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Technology-based Interventions for Substance Use and Comorbid Disorders: An Examination of the Emerging Literature

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Abstract

Among individuals with substance use disorders (SUDs), comorbidity with other psychiatric disorders is common and often noted as the rule rather than the exception. Standard care providing integrated treatment for comorbid diagnoses simultaneously has been shown to be effective. Technology-based interventions (TBIs) have the potential to provide a cost-effective platform for and greater accessibility to integrated treatments. For the purposes of this review, we defined TBIs as interventions in which the primary targeted aim of the intervention was delivered by automated computer, internet, or mobile system with minimal to no live therapist involvement. A search of the literature identified nine distinct TBIs for SUDs and comorbid disorders. An examination of this limited research showed promise, particularly for TBIs that address problematic alcohol use, depression, and/or anxiety. Additional randomized controlled trials of TBIs for comorbid SUDs and anxiety and depression are needed, as is future research developing TBIs that address SUDs and comorbid eating disorders and psychotic disorders. Ways of leveraging the full capabilities of what technology can offer should also be further explored.

Of the 20 million individuals with a substance use disorder (SUD), approximately 40% also have a comorbid mental illness.¹ Individuals with comorbid diagnoses seek treatment significantly more often than those with a single diagnosis,² with greater economic costs associated with their care.³ Empirically-based integrated treatments that address comorbid disorders simultaneously are recommended, but are limited in availability and accessibility to patients.⁴ Barriers to accessing treatment have also been noted for individuals with comorbid substance use and mental health disorders including, psychosocial instability, low motivation, deficits in social interaction skills, and concerns about stigma.⁵ Thus, it is not surprising that less than 55% of individuals with SUDs and comorbid diagnoses report receiving professional treatment.^{6–8}

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Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the article.

Technology-based interventions (TBIs) have the potential to address some of the treatment challenges of comorbidity by providing an easily accessible, cost-effective alternative to in-person services. A variety of terms have been used in the literature to refer to TBIs including, “computer-assisted therapies,⁹” “computer-based interventions,¹⁰” “web-based interventions,¹¹” and “internet-based interventions.¹²” Other common terms include mHealth (mobile health) and eHealth (electronic health). mHealth simply refers to health services accessed using a mobile hand-held device such as a smartphone or tablet (e.g., texting, apps) or wearable sensors such as smart watches and various sensing devices, while eHealth is a broader umbrella term for using any electronic communication often via the internet (e.g., electronic health records, telemedicine, etc.). We prefer to use the term “technology-based interventions” because it encompasses a broad array of platforms including the computer, internet, and mobile applications.

TBIs can be easily disseminated and used in a number of locations, including residential, outpatient, and community treatment settings, as well as home or public settings with an internet connection.^{13,14} Mobile applications offer additional flexibility in that users can access these applications at almost any time using handheld mobile devices, which can be an invaluable service for patients during difficult or triggering social situations.¹⁵ For those with financial limitations who are unable to afford in-patient or outpatient treatment services, TBIs could offer a cost-effective alternative.^{14,16} These interventions are also a helpful solution for patients who lack childcare or reliable transportation, have scheduling conflicts with outpatient services,¹⁴ or are not ready to seek formal services due to motivation or stigma. Consequently, such interventions not only have the ability to reach a larger number of individuals, but a wider demographic as well.¹³

TBIs for Substance Use Disorders

Several reviews and meta-analyses provide support for the acceptability, feasibility, and efficacy of TBIs for SUDs.^{10–12,17–24} TBIs for SUDs have been used for assessment,^{25,26} prevention (most often in the form of screening and brief intervention),^{27–31} treatment,^{32,33} and recovery and aftercare.^{34,35} In regard to specific types of substances, there is substantial literature for TBIs focused on decreasing alcohol use. Meta-analyses and reviews of the literature have found that TBIs for problematic alcohol use decrease alcohol consumption (i.e. quantity and frequency) and negative consequences of use.^{20,22,36–38} Similar results have been found with nicotine users, such that smoking cessation TBIs have been found to be effective overall in decreasing smoking frequency, and initiating and sustaining abstinence rates.^{39–41} Although the literature is limited, mobile and computer interventions for other substances show promise, particularly for reducing marijuana,²⁴ stimulant (e.g. methamphetamine⁴² and cocaine⁴³), and opioid use.^{32,44}

TBIs for Other Psychiatric Disorders

Empirical evidence supports the use of TBIs for prevention and treatment of other psychiatric disorders including, depression and anxiety,^{45–49} psychotic disorders,⁵⁰ and eating disorders.⁵¹ The largest body of literature on TBIs for psychiatric disorders focuses on interventions for depression and anxiety (for review see^{52–54}). Mobile technologies have

also been used to assess suicidal ideation among depressed individuals.⁵⁵ Improvement in schizophrenia symptoms has been reported using TBIs,^{50,56} as well as for eating disorder symptoms when used as an addition to other treatment services.⁵⁷

Comorbid disorders

Although the existing literature on TBIs is positive overall with respect to acceptability and efficacy, most TBIs target a single disorder. However, it is less common that an individual present with a single diagnosis. Rather, many patients have comorbid disorders, and this is especially true of individuals with SUDs.⁵⁸ Integrated treatments delivered in person in individual and group formats that address symptoms of SUDs and comorbid disorders simultaneously have been shown to be effective^{59,60} and often more effective than treatment of individual disorders separately or in sequence.⁶¹ Therefore, the importance of developing TBIs for comorbid SUD and other mental disorders is high. However, there currently exist only a handful of such TBIs for co-occurring SUDs and other disorders. The purpose of this review is to establish the current state of science for TBIs that target SUDs and comorbid disorders and provide guidance on plausible and needed next steps to increase the accessibility and effectiveness of these interventions.

METHODS

Between March 2016 and June 2016, we used the PubMed and PsycINFO databases to search for existing TBIs for co-occurring SUDs and other disorders. The following search terms were used in various combinations: (“technology” or “technology based intervention” or “computer” or “computer intervention” or “mobile” or “mobile application” or “mobile intervention” or “text message” or “Smartphone” or “internet” or “internet-based intervention”) AND (“substance use” or “substance use disorder” or “substance abuse” or “alcohol” or “alcohol use disorder” or “opioid” or “heroin” or “marijuana” or “stimulant” or “cocaine” or “methamphetamine”) AND (“comorbid” or “co-occur*” or “depression” or “anxiety” or “post-traumatic stress disorder” or “PTSD” or “eating disorder” or “borderline personality disorder”). We also identified manuscripts by searching through article references. For the purposes of this review we defined TBIs as interventions in which the primary targeted aim of the intervention was delivered by automated computer, internet, or mobile system with minimal to no live therapist involvement. This definition was based on other reviews in the literature of TBIs for SUDs.^{9,10,62} We excluded articles on e-therapy and telehealth including, therapist-delivered text messaging, email exchanges, and video or audio conferencing. Text messaging interventions were included if the texts were automated as these TBIs do not simulate live contact with a therapist (i.e., e-therapy). Applications and systems in which the primary aim was assessment were not considered interventions and were thus excluded, as well as non-English articles. Articles were included if the TBI was designed to address both substance use and another co-occurring disorder. In an effort to examine the literature in this nascent field, we retained feasibility and acceptability pilot studies and published protocols of studies that had not yet begun, in addition to randomized control trials.

We identified fourteen articles that examined nine distinct TBIs that met our search criteria. The comorbidity combinations varied across studies, with four TBIs developed for SUDs and depression,^{63–69} two for SUDs and Post-traumatic Stress Disorder (PTSD),^{70–73} one for SUDs and Borderline Personality Disorder (BPD),⁷⁴ and two for SUDs, depression, and anxiety.^{75,76} Table 1 provides a description of the studies that have examined these TBIs.

RESULTS

Randomized Controlled Trials

Our literature search yielded five TBIs for SUDs and comorbid disorders that were tested in six randomized controlled trials (RCTs); four TBIs targeted comorbid SUDs and depression^{63,64,66,67,69} and one TBI targeted comorbid SUDs and PTSD.⁷¹ Comparison groups varied widely among the RCTs and included active treatment with a live therapist,^{63,64} active online intervention,⁶⁹ online attention-control,⁶⁶ delayed intervention,⁷¹ and generic “thank you” text messages (of non-comparative attention to TBI).⁶⁷

A computer-based intervention developed for depression and comorbid alcohol and/or other drug use entitled *Self-Help for Alcohol and other drug use and Depression* (SHADE) was initially tested in an RCT with a small sample⁶³ and then replicated in a larger RCT.⁶⁴ SHADE is a 9-session manualized treatment that incorporates techniques from both cognitive behavioral therapy (CBT) and motivational interviewing (MI), and was originally developed as a therapist-delivered treatment. In the initial RCT, participants received a brief, in-person intervention (BI) and were subsequently randomized to receive therapist-delivered SHADE, computer-delivered SHADE, or no additional treatment (BI-only). The content delivered in both SHADE groups was the same. Results of the initial RCT showed significant reductions in alcohol and cannabis use across all intervention groups. In regard to overall reduction in alcohol use (baseline to 12 months), there were no significant differences between intervention groups. For overall reductions in cannabis use, both SHADE groups were equivalent in reductions, but produced significantly greater reductions compared to BI-only (effect size difference of 0.76 for in-person vs. BI-only; effect size difference of 1.11 for computer vs. BI-only). Depressive symptoms also decreased significantly across all intervention groups, with the in-person SHADE showing the quickest reduction which was then matched by the computerized SHADE at the 12-month follow-up. Both SHADE groups (computer and in-person) out-performed the BI-only group in depressive symptoms reduction (effect size difference of 0.31 for in-person vs. BI-only; effect size difference of 0.27 for computer vs. BI-only). Furthermore, engagement (i.e. sessions completed) in the in-person and computerized SHADE groups did not differ.

A larger replication RCT compared computerized SHADE, therapist-delivered SHADE, and supportive counseling (therapist delivered).⁶⁴ Participants in both SHADE groups had greater reductions in alcohol use at 3-month follow-up compared to supportive counseling, and participants receiving computerized SHADE had 2.5 times greater reductions compared to therapist-delivered SHADE. No significant differences between groups were found in regard to reductions in cannabis use. Both SHADE groups were associated with greater reductions in depressive symptoms compared to supportive counseling; however, no significant differences between the two SHADE groups (computer vs. therapist) were found.

Interestingly, in subsequent analyses, although the majority of participants indicated a preference for therapist-delivered treatment prior to randomization, post-treatment scores of satisfaction with treatment were equivalent for computer versus therapist-delivered SHADE.⁶⁵

SHADE has recently been adapted for young adults with depressive symptoms and problematic alcohol use.⁶⁶ The resulting TBI (named DEAL: DEpression-ALcohol) is a 4-module, 1 hour weekly, internet-based intervention that includes CBT and MI techniques with homework exercises. Participants in this study were randomized to receive DEAL or 4 modules of online generic health information and assessments (HealthWatch). Significant differences were observed between the groups, with the DEAL group showing greater reductions in alcohol use and improvement in depressive symptom severity compared to the HealthWatch group at post-treatment (5 weeks), but not at 3- or 6-month follow-up time points. Post-treatment effect sizes were large (reduction in depression severity = 0.71; reduction in drinks per week = 0.99 and drinking days per week = 0.76); whereas 6-month follow-up effect sizes were in the small to moderate range (0.09–0.39). Treatment retention was low for this sample and participants in the DEAL group completed significantly fewer sessions than those in the HealthWatch group (1.5 vs. 2.5 sessions, respectively).

Another TBI addressing problematic alcohol use and depressed mood was designed and tested as a preventive intervention for college students.⁶⁹ Unlike the previously described TBIs that included multiple sessions/modules, this TBI was a single session, brief personalized feedback intervention modeled from social norms approaches that have been shown to be efficacious in reducing heavy alcohol use and related consequences in college students.⁷⁷ The integrated intervention was compared to two TBIs targeting single symptoms (alcohol-only and mood-only) as well as an assessment-only control condition. Material from the alcohol and mood only interventions were combined to create the integrated intervention and additional information on the relationship between depression and alcohol was included as well. Unfortunately, no significant differences were observed among conditions with respect to alcohol use and depressive symptoms.

A supportive text messaging TBI focused on comorbid depression and SUDs has been tested as an addition to standard care for individuals with major depressive disorder and alcohol use disorder.⁶⁷ This intervention sends participants two automated supportive text messages twice daily for three months with content on stress management, abstinence, and overall wellbeing. A pilot RCT compared participants who received the intervention to those in a control group who received generic once fortnightly “Thank You” messages for three months. Reduction in depressive symptoms was significantly greater for those in the intervention group compared to the control group (effect size = 0.85), although alcohol abstinence rates were not significantly different between groups (effect size = 0.51). Considering the low interactivity and non-personalized messages of the intervention, it is promising that the messages were still capable of producing significant reductions in depressive symptoms.

The last TBI to be examined in an RCT was VetChange, which is a web-based intervention for Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF) veterans with

problem alcohol use and PTSD symptoms.^{70,71} VetChange consists of 8, 20-minute weekly psychoeducational and interactive web-based modules that provides personalized feedback on severity of alcohol problems and PTSD symptoms, assesses readiness to change, and helps users identify high risk situations, set goals, and develop adaptive coping skills. The modules also encourage veterans to build a strong social support network. Users receive weekly, personalized progress reports at the end of each module as well. Participants were randomized to the intervention group or a delayed treatment (8 weeks) control group. Those who received the intervention first showed significantly greater decreases in alcohol use and PTSD symptoms than participants in the delayed treatment group. Participants in the delayed treatment group demonstrated a similar pattern of reductions as the initial treatment group after receiving the intervention. However, one limitation of the study is low levels of sustained engagement. Although there were high rates of completion of one module (90% intervention and 88% delayed group), just over half of the sample (54% intervention and 58% delayed) completed 4 modules, and only 34% of the intervention group and 39% of the delayed treatment group completed all 8 modules. The authors conducted a secondary analysis of data from the VetChange RCT to examine the relationship between drinking outcomes and participants' drinking goals.⁷² Results showed that participants more often chose a goal of moderation compared to abstinence; however, alcohol reductions were observed 3 months post-intervention regardless of goal choice.

Uncontrolled pilot, feasibility and acceptability studies

Two small pilot studies examined feasibility, acceptability, and preliminary efficacy of novel TBIs for comorbid SUDs and other mental illnesses. DBT Coach is an interactive mobile phone application created for individuals with co-occurring SUDs and borderline personality disorder.⁷⁴ In a pilot study, the DBT Coach app was developed and assessed for feasibility as an addition to standard DBT treatment. The DBT Coach app provides coaching in the DBT skill of opposite action, which is an emotion regulation skill hypothesized to decrease emotional intensity and urges to use substances. Participants were instructed to use the DBT Coach app as often as needed for 10–14 days. Daily surveys were conducted via the app which asked about urges to use substances, emotions, and overall helpfulness of DBT coach. Participants were directed to different questions and tips depending on their answers to the prior screen, thus allowing for a more personalized experience. On average, participants used the app 15 times over the 10–14 day period and were highly compliant with daily assessments (85% completed). Participants rated DBT Coach highly in regard to usability and helpfulness of the app, and preliminary analyses show that substance use urges and intensity of emotions reduced significantly after each session. Self-reported confidence in applying the skill of opposite action increased throughout the trial as well. The authors reported that they are working on expanding DBT Coach to include more DBT skills.

The second pilot study assessed feasibility of a web-based computer program for individuals affected by disaster and struggling with substance use and depression and anxiety.⁷⁵ This TBI consisted of seven modules that provide psychoeducation and coping strategies for dealing with substance use and other mental health issues including, (1) marijuana, (2) alcohol, (3) nicotine, (4) other drugs, (5) depression, (6) worry/ anxiety, and (7) posttraumatic stress/panic). Participants qualified for each module based on their screening

responses, and modules were interactive and personalized based on screening questions about symptoms. Participants were recruited from a larger epidemiological study of New York City residents initially recruited six months after the September 11, 2001 terrorist attacks. The use of a documented probability sample allowed the researchers to compare participants to nonparticipants on a number of characteristics. Overall, 31% of invited participants logged onto the study website and 28% consented to the study. Compared to nonparticipants, participants were more likely to be male, of Asian descent, have greater education, and report better overall health. Completion rates for modules ranged from 64% (depression and smoking modules) to 36% (drug and worry/anxiety modules). Almost all (98%) participants stated that the intervention was easy to use and 80% gave positive answers with regard to helpfulness of the intervention. Changes in symptoms or substance were not assessed in this feasibility study.

Published research protocols and descriptions of program development

A small number of TBIs have recently been developed that have yet to be tested in a pilot study or RCT. We identified two published study protocols of RCTs^{68,76} and one manuscript describing the development process of a TBI for PTSD symptoms and problematic substance use.⁷³

The Internet Treatment for Alcohol and Depression (iTReAD) study is currently examining various combinations of the web-based intervention DEAL (previously described) for co-occurring binge drinking and depression in young adults.⁶⁸ Three groups will be compared: (1) online monthly assessments only, (2) online monthly assessments plus DEAL, and (3) online monthly assessments plus DEAL plus access to a social networking community (Breathing Space). Breathing Space is a closed social networking community moderated by research clinicians, where participants are asked to share their thoughts, successes and challenges related to drinking and their mood, and messages of support with other participants. Outcome measures will include change in depressive symptoms and frequency of binge drinking assessed at 26, 39, 52, and 64 weeks post-baseline.

Similar to VetChange, Coming Home and Moving Forward is a web-based intervention developed for veterans with SUDs and PTSD.⁷³ The intervention targets recent combat veterans from the wars in Afghanistan and Iraq. The authors obtained feedback from clinicians and from focus groups with veterans who screened positive for hazardous substance use and PTSD symptoms to inform the development of the intervention. The intervention was then beta tested individually by 34 veterans. The final product includes 24, 15- to 25- minute interactive modules that utilize CBT and MI techniques, including skills-building exercises, challenging automatic thoughts, and readiness to change. Coming Home and Moving Forward also assesses substance use and PTSD symptoms, offers a workbook of exercises, and provides graphs of personal progress. Data from beta testing showed a significant increase in knowledge scores from pre- to post-test. An RCT is currently underway to test the intervention as an addition to treatment as usual compared to a treatment as usual-only control group, with a target sample size of 164 veterans. Primary outcome measures will include substance use, PTSD symptoms, and quality of life assessed post-treatment, 1-month and 3-month post-treatment.

Finally, an RCT using cluster randomization is underway to test the effectiveness of an internet-based intervention called Climate Schools Combined (CSC), aimed at prevention and reduction of substance use, depressive symptoms, and anxiety among 13–15 year old students in 84 Australian schools.⁷⁶ The CSC is a combination of two previously developed interventions: Climate-Substance Use and Climate-Mental Health. Results from an RCT of the Climate-Substance Use intervention showed significant reductions in alcohol and cannabis use, and improvements in knowledge about substance use.^{78,79} The combined program (CSC) includes an individual internet-based component and a manualized classroom component, with 12 lessons focused on substance use and 6 lessons focused on mental health (i.e. depression and anxiety). Schools that agree to participate in the study are randomized to receive either: (1) CSC, (2) Climate-Substance Use only, (3) Climate-Mental Health only, or (4) usual health education courses (control group). Outcomes will focus on reduction in substance use, anxiety and depressive symptoms and increases in knowledge related to substance use and mental health.

DISCUSSION

The emerging research on TBIs for comorbid SUDs and other psychiatric disorders shows promising results; however, this area is very limited, varied, and requires much growth. Five TBIs for comorbid SUD and other psychiatric disorders were tested in six randomized controlled trials. There was substantial variability in the methodological quality of the studies, with only three studies including an active comparison group,^{63,64,69} and three studies reporting effect sizes.^{63,66,67}

Review of the six RCTS revealed that the two TBIs with the strongest support are VetChange⁷¹ and computer-delivered SHADE,^{63,64} as both of these skills-focused TBIs were associated with reductions in psychiatric symptoms and substance use. The evidence for computer-delivered SHADE is particularly compelling in that it is the only TBI that has been compared to an in-person equivalent and tested in a replication study.^{63,64} Results showed that computer-delivered SHADE was equivalent to therapist-delivered SHADE in reducing depressive symptoms and substance use and even outperformed therapist-delivered SHADE in reducing alcohol use.^{63,64} These findings have important implications for delivering cost-effective, evidence-based treatment. In particular, computer-delivered SHADE required an average of 16 minutes of clinician time per session compared to 60 minutes for therapist-delivered SHADE.⁶⁴ Thus, effective TBIs like SHADE could be beneficial in reducing the time burden on clinicians treating individuals with comorbid diagnoses.

Evidence is less robust for low-intensive and brief TBIs. A low-intensive supportive text messaging intervention was shown to reduce depressive symptoms, but not alcohol use.⁶⁷ The two TBIs that were designed for young adult populations were brief in duration (4 sessions⁶⁶ and 1 session⁶⁹). Although short-term reductions in alcohol use and depression severity were observed for the 4-session DEAL intervention,⁶⁶ these reductions were not sustained at longer follow-up points. In addition, a single-session integrated intervention was not found to be efficacious in reducing alcohol use and depressive symptoms even in the short-term (1 month post-intervention).⁶⁹ Thus, duration and intensity of TBIs seem to be an

important factor in efficacy of TBIs for comorbid symptoms. The current RCT that is investigating DEAL in combination with social networking allows participants to access the intervention for 12 months. It will be important to learn if extending the duration and intensity of this intervention impacts longer-term outcomes and whether participation can be sustained over time.

Feasibility and acceptability was demonstrated for TBIs focused on co-occurring SUDs and borderline personality disorder⁷⁴ and disaster-affected individuals with substance use, depression, and anxiety⁷⁵; however, the effects of these TBIs on substance use and psychiatric outcomes has yet to be tested in controlled trials. Data from the study with disaster-affected individuals⁷⁵ revealed differences in gender, race, education level, and overall health between participants and non-participants. Thus, efforts to engage a representative sample of participants in future research trials are needed, as well as data collection focused on reasons for participation and acceptability of the intervention by demographic subgroups.

Three RCTs of new TBIs are currently underway^{68,73,76} that will add to the literature in novel ways. The iTreAD study will examine a TBI with added access to a social networking support community. Nearly 65% of adults in the United States use social networking sites and this number increases to 90% when you look at usage rates only among young adults.⁸⁰ Thus, the potential to provide supportive services through a platform that many people are already using could increase engagement rates and leverage the unique strengths of technology. Similarly, the Climate Schools Combined intervention aims to use an internet-based TBI to engage school-aged children in universal prevention for substance use and mental health problems.⁷⁶ Similar to VetChange, Coming Home and Moving Forward is directed at recent combat veterans.⁷³ TBIs that address comorbidity for this population are needed given the high rates of both SUDs and PTSDs observed in previous studies.^{81,82} Participants will be recruited from VA primary care clinics in an effort to provide integrated treatment to veterans who may be reluctant to seek help in specialty mental health clinics.

Our examination of the literature revealed that the majority of the TBIs addressed alcohol use, depression, and/or some form of anxiety.^{63,64,66–68,71,73,75,76} This is not surprising given that research on TBIs for single disorders has largely focused on alcohol, depression, and anxiety. Two potential areas for growth in regard to TBIs for SUDs and comorbid diagnoses are eating disorders and psychotic disorders. A high rate of individuals with eating disorders often report problems with substances, with prevalence rates of co-occurring SUDs and eating disorders estimated to be upwards of 46% in clinical and community populations.⁸³ In addition, there is a high co-occurrence of SUDs and non-substance induced psychotic symptoms.⁸⁴ Therefore, TBIs for these individuals could be particularly useful. A pilot study using live text messaging between therapist and individuals with psychotic disorders found that participants reported that the intervention was helpful and useful.⁸⁵ This intervention was not included in our review of comorbid TBIs because the primary treatment (live text messaging with clinicians) was considered e-therapy. However, this study provides support for the potential acceptability of a mobile app for individuals with comorbid SUDs and psychotic disorders.

The extent of integration of treatment for co-occurring SUD and other psychiatric disorders was variable among the TBIs reviewed. At the highest level of integration were TBIs that presented information on the association between substance use and the targeted psychiatric disorder(s) AND provided skills aimed to cut across the different diagnoses. Several TBIs met this level of integration (SHADE, VetChange, DEAL, and Coming Home and Moving Forward).^{63,64,66,68,71,73} DBT Coach focused on one integrated skill that was hypothesized to reduced urges to use substances and decrease emotional intensity common in individuals with Borderline Personality Disorder.⁷⁴ The intervention for college students with depressive symptoms and problematic alcohol use provided integrated information, but strategies were separated by symptom.⁶⁹ Three TBIs were not considered integrated, such that separate modules or text messages were presented to address each targeted symptom or problem.^{67,75,76}

Patient engagement and adherence with TBIs is an important factor to consider when evaluating the literature. A previous review of computer-assisted therapies for psychiatric disorders found that few studies reported rates of engagement/completion.⁹ The initial SHADE trial⁶³ did not find any differences between computer compared with in-person delivery in regard to number of sessions completed. However, other studies reported much lower levels of engagement. Participants assigned to DEAL completed fewer sessions than those assigned to the control group, and only 68% of intervention participants completed at least one module.⁶⁶ The VetChange study⁷¹ reported high rates of completion for the first module, but only a third of the sample completed all 8 modules. Another study found that completion rates varied by topic, with more participants completing modules related to depression and smoking and less participants completing modules that targeted drugs and anxiety.⁷⁵ Future research should examine methods to improve engagement with TBIs (e.g., incentives, “gamification” of interventions, and adding some clinician involvement) and also investigate the optimal “dose” of TBIs for substance use and co-morbid disorders.

Given the early state of this field of research, the literature is focused mainly on feasibility and outcomes, with sparse discussion on barriers to implementation of TBIs for substance use and co-occurring disorders. One issue of importance for substance use and psychiatric populations is safety monitoring of patients engaged in a TBI without live contact with a therapist. Only one study explicitly discussed their process for dealing with reported suicidal ideation.⁷⁵ Another study is currently using research clinicians to monitor the social networking aspect of the study for crisis management and inappropriate posts.⁶⁸ The feasibility of employing this level of monitoring outside of a research setting is unknown. There has been one study that examined dissemination of SHADE in a substance use disorder clinical setting.⁸⁶ Results of this study showed that although clients reported a high level of willingness to engage in the TBI, clinicians only used the SHADE program with 34% of their clients. Thus, it is vital that we understand barriers clinicians and programs may face in implementing TBIs with their clients.

The majority of TBIs for comorbid SUDs and other diagnoses have focused on adapting traditional clinician delivered content for delivery via computer, internet, or mobile phone. Using technology in this way allows treatment to be delivered with guaranteed fidelity and allows patients 24/7 access to the treatment. This is an important first step in developing

TBIs that address comorbid illnesses. However, we should also consider ways to further take advantage of what technology has to offer (e.g., bio sensors, video, additional social interactions, gamification, etc.) which may require using the treatment development model with technology interventions from the ground up rather than relying on previously developed clinician delivered treatments that are translated to technology.

Some limitations of this review should be noted. As this is an emerging area of research, there were only a limited number of studies to review. Furthermore, we relied on the information that was available in the published articles. Some details related to the study or the TBI may have been omitted due to space restrictions from journals. We also restricted our search to published literature and did not search NIH Reporter or [Clinicaltrials.gov](https://clinicaltrials.gov) for NIH trials that are currently in process. Unpublished studies and studies and protocols from NIH reporter or [Clinicaltrials.gov](https://clinicaltrials.gov) were not included given that methods and procedures could be outdated or subject to change before publication.

Overall, the emerging literature on TBIs that address SUDs and comorbid psychiatric disorders is promising. TBIs have the potential to provide a cost-effective platform for delivering integrated treatments. The strongest support is for TBIs that address problematic alcohol use, depression, and/or anxiety. Future research should focus on designing more randomized controlled trials of comorbid TBIs, and developing TBIs that address SUDs and comorbid eating disorders and psychotic disorders. Ways of leveraging the full capabilities of what technology can offer should also be explored.

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Table 1
Description of studies of TBIs for comorbid SUDs and other Psychiatric Disorders

TBI name and study reference	Target symptoms/disorders	Participants	Technology platform	Sample size (n)	Comparison group(s)	Description of TBI	Level of Therapist Involvement in TBI
<i>Randomized Controlled Trials (RCTs)</i>							
SHADE Kay-Lambkin et al. (2009) ⁶¹	Depression and problematic alcohol and/or other drug use	Age 16+ Recruited from community and treatment settings in Australia	Computer-based	Randomized = 97 Follow-up: • 3 month = 82 • 6 month = 79 • 12 month = 82	1) Brief intervention only 2) SHADE therapy w/ live therapist 3) SHADE therapy via computer	9, 60-minute, weekly sessions of computer-delivered SHADE therapy that incorporates MI and CBT interactive components (e.g., video demonstrations, voice-overs, and in-session exercises)	10–15 minute weekly structured check-in with research clinician
SHADE (replication study) Kay-Lambkin et al. (2011) ⁶²	Depression and problematic alcohol and/or other drug use	Age 16+ Recruited from community and treatment settings in Australia	Computer-based	Randomized = 274 Follow-up: • 3 month = 163	1) SHADE therapy w/ live therapist 2) SHADE therapy via computer 3) Supportive counseling w/live therapist	9, 60-minute, weekly sessions of computer-delivered SHADE therapy that incorporates MI and CBT interactive components (e.g., video demonstrations, voice-overs, and in-session exercises)	10 minute weekly structured check-in with research clinician
Ayapong et al. (2012) ⁶⁵	Depression and alcohol use disorders	Adults Recruited from inpatient treatment	Mobile phone text messaging	Randomized = 54 Follow-up: • 3 month = 50	1) Supportive text messages twice daily 2) Thank you text messages once fortnightly	3 months of twice daily, supportive automated text messages; half of the messages targeted mood and medication compliance and half targeted alcohol abstinence	None
VetChange Brief et al.(2013) ⁶⁹	PTSD symptoms and problematic alcohol use	OEF/OIF veterans age 18–65 Recruited from Facebook ads	Internet-based	Randomized = 600 Follow-up:	1) VetChange 2) VetChange after 8-week delay	8-module self-management intervention that incorporates MI, CBT components; participants allowed	None

TBI name and study reference	Target symptoms/ disorders	Participants	Technology platform	Sample size (n)	Comparison group(s)	Description of TBI	Level of Therapist Involvement in TBI
				<ul style="list-style-type: none"> 3 month = 261 		8 weeks to complete intervention; includes home exercises, self-monitoring, and tailored feedback	
Geisner et al. (2015) ⁶⁷	Depressive symptoms and problematic alcohol use	Undergraduate students age 18–24 Recruited from randomly selected list of 5,777 enrolled undergraduates	Internet-based	Randomized = 339 Follow-up: <ul style="list-style-type: none"> 1 month = 311 	1) Alcohol only intervention 2) Mood only intervention 3) Integrated intervention 4) Assessment only	1 session, brief personalized feedback on alcohol use and depression; based on social norms approaches; includes psychoeducation and coping strategies for alcohol and depression	None
DEAL Deady et al. (2016) ⁶⁴	Depressive symptoms and problematic alcohol use	Young adults age 18–25 Recruited online and through radio ads and flyers	Internet-based	Randomized = 104 Follow-up: <ul style="list-style-type: none"> 5 weeks = 56 3 month = 45 6 month = 40 	1) DEAL 2) Attention control (HealthWatch)	4 weekly, 1 hour modules; based on CBT and MI strategies; homework at the end of each module	None
Uncontrolled pilot, feasibility and acceptability studies							
Ruggiero et al. (2006) ⁷³	Depression, anxiety, and substance use	Adult NYC residents Recruited from a larger epidemiological study with initial recruitment 6 months post-9/11 Needed to have home internet access and mailing address	Internet-based	Invited = 1,035 Accessed study website = 325 Consented = 285	N/A	7-module early intervention for disaster-affected populations; based on CBT principles; components of screening, psychoeducation, individualized feedback; participants screened into modules if they endorse relevant	None

TBI name and study reference	Target symptoms/ disorders	Participants	Technology platform	Sample size (n)	Comparison group(s)	Description of TBI	Level of Therapist Involvement in TBI
DBT Coach Rizvi et al. (2011) ⁷²	Borderline Personality Disorder and SUDs	Adults Recruited from outpatient DBT programs	Mobile phone application	Consented = 22	N/A	symptoms Mobile phone app that provides coaching in the DBT skill of opposite action; participants used app for 10–14 days as adjunct to their DBT treatment and completely daily assessments	No therapist involvement in using the app, but eligibility criteria required that participants be receiving outpatient treatment while enrolled in the study
<i>Published protocols and descriptive articles on treatment development</i>							
Climate Schools Combined (CSC) Teesson et al.(2014) ⁷⁴	Substance use, anxiety, and depressive symptoms	Target participants: Students age 13–15 years Australian secondary schools will be recruited	Internet-based	Target for RCT = 84 schools	Design for RCT: 1) CSC 2) Climate-Substance use 3) Climate-Mental health 4) Usual health education	18, 40-minute lessons containing psychoeducation presented in cartoon format; based on harm reduction approach for substance use and combines CBT principles, psychoeducation, and skill acquisition	Manualized classroom activities reinforce the psychoeducation presented in the TBI and allow students to engage in interactive communication
DEAL Kay-Lambkin et al. (2015) ⁶⁶	Depressive symptoms and problematic alcohol use	Target participants: Young adults age 18–30 years Recruited via online and traditional methods	Internet-based	Target for RCT = 369	Design for RCT: 1) 12 months of online monthly assessment 2) 12 months of online monthly assessment + DEAL 3) 12 months of online monthly assessment + DEAL + social networking site	4 weekly, 1 hour modules; based on CBT and MI strategies; homework at the end of each module; participants can review modules as much as they want within 12 months	Social networking site is monitored by research clinicians for crisis situations and inappropriate posts
Coming Home and Moving Forward Possemato et al. (2015) ⁷¹	PTSD symptoms and problematic substance use	Target participants: OEF/OIF/OND veterans Recruited from 4 VA primary care clinics	Internet-based	Target for RCT = 164	Design for RCT: 1) Coming Home and Moving Forward + TAU 2) TAU	24 modules (2 sessions/week for 12 weeks); CBT and MI approach focused on learning self-management skills for PTSD and substance use; optional guided exposure	None

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TBI name and study reference	Target symptoms/ disorders	Participants	Technology platform	Sample size (n)	Comparison group(s)	Description of TBI	Level of Therapist Involvement in TBI
						module	

SHADE = Self-Help for Alcohol and other drug use and Depression; MI = Motivational Interviewing; CBT = Cognitive-behavioral Therapy; OEF = Operation Enduring Freedom; OIF = Operation Iraqi Freedom; OND = Operation New Dawn; DEAL = Depression Alcohol intervention; TAU = Treatment as usual