



Published in final edited form as:

Alcohol Treat Q. 2013 ; 31(3): . doi:10.1080/07347324.2013.800425.

Smartphone-Based, Self-Administered Intervention System for Alcohol Use Disorders: Theory and Empirical Evidence Basis

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Abstract

Advances in mobile technology provide an opportunity to deliver in-the-moment interventions to individuals with alcohol use disorders, yet availability of effective “apps” that deliver evidence-based interventions is scarce. We developed an immediately available, portable, smartphone-based intervention system whose purpose is to provide stand-alone, self-administered assessment and intervention. In this paper, we describe how theory and empirical evidence, combined with smartphone functionality contributed to the construction of a user-friendly, engaging alcohol intervention. With translation in mind, we discuss how we selected appropriate intervention components including assessments, feedback and tools, that work together to produce the hypothesized outcomes.

Keywords

Technology; Alcohol; Intervention; Smartphone; Self-Administered

In the U.S. there are approximately 19 million individuals over the age of 12 who meet criteria for alcohol abuse or dependence; less than 10% of these individuals are treated and even amongst those individuals who meet DSM-IV criteria for alcohol dependence, only approximately 20% receive treatment (Grant et al., 2007). The large gap between those in need and those receiving treatment points to an urgent need to develop new and innovative strategies that circumvent attitudinal and access-related treatment barriers, particularly in light of the tremendous costs to U.S. society associated with alcohol use disorders (Cohen et al., 2007; Grant, 1997). Mobile communications technologies, such as GPS-enabled smartphones, have great potential to deliver effective treatment and support to individuals with alcohol use disorders while simultaneously addressing known barriers to treatment. In spite of this potential, it has been recognized that a gap exists between mobile “apps” currently available to consumers to address alcohol use and available evidence supporting their effectiveness (Cohn et al., 2011). We developed a theory and evidence-informed smartphone-based, stand-alone intervention system for alcohol use disorders, dubbed the Location-Based Monitoring and Intervention system for Alcohol use disorders (LBMI-A) whose overarching mission is to provide a self-administered, portable alternative to traditional treatment. The purpose of this paper is to describe how theory and empirical evidence were combined with smartphone functionality to design an easy-to-use, engaging alcohol intervention and discuss how theory informed our research questions and analytic methods. Outcomes from the current pilot study, which will compare pre-post usage of LBMI-A to an evidence-based website for alcohol reduction, are not yet available. However,

early analyses show that users of the LBMI-A significantly reduced their heavy drinking days and drinks per day when using the system.

The Evolution of Technology Use in Alcohol Treatment: A Review of the Evidence

Internet interventions

Internet-based alcohol treatment programs have been shown to be effective in reducing alcohol consumption among problem drinkers and younger populations at risk for developing alcohol use disorders (Bewick et al., 2008; Neighbors et al., 2009; Hester & Miller, 2006; Riper et al. 2009). A recent meta-analysis that included 9 randomized control trials indicated that web-based interventions result in a medium ($g = .44$) alcohol reduction effect size and that effectiveness increased with more user interactivity (Riper et al., 2011). In addition to potentially enhancing cost-effectiveness of alcohol treatment delivery (Smit et al., 2011), these interventions also hold promise for producing lasting treatment gains. Check Your Drinking, an intervention that provides web-based personalized feedback resulted in a 30% reduction in quantity of drinking among problem drinkers in the treatment group compared to those in a control group; the effect was maintained at 3 and 6-month follow-ups (Cunningham et al., 2009). A web-based intervention strategy for at-risk drinkers that provided alcohol-use assessment, individualized feedback and an intervention to develop a plan of behaviour change was found to reduce drinking by 50% at the end of the intervention which was maintained at a 12-month follow-up (Hester, Squires, & Delaney, 2005). It is becoming apparent that e-health systems for changing drinking that provide continued interaction following feedback result in more lasting gains (Riper et al., 2011).

Lieberman and Huang (2008) provided a key piece of evidence about how to bridge the current gap between those that need treatment and those that actually receive it. They found that problem drinkers who do not use treatment facilities will use an interactive alcohol-reduction oriented web-site and that such technology can increase motivation to change. While using technological tools to treat alcohol abuse and dependence is a new research area and many more studies are needed before definitive statements can be made, it appears from the studies that have been undertaken that immediate, personalized, and normative feedback is a vital ingredient (Hester & Miller, 2006; LaBrie et al., 2008).

Smartphone Interventions

The aforementioned technology-based interventions capitalized on the convenient 24/7 access, interactivity and tailoring capabilities of websites. A modern smartphone can do all of these things and adds other key features: the ability to identify the location of the user and provide immediate connectivity to supportive others. In other words, smartphones that access the internet and telephone networks can be programmed to recognize places identified by the user as high-risk for alcohol use and respond with a multitude of empirically supported interventions at the precise moments in which such services are most needed. Despite the potential potency of such an intervention, the use of “ecological momentary intervention”, that goes beyond assessing behavior in the moment, is conspicuous by its absence in the field of alcohol treatment and prevention (Cohn et al., 2011). Gustafson et al. (2011) have developed a smartphone-based, relapse prevention system for alcohol dependence that is based on their Comprehensive Health Enhancement Support System (CHESS). This system, termed ACHESS (Addiction CHESS), whose primary function is to diminish heavy drinking days post-treatment, contains numerous functions designed solely around relapse prevention; including using GPS to monitor proximity to geographic high risk locations, continued monitoring of alcohol and drug use, mood and withdrawal symptoms, all of which are delivered to the user's care manager or

counsellor. While research is not yet available about ACHES's effectiveness, it holds promise as a tool that can be used post-treatment to improve alcohol relapse rates post treatment.

Importance of Theory in eHealth Development

The rapidly growing field of e-Health has been described as the intersection among medical informatics, public health and business (Eysenbach, 2001). Eysenbach described 13 "e's" for e-Health that include; efficiency, enhancement of care quality, evidence-based, empowerment of consumers and patients, encouragement of shared decision-making between patients and health professionals, educational, enabling standardized information exchange, extending the scope of health care and services beyond traditional venues, ethical, equitable, easy-to-use, entertaining, and exciting. Theoretically informed was not listed, but its importance is becoming increasingly recognized by experts interested not only in what works, but also why it works (Cohn et al., 2011; Pingree et al., 2010). According to Pingree et al, theory serves as a framework that informs selection of intervention components from the universe of those that are evidence-based, and also provides a process map for determining hypothesized relationships between key variables such as potential moderators, mediators and outcomes. Such knowledge has practical implications with regard to what components of an intervention are essential to include. The LBMI-A was developed with a view towards the vital importance of grounding it in appropriate theoretical and empirical foundations.

The LBMI-A Development Process

With the help of funding from the National Institute on Alcohol Abuse and Alcoholism (NIAAA), starting in late-2009, we developed a system that contains a few similar features as ACHES, but was designed to function independently of care providers and treatment facilities. We aimed to develop a self-administered, stand-alone intervention system to be delivered in an individual's everyday environment that could overcome previously intractable treatment barriers such as the stigma of attending a treatment facility, the high cost of treatment and scheduling and transportation difficulties (Booth & McLaughlin, 2000; Fortney et al., 2004) and help to bridge the oft-cited gap between those in need and those who receive formal alcohol treatment (Grant et al., 2007). Following is a description of the LBMI-A's theoretical foundations, its system modalities and treatment functions as well as a description of how a user progresses through the system. Our strategy for developing the LBMI-A involved three phases.

Phase I: Drawing from Theory and Evidence. The design of the LBMI-A intervention was informed by numerous theoretical perspectives, namely motivational enhancement (Miller, 1999), relapse prevention (Marlatt & Donovan, 2005) and community reinforcement (Meyers, Villanueva, & Smith, 2005; Smith & Meyers, 2008). Motivational Enhancement is an undergirding approach that is based on principles of motivational psychology, including use of Motivational Interviewing (MI) (Miller & Rollnick, 2002) to help people move through the stages of change (Prochaska, DiClemente, & Norcross, 1992; DiClemente & Hughes, 1990) in a non-judgmental, facilitative manner without providing overt pressure or prescriptions of how to stop drinking. In keeping with MI principles, we designed the LBMI-A system to provide numerous options for users to choose from to provide encouragement and supportive feedback regardless of whether they indicate that they are continuing to drink alcohol. Relapse prevention was also a key driver for designing the LBMI-A intervention due to its focus on identifying high risk situations for continued drinking and providing strategies for coping with them when they cannot be avoided (Marlatt & Donovan, 2005). Community reinforcement, an approach that emphasized

intervention in multiple domains of a client's life, was also a fundamental component of the LBMI-A intervention. Specifically, LBMI-A proactively encourages the user to identify and include supportive others in treatment; to identify and plan non-drinking, recreational activities; and to develop other non-drinking lifestyle skills and strategies.

In addition to identifying and applying theory to the development of the system, phase I included identifying the essential, evidence-based components of effective alcohol interventions that could be delivered on a smartphone platform and would take maximum advantage of the features these devices possess. There currently exists a substantial amount of literature on effective psychosocial interventions for alcohol use disorders. Fortunately, we are not the first to distill this vast literature into a comprehensive package. William Miller and numerous leading alcohol treatment experts who participated in Project Combine (2004) surveyed the extant treatment literature and developed a treatment system that combined numerous empirically supported treatment components into a comprehensive, modular treatment. After reviewing the extant literature on empirically supported treatments and technologically-driven assessment and intervention strategies as well as the Combine Manual (Miller, 2004) we determined that a smartphone system could perform 6 fundamental functions that were in keeping with the research on empirically supported alcohol treatments: 1) enhance motivation to change through assessment and feedback; 2) provide immediate access to empirically supported coping strategies and techniques for managing high risk locations, craving, and negative affect; 3) identify and provide immediate access to supportive others; 4) identify and schedule pleasurable non-drinking activities; 5) provide psycho-educational information in modular form and; 6) continually monitor and provide regular feedback on continued drinking, triggering contexts, and means of coping.

Phase II: Technology Selection. We collaborated with software engineers to develop an initial version of the system. We specifically sought clarification with the engineers about the feasibility of the system functions that we were considering. The software engineers indicated at that time (early 2009) that the only smartphone operating system that would allow functions to operate in the background (keep a program running constantly while simultaneously performing standard smartphone functions) was Windows Mobile® and that the most appropriate phone for development was the HTC Tilt 2. In light of rapidly changing technological tools and limited research budgets, it is necessary to choose the devices and operating systems that are currently available even with knowledge that better tools are forthcoming. For instance, we knew that a new version of the iPhone® was going to be available in the following year that would provide the necessary functionality, but the version that was available to us at the time would not run applications in the background so we were forced to go with our only option at the time, the HTC-Tilt 2.

Phase III: Expert and User Beta-Testing. The third development phase involved receiving feedback on the original prototype from three nationally recognized experts with expertise in alcohol assessment and treatment. They reviewed the system for consistency with empirically supported interventions and usability; and identified areas for improvement. Each expert was provided with an LBMI-A enabled HTC Tilt-2 that they tested for four weeks. They then provided feedback in verbal and written form. We integrated all feedback from the expert reviewers and collaborated on a revision of the system to develop a beta version of the LBMI-A. The beta version was then tested for usability by the research team. We performed focus groups with individuals in our target demographic who were either in or recently discharged from alcohol treatment. Focus group attendees specifically provided feedback about the major LBMI features and interactivity. Their suggestions for improvements focused on reducing the amount of text in the modules, inclusion of common smartphone applications such as games, and to reduce the invasiveness of the LBMI high

risk location alert function, which they described as too loud and possibly embarrassing in the presence of friends.

Content of the LBMI-A System

The final LBMI-A program, called “Buddy” uses a stepwise approach (Buddy Steps) to provide assessment, information and intervention to the client through the smartphone. Each step contains a psycho-education module that presents key concepts pertaining to the topic. Steps differ in their overall length, but most can be easily read or listened to in an audio file in 15 minutes or less. Following completion of the Step by reading or listening to the psycho-educational information, the associated “Buddy Tool” becomes available for use. The Buddy Tools provide immediate coping strategies and monitoring functions for numerous alcohol-related issues (see below). The LBMI-A contains seven steps that are delivered over the course of one week. As the participant progresses through the system, it becomes more sophisticated, offering more functionality in the form of immediate intervention strategies and on-going monitoring.

Step 1: Assessment and Feedback

The first Buddy Step is a brief motivational intervention. The LBMI-A's Assessment and Feedback Step is similar to the Drinkers Check-up (Hester, Squires, & Delaney, 2005; Miller, Sovereign, & Krege, 1988). The Drinker's Check-up was originally designed to be delivered in-person and has been found to result in significant decreases in alcohol use (Miller, Benefield, & Tonigan, 1993; Miller, Sovereign, & Krege, 1988).

By starting the system with a motivational intervention that aids users in “taking stock” of their drinking it was hoped that participants would experience greater motivation to change (Walker, Roffman, Picciano, & Stephens, 2007), as well as enhance motivation to continue their use of the other system components. In the LBMI-A system, the assessment and personal feedback report were delivered on a smartphone. Therefore, efforts were made to keep the format brief, while still providing important normative feedback regarding drinking levels and alcohol-related consequences as well as; peak blood alcohol content, level of tolerance, severity of dependence, drinking motives, readiness to change, temptation to drink and confidence to avoid drinking in different contexts.

Step 2: High Risk Locations

The second step is High Risk Locations (HRL). In keeping with fundamental principles of relapse prevention, the HRL functions to identify and alert the user to geographical areas in which they have frequently drank or purchased alcohol in the past. Marlatt and Donovan (2005) indicate that such areas represent a high-risk situation for relapse and encourage individuals with an alcohol use disorder to initially avoid them as much as possible. We felt this was a particularly important feature given that recent research has indicated that in the context of drinking-related environmental cues, an addicted individual's rational decision making facilities are impaired (Goldstein & Volkow, 2011). We conceptualized this feature of the LBMI-A as providing an external frontal lobe that helps the user to keep focused on healthy choices while in the presence of high risk locations.

In the HRL step, information pertaining to the rationale behind geographical monitoring of proximity to specific high risk locations is provided, with a particular emphasis on how such locations can function as a trigger for continued alcohol use. When the user crosses a high risk location boundary, the LBMI-A smartphone produces an alert that indicates that they are entering a high risk zone. The LBMI-A then provides numerous strategies for managing the situation including; leave the area, call a supportive person, view reminder photos, and view reasons for change. It also provides the option to disable the alert. In keeping with

Motivational Interviewing principles, we chose to provide options for managing high risk locations as well as the option to simply turn the feature off (Miller, 1999).

Step 3: Supportive People

A fundamental advantage of a smartphone-based alcohol intervention system is the ability to immediately contact pre-selected supportive others during high risk situations. This feature is therapeutically indicated as research has repeatedly demonstrated a link between social support provided by friends and family members and alcohol treatment outcome (Groh et al., 2007). Research has also indicated that social support for sobriety is an important predictor of lasting treatment outcomes (Broome & Simpson, 2002).

People using the LBMI-A first read the supportive person step, which provides a rationale for including supportive others and some suggestions for who would be most appropriate to serve as supportive others (friends or family members who are generally supportive of healthy drinking and who don't drink heavily themselves). The participant is also provided the opportunity to share their assessment feedback with their chosen supportive other in order to educate them about the participant's alcohol use patterns and triggering situations.

The LBMI-A system, in keeping with principles from a treatment modality with substantial empirical support the Community Reinforcement and Family Training (CRAFT) approach (Smith & Meyers, 2004), provides instruction to supportive others regarding how to be most helpful in supporting change to a family member or friend with alcohol dependence (Miller & Wilbourne, 2002). This instruction outlines simple, behavioral strategies on how to reinforce sober behavior, instruction on positive communication skills and other information about how to best support a person with an alcohol problem. Once the participant enters their supportive person information, Buddy provides the option to call a supportive other when they are experiencing a craving, are feeling distressed or have entered a high risk for drinking location.

Step 4: Cravings

The Craving Step is oriented towards providing the participant with an understanding of the fundamental attributes of craving and how to effectively manage them. Some of the key messages of this step are that cravings are normal; they are predictably triggered by contexts, cognitions, and emotions; they are time limited; and cravings will become weaker with time if they are not given into (Miller et al., 2004). As part of the Craving Step, they are provided with a list of contexts in which they are moderately to strongly tempted to drink and lack confidence in their ability not to do so. This information allows the user to focus particular attention on techniques for dealing with cravings that are appropriate to their areas of risk for continued drinking.

The Craving Step also provides multiple strategies for managing cravings in-the-moment based on cognitive behavior coping skills training for alcohol use disorders (Kadden & Kranzler, 1992; Miller et al., 2004; Monti et al, 2002). Some of these techniques include avoiding or escaping the triggering situation, distraction from a craving until it passes, seeking social support, and urge surfing.

Step 5: Problem Management

Managing stressors through enhancing coping strategies in a productive manner without resorting to drinking is a goal common to numerous different therapeutic modalities (Maisto, Connors, & Dearing, 2007). Research indicates that alcohol dependent individuals over-utilize passive coping styles such as wishful thinking and self-blame while under-utilizing problem-focused strategies (Madden et al., 1995). Passive coping styles are also predictive

of higher overall drinking rates (Veenstra et al., 2007) and relapse following treatment (Demirbas, Ilhan, & Dogan, 2012; Noone & Markham, 2009). In addition, negative affect surrounding stressful events has been shown to be a consistent predictor of relapse across multiple studies (Witkiewitz & Villarroel, 2009; Cooney et al., 1997; Zywiak et al., 1996). We developed the Problem Management Step as a means with which to help participants productively manage stressful situations and to provide immediately available strategies for managing negative affective states, all in the service of minimizing drinking as a coping strategy.

The theoretical framework for the Problem Management Step stems from Problem Solving Therapy (PST). PST is a simple and straightforward intervention framework that has been shown in numerous studies to be an effective means with which to manage stressors and reduce psychological distress (D'Zurilla & Nezu, 2007; Nezu, Wilkins & Nezu, 2004). The Problem Management Step introduces the idea that life problems, negative emotions and continued drinking are related. It provides instruction on how to use a step-wise method of productive problem solving including identifying the problem, stating a goal, exploring solutions, taking action and evaluating the strategy (Nezu, Nezu, & D'Zurilla, 2007) and provides a case example that illustrates problem solving in action.

Step 6: Communications

The communications step was developed to provide training to participants on effectively communicating with others, particularly around high risk situations for drinking. Productive communication skills have been associated with lower rates of drinking, particularly for adolescents and young adults (Griffin et al., 2001). Communication skills training has been demonstrated to be an effective stand-alone intervention for alcohol dependence (Monti, Abrams, Binkoff & Zwick, 1990) and is often included in comprehensive alcohol treatment systems such as the system created for Project Combine (Miller, 2004). Adding communication skills training to treatment protocols has been shown to result in fewer drinking-related problems and reduced alcohol consumption, both immediately after treatment and at a 12-month follow-up (Rohsenow et al., 2001). We developed the Communications Step as a means to help participants develop productive communication for drink refusal and assertiveness skills including providing and receiving criticism.

The Communications Step was of sufficient length and complexity that it was deemed best delivered in the form of an interactive web page that a participant could access with their home computer. This step begins with an assessment of social situations that the participant has found to trigger ongoing drinking. They are then provided feedback on their specific risky social situations and suggestions for managing them. This step then provides instruction on drink refusal skills for use in numerous situations (being in a bar, at a friend's house, etc.). This step also includes a section that provides experiential instruction on assertive communication.

Step 7: Pleasurable Activities

The Pleasurable Activities tool was created with a view toward providing the participant with pleasurable, non-drinking related activities to take the place of drinking and drinking-related activities. Increasing pleasurable activities is a common intervention strategy that is present in many intervention systems (Monti et al., 2002; Kadden & Kranzler, 1992, Marlatt & Gordon, 1985). Finding new non-substance related activities to occupy one's time was a salient theme generated by recovering substance abusers related to their successful recovery (McIntosh & McKeganey, 2000). An active ingredient in substance use self-help groups also appears to be the emphasis on engagement in rewarding activities other than substance use (Moos, 2008). The Pleasurable Activities Step provides suggestions for when to take time to

engage in a pleasurable activity such as during times of the day that historically have been drinking times or when experiencing a poor mood. It then introduces the Pleasurable Activities Tool and provides instruction on how to use the tool to select amongst a diverse array of possible pleasurable activities and schedule them into the LBMI smartphone calendar.

Continual Interactivity

A central purpose of the LBMI-A is continuous momentary assessment and intervention for ongoing alcohol use and triggering factors such as cravings, high-risk situations and life stressors. The user is thus instructed to record such states on a momentary basis, when they are occurring. The system also provides the option for an intervention to manage the problematic situation. For instance, if a user indicates to the system that they are drinking, the LBMI records the amount and frequency of drinks and then asks if the user would like help to stop drinking, subsequently providing options for contacting social support, finding an AA meeting or viewing reminders of why they wanted to stop drinking.

Another primary function of the LBMI-A is to provide ongoing, accurate feedback to the user about their alcohol use and triggering factors over time, a common feature in empirically supported brief interventions (Maisto, Connors, & Dearing, 2007). Continually gathered formation is used to populate a “weekly feedback report”, which is provided to the user on a predetermined day of the week and outlines progress over time.

Summary

The purpose of this paper is to describe the theoretical and empirical basis for designing features of a smartphone application that addresses a gap between commercially available “apps” for alcohol use and availability of evidence-based mobile interventions that take advantage of the unique features of smartphones. We used a theory based, empirically informed process to identify efficacious treatments and then matched critical intervention features to the functionality of modern smartphones. We then engaged diverse “testers” including expert consultants, focus groups and research assistants to assure both function and content of our intervention was sound. We described specific features to allow others interested in developing similar e-Health applications with both information on both our process and content.

We are currently evaluating the impact of our LBMI-A smartphone intervention on approximately 30 young adults who engaged with the program for six weeks compared with similar subjects who utilized a publically available web-based intervention. We are using mixed-methods to understand both impact and context for using the program. Once the trial is completed we look forward to answering the following research questions:

1. Was the LBMI-A effective in reducing alcohol use and how did its effectiveness compare with a similarly focused, stand-alone web based system?
2. What were the moderators (e.g., motivation to change; age; gender; severity of dependence) and mediators (e.g., self-efficacy; awareness) of LBMI-A effectiveness?
3. Which modules or tools were most effective at supporting theory-based mediators?
4. Did individual use of these key modules and tools support hypothesized outcomes?

These questions will not only allow us to understand effectiveness of specific features of LBMI-A, they will also elucidate how theory might inform improvements to medical informatics, public health and business, and assure that e-Health applications address the

most important mechanisms to change behavior. Results from this project will also be utilized to inform a future version of this system that will be designed for availability on multiple different smartphone operating systems. A continual challenge in the rapidly changing field of smartphone technology health “apps” is to stay current with contemporary operating systems. For instance, the operating system we utilized for the development of this system is now outdated and the phones that we utilized are now used by very few individuals. In order for mobile health systems such as the LBMI-A to be widely utilized, they must be available on multiple different contemporary platforms and be responsive to changes in smartphone device uptake, changes in operating systems, and reflect the technology and usage preferences of diverse target populations.

Acknowledgments

This project was funded by the National Institute of Alcohol Abuse and Alcoholism (NIAAA), Grant # RC2 AA019422-02

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