

Yale University

## EliScholar – A Digital Platform for Scholarly Publishing at Yale

---

Public Health Theses

School of Public Health

---

1-1-2019

### Feasibility Of Augmenting Brief Interventions With Text Messaging To Reduce Adolescent Alcohol And Marijuana Use: A Pilot Study.

Jonathan Phillip Williams  
jonathan.williams@yale.edu

Follow this and additional works at: <https://elischolar.library.yale.edu/ysphtdl>

---

#### Recommended Citation

Williams, Jonathan Phillip, "Feasibility Of Augmenting Brief Interventions With Text Messaging To Reduce Adolescent Alcohol And Marijuana Use: A Pilot Study." (2019). *Public Health Theses*. 1849.  
<https://elischolar.library.yale.edu/ysphtdl/1849>

This Open Access Thesis is brought to you for free and open access by the School of Public Health at EliScholar – A Digital Platform for Scholarly Publishing at Yale. It has been accepted for inclusion in Public Health Theses by an authorized administrator of EliScholar – A Digital Platform for Scholarly Publishing at Yale. For more information, please contact [elischolar@yale.edu](mailto:elischolar@yale.edu).

**Feasibility of Augmenting Brief Interventions with Text Messaging to Reduce Adolescent Alcohol and Marijuana Use: A Pilot Study.**

**Jonathan P. Williams**  
**Yale University – School of Public Health**  
**Social and Behavioral Sciences**  
**May 2019**

Thesis Committee:  
Dr. Trace Kershaw, PhD  
Dr. Deepa Camenga, MD, MHA

## TABLE OF CONTENTS

Abstract.....	1
Introduction.....	4
Background and Rationale.....	4
Specific Aims & Hypothesis.....	8
Methods.....	8
Intervention.....	9
Study Population.....	11
Research Procedure.....	12
Primary Outcome.....	14
Additional Measures.....	14
Sample Size / Power Calculation.....	15
Results.....	16
Enrollment.....	16
Retention.....	18
Satisfaction.....	18
Discussion.....	19
Acknowledgements.....	25
References.....	26
Figures and Tables.....	39

## **ABSTRACT**

**Background** – Alcohol and marijuana use in adolescents remains widespread, pervasive and recognized as a major public health concern. This pilot study aimed to test the feasibility of a novel health intervention that adds a 4-week series of text messaging to the Brief Negotiation Interview (BNI; a brief motivational technique) for 13-18 year olds with high-risk alcohol or marijuana use in an emergency department or primary care setting.

**Methods** –13-18-year-old patients presenting to a Children’s emergency department or a primary care clinic in the Northeast were screened with the CRAFFT substance use screener. Adolescents who scored 2+ on the CRAFFT were asked to participate in this study. After obtaining written consent and/or assent and parental permission, adolescent participants completed baseline surveys, participated in a BNI with a trained research assistant, and enrolled in the 4-week text messaging program, which consisted of weekly goal setting and reflection exercises. Participants completed an in-depth interview to assess satisfaction at 4 weeks post-enrollment. Feasibility measures include enrollment, retention and satisfaction.

**Results** – Between November 2017 and May 2018, we screened 71 adolescents. We obtained parental consent and adolescent assent to enroll 10 of 27 eligible participants (37%), of which 8/10 (80%) completed the 4-week text messaging intervention. Analysis of the 494 reflection and goal setting text messages sent during the program demonstrated that participants completed a higher proportion of alcohol reflection and goal setting text message exercises (85% and 70%, respectively) than marijuana exercises (both 64%). From the open-ended interviews, 43% of active participants believed the exercises gave good ideas on how to quit alcohol and marijuana use.

Further, 100% liked the content of the messages received and would recommend the program to a friend.

**Conclusions** – These data indicate that, although it is challenging to identify and enroll adolescents with high-risk alcohol and/or marijuana use in medical settings, adolescents who enroll are generally satisfied with the intervention, supported by high levels of retention. The feasibility data suggest that text messaging programs may need to improve parental engagement models and refine texts to enhance motivation to change marijuana use. Future research is needed to continue exploring the sophisticated role of tailored texting in improving adolescent behavior.

## **INTRODUCTION**

### **Background & Rationale**

The use of tobacco, alcohol, and other drugs has proven to be a major contributor to the onset of several diseases and serious injuries globally (World Health Organization, 2002; Anderson et al., 2002). A considerable amount of public health research suggests that substance use is the leading cause of preventable morbidity and mortality in the US and globally, and over 90% of substance use begins in adolescence (Levy and Williams, 2016; Jha & Peto, 2014).

Alcohol and marijuana are substances most commonly used by adolescents (NSDUH, 2017). A recent national survey revealed that approximately half (45.5%) of high school seniors have used marijuana and more than two-thirds (68%) have used alcohol (NSDUH, 2017). Despite a push for more lenient policies on the use of marijuana and other substances, excessive use of alcohol and

drugs during adolescence has been linked to numerous poor health outcomes. Within this age group, negative outcomes associated with adolescent alcohol-use include poor academic performance and attainment, impaired social relationship development, decreased cognitive functioning, development and memory capacity, reduced occupational productivity, increased probability of driving while impaired, and several mood and substance use disorders (SUDs) (Clark, Kirisci & Moss, 1998; Jewett et al., 2015; Rehm et al., 2009; Sokol, Delaney-Black & Nordstrom, 2003; Lange & Hills, 2001; Degenhardt & Hall, 2012, National Highway Traffic Safety Administration, 2015; FBI, 2012; Berning, Compton & Wochinger, 2015; Brown et al., 2008; Hall and Degenhardt, 2009; Johnson et al., 2009).

Adolescent marijuana use has also been associated with reduced sense of motivation, inability to focus, and poor school performance (Brook et al., 2002). In recent years, it was observed that a reduction in motivation and poor attentiveness among adolescents has paralleled the inclining rate of frequent marijuana use (Brook et al., 2002). Thus, it is not surprising that a nationally representative survey concluded that adults rated drug use and abuse as a primary health concern for adolescents, exceeding the concern for obesity, cardiovascular disease, and other serious chronic conditions (University of Michigan, 2011).

Encounters with healthcare providers may in fact be effective point to intervene and promote healthy behaviors within a population. Within the realm of such clinical interventions that attempt to effectively change certain ongoing behaviors, brief interventions have proven to reduce risky drug and alcohol use while remaining one of the most cost-effective solutions (U.S. H.H.S., 2016; Heather, 1996; Wutzke et al., 2001; Tanner-Smith & Lipsey, 2015; Levy, Williams, & Committee

on Substance Use and Prevention, 2016; Larimer & Cronce, 2007; Carey et al., 2007; Cronce & Larimer, 2011; Seigers & Carey, 2010; Fachini et al., 2012; Huh et al., 2015). Brief interventions consist of a conversation that focuses on encouraging healthier choices so the risk of harmful behaviors are prevented, reduced, or stopped altogether (Levy and Williams, 2016). Among adolescents, brief interventions include series of potential responses, which include positive reinforcement for those who report no substance use; brief medical advice, for those who report use with no evidence of SUD; brief motivational interventions, for those with moderate SUD; and referral to treatment for those with severe SUD (Levy and Williams, 2016).

Populations of interest in which this intervention can be tailored toward has been explored across several studies, incorporating different elements to the brief intervention. Brief interventions have been tested in a variety of populations. Such brief interventions that have incorporated motivational interviewing with personalized feedback have been shown to reduce excessive alcohol use in college students (Huh et al., 2015; Butler & Correia, 2009; Carey et al., 2007; Cronce & Larimer, 2011; Dimeff et al., 1999).

Among emergency department patients, the *Brief Negotiation Interview*, or BNI, has been shown to be effective in reducing alcohol and general substance use. Components of the BNI include (1) consenting the participant into discussing their current alcohol/marijuana use; (2) establishing a connection between the participant's substance use behavior(s) and deleterious consequences; (3) enhancing motivation by asking the likelihood of changing behavior on a scale from 1 to 10, otherwise known as a *readiness ruler*, and inquiring why the participant did not choose a lower number; and (4) establishing a realistic altered substance use goal (D'Onofrio et al., 2012).

Behavioral contracting, or the process of establishing a realistic goal for changing behavior when coupled with positive reinforcements, is a foundational component of the BNI (Stuart, 1971). In a clinical trial with 740 hazardous and harmful drinkers comparing the BNI to standard treatment, implementing the BNI significantly reduced high-risk behaviors such as impaired driving practices (D'Onofrio et al., 2012). Another study that targeted alcohol use among emergency department patients revealed that 338 participants that received the BNI reported consuming 3.25 fewer drinks per week on average compared to those that did not receive the BNI (Academic ED SBIRT Research Collaborative Group, 2007).

Additional intervention instruments have been explored to promote and facilitate effective behavior change among adolescents. Specifically, the use of Tailored Texting has been a rapidly growing dimension of electronic health (eHealth) and mobile health (mHealth) research. Given that text messaging is both a widespread and desired form of communication among adolescents across all sociodemographic groups, it was speculated that tailored texting may serve to reduce substance use behavior (Lenhart, 2015). In recent measures, it is estimated that approximately 95% of all teenagers report owning or having access to a smartphone (Anderson & Jiang, 2018). Existing literature now shows that tailored texting is effective for encouraging a variety of behavior outcomes such as reducing substance use, promoting smoking cessation, reducing anxiety symptoms, and improving diabetes self-management care (Mason et al., 2014; Heron and Smyth, 2010; Wei, Hollin, and Kachnowski, 2011). Essential elements of this text-delivered intervention include tailored text content on a focused behavioral aspect, refined interactivity allowing for participant input and engagement, and concurrent intervention initiation by both the research team and the participant (Fjeldsoe, Marshall, and Miller, 2009).

Unfortunately, there has been little work to implement these intervention tools simultaneously in adolescents. More research is needed to fully understand the role that these interventions play in a clinical context. The broader implications of such studies carry heavy significance on the role that mobile health technology plays on bolstering the already effective use of brief motivational interventions.

### **Specific Aims & Hypothesis**

**Aim:** To test the feasibility of an intervention that adds a 4-week course of tailored text messaging to the brief negotiation interview (BNI) for 13-18-year-old adolescents with risky alcohol and marijuana use.

*Hypothesis A:* The intervention will have adequate *enrollment* (1-2 participants/week per recruitment site).

*Hypothesis B:* The intervention will have high rates of *retention* (>80%) for follow-up assessments and the text messaging program.

*Hypothesis C:* Participants will report high levels of *satisfaction* with the text messaging program.

## **METHODS**

## **Intervention**

We tested a combination of the BNI and tailored texting within an adolescent population in both emergency department and primary care settings.

The theoretical basis for this intervention is framed around the interacting processes for behavior change in any given population. More specifically, the *Theory of Planned Behavior* (TPB) provides a systematic understanding of which key elements play a role in an individual's decision making process. TPB posits that attitudes, subjective norms, and perceived behavioral control shape an individual's behavioral intentions, which leads to subsequent behavior (John Wiley & Sons, 2015; Sheeran, 2002; Webb & Sheeran, 2006). There have been numerous published interventions that illustrate the utility of incorporating TBP into behavioral interventions (Albarracin et al., 2003, 2005; Glasman & Albarracin, 2006; Jemmott, 2012; Johnson et al., 1998; Mosleh et al., 2013; Rhodes et al., 2007; Webb & Sheeran, 2006).

Given that this theoretical framework has been explored across several research studies, it has been found that many attitudes are highly changeable, and therefore are ideal targets for behavioral interventions (John Wiley & Sons, 2015). TPB will target attitudes and will serve to enhance motivation for behavior change by increasing perceptions of the adverse effects of alcohol and/or marijuana use. Within this clinical context, there will be a specific focus on the link between risky drug use and driving while intoxicated/riding while intoxicated. The BNI delivered in a healthcare setting along with an extended follow-up period that incorporates tailored text messaging

encompass major motivational elements of TPB. Together, the combined BNI + text messaging will function to support behavioral contracting with intended change by leveraging motivational interviewing and self-regulation.

**The BNI:** Developed from standardized motivational interventions, the BNI incorporates elements of recognizing one's current behavior, a degree of behavioral contracting, social cognition, and brief advice (D'Onofrio et al., 2008; D'Onofrio et al., 2012; D'Onofrio et al., 2005). Four stepwise processes of the BNI include: 1). Establish patient rapport and ask permission to discuss the topic of substance use and any associated behavior; 2). Share evidence-based findings on adolescent substance use based on NIAAA guidelines for drinking (NIAAA, 2011) and AAP guidelines for marijuana use (Ammerman, Ryan, and Adelman, 2015) while making linkages between use and dangerous behavioral outcomes; 3). Enhance intrinsic or extrinsic motivation to change behavior using a readiness ruler; and 4). Negotiate a feasible behavior change contract with realistic measures (Mallett, Marzell, and Turrisi, 2011; Delva, 2004). Individual members of the research team that administered the BNI received a 2-hour training program (D'Onofrio et al., 2005).

**Tailored Texting:** Auto-adjusted texts are tailored to 1). Baseline and ongoing substance use 2). Baseline and ongoing changes in willingness to change and 3). Self-identified high risk times. Three different types of tailored texts are sent during the four-week study duration: Goal Setting, Reflection Prompts, and Reminder Texts (Table 1). The text messages were delivered using the interface *Mosio*. Individuals that self-reported a history of alcohol use within the past year were enrolled in the alcohol texting program, individuals that reported a history of marijuana use within

the past year were enrolled in the marijuana texting program, and individuals that reported a history of using both substances were enrolled in both texting programs.

**Mosio:** Mosio ([www.mosio.com](http://www.mosio.com)) is a two-way text messaging company specializing in mobile solutions for clinical research. Mosio programs are 21 CFR Part 11 compliant. Mosio texting programs can schedule a series of days/times to automatically send surveys via texts (i.e. Y/N, A-E multiple choice and user-defined character sets), and has the capability to deliver the proposed TT intervention (Figure 1). Participant data was exported via .csv files to the research team and stored on a secured server at Yale. The data-base was examined daily to ensure the continued functioning of the texting program. In order for timely collection of useful data, this particular commercial texting system was selected because of its specific focus on texting as it relates to clinical research.

### **Study Population**

We recruited n = 10 patients between the ages of 13-to-18-years-old who presented to the Yale New Haven Hospital (YNHH) Adolescent Primary Care Center (PCC) or the YNHH Pediatric Emergency Department (ED). Participants were included if they: were 13 to 18 years of age; screened positive for risky alcohol or marijuana use (a score of  $\geq 2$  on the CRAFFT scale for either substance); spoke English (parents providing consent must speak English); a functioning cell phone with active text messaging for at least 4-weeks after enrollment. Conversely, participants were excluded if they: screened positive for severe alcohol/marijuana use disorder; were enrolled in any substance use treatment program; presented with a life-threatening injury/illness; were

actively suicidal, homicidal or psychotic; presented for sexual assault; were cognitively impaired (including due to intoxication) and were unable to provide consent; were non-English speaking; were in police or state (DCF) custody; were unable to provide parental permission if not a legal adult; and/or were unable to provide two contact numbers for post enrollment follow-up.

## **Research Procedures**

Preliminary screening of age-eligible patients was assessed if an attending physician in either the YNHH PCC or the YNHH Pediatric ED determined that the patient was appropriate to approach (using the aforementioned inclusion and exclusion criteria). Following this, patients were approached and assessed on initial interest in learning about the research study (receiving sufficient verbal consent) by explaining a general overview of the study. The patient then received the screening eligibility form that incorporated a standard clinical CRAFFT scale. This portion of the intervention recruitment process was conducted with only the patient to ensure their substance use behavior remains private. The patient was then advised that their parent and/or guardian may become aware of their substance use behavior if they were determined eligible and consented to participate in the study.

If at that point the patient was determined eligible and was interested in participating, the research team further explained a more specific description of the study design with the patient and their parent, and administered a brief questionnaire to ensure complete/informed understanding of the project. The research assistant then disseminated and reviewed an informed consent assessment quiz to ensure complete comprehension of the overall study components. Written participant

consent or assent and parental permission was obtained along with two separate written contact information for follow-up purposes. Baseline assessments were conducted (e.g. baseline survey and 28-day timeline follow back) to determine exact substance usage for either alcohol and/or marijuana. Trained research team members completed a BNI with the participant (Sobell & Sobell, 1992). A psychological health care provider trained the research team to ensure that all necessary components of the BNI were completed for the specific substance(s) that the adolescent used. The components included asking: permission to discuss the participant's substance use behavior, whether there are negative consequences associated with this behavior, participant's position on a readiness scale to indicate the likelihood of changing behavior, and potential life changes to help achieve such change.

After completion of assessment instruments, the participants received a *STAR Study Tips* card that provided necessary contact information in the event of an emergency throughout the research period. A member of the research team then enrolled the participant in the Mosio text messaging program using their cell phone number. Participants that completed the enrollment process were compensated with a \$25 gift card. The research team completed progress notes and described any pertinent information regarding the participant enrollment process, including relevant information obtained from the BNI.

During the following 4 weeks, participants received and were prompted to respond to a combination of reminder, goal setting, and reflection messages and surveys. All messages exchanged were documented and recorded on Mosio's online platform. Following the text messaging period, a research team member called the participant and administered the post-

reflection survey, which also included a 28-day timeline follow back. After completing the brief follow-up interview, participants were compensated with a \$35 gift card.

### **Primary Outcome**

Given the nature of this preliminary pilot study, essential measurable outcomes included sufficient participant enrollment, retention, and overall satisfaction and are measured at different stages of this study (Figure 2). Specific measures are assessed either at the baseline visit or during the 4-week follow up session (Table 2). The following detailed records were documented in order to obtain this information: the number of age-eligible adolescents in each clinical setting who 1) are asked to participate; 2) formally consent to enrolling; and 3) follow-up during the post-enrollment phone interview. The follow-up interview possessed open-ended questions that assessed whether participants liked the frequency and content of the texts, how helpful they found the texts in supporting a quit attempt, and whether they would recommend this particular intervention program to a fellow peer. Generalized descriptive statistics will be reported.

### **Additional Measures**

Further exploratory analyses were conducted on the following scales included in the administered surveys: Rutgers Alcohol Problem Index (RAPI) (White, 1989), Rutgers Marijuana Problem Index (RMPI) (Simons, 1998), Driving Tendencies Questionnaire, Substance Use Risk Profile Scale (SURPS) (Woicik et al., 2009), Parent Monitoring Questionnaire and Alcohol/Marijuana/Tobacco Assessment. The RAPI consists of a 23-item survey that objectively presents a standardized

method, that when effectively implemented in a clinical setting, measures the degree of adolescent problem drinking (White, 1989). The RMPI is a similarly designed tool to measure problem marijuana use among adolescents (Simmons, 1998). In addition to these exploratory scales, the baseline survey quantified participant's substance use risk profile with the incorporation of the SURPS instrument. More specifically, the SURPS 23-item instrument measures personality factors of hopelessness, anxiety predisposition, impulsiveness, and sensation seeking, which provide insight on the reinforcement-specific factors of substance use (Woicik et al., 2009).

### **Sample Size/Power Calculations**

Given the nature and complexity of this pilot study, a sample size of approximately 10 participants may be sufficient to draw generalizable conclusions that may inform future, larger research projects (Rounsaville, Carroll & Onken, 2001).

### **Data Analysis**

Following comprehensive recruitment in the clinical setting, data was stored at a secured data management center on a monitored server at Yale University. The datasets maintained did not include any patient identifying information. The Principal Investigator and the Research Assistant were the only individuals with access to the datasets during the duration of the study. The datasets were exported and analyzed using *Statistical Analysis System* (SAS) 9.4. Standard descriptive measures of analysis were used to determine the percentage, the mean and the standard deviation for continuous variables. All incorporated scales were scored using their originally outlined

methods of utilization. The grouping of RAPI, RMPI, and SURPS scoring scales were summed. Open-ended satisfaction assessment responses were filtered into generalized theme categories; they were collated and reported as most common themed responses regarding satisfaction or dissatisfaction.

## **RESULTS**

A total of 196 adolescent patients that met the inclusion age criteria (13-18 years) and presented in the either YNHH PCC or the YNHH Pediatric ED during the recruitment period; 106 individuals were deemed ineligible by an attending physician and 19 were missed by the Research Assistant due to physical constraints (Figure 3). Among the 71 adolescent patients that were approached, 41 individuals screened ineligible on the CRAFFT scale and 10 individuals were enrolled in the pilot study (Figure 3). More often than not, an individual who was eligible but did not enroll was doing so because their parent/guardian was not interested in participation in the study. A waiver of parental permission was obtained for screening, therefor the parent would need to consent only after the patient was deemed eligible. Enrollment of participants was augmented by research fliers that were disseminated to all medical staff in both clinical settings during the recruitment period.

### **Enrollment**

Of the 10 eligible adolescent participants that provided consent and were recruited into the text-messaging pilot study, 50% were 5 male (n=5) and 50% were females (n=5) with a mean age of 16.8 ( $\pm$  1.4) years (Table 3). Among the 2 Hispanic-identifying individuals and 8 non-Hispanic-

identifying individuals, 4 individuals self-identified as White (Caucasian), 5 individuals self-identified as Black or African American, and 1 individual self-identified as both White (Caucasian) and Black or African American (Table 3). 5 individuals indicated a history of alcohol use within the past 28 days and 8 individuals reported a history of marijuana use within the past 30 days (Table 3). Of all patients that indicated owning a cell-phone with text-messaging capability (n=10), the mean reported number of text-messages sent and received on an average day was 91 ( $\pm$  120) messages.

Among those that positively indicated a previous history of alcohol consumption, the mean onset age of use was 14 ( $\pm$  2.1) years. Of this group, one individual (20%) previously made an attempt on changing their behavior to effectively cut down on their current drinking, and one individual (20%) kept drinking after promising themselves to quit. Among those that positively indicated a previous history of marijuana use, six participants (75%) made an attempt on changing their behavior to cut down on smoking and four participants (50%) kept smoking after promising themselves to quit. Three participants (38%) reported feeling physically or physiologically dependent on marijuana, while no individuals reported the same for alcohol.

One recruited adolescent participant had a legal driver's license that allowed for independent, unsupervised driving, two participants had a permit allowing for supervised practice driving, and seven patients had neither a driver's license nor a permit of any sort. During the past 30 days of recruitment, three participants (30%) indicated riding in a car or another vehicle driven by someone who had been drinking alcohol, while no participants indicated operating a vehicle after drinking alcohol.

## **Retention**

The overall retention rate for the sampled group of adolescents varied across the type of substance-tailored programs that were delivered. Of the 494 text messages exchanged throughout the research period, participants completed a higher proportion of alcohol reflection and goal setting text message exercises (85% and 70%, respectively) compared to the marijuana exercises (both 64%) (Table 4). Among the 10 eligible participants that were recruited at the baseline portion of the study, two individuals did not respond to any of the texts delivered immediately after leaving the clinical setting. The research team made several attempts to contact these individuals, however, neither individual responded despite confirming to have a functioning cell phone. No other participant was contacted by the research team directly throughout the text messaging program. The remaining 8 individuals recruited to participate in the intervention completed the entire 4-week texting program and the follow-up assessment.

## **Satisfaction**

Among the seven participants that successfully completed the 4-week texting program and completed the post-intervention follow-up assessment, all individuals either strongly agreed or agreed that they liked the content of the messages they received (7/7) (Table 5). Similarly, all participating individuals (7/7) indicated that they would recommend this designed Mosio texting program to a friend (Table 5). Furthermore, 88% (5/7) stated that the text messages were helpful in getting them to try to quit either drinking alcohol or using marijuana, that all of the text messages

were written specifically for adolescents, and that the text messages came at the right time of the day (Table 5). Notably, 43% (3/7) strongly agreed or agreed, 14% (1/7) neutrally stated, and 43% (3/7) strongly disagreed or disagreed, that the text messages they received gave them good ideas on how to quit drinking alcohol and/or quit using marijuana (Table 5).

When given the opportunity, seven of the enrolled individuals participating in the follow-up assessment to provide general and open-ended feedback to the research team. The most popular texts were motivational and required no reply, such as “a quick reminder to remember your goals” and “even a little change can make a difference.” Similarly, participants mentioned that they appreciated the toned of the messages referring to them like adults. One patient stated “there could have been more motivational/inspiration text messages... Consider increasing the number of motivational texts.” Conversely, participants receiving both alcohol and marijuana text messages reported feeling overwhelmed by two text strings being delivered simultaneously, introducing the risk of inadvertently ignoring one string. This occurrence may explain the variation in response rates between the alcohol texting program and the marijuana texting program. Participants reported feeling as though the text messages were not equipped with enough information about the risks of alcohol and marijuana use among adolescents. When referencing the nature of the text messages being delivered, one participants stated, “[the text messages were] vague – it didn’t tell me how to quit.” In terms of the structuring and timing of the program, one participant suggested that the type of texts delivered should be staggered for participants receiving both alcohol and marijuana texts.

## **DISCUSSION**

Given the findings of this behavioral intervention pilot study, tailored text messages were a highly favored approach to addressing risky alcohol- and marijuana-use among adolescents in a clinical setting. Essential findings that support this claim include the adequate enrollment of adolescent patients presenting in an emergency and primary care setting given the set of inclusionary and exclusionary criteria, sustained levels of retention among recruited participants, and the overall satisfaction reported during the follow-up period.

The tailored intervention was appropriately directed, as the patient population presenting in these clinical settings were in fact risky alcohol- and marijuana-using adolescents. Of the presenting patients, 54% (106/196) individuals were immediately deemed ineligible by the attending physicians present. Reasons for the immediate exclusion of these pediatric patients are defined by the study design's approved exclusionary criteria. Physicians were informed about such exclusionary criteria and therefore made an informed decision regarding the potential for participation on behalf of their patient. The prioritization of patient's conditions was of principle concern throughout the duration of this clinical intervention. Among patients that were determined eligible for the study, 63% (17/27) did not consent to participating. This group of patients did not participate because their parents refused to provide assent for various reasons. Factors that influence parental consent include a parent's understanding of their child's illness and the overall motivation for advancing medical knowledge (Rothmier, Lasley & Shapiro, 2003). Often, parents expressed that they believe their children does not have a problem with alcohol and/or marijuana, and therefore do not need to participate in the study. This study compares to similar feasibility prototype studies in that constructing an age-appropriate texting program served as an acceptable

approach to communicating with adolescents about their substance use behaviors (Blitchtein-Winicki et al., 2017).

Beyond utility, several studies support that the use of text-messaging programs serve to promote substance use cessation, while incurring minimal costs to investigators (Naughton et al., 2017; Head et al., 2013). The technology involved in the text-messaging program itself is delivered at a considerably small cost to any population that already has access to a cell phone (Stross, 2008). Fortunately, the future for similarly aimed behavioral text messaging messages is predicted to incur fewer costs with advancements in developing mobile apps that send/receive messages through media platforms independent of cellular carriers (Wortham, 2011). Consistent with the nature of this study, few additional expenses associated with this prototype includes the pre-paid cards given to participants, which investigators believe to bolster the incentive to enroll and adhere to the intervention (Blitchtein-Winicki et al., 2017). During the feedback follow-up assessment, no participant expressed that the costs of the text messages were a burden on themselves or their families. Overall, the low-cost burden of this intervention served as a considerable strength and contributed to the feasibility of its implementation.

The findings from the open-ended feedback questions further illustrate additional strengths of this intervention. As previously mentioned, a majority of patient feedback and suggestions were directed toward the content of the text messages, the overall structuring of the messages program, and the usefulness in the messages to promote behavior change. Incorporation of a motivational framework in the text message strings proved to be salient to this adolescent population. The basis for attempting to use motivational efforts to elicit behavior change among adolescents appears to

be consistent with similarly designed studies (Haug et al., 2012; Wilson, Wallston & King, 1990). The degree of confidentiality along with the direct and explicit language used in the text messages played a role in a satisfying feeling of adulthood interactions. Mass media campaigns aimed at reducing substance use have emphasized the importance of execution (stylistic) considerations when interacting with adolescents to ensure satisfaction and effectiveness of intervention (Pechmann & Reibling, 2000). Feedback from the patients who were eligible and recruited for this prototype study highlighted the useful nature of incorporating a text messaging program to support continued care beyond a clinical setting.

In addition to these identifiable advantages, information gathered during both the baseline and follow-up assessments revealed certain limitations of this implemented study design. Initial attempts to recruit patients proved difficult, as many individuals screened out due to high-risk substance use behaviors (e.g., frequent binge drinking and blacking out episodes). A reevaluation of risk measures was not considered until later in the recruitment period, which extended the overall anticipated study period. Additional research may prove to be useful when designing eligibility criteria for this particularly risky adolescent population.

These preliminary findings suggest that future iterations of this behavioral prototype intervention should enhance or restructure certain elements of the texting program. Consistent with patient satisfaction feedback, this program would benefit from incorporating additional motivational text messages. In order to directly target substance use behaviors, the texting program should also provide concrete, actionable advice texts to equip patients with knowledge on alternatives to substance use. This component exists when delivering the BNI in clinical settings, however, it may

prove useful to have continued and long-term delivery of such information. Future designs may also consider the experience of adolescent patients enrolled in texting programs for both alcohol and marijuana, as feedback suggests that the delivery timeline was not conducive to appropriate responsiveness. Possible solutions for this problem include (1) staggering the time period on days of delivery; or (2) delivering tailored messages that combine alcohol- and marijuana-targeted texts. An additional limitation may include the collection of data regarding immediate exclusion of patients. This comprehensive information may be best utilized in designing additional clinical interventions directed toward adolescents.

Although beyond the scope of this study design's primary outcomes, self-reporting played an essential role in the assessment of substance use before and after the tailored intervention. Several studies discuss the shortcomings of a self-reporting assessment method, especially among adolescent groups (Stanton et al., 1996). Specifically, researchers have pointed to the potential for recall bias and Hawthorne bias, or the change in sample characteristics as a result of a study, when using similarly utilized self-reporting methods (Murray et al., 1988). Furthermore, researchers speculate the degree to which this measuring system contributes to high levels of negative self-reports (Noonan D., Jiang Y. & Duffy S.A., 2013; Connor et al., 2009). Upon establishing both the utility and feasibility of this particular intervention, future studies may consider incorporating a precise and sustainable method of measuring substance use to capture evidence of overall efficacy.

The information gathered from this pilot behavioral health intervention study may contribute to the future efforts to effectively reduce substance use in adolescents while also strategically reducing in-clinic burden for all necessary medical staff.

## **ACKNOWLEDGEMENTS**

I would like to thank Dr. Trace Kershaw, Department Chair and Professor of Public Health, and Dr. Deepa R. Camenga, Assistant Professor of Emergency Medicine, for their invaluable individual support throughout the formation of this thesis project. Additionally, I would like to express my gratitude toward Dr. Michael Pantaloni, Dr. Federico E. Vaca, Dr. Meghan Beucher, and the tremendous medical teams at Yale New Haven Hospital (YNHH) Pediatric Emergency Department / Adolescent Primary Care Center. This research study was funded and supported by the Yale Department of Emergency Medicine New Investigator Award.

## REFERENCES

Aalto M., Seppa K., Mattila P. et al. (2001). Brief intervention for heavy drinkers in routine general practice: a three-year randomized controlled study. *Alcohol and Alcoholism* 36 (1): 224-230.

Academic ED SBIRT Research Collaborative Group (2007). The impact of screening, brief intervention, and referral for treatment on emergency department patients' alcohol use. *Annals of Emergency Medicine* 50 (6): 699-710.

Ammerman S., Ryan S., Adelman W.P. (2015). The committee on substance abuse tcoa. The impact of marijuana policies on youth: clinical, research and legal update. *Pediatrics* 10 (1542): 2014-4147.

Anderson M. & Jiang J. (2018). *Teens, Social Media & Technology 2018*. Pew Research Center: Internet & Technology.

Albarracín D., Gillette J.C., Earl A.N., Glasman L.R., Durantini M.R. & Ho M.H. (2005). A test of major assumptions about behavior change: a comprehensive look at the effects of passive and active HIV-prevention interventions since the beginning of the epidemic. *Psychological Bulletin* 131 (6): 856-897.

Albarracín D., McNatt P.S., Klein C.T., Ho R.M., Mitchell A.L., Kumkale G.T. (2003). Persuasive communications to change actions: an analysis of behavioral and cognitive impact in HIV prevention. *Health Psychology* 22 (2): 166-177.

Anderson J.E., Jorenby D.E., Scott W.J., Fiore M.C. (2002). Treating tobacco use and dependence. *Chest* 121 (3): 932-941.

Berning A., Compton R. & Wochinger K. (2015). *Results of the 2013-2014 National Roadside Survey of Alcohol and Drug Use by drivers*. (DOT HS 812 118). Washington, DC: National Highway Traffic Safety Administration.

Blitchtein-Winicki D., Zevallos K., Samolski M.R., Requena D., Vetarde C., Briceño P., Piazza M., Ybarra M.L. (2017). Feasibility and acceptability of a text message-based smoking cessation program for young adults in Lima, Peru: pilot study. *JMIR mHealth and uHealth* 5 (8): 1-26.

Brook J.S., Adams R.E., Balka E.B., Johnson E. (2002). Early adolescent marijuana use: risk for the transition to young adulthood. *Psychol Med* 32 (1): 79-91.

Brown S.A., McGue M., Maggs J., Schulenberg J., Hingson R., Swartzwelder S., Martin C., et al. (2008). A developmental perspective on alcohol and youths 16 to 20 years of age. *Pediatrics* 121 (1): S290-S310.

Butler L.H., Correia C.J. (2009). Brief alcohol intervention with college student drinkers: face-to-face versus computerized feedback. *Psychol Addict Behav* 23 (1): 163-167.

Carey K.B., et al. (2007). Individual-level interventions to reduce college student drinking: a 1557 meta-analytic review. *Addictive Behaviors* 32 (11): 2469-2494.

Clark D.B., Kirisci L., Moss H.B. (1998). Early adolescent gateway drug use in sons of fathers with substance use disorders. *Addictive Behaviors* 23 (4): 561-566.

Connor G.S., Schofield-Hurwitz S., Hardt J., Levasseur G., Tremblay M. (2009). The accuracy of self-reported smoking: a systematic review of the relationship between self-reported and cotinine-assessed smoking status. *Nicotine Tob Res* 11 (1): 12-24.

Cronce J.M. & Larimer M.E. (2011). Individual-focused approaches to the prevention of college student drinking. *Alcohol Res Health* 34 (2): 210-221.

Degenhardt L. & Hall W. (2012). Extent of illicit drug use and dependence, and their contribution to the global burden of disease. *The Lancet* 379 (1): 55-70.

Delva J. (2004). A study of the relationship between protective behaviors and drinking consequences among undergraduate college students. *Journal of American College Health* 53 (1): 19-27.

Dimeff L.A., Baer J.S., Kivlahan D.R., Marlatt G.A. (1999). Brief alcohol screening and intervention for college students (BASICS): a harm reduction approach. Guilford, New York, NY.

D'Onofrio G., Pantalon M.V., Degutis L.C., et al. (2008). Brief intervention for hazardous and harmful drinkers in the emergency department. *Annals of Emergency Medicine* 51 (6): 742-750.

D'Onofrio G., Fiellin D.A., Pantalon M.V., et al. (2012). A brief intervention reduces hazardous and harmful drinking in emergency department patients. *Ann Emerg Med* S0196-0644 (12) 00151-5.

D'Onofrio G., Pantalon M.V., Degutis L.C., Fiellin D.A., O'Connor P.G. (2005). Development and implementation of an emergency practitioner-performed brief intervention for hazardous and harmful drinkers in the emergency department. *Academic Emergency Medicine: Official Journal of the Society for Academic Emergency Medicine* 12 (3): 249-256.

Fachini A., Aliane P.P., Martinez E.Z., Furtago E.F. (2012). Efficacy of brief alcohol screening intervention for college students (BASICS): a meta-analysis of randomized controlled trials. *Substance Abuse Treatment, Prevention, and Policy* 7 (40).

Federal Bureau of Investigation (FBI) (2012). Estimated number of arrests: United States, 2012 *Crime in the United States 2012: Uniform Crime Reports*. Retrieved from <https://ucr.fbi.gov/crime-in-the-u.s/2012/crime-in-the-u.s.-2012/tables/29tabledatadecpdf>.

Fjeldsoe B.S., Marshall A.L., Miller Y.D. (2009). Behavior change interventions delivered by mobile telephone short-message service. *Am J Prev Med* 36 (2): 165-173.

Gates S., McCambridge J., Smith L.A., Foxcroft D. (2009). Interventions for prevention of drug use by young people delivered in non-school settings. *Cochrane Database of Systematic Reviews* 2006, Issue 1.

Glasman L.R. & Albarracín D. (2006). Forming attitudes that predict future behavior: a meta-analysis of the attitude-behavior relation. *Psychological Bulletin* 132 (5): 778-822.

Grossberg P.M., Brown D.D., Fleming M.F. (2004). Brief physician advice for high-risk drinking among young adults. *Ann Fam* 2 (1): 474-80.

Hall W., Degenhardt, L. (2009). Adverse health effects of Non-medical cannabis use. *Lancet* 374 (1): 1383-1391.

Haug S., Meyer C., Dymalski A., Lippke S., John U. (2012). Efficacy of a text messaging (SMS) based smoking cessation intervention for adolescents and young adults: study protocol of a cluster randomized controlled trial. *BMC Public Health* 12 (51): 1-7.

Head K.J., Noar S.M., Iannarino N.T., Harrington N.G. (2013). Efficacy of text messaging-based interventions for health promotion: a meta-analysis. *Social Science & Medicine* 97 (1): 41-48.

Heather N. (1996). The public health and brief interventions for alcohol consumption: the British experience. *Addictive Behaviors* 21 (1): 857-868.

Heron K.E., Smyth J.M. (2010). Ecological momentary interventions: incorporating mobile technology into psychological and health behaviour treatments. *Br J Health Psychol* 15 (Pt. 1): 1-39.

Higgins J.P.T., Green S. (2011). The Cochrane Collaboration. *Cochrane Handbook for Systematic Reviews of Interventions* 5.1.0.

Huh D., Mun E.Y., Larimer M.E., White H.R., Ray A.E., Rhew I.C., Kim S.Y., Jiao Y., Atkins D.C. (2015). Brief motivational interventions for college student drinking may not be as powerful as we think: an individual participant-level meta-analysis. *Alcohol Clin Exp Res* 39 (5): 919-931.

Jemmott J.B. III (2012). The reasoned action approach in HIV risk-reduction strategies for adolescents. *Annals of the American Academy of Political and Social Science* 640: 150-172.

Jewett A., Shults R.A., Banerjee T., Bergen G. (2015). Alcohol-impaired driving among adults – United States. *MMWR* 64 (30): 814-817.

Jha P., & Peto R. (2014). Global effects of smoking, of quitting, and of taxing tobacco. *N Engl J Med* 370 (1): 60-68.

Johnson K.A., Bonn-Miller M.O., Leyro T.M., Zvolensky M.J. (2009). Anxious arousal and anhedonic depression symptoms and the frequency of current marijuana use: testing the mediating role of marijuana-use coping motives among active users. *J Stud Alcohol Drugs* 70 (1): 543-550.

Johnson B.T., Scott-Sheldon L.A.J., Huedo-Medina T.B. & Carey M.P. (2011). Interventions to reduce sexual risk for HIV in adolescents: a meta-analysis of trials, 1985-2008. *Archives of Pediatrics & Adolescent Medicine* 165 (1): 77-84.

Johnston, L.D., O'Malley P.M., Miech, R.A., Bachman, J.G., Schulenberg, J.E. (2014). Monitoring the future: national survey results on drug use, 1975-2013: overview, key findings on adolescent drug use. *Ann Arbor, MI: Institute for Social Research, The University of Michigan.*

Jonas D.E., Garbutt J.C., Brown J.M., et al. (2012). Screening, behavioral counseling, and referral in primary care to reduce alcohol misuse. *Comparative Effectiveness Review* (64).

Kamb M., Fishbein M., Douglas J.M. Jr., Rhodes F., Rogers J., Bolan G., Peterman T.A., et al. (1998). Efficacy of risk-reduction counseling to prevent human immunodeficiency virus and sexually transmitted diseases: a randomized controlled trial. *JAMA* 280 (13): 1161-1167.

Kaner E., Beyer F., Dickinson H., et al. (2007). Effectiveness of brief alcohol intervention in primary care population. *Cochrane Database Syst Rev.*

Lange R.A. & Hillis L.D. (2001). Cardiovascular complications of cocaine use. *New England Journal of Medicine* 345 (5): 351-358.

Larimer M.E. & Crouce J.M. (2007). Identification, prevention, and treatment revisited: individual-focused college drinking prevention strategies 1999-2006. *Addictive Behaviors* 32 (11): 2439-2468.

Larson E. (1994). Exclusion of certain groups from clinical research. *Journal of Nursing Scholarship* 26 (3): 185-190.

Lenhart A. (2015). Teens social media and technology interview. [http://www.pewinternet.org/files/2015/04/PI\\_TeensandTech\\_Update2015\\_0409151.pdf](http://www.pewinternet.org/files/2015/04/PI_TeensandTech_Update2015_0409151.pdf).

Levy S.J.L., Williams J.F. (2016). Substance use screening, brief intervention, and referral to treatment. *Pediatrics* 138 (1): 1-15.

Mallett K.A., Marzell M., Turrisi R. (2011). Is reducing drinking always the answer to reducing consequences in first-year college students? *J Stud Alcohol Drugs* 72 (2): 240-246.

Mason M., Ola B., Zaharakis N., Zhang J. (2014). Text messaging interventions for adolescent and young adult substance use: a meta-analysis. *Prevention Science* 1 (1): 1-8.

Mosleh S.M., Bond C.M., Lee A.J., Kiger A. & Campbell N.C. (2013). Effectiveness of theory-based invitations to improve attendance at cardiac rehabilitation: a randomized controlled trial. *European Journal of Cardiovascular Nursing* 13 (3): 201-210.

Murray M., Swan A.V., Kiryluk S., Clarke G.C. (1988). The Hawthorne effect in the measurement of adolescent smoking. *Journal of Epidemiology and Community Health* 42 (1): 304-306.

National Highway Traffic Safety Administration (2015). *Traffic safety facts 2014 data: alcohol-impaired driving*. (DOT HS 812 231). Washington DC: U.S. Department of Transportation.

National Institute on Alcohol Abuse and Alcoholism (2011). *Alcohol Screening and Brief Intervention for Youth*.

National Survey on Drug Use and Health: Annual National Report (2016-2017). *U.S. Department of Health & Human Services: Substance Abuse and Mental Health Services Administration*.

Naughton F., Cooper S., Foster K., Emery J., Leonardi-Bee J., Sutton S., Jones M., Ussher M., Whitemore R., Leighton M., Montgomery A., Parrott S., Coleman T. (2017). Large multi-centre pilot randomized controlled trial testing a low-cost, tailored, self-help smoking cessation text message intervention for pregnant smokers (MiQuit). *Addiction* 112 (1): 1238-1249.

Noonam D., Jiang Y., Duffy S.A. (2013). Utility of biochemical verification of tobacco cessation in the Department of Veterans Affairs. *Addict Behav* 38 (3): 1792-1795.

Pechmann C., & Reibling E.T. (2000). Planning an effective anti-smoking mass media campaign targeting adolescents. *Journal of Public Health Management and Practice: JPHMP* 6 (3): 80-94.

Rehm J., Mathers C., Popova S., Thavorncharoensap M., Teerawattananon Y., Patra J. (2009). Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *The Lancet* 373 (9682): 2223-2233.

Rhodes F., Stein J.A., Fishbein M., Goldstein R.B. & Rotheram-Borus M.J. (2007). Using theory to understand how interventions work: Project RESPECT, condom use, and the integrative model. *AIDS and Behavior* 11 (3): 393-407.

Rothmier J.D., Lasley M.V. & Shapiro G.G. (2003). Factors influencing parental consent in pediatric clinical research. *Pediatrics* 111 (5): 1037-1041.

Rounsaville, B. J., Carroll, K. M., & Onken, L. S. (2001). A stage model of behavioral therapies research: Getting started and moving on from stage I. *Clinical Psychology: Science and Practice* 8 (2): 133-142.

Sheeran P. (2002). Intention-behavior relations: a conceptual and empirical review. *European Review of Social Psychology* 12 (1): 1-36.

Seigers D.K. & Carey K.B. (2010). Screening and brief interventions for alcohol use in college health centers: a review. *Journal of American College Health* 59 (3): 151-158.

Simons J. (1998). Validating a five-factor marijuana motives measure: relations with use, problems, and alcohol motives. *Journal of Counseling Psychology* 45 (3): 265-273.

Sobell L.C. & Sobell M.B. (1992). Timeline follow-back: a technique for assessing self-reported alcohol consumption. In: Litten RZ, Allen J, eds. *Measuring Alcohol Consumption: Psychosocial and Biological Methods*. Totowa, NJ: Humana Press: 41-72.

Sokol R.J., Delaney-Black V., Nordstrom B. (2003). Fetal alcohol spectrum disorder. *JAMA* 290 (22): 2996-2999.

Stanton W.R., McClelland M., Elwood C., Ferry D., Silva P.A. (1996). Prevalence, reliability and bias of adolescents' reports of smoking and quitting. *Addiction* 91 (11): 1705-1714.

Stross R. (2008). What carriers aren't eager to tell you about texting. *The New York Times*. Web. <http://www.nytimes.com/2008/12/28/business/28digi.html>.

Stuart R.B. (1971). Behavioral contracting within the families of delinquents. *J Behav Ther & Exp Psychiat* 2 (1): 1-11.

Tanner-Smith, E.E. & Lipsey M.W. (2015). Brief alcohol interventions for adolescents and young adults: a systematic review and meta-analysis. *Journal of Substance Abuse Treatment* 51 (1): 1-18.

University of Michigan (2011). Drug abuse now equals childhood obesity as top public health concern for kids. Ann Arbor, MI: *University of Michigan, C.S. Mott Children's Hospital* 13 (1).

U.S. Department of Health and Human Services (HHS), Office of the Surgeon General. *Facing Addiction in America: The Surgeon General's Report on Alcohol, Drugs, and Health*. Washington, DC. November 2016.

Viswanath K., Rimer B.K., Glanz K. (2015). *Health Behavior: Theory, Research and Practice*. Jossy-Bass Public Health. Print.

Webb T.L & Sheeran P. (2006). Does changing behavior intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin* 132 (2): 249-268.

Wei J., Hollin I., Kachnowski S. (2011). A review of the use of mobile phone text messaging in clinical and healthy behaviour interventions. *J Telemed Telecare* 17 (1): 41-48.

White H.R., Labouvie E.W. (1989). Towards the assessment of adolescent problem drinking. *J Stud Alcohol* 50 (1): 30-37.

Wilson D.K., Wallstone K.A., King J.E. (1990). Effects of contract framing, motivation to quit, and self-efficacy on smoking reduction. *J Appl Social Psychol* 20 (7): 531-547.

Woicik P.A., Stewart S.H., Pihl R.O., Conrod P.J. (2009). The substance use risk profile scale: a scale measuring traits linked to reinforcement-specific substance use profiles. *Addictive Behaviors* 34 (12): 1042-1055.

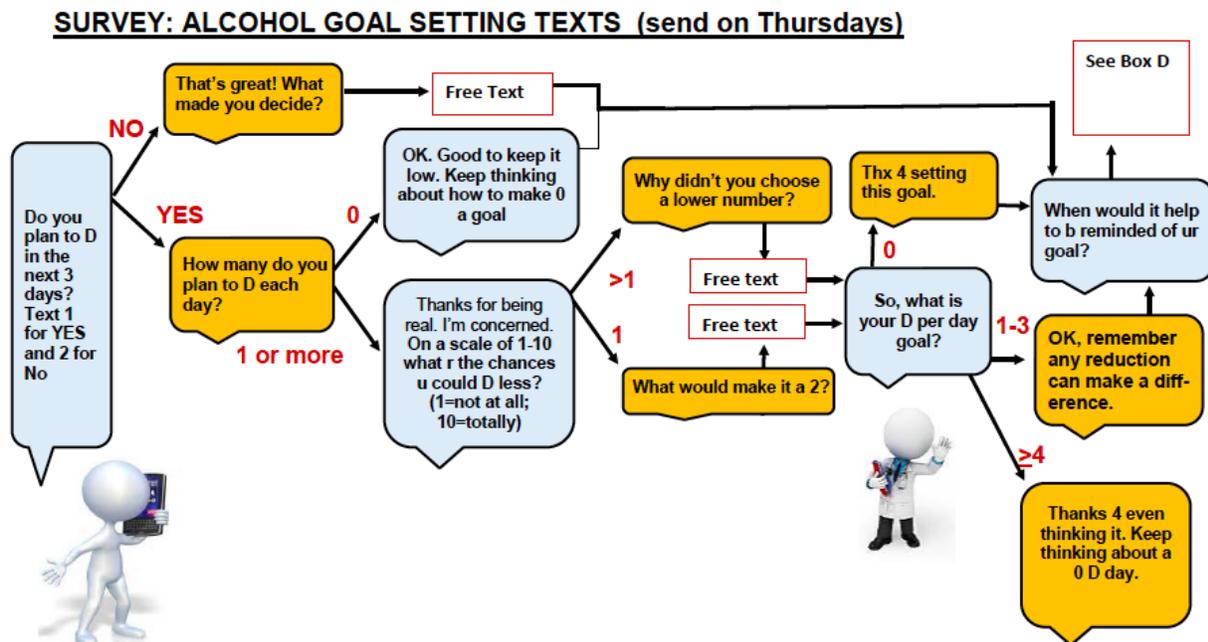
World Health Organization (2002). The World Health Report 2002. Reducing Risks, Promoting Healthy Life. [http://www.who.int/whr/2002/en/whr02\\_en.pdf](http://www.who.int/whr/2002/en/whr02_en.pdf).

Wortham J. (2011). Free texts pose threats to carriers. *The New York Times*. Web. <http://www.nytimes.com/2011/10/10/technology/paying-to-text-is-becoming-passe-companies-fret.html?pagewanted=all>.

Wutzke S.E., Shiell A., Gomel M.K., et al. (2001). Cost effectiveness of brief interventions for reducing alcohol consumption. *Social Science and Medicine* 52 (1): 863-870.

# FIGURES AND TABLES

Figure 1. Sample flowchart of SMS Alcohol Goal Setting, Alcohol Reflection, Marijuana Goal Setting and Marijuana Reflection text-message surveys delivered to study participants.



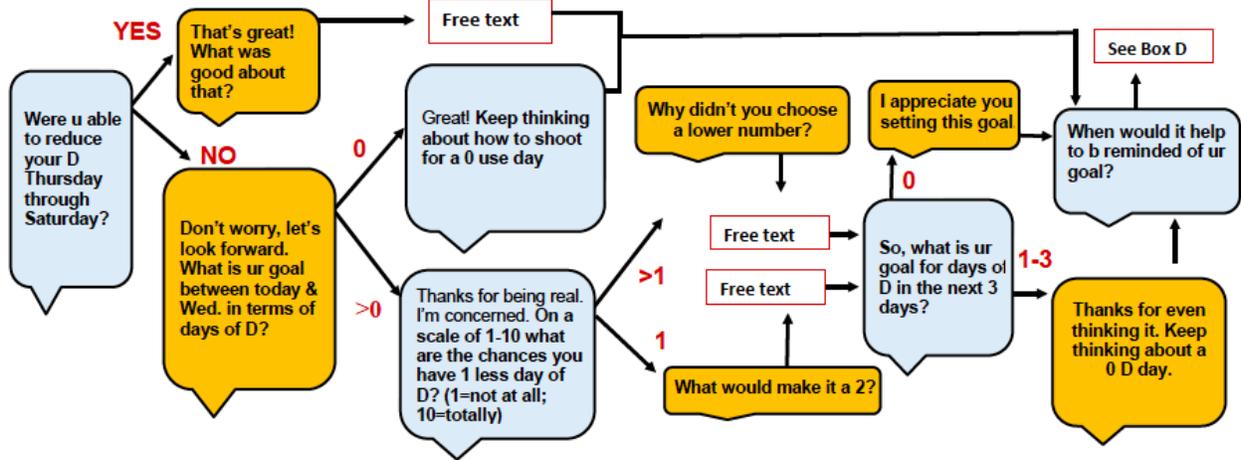
**NOTE: Goal setting texts start with the following two questions:**

1. Is it OK to text for the STAR study now? Text 1 when you are ready.
2. If you feel unsafe or there is an emergency, remember to call 911 or 211. You can also call us at 203-900-4005 with questions. So...Do u plan on using M in the next 3 days? Text 1 for YES or 2 for No.

**D. Message Library: Self-programmed reminders**

1. Friday
2. Saturday
3. Sunday

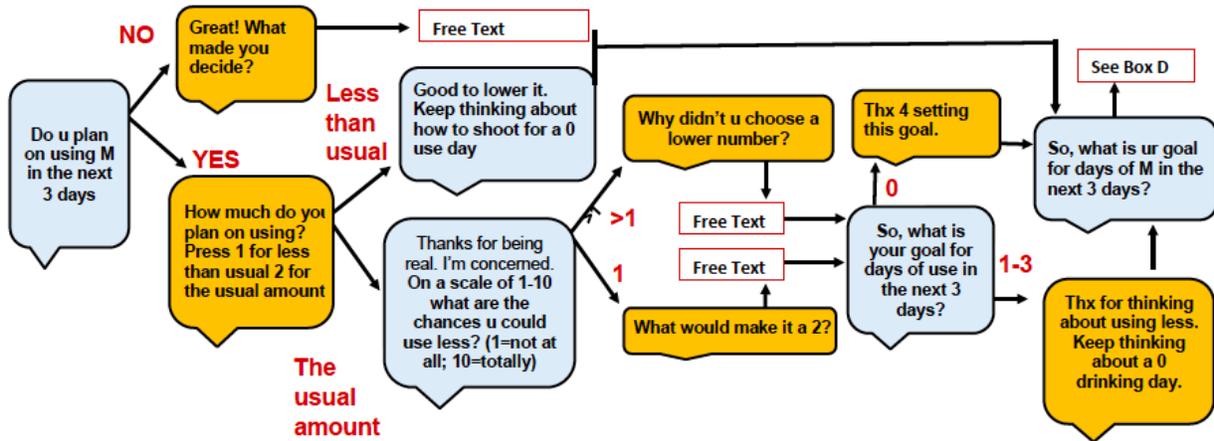
**Survey: ALCOHOL REFLECTION TEXTS (Send on Sundays)**



**D. Message Library: Self-programmed reminders**

1. Friday
2. Saturday
3. Sunday

**Survey: Marijuana Goal setting texts (send ON Thursdays)**



**D. Message Library: Self-programmed reminders**

1. Monday → what time?
2. Tuesday → what time?
3. Wed. → what time?

**NOTE: Goal setting texts start with the following two questions:**

1. Is it OK to text for the STAR study now? Text 1 when you are ready.
2. If you feel unsafe or there is an emergency, remember to call 911 or 211. You can also call us at 203-900-4005 with questions. So... Do u plan on using M in the next 3 days? Text 1 for YES or 2 for No.

**SURVEY: MARIJUANA REFLECTION TEXTS (send on Sundays)**

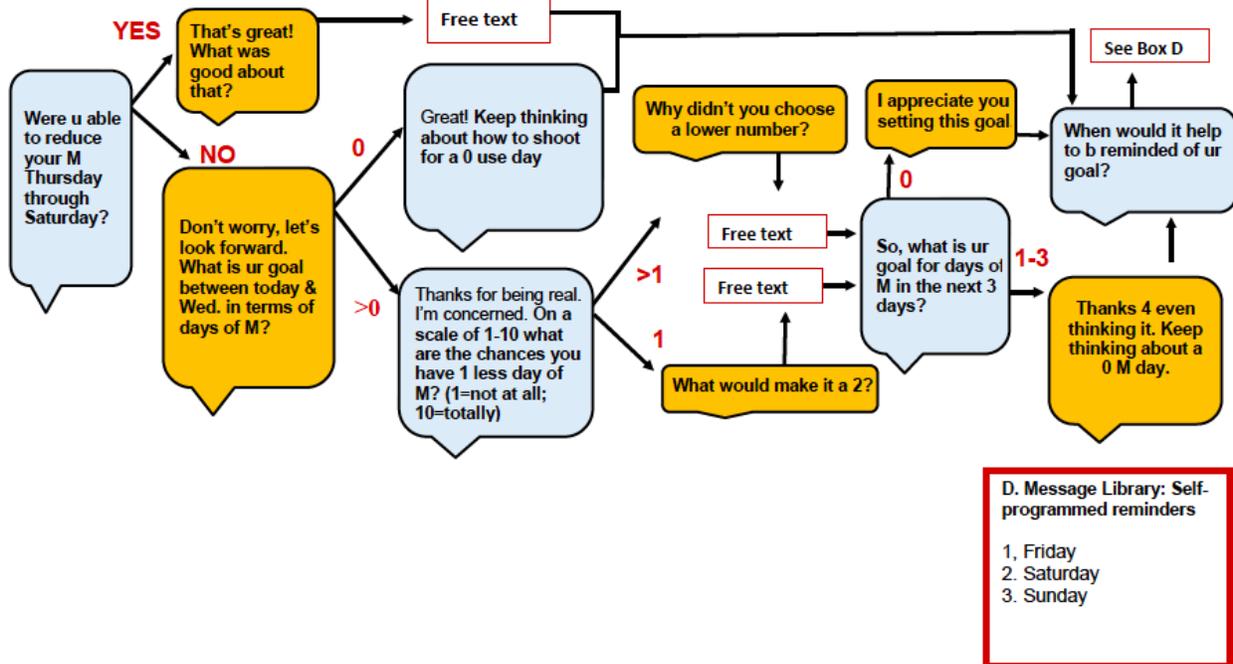


Figure 2. Outline of intervention, clinical recruitment process, and primary outcome measures.

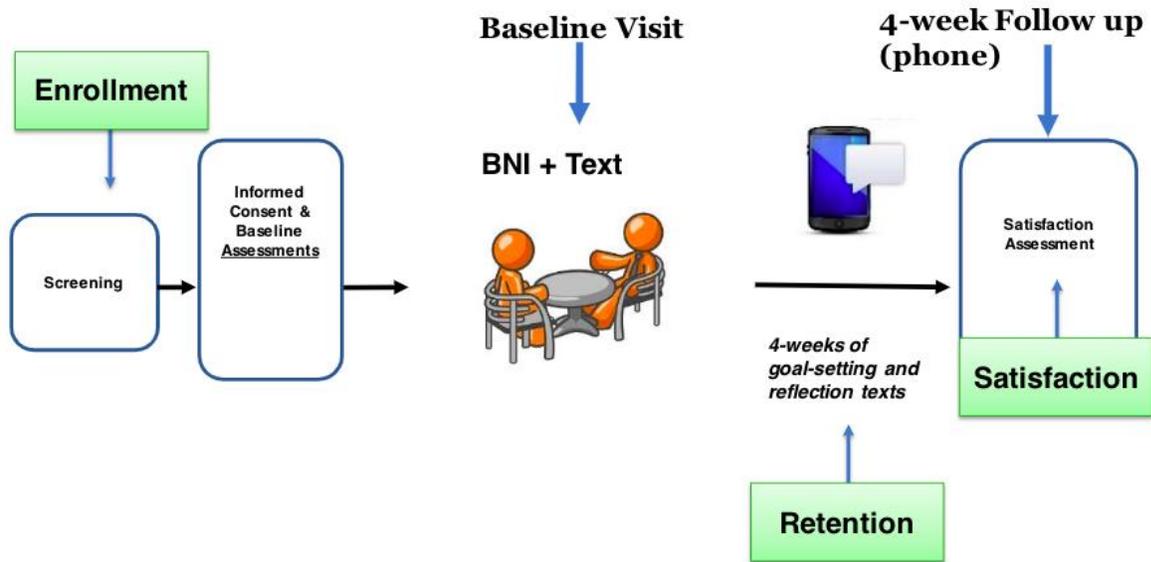


Figure 3. Flowchart of individuals included in the study based on inclusion criteria.

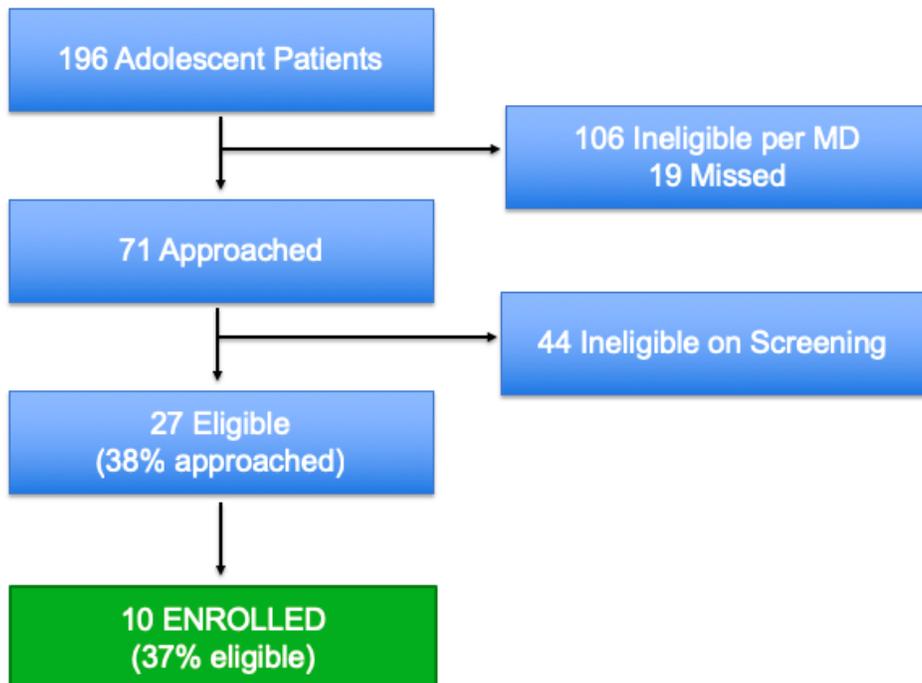


Table 1. Overview of Tailored Text-Messages.

<i>Text Type</i>	<i>Delivery Day</i>	<i>Interactive</i>	<i>Tailoring Variables</i>	<i>Purpose</i>
<i>Goal Setting</i>	Thursdays	Yes	Readiness to change, use-patterns	Set goals for use, enhance motivation
<i>Reflection</i>	Sundays	Yes	Use-patterns	Reflect on past substance use
<i>Reminder</i>	Up to 2x/week	No – scheduled by participant	Self-identified high-probability use times	Provide self-programmed reminders of goals

Table 2. Measures Description and Time of Completion.

<b>Measure</b>	<b>Description</b>	<b>Baseline</b>	<b>4 Week Follow-Up</b>
Demographics (<1 minute)	Age, gender, race, ethnicity, insurance status, education status	X	
Alcohol and Marijuana Use (~5 minutes)	Self-report data on alcohol and marijuana via the 28-day Timeline Follow Back (validated in adolescents and for collection via phone)	X	X
Drug-Related Problems (~8 minutes)	23-item Rutgers Alcohol Problem Index (RAPI), 18-item Rutgers Marijuana Problem Index (RMPI), Youth Risk Behavior Survey questions assessing DWI/RWI	X	X
Technology Use (~2 minutes)	# texts sent/received per day, preferences for text vs. voice calls and use of additional technologies (e.g. Facebook, Twitter)	X	
Potential modifiers of drug use, engagement and retention (~8 minutes)	Parenting practices questionnaire, substance use risk profile scale	X	
Engagement in text messaging program (~5 minutes)	Number of bidirectional prompts replied to, types of replies, use of ‘STOP’ function		X
Reasons for reading/responding to texts (or not) (~5 minutes)	Open-ended responses to semi-structured questionnaire		X

Table 3. Description of Sampled Participants.

Characteristic	Adolescent (N = 10) <sup>a</sup>
Age (years)	16.8 ± 1.4
Sex	
Male	5
Female	5
Race / Ethnicity	
White (Caucasian)	5
Black or African American	5
Other	1
Hispanic	
Yes	2
No	8
Drug Used	
Alcohol	5
Marijuana	8
RAPI Score <sup>b</sup>	3.5 ± 4.4
RMPI Score <sup>c</sup>	10.4 ± 7.1
Parental Monitoring Score	
Mother/Female Guardian	6.4 ± 2.4
Father/Male Guardian	2.5 ± 3.8
SURPS Score	
<i>Hopelessness (H)</i>	19.1 ± 3.0
<i>Anxiety Sensitivity (AS)</i>	13.3 ± 2.9
<i>Impulsivity (IMP)</i>	10.6 ± 2.8
<i>Sensation Seeking(SS)</i>	15.1 ± 3.8

<sup>a</sup> Table values are mean ± SD for continuous variables. Study participants satisfy multiple characteristic traits.

<sup>b</sup> Rutgers Alcohol Problem Index.

<sup>c</sup> Rutgers Marijuana Problem Index.

Table 4. Breakdown of individual text-message program completion.

Text String Type	Percentage Completed (%)
Alcohol Goal Setting	86.0
Alcohol Reflection Survey	70.0
Marijuana Goal Setting	64.0
Marijuana Reflection Survey	64.0

Table 5. Distribution of satisfaction measure responses.

	Response Type N (%)		
	Strongly Agree / Agree	Neutral	Disagree / Strongly Disagree
I liked the content of the message I received.	7 (100.0)	0 (0.0)	0 (0.0)
The text messages were helpful in getting me to try to quit.	5 (88.0)	0 (0.0)	2 (12.0)
The text messages gave me good ideas on how to quit drinking or quit using marijuana.	3 (43.0)	1 (14.0)	3 (43.0)
I would recommend the Mosio program to a friend.	7 (100.0)	0 (0.0)	0 (0.0)
All of these text messages were written specifically for adolescents.	5 (88.0)	0 (0.0)	2 (12.0)
The text messages came at the right time of day.	5 (88.0)	0 (0.0)	2 (12.0)