HHS Public Access

Author manuscript

Drug Alcohol Depend. Author manuscript; available in PMC 2022 April 01.

Published in final edited form as:

Drug Alcohol Depend. 2021 April 01; 221: 108625. doi:10.1016/j.drugalcdep.2021.108625.

Piloting a Brief Intervention Plus Mobile Boosters for Drug Use among Emerging Adults Receiving Emergency Department Care

Erin E. Bonar[a,b,c], **Rebecca M. Cunningham**[b,d,e,f], **Emily C. Sweezea**[a], **Frederic C. Blow**[a,g], **Laura E. Drislane**[a,h], **Maureen A. Walton**[a,b]

[a]Addiction Center, Department of Psychiatry, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd. Building 16, Ann Arbor, MI 48109, USA

[b]Injury Prevention Center, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd. Building 10, Ann Arbor, MI 48109, USA

[c]Center for Sexuality and Health Disparities, University of Michigan, 400 North Ingalls Street, Ann Arbor, MI 48109, USA

[d]Department of Emergency Medicine, University of Michigan, North Campus Research Complex, 2800 Plymouth Rd. Building 10, Ann Arbor, MI 48109, USA

[e]Department of Health Behavior and Health Education, School of Public Health, University of Michigan, 1415 Washington Heights, Ann Arbor, MI 48109, USA

[f]Emergency Medicine, Hurley Medical Center, 1 Hurley Plaza, Flint, MI 48503

[g]VA Center for Clinical Management Research, North Campus Research Complex, 2800 Plymouth Rd Bldg 16, Ann Arbor, MI 48109-2800

[h]Department of Psychology and Philosophy, Sam Houston State University, 1901 Avenue I, Huntsville, TX 77340

Abstract

Purpose: There are few efficacious prevention interventions for emerging adults (ages 18–25) drug use and concomitant risks (e.g., sexual risk behaviors). We developed and evaluated the feasibility and acceptability of an Emergency Department (ED)-initiated brief intervention (BI) combined with booster messaging as a clinician-extender primarily focusing on drug use, with a secondary focus on condomless sex. We examined descriptive outcomes of alcohol, drug use, and condomless sex.

Contributors: Dr. Bonar led the trial, analysis, and drafting of the manuscript, with mentorship from her K23 mentors, Drs. Walton and Cunningham, and contributor, Dr. Blow, whom all provided important scientific mentorship as well as contributed to the drafting of the manuscript. Ms. Sweezea was the study coordinator who supervised the trial and staff, contributed to the writing of the methods and final draft of the manuscript. Dr. Drislane provided clinical supervision on the trial and contributed to the drafting of the manuscript. All authors approve the manuscript and its submission to this journal.

Conflict of interest: The authors do not have any personal financial interests related to the subject matters discussed in this manuscript.

Procedures: We recruited N = 63 emerging adults who used drugs (primarily cannabis) from an ED (72.4% participation rate). Their mean age was 21.7 years (SD = 2.3); 67% were female and 52.4% were Black/African American. Participants randomized to the intervention (N = 31) received a BI and 28 days of tailored booster messaging (based on drug use motives) daily, and the control condition received a community resource brochure. A post-test occurred at 1-month with a follow-up at 2-months.

Results: The intervention was well-received (83.9% allocated completed the BI) with 79% overall liking the BI and 71% finding it helpful to discuss substances. Mean ratings of booster messages were ≥4.0 (5-point scale); 77% liked the daily messages and 91% found them helpful. Descriptively, the intervention group evidenced absolute reductions over time on alcohol outcomes, cannabis use, and condomless sex.

Conclusions: This BI with booster messages was feasible and acceptable in the target population of emerging adults who use drugs (i.e., mostly cannabis). This intervention model, initiated during a healthcare visit and accompanied by a clinician-extender, should be tested in a future fully-powered trial.

Introduction

Emerging adults (ages 18–25) have the highest rates of past-year and past-month drug use in the United States (38.7% and 23.9%, respectively), which is mostly comprised of cannabis use, followed by misuse of prescription medications (tranquilizers/sedatives, stimulants, opioids) (Substance Abuse and Mental Health Service Administration, 2019). It is well-documented that drug use among young people increases risk for negative health and social outcomes (Bonar et al., 2020; Danielsson et al., 2014; Fallu et al., 2014; Hammond et al., 2020; O'Connor et al., 2020a), including sexually transmitted infections (STIs) and HIV/AIDS (Banks et al., 2020; Tapp and Hudson, 2020). Given that emerging adults are in a distinct developmental period of transitions (e.g., increased independence, entering the work force) involving increased risk-taking (including unprotected sex; Arnett, 1992), drug use during this period can confer acute negative consequences (Sussman and Arnett, 2014). Thus, prevention interventions tailored for this population are needed to curtail development of drug use disorders (Stone et al., 2012) and related negative health outcomes (e.g., HIV/AIDS, STIs).

Brief intervention (BI) approaches to prevention of substance use among adolescents and adults are recommended (Aldridge et al., 2017; Babor et al., 2017; Beaton et al., 2016), with such approaches often drawing on Motivational Interviewing (MI), an evidence-based psychotherapy approach to increasing health behaviors (Miller and Rollnick, 2013). Data are lacking on efficacious BIs for drug use specifically developed for and delivered to emerging adults. A 2020 review from the U.S. Preventive Services Task Force (O'Connor et al., 2020) identified 29 trials of prevention interventions for adolescents, children, and emerging adults with a primary focus on drug use. Only 2 trials focused exclusively on emerging adults, a study of 19 year-old males in Switzerland (Gmel et al., 2013) (a 20-min BI with a randomized booster) and another study of American college students (Lee et al., 2010) (web-based personalized feedback session), which both found no differences in drug use between intervention and control groups. In contrast, another recent review concluded that

1–2 session BIs can result in short-term reductions in cannabis use and symptoms of cannabis use disorders among emerging adults (Halladay et al., 2019). Further, other studies not included in this review found, among samples eligible for alcohol use, longer-term reductions in cannabis use among emerging adults in college (Yurasek et al., 2015) and in the Emergency Department (Magill et al., 2009).

Although this literature supports the promise of BIs tailored for emerging adults' drug use, inconsistent data regarding sustainability over time (McCambridge and Strang, 2005) has led to research testing the inclusion of booster sessions to enhance and sustain efficacy (Blow et al., 2017). Few studies have tested the benefits of boosters among emerging adults. For example, an alcohol-focused BI that included booster phone calls reduced cannabis use, with effects sustained at 12-months (Magill et al., 2009). Further, the widespread adoption of smartphones (Anderson, 2019), creates opportunities for booster messaging, extending beyond the scheduled phone call or therapy session, to deliver content as emerging adults navigate their daily lives.

In a Stage I pilot trial (Onken et al., 2014), we developed and piloted an in-person BI for emerging adults' drug use that was supplemented by booster messages delivered via a mobile app for 4 weeks post-BI. Recruitment and initiation of the intervention occurred in an inner-city emergency department setting in an under-resourced community where drug use, particularly cannabis, is common among emerging adults (Bohnert et al., 2015; Bonar et al., 2017; Cunningham et al., 2014) and where efficacious drug and alcohol BIs have been delivered previously (Blow et al., 2017; Walton et al., 2010). Further, given increased rates of sexual risk-taking (Bonar et al., 2017a; Bonar et al., 2017b; Bonar et al., 2016; Walton et al., 2011), particularly among young people using drugs (Arnett, 1992, 2005; Stone et al., 2012), we capitalized on this clinical opportunity to address unprotected sex (i.e., one of several possible sexual risk behaviors) from a public health standpoint. Thus, unprotected sex was a secondary intervention focus, consistent with other efficacious drug BIs (Blow et al., 2017; Parsons et al., 2014; Tucker et al., 2017). Herein, our primary purpose is to describe findings from this pilot study regarding intervention feasibility and acceptability, with additional preliminary data presented regarding substance use and condomless sex as primary and secondary outcomes, respectively.

Method

Study Design

We conducted a pilot randomized controlled trial (RCT) for emerging adults (ages 18–25) with recent drug use and sexual risk behavior who presented to an inner city ED for medical care. At the baseline ED visit, participants were randomly assigned to either an intervention or enhanced usual care control (EUC) group, with a post-test 1 month later and a follow-up assessment at 2-months. Procedures were approved by the institutional review boards at University of Michigan and Hurley Medical Center. A Certificate of Confidentiality was provided by the National Institutes of Health.

Setting and Patient Population

Participants were recruited from the level-one trauma center ED at Hurley Medical Center in Flint, Michigan. Patients ages 18–25 were identified using the ED's electronic medical record (EMR). Exclusion criteria for screening included inability to read/speak English, hearing/visual impairment, ED presentation for acute sexual assault or suicidality, and medical conditions precluding informed consent (e.g., acute psychosis, unconsciousness). We excluded participants from the site who completed a prior study that informed intervention development (Bonar, E. E. et al., 2017a).

Study Protocol

Participants were recruited between October 2017 and August 2018. Research Assistants (RAs) identified patients eligible for approach via the EMR, located them in the ED, described the study, and obtained informed consent among interested participants. Screening involved a 10-minute survey self-administered on a tablet computer. A gift valuing $1 (e.g., puzzle book, earbuds, lotion), was provided as screening compensation. RCT eligibility criteria were: 1) past 28-day use of drugs (i.e., cannabis, cocaine, methamphetamine, inhalants, hallucinogens, street opioids) or misuse of prescription stimulants, sedatives or sleeping pills, or prescription opioids; 2) condomless sex in the past 28 days, 3) having a smartphone, and 4) unmarried. Eligible participants were invited to participate in the trial, where voluntary enrollment was emphasized and randomization was explained during informed consent with the control group receiving a 5-minute health resource brochure and the intervention group described as a 30-minute discussion of health, future health goals, and plans for reaching health goals. Interested individuals completed a written informed consent for the RCT, followed by a ~20-minute baseline survey and a semi-structured Timeline Follow Back (TLFB) interview lasting ~17 minutes (assessment compensation was $20 cash), a urine drug screen (UDS; $5 cash), and a rapid point-of-care saliva-based HIV test ($5 cash). Procedures were paused during periods of medical care or testing (e.g., blood draws, exams, x-ray).

Upon completion of the above activities, participants were randomized to an EUC control condition or the intervention condition. Urn randomization occurred in blocks of 4, balanced by age (18–21, 22–25), sex, and frequency of the drug they used most often (1–20 days in past 28; 21–28 days, chosen based on preliminary work at the study site). The EUC involved a brief 2-minute review of a community resource brochure (e.g., substance use treatment, suicide prevention, social services) that included educational content regarding the impact of substance use on health and pregnancy, tips for avoiding substance use or engaging in harm reduction, and prevention and testing for HIV and STIs. Intervention participants received the brochure and brief overview in order to control for information receipt. All participants completed a <5-minute immediate post-test with ratings of the BI/EUC, and were scheduled for a 1-month online post-test ($10 gift card), and 2-month follow-up assessment ($25 survey, $5 UDS), which was completed in-person when possible with the RA blinded to condition assignment. Participants randomized to the intervention group received a BI and post-test, and then were prompted to download the LifeData app, a mobile application used by researchers to deliver messages and collect data from participants in their daily lives. Within this app, intervention participants completed a single-item daily rating of a message

received, for which they received $1 per daily message rating (up to $28 dollars paid after the 1-month post-test).

Measures

Eligibility and background characteristics.—Items were adapted from prior work to assess demographics and background characteristics (e.g., race/ethnicity, marital status, etc.; Johnston et al., 2011). Drug use eligibility was based on whether participants indicated using these substances in the past 28 days (Smith et al., 1996; Smith et al., 2006): cannabis, cocaine, methamphetamine, inhalants, hallucinogens, street opioids, and misuse of prescription stimulants, sedatives, or opioids. Past 28-day condomless sex was measured based on an adaptation from Monitoring the Future (Johnston et al., 2010). Smartphone ownership was queried with an item we created. Additionally, using standard chart review procedures (Bohnert et al., 2015), we coded participant's baseline ED visit as medical or injury, with the visit also being coded as related to alcohol or drugs or not.

Timeline Follow Back (TLFB).—Research staff administered the TLFB semi-structured interview assessing substances used (those listed above) and condomless sexual intercourse (Weinhardt et al., 1998) for a period of 28 days (i.e., 4 weeks) at baseline and 56 days (i.e., 8 weeks) at the follow-up assessment. We showed photos of a ½ gram cannabis in loose and joint form to aid participants' recall of cannabis quantity during the interview (Collins et al., 2014). For analyses, and ease of interpretation, we calculated separate TLFB values for the first month after baseline (i.e., concurrent with booster message delivery) and the second month (i.e., after booster message end). Variables examined included total cannabis consumption (in joints; e.g., total joints/28 days reported * 30 days in a month), drinks per month, substance use days per month (including alcohol and cannabis), and the percentage of days of sexual intercourse where condom use did not occur.

BI acceptability.—Participants rated acceptability of the BI session on the immediate post-test using 9 items with Likert-style response options (0 to 4 range, where 4 is the best possible response) that were developed for this study.

Booster message acceptability.—Participants rated each daily message after viewing, and at the 1-month post-test they provided overall ratings of the booster messaging program. Ratings were from 1 to 5 ("hate it" to "love it").

Intervention condition

The intervention consisted of a BI counseling session and daily booster messages tailored to substance use motives sent via a mobile app. The BI used Motivational Interviewing and was informed by a prior data at the study site, including an efficacious brief intervention among adults (Blow et al., 2017a; Bonar et al., 2018), and data from emerging adults indicating that cannabis use, in particular, was common, and that motives for cannabis use were associated with same-day quantity (Bonar et al., 2017). Although our prior work (Blow et al., 2017; Bohnert et al., 2015; Bonar et al., 2017a) indicated that cannabis would likely be the most frequently used substance in our sample, the BI and messages were designed to address any substances used by the participant (e.g., cannabis, other drugs, alcohol). After developing

prototypes of the BI and daily messages, we recruited 7 individuals (4 female, 3 male) using the procedures above to obtain feedback that was used to finalize the intervention components. For the RCT, intervention and control procedures (e.g., recruitment, BI, EUC) were completed by bachelor's level research staff with training in Motivational Interviewing from the PI (a member of the Motivational Interviewing Network of Trainers). BI sessions were audio-recorded for review in ongoing group and individual supervision, which was provided by the PI and a post-doctoral fellow in clinical psychology with experience and training in MI and substance use.

BI counseling session.—The BI was designed for delivery in a ~45-minute session (M = 45, SD = 23) and included a tablet-based computer decision support tool. The touchscreen tablet provided prompts and guidance to assist the counselor in maintaining fidelity, keeping track of the intervention progress if interrupted for medical care, and capturing participants' selections throughout the intervention. The intervention was rooted in the *Explore, Guide, Choose* model of MI (Resnicow and McMaster, 2012) with components in each phase shown in Table 1. The primary focus was on substance use; however, unprotected sex was briefly addressed. Counselors used MI skills to guide the participant through the components, selectively reflecting change talk, building self-efficacy through affirmations, and developing a plan for next steps and use of tools, consistent with MI-based mechanisms of change [e.g., diminishing sustain talk and increasing self-efficacy and change talk (Apodaca and Longabaugh, 2009; Magill and Hallgren, 2019)]. Unique to this intervention and informed by pilot work (Bonar et al., 2017), the counselor elicited participants' motives for substance use [i.e., coping, enhancement, social, conformity, boredom, pain/sleep, other (which included the ability to capture participants' response in their own words)]. Participants could discuss any motives that were salient to them, and the therapist collaboratively helped establish the participants' top three most salient motives, which were rank-ordered by participants. Participants top three motives for substance use (which can vary across substances) later populated tailored tools to address substance use motives in the tools section. When choosing these tools, participants could identify multiple tools associated with their motives, but also indicated their most preferred tool or strategy (i.e., to assist in planning for change). Out of 42 tools (7 per listed motive) examples of tailored tools covered in the intervention screens include: distraction, relaxation, meditation, positive self-talk for *coping* motives, enjoyable leisure activities, alternative activities, physical activity for *enhancement* motives, focus on hobbies, obtaining support, removing drugs and/or paraphernalia for *boredom* motives, and pain management strategies, walking in a safe location, and identifying past effective strategies for *health* motives. The corresponding motive associated with their most preferred tool was used to tailor their receipt of subsequent booster messages.

Daily messages.—Study staff trained participants in downloading the app and installing our study-specific, tailored "Lifepak" set of prompts. As part of an in-app "start-up" session, participants were trained how to navigate the app, including the message rating task, as well as locating study contact information and community resources (both accessible 24/7). The training reviewed: a) that daily prompts would arrive at 11am notifying participants of their daily message, b) the requirement that daily ratings be completed before 11:59pm to receive

compensation, c) that they would receive a reminder at 4pm if they had not yet rated the message, and d) that they needed to keep the application on their device until study completion. Participants who did not have their phone available were given an information sheet and verbal description of how to install the app, followed by a telephone call within 72 hours of enrollment to offer assistance.

Standard daily messages covered benefits of reducing substance use (N = 8), goals (N = 4), affirmations of strengths (N = 4), and sexual risk reduction (N = 4). Goals, affirmations, benefits, and provision of messages focusing on tools are consistent with Motivational Interviewing theory (Miller and Rollnick, 2013; Miller and Rose, 2009), and were, in particular, conceptualized as potential active ingredients that enact MI spirit and reinforce elements verbalized in the BI session (i.e., benefits of change are change talk, goals help develop discrepancy with current behaviors). Messages reflecting substance use (N = 8) were tailored based on the "top motive" (i.e., most salient) selected during the BI session. Messages were MI-consistent text overlaid on stock photo images (e.g., sports field, park bench, camp fire). After viewing the message, participants rated it on a 1–5 Likert-type scale (1 = hate it, 5 = love it) and then received a novel greeting (e.g., humorous memes, images expressing appreciation) as a "thank you" for their rating. Once a week, participants received an open prompt querying their goals or something important to them.

Data Analysis

Most data presented herein are descriptive in nature. To examine demographic differences between those randomized to the intervention and control group we used t-tests and chi-square analysis. To descriptively examine measurements of key outcomes among groups from baseline to 1-month (end of intervention period), and baseline to 2-month follow-up, we present available data based on follow-up completion.

Results

Sample characteristics

Demographic characteristics are shown for the full sample and by condition in Table 2. The mean age of the sample was $M = 21.7$ years ($SD = 2.31$). Most were female (66.7%), Black/African American (52.4%), and receiving public assistance (55.6%). Demographic variables did not significantly differ by condition assignment.

Based on chart review, most participants were attending the ED on the day of enrollment for a medical reason (79.4%) or injury (15.9%), with 1.6% for psychiatric reasons and 3.2% undetermined due patient enrolling and leaving before triage). Only 2 (3.2%) had a baseline visit coded as related to alcohol or drug misuse. At baseline, total substance use days (alcohol, cannabis, and other drugs) occurred on average 14.29 (SD = 9.71) days in the past month, and cannabis was the substance most often consumed, with an average of 56.29 (SD = 107.44) joints in the past month. Participants drank an average of 11.42 drinks over the past month. As shown in Table 2, there were no statistically significant baseline differences between groups on condomless sex and substance use variables, except that alcohol consequences were significantly higher in the intervention than the control group. Five

individuals declined the baseline HIV test, 57 had negative results, and 1 result was inconclusive.

Feasibility.—During recruitment shifts, there were 788 ED visits by individuals ages 18–25 whom were eligible to approach (See Figure 1). Largely due to the limited pilot trial staffing, we missed 34.6% of patients eligible to approach (e.g., recruiter with another participant, patient discharged/admitted). The RA approached 516 participants, 65.7% consented to screening, 25.7% were eligible, and among those eligible 72.4% agreed to participate.

Thus, 63 participants were enrolled, completed baseline, and were randomized to conditions. The baseline survey lasted $M = 21$ minutes, the TLFB lasted $M = 17$ minutes, and the intervention lasted $M = 32$ minutes. All participants allocated to the control received their assigned, whereas 83.9% allocated to the intervention group received the BI (i.e., 5 of 31 were intent to treat). Further, 4 participants in the intervention group did not install LifeData and did not receive the booster messages.

Acceptability

BI.—Overall, participants rated the BI favorably (see Table 4). For example, over two-thirds liked talking to the counselor (79%), liked the session overall (67%), found it helpful to discuss goals, strengths, and values (75%), and found it helpful to discuss substance use (71%). Although a number of people rated aspects of the session as “neutral” (e.g., 46% for benefits of changing substance use, 42% for steps to take toward goals), there were no unfavorable ratings across these components.

Booster messages.—In the daily ratings, participants generally rated the messages favorably, with all means ≥ 4.0 (Table 5). Of the non-tailored messages, affirmations were rated highest ($M = 4.3$, $SD = 0.7$), followed by goals ($M = 4.2$, $SD = 0.7$), benefits of changing drug use ($M = 4.1$, $SD = 0.8$), and sexual risk reduction ($M = 4.1$, $SD = 0.9$) topics. Participants received tailored messages for coping ($n = 14$), health ($n = 4$), enhancement ($n = 3$), or boredom ($n = 1$) motives; none selected conformity or social as top motives. Boredom motives messages had the highest average rating ($M = 4.5$), but only one person received these messages. Health motives messages were rated next highest ($M = 4.3$, $SD = 1.0$), followed by coping ($M = 4.2$, $SD = 0.6$), and enhancement ($M = 4.0$, $SD = 1.4$). When asked to type in a goal or something important for the next week, between 59% to 82% of participants provided a response. Responses spanned a number of topics including things such as school and job-related goals (e.g., “Starting my new job,” “I need to start studying for finals,”), family events or stating the importance of family (e.g., “My nephew’s birthday,” “My son.”), daily living tasks (e.g., “Getting my car looked at,” “Finding housing.”), and well-being (e.g., “I hope to not feel as stressed and take things one thing at a time,” “Taking care of my body”).

At the 1-month post-test, 77.3% of intervention participants liked the daily messages and 90.9% found them helpful. Further, 68.2% indicated that the messages helped them feel good about themselves, with 59.1% saying they learned more about themselves. Although negative ratings were less common one person did not find the program helpful (4.6%), two

people said that substance use-focused messages (9.1%) were not helpful or somewhat unhelpful, and two (9.1%) disagreed with the statement that they learned more about themselves because of the messages. At the same time, most participants (81.8%) desired more messages whereas only four (18.2%) said there were too many. Most (72.7%) liked receiving a thank you message after their rating.

Descriptive behavioral outcomes

Measurements of pre-registered (NCT 03079856) outcomes interest are shown in Table 5. Descriptively, there were greater absolute reductions in intervention vs. control groups in quantity of cannabis consumption, alcohol consumption (drinks per month), alcohol consequences, and percentage of condomless sex days. Substance use days per month appeared stable in the intervention group and declined in the control group whereas reported substance use consequences appeared to decline in both groups.

Discussion

We conducted a pilot randomized controlled trial of a brief intervention combined with booster messaging among drug-using emerging adults who presented to an ED for care. Results support the promise of this extended intervention in terms of feasibility and acceptability. First, many liked talking to a counselor during their ED visit, even though they were not seeking such behavioral counseling. The strengths-based MI approach likely facilitated rapport and allowed participants to feel comfortable sharing about their substance use and sexual behaviors, as the BI was rated as helpful by 71% of participants. Discussions of benefits of change, a core component the MI-based decisional balance exercises and mechanism for promoting change talk, was rated as helpful by just over half of participants (with no one rating this as not helpful), potentially reflecting ambivalence to change given participants were not seeking care for substance use. Although it was not comprehensive in nature, the intervention also addressed sexual risk reduction (i.e., unprotected sex) as a secondary behavioral target, and fewer participants found this helpful (62.5%), although no one rated this topic as unhelpful.

At the daily level, overall the booster messages, including those covering sexual risk reduction and those tailored to participants' drug use motives, were rated positively, averaging just over 4.0 on a 5-point scale. Ratings after the booster period also reflected high acceptability (i.e., 91% said the messages were helpful). Yet, in a parallel fashion to ratings of the BI session and likely reflecting the pre-contemplative status of the sample, substance use specific messages were less well-received (64% found them helpful, 10% not helpful/unhelpful). At the same time, the majority of participants desired more than 1 message per day and they enjoyed receiving novel greetings (e.g., memes, images) as a "thank you" for rating. These novel thank you messages could be used in future research to refine intervention messages with minimal burden. Our booster messages were considered "push" messages, where participants could not reply back on most days; a weekly "pull" message about participants' goals yielded responses 60–80% of the time, which resulted in thoughtful responses, with no inappropriate responses received.

With regard to trial feasibility, the eligibility rate was 25%, which is consistent with national data on emerging adults' drug use at the time the study occurred (Substance Abuse and Mental Health Service Administration, 2019). Further, the rate of baseline enrollment and randomization (72.4%) was just below the 74.6% found among adults at the study site who also used drugs (Blow et al., 2017). Lower intervention completion and follow-up rates in this pilot compared to other work at this setting (Blow et al., 2017; Cunningham et al., 2015) may reflect the limited staffing for this pilot, as extensive tracking efforts require greater resources (Roche et al., 2018). The BI completion rate was 84%, and slightly lower than prior research at the study site which yielded somewhat higher completion rates in prior BI studies (>90%; Blow et al., 2017; Walton et al., 2010) which may have reflected extended ED wait times at that time wherein procedures could be accomplished prior to formal discharge. Notably, 4 participants assigned to the intervention did not fully install the app to receive boosters, because they did not have their phones in the ED, the phone battery died, and/or they did not complete instructions, which underscores the benefit of having chargers available, and the need to complete all enrollment procedures during the ED visit (without disrupting clinical care).

When considering behavioral outcomes, it is important to note that pilot RCTs such as this are typically under-powered, and can provide unstable estimates (Kraemer et al., 2006), particularly given the small sample size. Nonetheless, the intervention may have resulted in short-term reductions in alcohol use and consequences relative to the control (intervention groups declined, control groups increased at 2 months). Given baseline variation between groups in this small pilot trial, regression to the mean could explain these data. Further, alcohol use was not an eligibility criterion; however, the intervention did address any substances the participant used, querying alcohol separately from drugs during the BI. Given that alcohol was the second most frequently consumed substance among this sample, these findings are worth exploring in future research. Data for cannabis use, and other drug use were promising given the greater absolute reductions in the intervention condition versus the control condition. Further, measuring cannabis consumption is a challenge for the field, and there is no agreed upon gold standard measurement to capture consumption for clinical trials given varying potency and routes of administration (Loflin et al., 2020). As the substance use field moves toward embracing functional measures of outcome (Witkiewitz et al., 2019), inclusion of such measures in future research examining this intervention is recommended, particularly given participants' reports of feeling the program helped them focus on important goals, feel good about themselves, and to learn more about themselves.

Although this pilot study provides promising acceptability data for this BI with tailored mobile boosters, there are some limitations. First, this ED population of racially-diverse emerging adults in an under-resourced community is not representative of the general population of emerging adults; however, this at-risk population needs prevention services given health disparities in access to services, and the ED visit presents a window of opportunity to initiate interventions. As mentioned above, our analyses are under-powered given this is a pilot study and although the trial included urn randomization, there was wide variation in baseline measurement on key outcomes, suggesting caution when interpreting descriptive behavioral outcomes. Although only two visits were coded as substance-related, it is possible that changes in substance use could follow from the reasons that led

participants to the ED in the first place, and thus future large scale trials could consider allocating resources to collect more fine-grained detail about participants' health conditions. As unprotected sex was a secondary focus, our intervention was not comprehensive in targeting this behavior, and follow-ups were short-term, thus we did not assess biological indicators of sexual risk (HIV or STI testing) in this pilot trial. Finally, reliance on self-report data is sometimes viewed as a limitation, however, self-report of substance use is valid (Simons et al., 2015), and we used the Timeline Follow Back method, which is reliable and valid.

Given the continued need for interventions to reduce drug use and concomitant risks (e.g., unprotected sex), and in particular cannabis use, especially given the growing legalization of recreational cannabis use in the U.S., a fully powered trial is warranted to further test this well-received and promising intervention. Also, given the efficacy of our prior drug-focused BIs on cannabis and sexual risk outcomes (Blow et al., 2017; Bonar et al., 2018), future research could employ a dismantling approach to examining the current intervention (e.g., BI only vs. BI+booster messages) to help determine the most efficient approach and/or whom would benefit most from extending dose in order to aid dissemination. Further, in the COVID-19 context, delivery of the BI via video therapy from a telemedicine hub with seamless integration into the ED clinical care flow could be tested, with the mobile message boosters being beneficial as contactless therapy clinician extenders.

Acknowledgements:

We extend our gratitude to the patients and staff of Hurley Medical Center who made this study possible. We thank Ms. Linping Duan for statistical support.

Role of Funding Source:This work was funded by the National Institute on Drug Abuse (DA #036008; PI Bonar). Center support was provided the Centers for Disease Control and Prevention to the UM Injury Prevention Center (CE #002099; PI Cunningham). Dr. Drislane's effort was supported in part by a training grant from the National Institute on Alcohol Abuse and Alcoholism (AA #007477, PI Blow). These institutes had no role in the design, conduct, analysis, or reporting of data.

Funding: DA036008; CE002099; AA007477

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Highlights

- Preventive interventions are needed for drug use among emerging adults.
- A motivational interviewing brief intervention with app boosters was acceptable.
- The brief intervention with booster messaging was feasible in the study sample.
- Exploratory behavioral outcomes highlight the need for a fully powered trial.

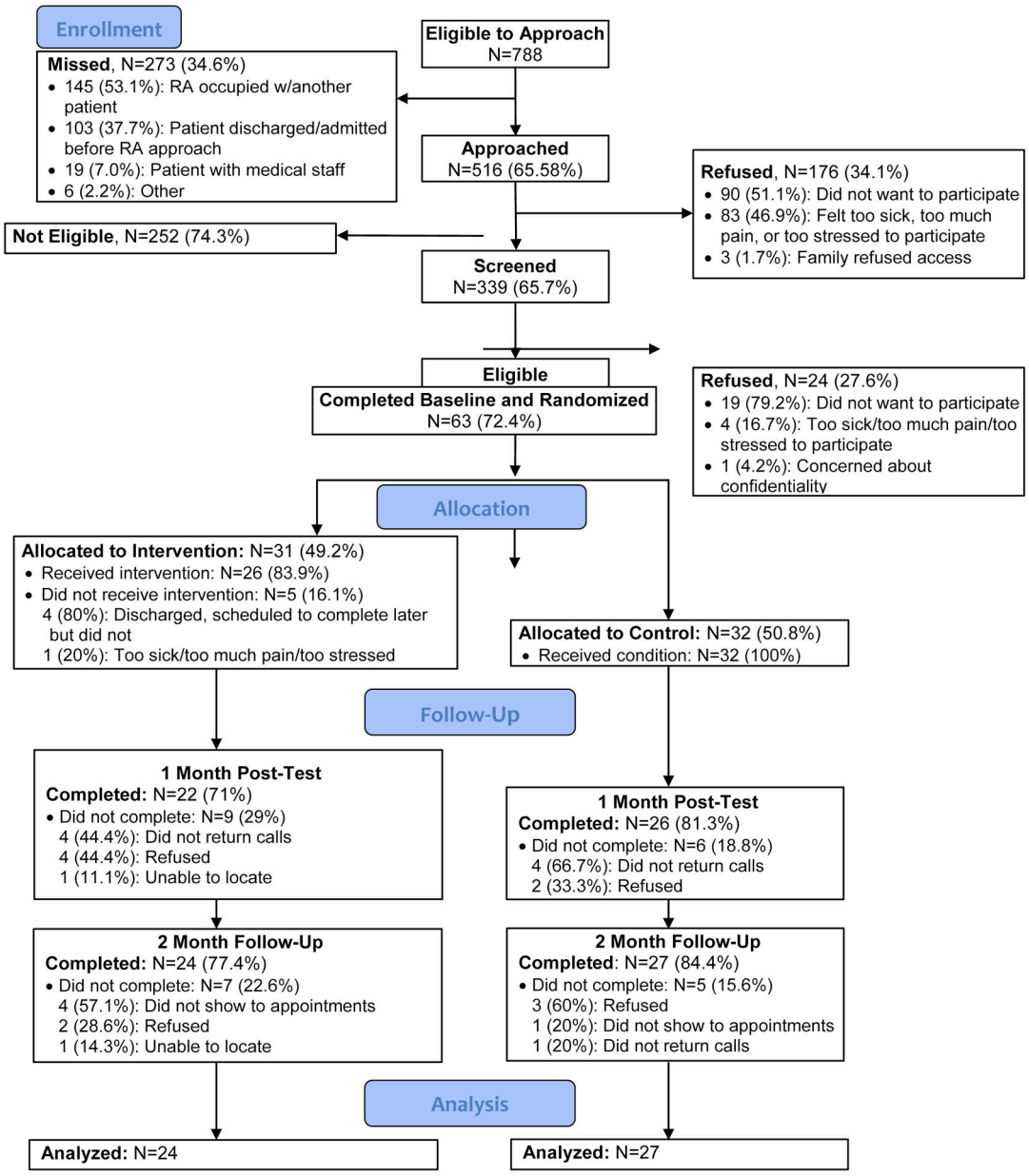

Figure 1.
Study flow diagram (October 9, 2017 – August 19, 2018)

Table 1.

Brief intervention components

	Counselor Tasks	
Explore		
Introduction	•	Affirm participation
	•	Discuss plan for session and explain use of tablet guide
	•	Reminder of exceptions to confidentiality
	•	Emphasize autonomy and seek permission to begin session
Strengths	•	Elicit participant's strengths/best qualities, affirm and reflect 💻
Goals	•	Elicit and explore participant's goals and values (feelings, relationships, responsibilities, activities, health), reflect 💻
Guide		
Substance use (drugs, alcohol)	•	Explore participant's substance use (what, where, when, with whom, triggers for increased use)
	•	Elicit concerns (i.e., downsides of use or less positive experiences), develop discrepancy with goals; reflect change talk
	•	Elicit top motives for use (e.g., coping, enhancement, social, etc.) 💻
Substance use and sexual risk (i.e., unprotected sex)	•	Briefly introduce topic by exploring role of substance use in dating/sexual relationships
	•	Elicit-Provide-Elicit regarding substance use and HIV/STI risk (i.e., likelihood of unprotected sex)
	•	Elicit concerns about substance use and sex (e.g., inconsistent condom use)
Benefits of reducing substance use (drugs, alcohol)	•	Elicit and reflect benefits of reducing substance use (e.g., feelings, relationships, health, responsibilities, activities) 💻
Readiness	•	Elicit participant's readiness to change substance use (drugs, alcohol), participants select one statement 💻:
		– Cut down my use
		– Quit using
		– Not sure I want to cut down my use, but I want to avoid problems or consequences
		– Thinking about cutting down my use in the future
		– Not interested at all in changing my use right now
Choose		
Tools for change	•	Elicit strategies for cutting back drugs and/or alcohol (including hypothetical change for pre-contemplative individuals) and reflect 💻
	•	Share list of strategies tailored to chosen motives, elicit challenges to implementing strategies and build self-efficacy by affirming participant's strengths
	•	Identify tool most salient to participant and select use motive associated with that tool (💻 to inform daily messaging tailoring)
Summary and next step	•	Strategic summary of session, emphasizing change talk and tools
	•	Elicit a concrete, near-term action step toward goals

Note. 💻 reflects a tablet screen allowing for data capture.

Table 2.

Participant demographics and baseline substance use by condition

	Total Sample N=63 Mean (SD) N (%)	**Intervention N=31, 49.2% Mean (SD) N (%)**	**Control N=32, 50.8% Mean (SD) N (%)**
Demographics			
Age (M,SD)	21.70 (2.31)	21.68 (2.34)	21.72 (2.32)
Female sex	42 (66.7%)	21 (67.7%)	21 (65.6%)
Male sex	21 (33.3%)	10 (32.3%)	11 (34.4%)
Black/African American	33 (52.4%)	14 (45.2%)	19 (59.4%)
White	24 (38.1%)	15 (48.4%)	9 (28.1%)
Other	6 (9.5%)	2 (6.5%)	4 (12.5%)
Hispanic	5 (7.9%)	2 (6.5%)	3 (9.4%)
Public Assistance	35 (55.6%)	17 (54.8%)	18 (56.3%)
Baseline substance use and sexual risk			
Total cannabis consumption (joints/month)	56.29 (107.44)	70.87 (107.80)	42.63 (107.00)
Total alcohol consumption (drinks/month)	11.42 (24.71)	17.47 (31.45)	5.75 (14.42)
Substance use days/month (including cannabis and alcohol)	14.29 (9.71)	15.97 (10.01)	9.31 (1.65)
Total alcohol consequences **	1.18 (2.18)	1.97 (2.79)	0.44 (0.98)
Total substance use consequences	3.21 (3.48)	3.87 (3.68)	2.59 (3.22)
% sex days without condom use	93.01% (20.09)	90.55% (20.74)	95.31% (19.51)

** $p<.01$

Table 3.

BI acceptability ratings

	% (n)
How much did you like talking to your counselor today?	
Disliked it/disliked it a lot	0.0% (0)
Neutral	20.8% (5)
Liked it/liked it a lot	79.2% (19)
How did you feel about the session overall?	
Disliked it/disliked it a lot	0.0% (0)
Neutral	33.3% (8)
Liked it/liked it a lot	66.7% (16)
How helpful did you find it to talk about your goals, strengths, and values in the session?	
Not helpful at all/somewhat unhelpful	0.0% (0)
Neutral	25.0% (6)
Somewhat helpful/very helpful	75.0% (18)
How helpful did you find it to talk about your substance use in the session?	
Not helpful at all/somewhat unhelpful	0.0% (0)
Neutral	29.2% (7)
Somewhat helpful/very helpful	70.8% (17)
How helpful did you find it to talk about your sexual relationships?	
Not helpful at all/somewhat unhelpful	0.0% (0)
Neutral	37.5% (9)
Somewhat helpful/very helpful	62.5% (15)
How helpful did you find it to talk about the possible benefits of changing your substance use in the session?	
Not helpful at all/somewhat unhelpful	0.0% (0)
Neutral	45.8% (11)
Somewhat helpful/very helpful	54.2% (13)
How helpful did you find it to talk about the possible benefits of changing your sexual relationships in the session?	
Not helpful at all/somewhat unhelpful	0.0% (0)
Neutral	37.5% (9)
Somewhat helpful/very helpful	62.5% (15)
How helpful did you find it to decide on the one thing you will do in the next few weeks to help you meet your goals?	
Not helpful at all/somewhat unhelpful	0.0% (0)
Neutral	41.7% (10)
Somewhat helpful/very helpful	58.3% (14)

Note. N=24 participants receiving the BI

Table 4.

Acceptability ratings for booster messages

	Mean (SD)
Benefits (8 items)[a]	4.1 (0.8)
Affirmation of strengths (4 items)[a]	4.3 (0.7)
Goals (4 items)[a]	4.2 (0.7)
Sexual risk reduction (4 items)[a]	4.1 (0.9)
Tools for motives (8 items)[a]	4.2 (0.8)
Coping	4.2 (0.6)
Enhancement	4.0 (1.4)
Social	N/A
Conformity	N/A
Boredom	4.5
Health	4.3 (1.0)
Participants who completed an open response on[a]:	
Day 1	72.7%
Day 8	81.8%
Day 15	68.2%
Day 22	72.7%
Day 28	59.1%
How much did you like receiving the daily messages?[b]	
Disliked/disliked it a lot	0 (0.0%)
Neutral	5 (22.7%)
Liked it/liked it a lot	17 (77.3%)
How helpful was the program in helping you focus on things that might be important to you?[b]	
Not helpful at all/somewhat unhelpful	1 (4.6%)
Neutral	3 (13.6%)
Somewhat helpful/very helpful	18 (81.8%)
In general, how helpful were the messages?[b]	
Not helpful at all/somewhat unhelpful	1 (4.6%)
Neutral	1 (4.6%)
Somewhat helpful/very helpful	20 (90.9%)
How helpful did you find the messages that focused on substance use?[b]	
Not helpful at all/somewhat unhelpful	2 (9.1%)
Neutral	6 (27.3%)
Somewhat helpful/very helpful	14 (63.6%)
How helpful did you find the messages that talked about relationships and sex?[b]	
Not helpful at all/somewhat unhelpful	0 (0.0%)
Neutral	6 (27.3%)

	Mean (SD)
Somewhat helpful/very helpful	16 (72.7%)
How helpful were the other messages that gave advice, a positive comment, or something to think about?[b]	
Not helpful at all/somewhat unhelpful	1 (4.6%)
Neutral	2 (9.1%)
Somewhat helpful/very helpful	19 (86.4%)
Each day you received 1 message, and if you rated the message you received a second [thank you] message. Was this too many messages, not enough, or just right?[b]	
Too many messages	4 (18.2%)
Not enough messages	18 (81.8%)
Just the right amount of messages	0 (0.0%)
If you rated the first message, you then unlocked a second “thank you” greeting. How much did you like these greetings?[b]	
Disliked it a lot/disliked it	1 (4.6%)
Neutral	5 (22.7%)
Liked it a lot/liked it	16 (72.7%)
Reading the messages helped me feel good about myself.[b]	
Disagree/Strongly disagree	0 (0.0%)
Neutral	7 (31.8%)
Agree/Strongly agree	15 (68.2%)
I learned more about myself by reviewing the messages.[b]	
Disagree/Strongly disagree	2 (9.1%)
Neutral	7 (31.8%)
Agree/Strongly agree	13 (59.1%)

[a]Data obtained from the LifeData app.

[b]Data obtained from the 1-month post-test.

Note. N = 22 participants provided ratings at post-test. Up to 20 participants provided ratings of daily messages, depending on message type and day.

Table 5.

Measures in intervention target behaviors at each assessment

	Baseline	1-month	2-month
Total cannabis consumption (joints/month)			
-Intervention (N=24)	86.33 (115.76)	53.79 (56.77)	54.42 (55.74)
-Control (N = 27)	47.67 (106.98)	24.48 (45.18)	21.57 (40.40)
Total alcohol consumption (drinks/month)			
-Intervention (N=24)	21.58 (34.03)	12.00 (31.75)	16.96 (28.24)
-Control (N = 27)	4.74 (18.08)	3.22 (10.31)	4.89 (10.54)
Substance use days/month (including cannabis and alcohol)			
-Intervention (N=24)	17.58 (10.05)	17.33 (11.33)	17.33 (11.33)
-Control (N = 27)	13.56 (9.66)	10.26 (11.54)	10.26 (10.03)
Total past 2-month alcohol consequences			
-Intervention (N=24)	2.46 (2.92)	n/a	1.96 (2.55)
-Control (N = 27)	0.37 (0.79)		0.70 (1.75)
Total past 2-month substance use consequences			
-Intervention (N=24)	4.00 (3.06)	n/a	3.57 (3.40)
-Control (N = 27)	2.67 (3.41)		1.89 (2.79)
% **sex days with condomless sex**			
-Intervention (N=19)	92.38 (19.97)	83.33 (36.19)	83.10 (36.08)
-Control (N = 15)	92.11 (25.07)	94.74 (22.94)	92.11 (25.07)

Note. Consequences were queried for the past two months at baseline and 2-month follow-up, there is no one-month value for this variable.

$^{*}p<.05$