquor. We calculated the number of days when a woman reported four or more standard drinks or a man reported five or more standard drinks as a binge drinking day.

Secondary outcomes

Secondary outcomes included number of binge drinking days at 6 months as well as drinks per drinking day and prevalence of any binge drinking at 3 and 6 months, all derived from the 30-day TLFB. We calculated drinks per drinking day as the mean drinks divided by the number of days with any alcohol consumption. We calculated the prevalence of any binge drinking days in the past 30 days, represented as a dichotomous variable (1 = any binge drinking day; 0 = no binge drinking day). Secondary outcomes also included alcohol-related consequences from the Brief Young Adult Alcohol Consequences Questionnaire (B-YAACQ) [40]. The B-YAACQ is a 24-item measure of alcohol-related problems that utilizes a dichotomous (present or absent) scoring format. Higher scores (count of items marked as 'present') on the B-YAACQ not only indicate a wider variety but also reflect a more severe pattern of alcohol-related problems.

Eligibility Criteria

Patients aged 18–25 years who presented to one of four EDs in western Pennsylvania were eligible to be screened if they were medically stable, provided permission to be approached and were not being discharged imminently. Patients were excluded from screening in the ED if they were already enrolled into the trial or were not interested in study participation. Screened patients were included if they reported an Alcohol Use Disorder Identification Test for Consumption (AUDIT-C) score of ≥ 3 for women or ≥ 4 for men [23]. We used the AUDIT-C to screen-in patients as it is a brief alcohol screening instrument that reliably identifies people who are hazardous drinkers or have active alcohol use disorders (including alcohol abuse or dependence) [24] and permits comparison to prior studies [11]. Screened patients were excluded if they reported not being interested in participating in a clinical trial, past treatment for drug or alcohol problems, current psychiatric treatment or did not own their own telephone with text messaging.

Statistical Considerations

Missing outcomes (primary and secondary)

For intent-to-treat (ITT) analyses, following current recommendations when outcomes are missing [41, 42] and following best practices for alcohol trials [43], we used multiple imputation procedures to generate accurate estimates of uncertainty. We first ensured that missing outcome data were not missing completely at random (MCAR) using Little's test [44]. We therefore assumed that outcomes were missing at random (MAR) [45]. To reduce probability of

outcomes being missing due to unmeasured factors (i.e. missing not at random: MNAR), we examined baseline covariates associated with missing outcomes (see Supporting information, Table S3) and included those with significant associations in the imputation model. Because the pattern of missingness was non-monotonic, we used multiple imputation chained equations (MICE) [46]. Because missing binge drinking days were not normally distributed and bounded by 0 to 30 day, we used predictive mean matching with $k = 5$ nearest neighbors [47]. We included sex, college-enrolled, tobacco use and baseline impulsivity score as predictors of outcomes. We generated 30 sets of imputed data based on the highest fraction of missing information, which was 0.27, as per recommendations [48]. We checked how well the imputation model fitted the observed outcome data by inspecting their distributions in each treatment arm.

Analytical models

For our primary outcome analysis of mean binge drinking days at 3-month follow-up as well as the secondary outcome analysis of mean binge drinking days at 6-month follow-up, we used separate negative binomial regression functions [49]. Secondary outcome analyses also included at 3- and 6-month mean drinks per drinking day using the Poisson regression function, the point prevalence of any binge drinking days in the past month using the logit function and mean number of negative alcohol consequences (B-YAACQ) using a negative binomial regression. Covariates with significant univariate associations with the primary and secondary outcomes were included in the models as covariates, and white race, baseline tobacco use, baseline impulsivity score and baseline measures of the main outcome (e.g. binge drinking days) were kept in the final models, as their inclusion improved model fits (based on Akaike information criterion and Bayes information criterion). Interactions between intervention arm and site of recruitment were examined, and no significant interactions were identified in relation to the primary or secondary outcomes. Estimated treatment effects are reported as either adjusted β or odds ratios (ORs) with 95% CIs. Sensitivity of all imputed model findings was assessed by conducting complete case analyses (CCA).