Text Messaging for Addiction: A Review

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Abstract

Individuals seeking treatment for addiction often experience barriers due to cost, lack of local treatment resources, or either school or work schedule conflicts. Text messaging-based addiction treatment is inexpensive and has the potential to be widely accessible in real time. We conducted a comprehensive literature review identifying 11 published randomized controlled trials (RCTs) evaluating text messaging-based interventions for tobacco smoking, 4 studies for reducing alcohol consumption, 1 pilot study in former methamphetamine (MA) users, and 1 study based on qualitative interviews with cannabis users. Abstinence outcome results in RCTs of smokers willing to make a quit attempt have been positive overall in the short term and as far out as at 6 and 12 months. Studies aimed at reducing alcohol consumption have been promising. More data are needed to evaluate the feasibility, acceptability, and efficacy of this approach for other substance use problems.

Keywords

text messaging; mobile health technology; addiction; smoking; smartphone

Introduction

Despite the high prevalence of substance use disorders and their individual, societal, and economic costs (Bouchery et al. 2011; Swanke & Zeman 2011; Compton et al. 2007; Office of National Drug Control Policy 2004), only a minority 8.1% of persons who abuse drugs in the United States receive treatment (Compton et al. 2007). Addiction is often a chronic, relapsing condition (Compton et al. 2007; McLellan et al. 2000), but reimbursement mechanisms for prolonged, expensive interventions are lacking (Kelly & White 2011). Moreover, prevalence of drug abuse and dependence are generally greater among those with lower socioeconomic status (Compton et al. 2007), limiting the ability to self-pay for treatment. Mobile health technologies have potential to assist individuals suffering from addictive disorders who would not otherwise have access to treatment due to cost, geographic availability, or school or work schedule conflicts. Mobile health technologies

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could also be used to enhance existing interventions, and may be useful in maintaining improvement after completion of treatment. For example, these interventions could be used to reinforce skills learned during treatment as well as to present reminders about how to handle relapse.

During treatment, these technologies have the potential to serve as real-time interventions when patients are not in the clinic and craving and risk of use are high (although outpatient therapies are a more affordable approach than inpatient or residential treatment, support is generally only available for a limited number of hours each day). Furthermore, cognitive behavioral therapy (CBT) interventions rely on a learning component. Even for healthy individuals, repetition can improve retention of new information. In addition, individuals with substance use disorders may have significant impairment in a number of neuropsychological domains, notably prospective memory (Weinborn et al. 2011) and decision making (Fernandez-Serrano, Perez-Garcia & Verdejo-Garcia 2011). Use of some drugs is also associated with amplified delay discounting, in which users prefer immediate, smaller rewards to delayed larger rewards (Fernandez-Serrano, Perez-Garcia & Verdejo-Garcia 2011). Messages sent in real-time could help to compensate for these deficits by, for instance, reinforcing negative consequences of using or reminding participants of what they have learned in therapy sessions.

Interventions using sophisticated technologies such as smart phones have been made feasible in recent years. However, while smart phone saturation is incomplete, a 2011 21-country survey by the Pew Research Center (2012) found that 75% of cell phone users send and receive short message service (SMS) text messages. Thus, text messaging-based interventions show potential in that they are readily-available, simple to use, and, if automated rather than sent by clinicians, can reach a wide audience. Furthermore, studies of cannabis and opioid dependent participants indicate that computer-delivered therapy may have equivalent efficacy to the same therapist-delivered treatment (Budney et al. 2011; Bickel et al. 2008). Automated text messaging has been shown to be inexpensive and efficacious, and hence cost effective (Guerriero et al. 2013). In addition, tailoring messages to individual users through a screening interview or computerized algorithm may enhance the efficacy of these interventions.

Other reviews have been performed to summarize available data on mobile health interventions for tobacco smoking cessation and/or alcohol use reduction (Chen et al. 2012; Haug et al. 2012; Whittaker et al. 2012; Whittaker et al. 2009); this paper includes only interventions that include a text messaging-based component and summarizes important addiction-related studies using different populations.

Methods

We searched on the following combinations of terms in PubMed to identify studies that included phone-based text messaging as a component of interventions for substance use problems: {[tobacco use cessation [mesh] OR smoking OR alcohol OR methamphetamine OR cocaine OR benzodiazepine OR opiate OR opioid OR cannabis OR marijuana OR substance-related disorders[mesh]] AND [(text AND messag*) OR phone OR smartphone

OR SMS]}. We also checked the reference lists of included publications. We included only randomized controlled trials (RCTs) for tobacco cessation and all studies for other substance use problems. Studies were organized in the results section by type of drug of abuse and whether text messaging was a standalone intervention or one component of a multimodal intervention. Earlier stage studies are described first, regardless of publication date. We excluded case reports and medication adherence studies. The proportions of primary and secondary outcomes meeting statistical significance for studies whose primary outcome measures were adequately or nearly adequately powered were calculated [Table 1].

Results

As of March 31, 2013, there have been 11 published RCTs evaluating tobacco smoking cessation interventions with a text messaging component, 4 studies evaluating these types of interventions for reduction of alcohol consumption, 1 pilot study in former MA users, and 1 study based on qualitative interviews in cannabis users [Table 1 includes additional details]. We have included results of an additional RCT for alcohol dependence (Gustafson, et al. 2014), published online in March 2014, as preliminary data were provided in an earlier study (McTavish et al. 2012) prior to our cutoff date. All results described are based upon intent to treat analyses unless specified otherwise.

RCTs with Smokers

The literature on text messaging-based interventions for tobacco smoking cessation is more developed than for other substance use problems, with nearly 13,000 participants combined in the 11 RCTs described below (7 with text messaging as a stand-alone intervention and 4 with text messaging as a component of the intervention). In these studies, participants with missing data were coded as smokers, unless otherwise specified.

With SMS as a stand-alone intervention

Pilot Studies—An early pilot study in tobacco smokers (n=194) recruited from a German university differed from subsequent smoking cessation studies described in this review since a willingness to quit was not an inclusion criterion (Haug et al. 2009). Participants were randomized to one of 3 groups: two intervention groups that received text messages 3 times per week, or 1 time per week, or a control group that received text assessments only. The intervention was tailored to participants' stage of change according to the transtheoretical model (TTM). Feasibility and acceptability of the intervention were demonstrated. Most participants in the intervention groups reported a moderate level of satisfaction with the program and indicated they would participate again.

An intervention developed for use in an earlier study in New Zealand (Rodgers et al. 2005) was tailored for tobacco smokers ≥ 16 years in the United Kingdom who were willing to make a quit attempt (Free et al. 2009). The authors conducted a 26-week pilot study that showed self-reported quit rates (point prevalence, defined in this review as not smoking in the past 7 days) at 4 weeks to be 26% in the intervention group versus 12% in controls, RR 2.08 [95% confidence interval (CI): 1.11, 3.89]. While the study was not powered to show

efficacy at 26 weeks, investigators were able to obtain 92% long-term follow-up, and there was a high level of participant-reported acceptability of the text messages.

A 3-month pilot study in Ankara, Turkey evaluated an automated stand-alone text-messaging intervention versus a brochure that provided similar information. Participants were adult daily cigarette smokers who were willing to make a quit attempt (n=151) (Ybarra et al. 2012). Smoking prevalence rates in Turkey are higher than in the United States and most adults in Turkey own cellular phones (and a majority regularly uses text messaging), indicating this was an important population in which to evaluate a text messaging-based intervention. Content emphasized CBT but was also based upon self-efficacy theory and relapse prevention. Difficulties were encountered with the text messaging system despite the fact that it had functioned well in an earlier pilot (Ybarra et al. 2013a). At 4-week follow-up, 59/76 (78%) of intervention participants evaluated the acceptability of the program (Ybarra et al. 2012). Forty-one (69%) of responders indicated they somewhat or strongly liked the program and 46 (78%) were somewhat or very likely to recommend the program to others; these results are similar to those of the earlier pilot in which software issues did not arise. Three-month follow-up data were collected from only 40% of participants overall with dropout rates being similar between groups (see Table 1).

Another RCT by Ybarra et al., this time conducted in the United States, is novel in that there was a time and attention control consisting of messages intended to improve participants' sleep and exercise habits within the context of how it would help them to abstain from smoking (Ybarra et al. 2013b). Participants were 18–25 year old daily smokers (n=164) who were seriously considering quitting within 30 days. The 6-week intervention was personalized based upon an individual's quitting phase and whether they had relapsed during the study. At 4 weeks, self-reported continuous abstinence was 39% in the intervention group versus 21% in the control group, adjusted OR 3.33 [CI: 1.48, 7.45] and point prevalence was 44% versus 27% in favor of the intervention group, adjusted OR 2.55 [CI: 1.22, 5.30]. Results favored the intervention group at 3 months on self-reported continuous abstinence but was not significant, adjusted OR 1.59 [CI: 0.78, 3.21]; however, the study was not powered for this outcome.

Efficacy Studies—The earliest tobacco cessation RCT evaluated a personalized text messaging-based intervention that included smoking cessation advice and support and distraction versus a control group in which participants received texts simply thanking them for their participation and providing study details (Rodgers et al. 2005). Participants included tobacco smokers 16 years in New Zealand who were willing to quit. Intervention participants were asked to set a quit date within 30 days. Overall self-reported abstinence rates (point prevalence defined in this review as not smoking in the past 7 days) at 6 weeks were 28% in the intervention group versus 13% in the control group, relative risk (RR) 2.20 [CI: 1.79, 2.70]. At 12 weeks, results remained significant, RR 1.55 [CI: 1.30, 1.84], but at 26 weeks, group differences were less apparent, RR 1.07 [CI: 0.91, 1.26]; the authors speculated that this lack of efficacy might be a function of differential loss to follow up (see Table 1), with participants missing follow-up data assumed to be still smoking. Continuous abstinence for the past 24 weeks, as assessed at the 26 week follow up, also favored the

intervention group. Although low in both groups, the RR was 1.50 [CI: 0.92, 2.44] for complete abstinence and 1.64 [CI: 1.12, 2.42] for abstinence with 3 or fewer lapses.

As a follow-up to the pilot study (Free et al. 2009), the authors conducted a large RCT in the United Kingdom, also in tobacco smokers 16 years who were willing to try to quit (Free et al. 2011). Intervention participants set a quit date within 2 weeks of randomization. This trial had some improvements over the New Zealand study: first, biological verification for all participants was incorporated into the primary outcome measure of continuous abstinence at 6 months. Additionally, the study achieved follow-up rates of 94% in the intervention group and 97% in controls. Results showed continuous abstinence rates of 10.7% in the intervention group and 4.9% controls, RR 2.20 [CI: 1.80, 2.68]. As with the Rodgers et al. (2005) RCT, continuous abstinence rates were low in both groups; however, the effect sizes seen with this simple intervention are important. The authors note that the pooled RRs for group and individual counseling as well as for telephone advice are lower than those found in this study.

An RCT in 3,530 current smokers and recent quitters 18 years in Australia enrolled participants who had agreed to take part in a study about understanding smoking cessation. Participants were randomized to a text messaging intervention only or one of 4 other conditions: an internet-delivered advice program only, both interventions together, a choice of the prior 3 interventions, or a control (Borland, Balmford & Benda 2013). The intervention was CBT-based and provided strategic advice and motivation, while the control included information on internet and phone-based cessation services. Participants were not told initially about the study's interventional nature, and the authors did not seek a commitment to use the assigned interventions. This may have contributed to only 43% of those assigned to an intervention actually using it, and may have reduced the effect sizes observed. The ORs for self-reported, 6-month continuous abstinence were approximately 1.5, favoring all three intervention groups that included text messaging versus the control group. The upper limits of the CIs were similar, ranging from 2.31–2.44, although the lower limits of the CIs crossed 1, ranging from 0.91–0.96.

With SMS as a component of the intervention

Pilot Study—In a pilot in the United Kingdom, pregnant tobacco smokers 16 years (n=207) were randomized to either an intervention consisting of a tailored self-help brochure combined with text messages (based on Social Cognitive Theory, the Perspectives on Change Model and the Elaboration Likelihood Model) or a non-tailored self-help brochure plus text assessments only (Naughton et al. 2012). This 11-week intervention was deemed feasible and acceptable. Outcomes related to self-efficacy, harm beliefs, and motivation were superior in the intervention group. Determination to quit smoking during pregnancy and overall self-efficacy were both significantly higher in the intervention group. The odds of participants setting a quit date were 86% higher in the intervention group, [CI: 1.04 to 3.33]. The odds of making at least one 24 hour quit attempt were higher in the intervention versus control group, although the results were not definitive: OR 1.68 [95% CI: 0.90 to 3.16].

Efficacy Studies—Two RCTs which incorporated text messaging as part of a mobile health intervention including internet, email, and phone have been performed in Norway with tobacco smokers 16 years willing to make a quit attempt (Brendryen & Kraft 2008; Brendryen, Drozd & Kraft 2008). The intervention was based upon principles of self-regulatory theory, social cognitive theory, CBT, motivational interviewing, and relapse prevention; controls received a self-help brochure.

The first RCT (Brendryen & Kraft 2008) included optional nicotine replacement therapy (NRT). The primary outcome measure was repeated point abstinence (based on self-report) at 1, 3, 6 & 12 months (i.e., smoke-free for the past 7 days at all 4 time points) following smoking cessation. Repeated point abstinence rates were 22.3% in the intervention group versus 13.1% in the control group, OR 1.91 [CI: 1.12–3.26]. Twelve-month abstinence rates (point prevalence) were 37.6% (intervention) versus 24.1% (control), OR 1.89 [CI: 1.23–2.92].

The second RCT (Brendryen, Drozd & Kraft 2008) excluded participants on NRT. However, 24% of intervention participants and 10% of controls used NRT anyway. This study used repeated point abstinence, the same primary outcome, and found abstinence rates of 20% in the intervention group and 7% in the control group, an OR of 3.43 [CI: 1.60–7.34]. Results suggest the intervention may be an important tool for quitting smoking (point prevalence) as far out as 12 months, but results did not reach statistical significance: 33% (intervention) versus 23% (control) participants were abstinent, OR 1.66 [CI: 0.99–2.79]. The authors noted that the proportion of abstainers increased over time, particularly in the control group. They speculated that the lack of a significant effect at this time point may have been due to controls making a second quit attempt rather than intervention participants relapsing to smoking.

Following upon the success of the Rodgers et al. text messaging RCT (Rodgers et al. 2005), its authors evaluated a 6-month combined video and text messaging intervention versus general health video messages in 226 daily tobacco smokers 16 years in New Zealand who were ready to quit (Whittaker et al. 2011). Intervention participants initially received text messages as well as video messages from role models of their choice who were ex-smokers. Afterwards, they received text messages and other videos (animations about reasons to quit and "truth" campaign mass media advertisements). Messages used evidence-based behavior change techniques. Only a fraction (226/1300) (17%) of the target sample size was achieved due to difficulties with recruitment. However, feasibility and acceptability were good.

Summary of RCTs with smokers

Automated text messaging-based interventions in tobacco smokers are feasible and acceptable. Efficacy results in larger trials of smokers willing to make a quit attempt have been positive overall in the short term.

Five RCTs had adequate or nearly adequate power at 6 months, they included a total of 11,721 participants and four demonstrated significantly higher repeated point or continuous abstinence rates in favor of the intervention group (Borland, Balmford & Benda 2013; Free et al. 2011; Brendryen & Kraft 2008; Brendryen, Drozd & Kraft 2008; Rodgers et al. 2005).

While the other RCT (Borland, Balmford & Benda 2013) did not reach statistical significance, its results suggest a benefit in each of the three intervention groups that included text messaging relative to the control group. Two of these RCTs also followed participants to 12 months and found statistically significant repeated point abstinence over 12 months. One of these studies also showed significantly higher point prevalence of abstinence at 12 months (Brendryen & Kraft 2008) and the other provided evidence of an important benefit of the intervention at this time point, although results were not statistically significant (Brendryen, Drozd & Kraft 2008). In these two studies, text messaging was only one component of the intervention, which also included internet and phone. This makes it difficult to ascertain the impact of text messaging alone. However, the Borland et al. RCT does permit an evaluation of text messaging alone, internet alone, and both combined versus controls: the odds of 6-month continuous abstinence were similar across groups, OR 1.51, [CI: 0.94, 2.41], OR 1.44, [CI: 0.91, 2.30] and, OR 1.45, [CI: 0.91, 2.31], respectively. Similarly, the odds of abstinence at 7-months (point prevalence) was higher in the text only group than in the internet only or combined groups versus controls, OR 1.26, [CI: 0.94, 1.68] versus OR 1.07, [CI: 0.80, 1.43] and OR 1.07, [CI: 0.79, 1.42]. Although these results were not statistically significant, they favor the intervention groups and do not support the hypothesis that a multimodal intervention is superior to text messaging alone.

Sixty-three percent (5/8) of the primary outcomes assessed at various time points in adequately or nearly adequately powered smoking cessation studies showed significant efficacy of the intervention [Table 1]. Results of the other three primary outcome assessments, all from the same study (Borland, Balmford & Benda 2013) were, as described in the preceding paragraph, suggestive of benefit, although results were not definitive. Quit rates generally decreased as time went on, although, as most interventions were tapered over time, it may be that more sustained interventions would have led to better outcomes. In spite of the fact that it is likely at least some of the secondary smoking outcomes were not adequately powered, 64% (16/25) significantly favored the intervention group.

Sensitivity analyses performed generally confirmed the findings for the primary outcome measures. Subgroup analyses have shown equivalent efficacy across gender, age, education, socioeconomic status, or Fagerström Test for Nicotine Dependence scores (Free et al. 2011; Brendryen 2009; Brendryen & Kraft 2008; Brendryen, Drozd & Kraft 2008; Rodgers et al. 2005). The positive results from these text messaging-based interventions suggest generalizability to tobacco smokers across different developed countries.

While interventions in these studies resulted in higher quit rates than seen in controls, absolute quit rates remained low. Nonetheless, automated text-messaging based interventions show potential to be cost effective. Based on the age and gender distribution observed in the Free, et al (2011) trial, Guerriero et al. (2013) estimated the anticipated costs of adding text messaging to the standard of care for smokers enrolled in the United Kingdom's National Health Service. The cost of the text messaging-based support for each enrolled subject was estimated at £16.11; however, after taking into account quit rates observed in this study and future health costs saved due to reduced smoking, the text messaging program was determined to provide an overall cost savings (Guerriero et al. 2013).

Studies Evaluating Reduction of Alcohol Consumption

Four studies that evaluated phone-based text messaging aimed at problem drinkers have been published.

With SMS as a stand-alone intervention

A pilot study in 54 adult participants 18 years with depression and comorbid alcohol use disorder in Ireland randomized participants to receive either twice daily intervention text messages (e.g., aimed at stress reduction, or encouragement of abstinence) or control messages thanking them for their participation (Agyapong et al. 2012). Participants were in their third week of a four week inpatient program at baseline and were not precluded from participating in any follow-up program. At 3 months, total days of abstinence favored the intervention group; however, results were not definitive: 88.3 (SD: 6.2) days versus 79.3 (SD: 24.1) days, p=.08. After adjusting for baseline Beck Depression Inventory (BDI) scores, mean reduction in BDI at 3 months was significantly greater in the intervention group (31.6 (SD: 7.7) to 8.6 (SD: 7.9)) versus the control group (32.0 (SD: 9.5) to 16.6 (SD: 9.8)), p=.003. A cross-sectional semi-structured survey of intervention found that the messaging intervention was acceptable, and participants found it helpful (Agyapong et al. 2013).

Another 2012 pilot study enrolled forty-five 18 to 24 year old hazardous drinkers who presented in one of three emergency departments in Pennsylvania (Suffoletto et al. 2012). The study included an intervention group who received once weekly messages describing safe drinking guidelines, strategies for reducing drinking, and other supports, and 2 control groups, one who received text assessments only and one who received only reminders about completing a final survey. Seventy-three percent of participants in the assessments only group and 80% in the intervention group completed the full 12 weeks of assessments, demonstrating the feasibility of collecting data with this design. Acceptability of the intervention was rated as high among the 14 intervention participants who completed the study. Two out of six pairwise exploratory efficacy outcomes at 3-month follow-up significantly favored the intervention group versus the assessments only group: change in number of heavy drinking days in the last month was –3.4 (SD: 5.4) versus +1.8 (SD: 5.2) and change in drinks per drinking day in the last month was –2.1 (SD: 1.5) versus +1.1 (SD: 2.1).

With SMS as a component of the intervention

Sixty-seven men aged 25–44 who had regular episodes of heavy drinking and lived in areas of high social deprivation in Scotland were randomized to either a combined SMS and multimedia messaging service- (MMS-) based intervention or a control condition (Irvine et al. 2012). The authors assessed feasibility based on the 34 men who were randomized to the intervention group. The 28-day computer-automated intervention used behavior change techniques based on social cognition models and motivational interviewing and was organized by the stages of the TTM. Participants were asked 9 questions about reasons for drinking, benefits of drinking less, subjective norms, and perceived behavioral control. Thirty (88%) of participants responded to 1 of these questions and 18 (53%) replied to 7 of the 9 questions.

A sophisticated smartphone intervention with a text messaging component was tested in participants 18 years with alcohol dependence in the United States (Gustafson et al. 2014). Participants, mostly unemployed, white males in their 30s and 40s, were about to leave residential treatment and were randomized to either the intervention with treatment as usual (TAU) or TAU alone. In addition to text messaging, the intervention included anonymous discussion groups; responses to "ask an expert" addiction-related questions; video accounts of recovery experiences; website links; GPS technology that tracked when participants were in a high-risk area so that real-time support could be provided; a panic button that participants could press when craving, their personalized reasons for not drinking, and computer-generated alerts to other individuals who had agreed to provide support. Results of the primary outcome, mean number of self-reported risky drinking days in the previous 30, significantly favored the intervention group overall (2.75 (Standard Error (SE) 0.34) versus 1.39 (SE 0.34) days, p=.003) and at 4 (p=.02) and 12 months (p=.03), but not at 8 months (p=.10). In addition, the odds of self-reported abstinence in the prior 30 days was significantly greater overall in the intervention arm, OR: 1.65 (CI: 1.05, 2.57) and gradually increased over time.

Summary of studies evaluating reduction of alcohol consumption

Data on text messaging-based therapy alone or as a component of interventions aimed at curbing problematic alcohol use have demonstrated feasibility, acceptability, or some preliminary efficacy. Studies reviewed here included participants with varying levels of problematic alcohol use and enrollment included both outpatients and those exiting inpatient or residential treatment. Two of these studies targeted participants with co-morbid psychiatric conditions or high social deprivation, suggesting feasibility and acceptability in these subgroups. Research in this area should continue, and a search of Clinicaltrials.gov shows this is an active area of research.

Pilot Study in MA Users

An uncontrolled pilot study (n=52) in the United States assessed a two-week text-messaging intervention designed to reduce MA use and high-risk sexual behaviors among out-of-treatment men who have sex with men (MSM) (Reback et al. 2012). They used 400 pre-written social support and health education messages that study staff wove into text conversations, as well as allowed for 20% of each conversation to include extemporaneously-created messages by study staff (participants in an earlier pre-test of the same intervention indicated they could not differentiate between pre-composed messages and those that were composed extemporaneously by study staff (Reback et al. 2010). Five MA use outcomes were evaluated at 2-month follow-up (n=48) and compared to the 2 months prior to baseline (Reback et al. 2012). The percentage of participants who reported they had discontinued using MA increased from 13.3% to 48.9% between baseline and follow-up (p<.001). Participants also reported significant increases at follow-up in the length of time since their last use of MA (p<.01). In contrast to the self-report findings, urinalysis results in this pilot study revealed a decrease in the number of participants testing positive for MA (from 42.3% to 39.5%) that was neither clinically nor statistically significant. Of participants who were still using MA at follow-up, frequency of use declined significantly at follow-up (p<.001). The percentage of participants who had injected MA declined from 20.8

at baseline to 8.3 at follow-up (p<.05). Additionally, the percentage of participants who had stopped having unprotected sex on MA increased from 20.9 to 44.2 (p<.01), and significant reductions were achieved in 8 out of 10 outcomes pertaining to high HIV-risk sexual behavior with non-primary partners.

Qualitative Study in Cannabis Users

A subgroup of young cannabis users (n=12) who were registered users of one of two text messaging packages developed in Denmark were interviewed after being provided either facts about cannabis (Hashfacts) (e.g., "a month after you stop smoking cannabis, you will find that you feel more fresh and awake, and that both language and memory are reappearing.") or messages oriented toward reducing use (Restart) (e.g., "Decide that you will smoke less today, and only today. Take one day at a time. That way, you will be able to keep a better perspective on the situation.") (Laursen 2010). While only the Restart group included an entry criterion of actively seeking to reduce their use, most of the interviewees desired to reduce their frequency of use or quit altogether. Most participants liked the idea of receiving information about cannabis and counseling via text message, and preferred Hashfacts messages to Restart ones. Hashfacts messages were praised for providing new information and for being simple, direct, and easy to understand. Restart messages were criticized for being abstract, soft, and pedagogical. Hashfacts participants had a much more favorable view of the intervention than did Restart participants.

Discussion

Given the safety and efficacy profile of fully automated text messaging-based interventions for tobacco smoking, as well as text messaging's lack of expense, it is clear that this is a promising approach. An important target for this area of research is developing countries that have a high prevalence of nicotine addiction. A 2013 survey of 24 emerging and developing economies by the Pew Research Center Global Attitudes Project (2014) provides support for this recommendation, revealing that a median of 83% of the populations in these countries report owning a cell phone and that 78% of cell phone users send text messages. While literature on text messaging as a mechanism for delivering interventions to tobacco smokers is becoming extensive, more data are needed to evaluate the safety, feasibility, acceptability, and efficacy of this approach in other substance use problems. Given the relatively high frequency of addictive disorders (Swanke & Zeman 2011; Compton et al. 2007), their frequent chronicity (Compton et al. 2007; McLellan et al. 2000), and the fact that only a minority of patients receive treatment (Compton et al. 2007), this is an important future area of research.

In the aggregate, these studies indicate potential for the use of text messaging-based interventions for the treatment of addiction and have a number of strengths. Fully-automated text messaging-based interventions can be both acceptable to participants and effective as well as a cost-effective (Guerriero et al. 2013). Effect sizes for repeated point or continuous abstinence seen in the 5 adequately or nearly-adequately powered text messaging-based tobacco smoking cessation studies with 6 or 12 month outcomes compare favorably to results from a 2009 Cochrane review evaluating 6-month smoking abstinence rates for

minimal contact interventions (i.e., written materials, videos, audio tapes, or computer programs) (Lancaster & Stead 2009). A pooled effect of 12 studies of minimal contact interventions alone versus control groups which received no materials was RR 1.24 [CI: 1.05, 1.39]. In comparison, of the 5 studies described here with durations of 6 months, the RRs ranged from 1.41 [CI: 0.91, 2.18] (Borland, Balmford & Benda 2013) to 2.94 [CI: 1.49, 5.81] (Brendryen, Drozd & Kraft 2008).

The studies in smokers have large sample sizes, long durations, often included biological verification of abstinence, and showed efficacy across subgroups. Frequent assessments, as were performed in these studies, are known to increase placebo response rates in clinical trials; hence, it is possible that the data collection efforts provided additional monitoring that may have reduced the overall effect sizes seen in these studies.

One weakness of these data is that interpretation of the efficacy of text messaging in some studies is limited by inclusion of other modalities in addition to text messaging. Another weakness is that users of illicit drugs may have confidentiality concerns that could limit the generalizability of the findings from tobacco smokers. Furthermore, only one of the studies controlled fully for time and attention by providing an equal number of control text messages, and this will be important to address in future trials.

These smoking cessation studies also provide insight into the optimal design of future addiction-related text messaging-based studies. First, in many cases, informed consent was successfully managed either via text message (with baseline data collected via phone calls) or over the internet. Authors also successfully collected subsequent self-report data remotely, either via text messaging (importantly, often with follow-up phone calls to non-responders) or the internet. Free et al. (2009) showed that results for mailed-in specimens for biological verification of smoking abstinence were consistent with results for specimens provided in the clinic and used this technique successfully in their subsequent RCT (Free et al. 2011). Handling study procedures remotely in these ways may augment both recruitment and follow-up rates, since it is imposes less burden on participants.

Although many people think of text messaging as being more suitable to younger generations, older participants may also respond well to these interventions and recruitment planning should take this into consideration. Subgroup analyses in some of the smoking cessation studies showed effect sizes did not vary significantly by age (Free et al. 2011; Brendryen 2009; Brendryen & Kraft 2008; Brendryen, Drozd & Kraft 2008; Rodgers et al. 2005). However, Brendryen did find that older participants had greater adherence to the intervention than younger participants (Brendryen 2009), suggesting that older people may be even better suited to trials of addiction-related text messaging-based interventions than their younger counterparts.

When designing subsequent text messaging studies, careful attention must be provided to incentives (e.g., NRT or free text messaging) and how they can affect attrition. Differential incentives by group in particular can be problematic. For instance, there was differential loss to follow-up at 6 months in Rodgers et al. (2005). This may have been because control participants received a month of free text messaging in exchange for continuing to

participate that, due to limited resources, the intervention group did not receive. Additionally, regulatory resistance to incentives can compromise both recruitment and overall follow-up. For instance, Whittaker et al. (2011) cited problems gaining timely ethics board approval for incentives as a significant reason for achieving only 17% of expected enrollment into their RCT. Furthermore, a 3-month follow-up rate of only 40% was a concern in the Ybarra, et al (2012) study conducted in Turkey; this may be in part because research incentives were not provided, as they are not culturally normative in that country (Ybarra et al. 2012). Ongoing efforts need to be made to educate ethics boards about the role and appropriateness of incentives (Volpp et al. 2009; Festinger et al. 2008; Festinger et al. 2005; Dickert & Grady 1999).

Quit rates (point prevalence) diminished over time as the frequency of the text messages was gradually tapered in these studies, but continued to favor the intervention groups at 6 and 12 month follow-ups. Data from other addiction therapies such as methadone and NRT indicate that higher doses and longer duration are more beneficial. Future addiction-related text messaging studies should explore continuing with a higher level of exposure for longer periods.

Subsequent studies should also address a number of outstanding questions. The mechanism of action by which text messages work is still uncertain, as different studies used varying theoretical models (e.g., self-efficacy, distraction) to develop the interventions. The messages were also tested with different frequencies and durations; optimal length and frequency of treatment are as yet undetermined. Tailoring participants' text messages based upon readiness to quit, relapse status, as well as other factors mimics clinical practice, and as in some of the studies described, can be performed via computerized algorithm or screening interview. For instance, participants can be reminded of personalized negative consequences or specific reasons they want to quit, instructed to contact pre-specified individuals when craving and provided their phone numbers, or receive certain messages (e.g., related to prayer or self-help group participation) only if they feel they would be helpful. At this time, it is unclear whether tailoring enhances the efficacy of text messaging-based interventions for addiction. However, some studies indicate that tailoring other types of interventions for tobacco smoking cessation increases efficacy (Wangberg et al. 2011; Lancaster & Stead 2009; Strecher, Shiffman & West 2005).

Finally, text messaging as one component of an intervention using smartphone technology was described in one study in this review and is an exciting direction of mobile health technologies for substance use problems; smartphones allow for more features such as GPS technology, "instant libraries" where participants can find information on addiction, discussion groups, and even CBT-based programs to alter addictive behaviors (Gustafson et al. 2014).

Acknowledgments

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Summary of Text Messaging-Based Studies (in order of appearance in review)

Table 1

Authors	Country (Year)	Sample Size[1]	Main Eligibility Criteria	Intervention	Control	Concomitant Therapy	Proportion of Primary Efficacy Outcomes Significant[2]	Proportion of Secondary Efficacy Outcomes Significant[2]	Detailed Study Results
Haug, Meyer, Schorr, Bauer & John	Germany (2009)	n=194	Daily smokers who text message. Participants were recruited at a university.	Three months of fully-automated texts tailored to stage of change as per the TTM. Texts were customized based on baseline assessments. A craving helpline was also included. Two intervention groups received either 3x/week or 1x/week messages.	Text assessments only	Not discussed	n/a	0% (0/5)	Feasibility and acceptability of this intervention were demonstrated. Measures of efficacy were assessed at 3 months with no directional differences across the 3 groups. Authors indicated that the study was insufficiently powered for these outcomes.
Free, Whittaker, Knight, Abramsky, Rodgers & Roberts	United Kingdom (2009)	n=200*	Smokers 16 years old, living near London, and willing to make a quit attempt	Same intervention as Rodgers, et al, but tailored to UK smokers	Same as Rodgers, et al	Not described	100% (1/1)	n/a	At 4 weeks, self-reported quit rates (point prevalence) were 26% in the intervention group versus 12% in the control group. RR 2.08 [CI: 1.11, 3.89].
Ybarra Bagci Bosi, Korchmaros, & Emri	Turkey (2012)	n=151	Daily smokers 18 years without a chronic or serious illness, in Ankara, and were willing to attempt quitting within 15 days.	Six-week intervention developed based upon review of telephone-based counseling approaches to smoking cessation, emphasized CBT, self-efficacy theory and relapse prevention. Messages were automated and personalized dependent upon an individual's quitting phase and whether they had relapsed during the intervention. In the pre-quit phase, 5 messages per day were sent, increasing as the quit day approached. Following quit day, messages were gradually tapered to 1 per day.	Information about quitting provided in a 7-page brochure	Pharmaco-therapy allowed for all participants and encouraged in those who smoked 10 cigarettes per day	n/a	0% (0/5)	The expected total number of messages for participants ranged from 91 to 146, depending upon how their quit attempts fared. Due to technical problems, approximately 20% of intervention participants missed receiving five or more intervention messages, and about 33% received 22 or more duplicate messages. However, data from a 4-week follow-up survey suggest that the intervention was received favorably by participants. Follow-up at 3 months was 40%. Participants did not receive research incentives for participation, since they are not culturally normative in Turkey, and this also may be a causative factor for follow-up rates being lower than in other studies. A number of efficacy outcome measures (sustained and point prevalence) were evaluated at 4 weeks and at 3 months with no significant differences between groups..
Ybarra, Holtrop, Prescott, Rahbar, & Strong	United States (2013)	n=164 (101 in intervention group and 63 in control group)[3]	Daily smokers (recruited nationally) age 18–25 who were seriously thinking about quitting within the next 30 days.	Six weeks of messages, which were personalized based upon an individual's quitting phase and whether they had relapsed during the intervention. During the pre-quit phase 4–6 daily messages encouraging them to clarify reasons for quitting and to understand their environmental cues.. On quit day and the day after 9 messages were sent, and were	Texts aimed at improving sleep/ exercise habits within the context of how it would help with quitting smoking. Number of texts similar to intervention group.	Pharmaco-therapy encouraged in those who smoked 10 cigarettes per day	n/a	(67%) 2/3	Results significantly favored the intervention group at 4-weeks: continuous abstinence 39% versus 21%, adjusted OR 3.33 [CI: 1.48, 7.45] and point prevalence 44 % versus 27%, adjusted OR 2.55 [CI: 1.22, 5.30]. Follow-up rates in the intervention and control groups were 86% and 87%, respectively, at 4 weeks and 80% in both groups at 3 months. Self-reported 3-month continuous abstinence (defined as 5 cigarettes smoked), was, 40% (intervention) versus 30% (control), OR 1.62 [CI: 0.82, 3.21], although the study was not adequately powered for this outcome.

Authors	Country (Year)	Sample Size[1]	Main Eligibility Criteria	Intervention	Control	Concomitant Therapy	Proportion of Primary Efficacy Outcomes Significant[2]	Proportion of Secondary Efficacy Outcomes Significant[2]	Detailed Study Results
				tapered gradually to 4 per day; these messages emphasized negative aspects to quitting and encouraged coping strategies.					... felt their quit buddy was supportive and helpful were significantly more likely to have quit at 3 months.
Rodgers, Corbett, Bramley, Riddell, Wills, Lin & Jones	New Zealand (2005)	n=1705*	Smokers in New Zealand 16 years old and willing to make a quit attempt	Personalized text messages (5 per day until 4 weeks post quit day, and afterwards reduced to 3 per week) until 6-month follow-up. Content was smoking cessation advice, support & distraction. Participants could "pull" text messages when they were craving. Maori (an indigenous population of New Zealand with a particularly high prevalence of cigarette smoking) participants also received Maori-specific text messages. Participants were asked to set a quit date within 30 days of randomization. Messages were fully automated except those sent to and from a "quit buddy," another participant with similar characteristics and quit days.	1 text every 2 weeks thanking participants for their participation and providing study-related details	Information given about concomitant therapies available from the government	100% (1/1)	60% (3/5)	Twenty-eight percent of participants in the intervention group reported not smoking in the past 7 days at 6 weeks post randomization, versus 13% in the control group, RR 2.20 [CI: 1.79, 2.70]. Sensitivity analyses included biochemical verification of abstinence in a random subsample of participants. Over-reporting of quit rates was discovered; however, it appeared to occur at approximately the same rate in both the intervention and control groups. At 12 weeks, results were similar to those in the primary analysis (29% versus 19%), RR 1.55 [CI: 1.30, 1.84], but not at 26 weeks (25% versus 24%), RR 1.07 [CI: 0.91, 1.26], which may be a result of differential loss to follow-up (33% in the intervention group vs. 22% in the control group) that occurred because an incentive was offered only to the control group due to resource limitations. It may have also been negatively affected by an over-reporting of quit status in the control group, possibly because some participants thought that their incentive was dependent on their quit status. Continuous abstinence rates were low in both groups; however, the intervention group had a significantly higher number of participants at 24 weeks with continuous abstinence (8% versus 5%), defined as 3 lapses with 2 cigarettes per lapse, RR 1.64 [CI: 1.12, 2.42]. For complete continuous abstinence, the data favored the intervention group but was not statistically significant (5% versus 3%), RR 1.50 [CI: 0.92, 2.44].
Free, Knight, Robertson, Whitaker, Edwards, Zhou, Rodgers, Cairns, Kenward & Roberts	United Kingdom (2011)	n=5800*	Smokers in the UK 16 years old and willing to make a quit attempt	Same intervention as Rodgers, et al, but tailored to UK smokers. Participants were asked to set a quit date within 2 weeks of randomization.	Same as Rodgers, et al	Smoking cessation helpline numbers provided and NRT encouraged	100% (1/1)	100% (3/3)	Continuous abstinence [5 cigarettes in the past week at 4 weeks follow-up and 5 cigarettes since the start of the abstinence period at 6 months follow-up (biochemically verified)] rates were 10.7% in the intervention group and 4.9% in the control group, RR 2.20 [CI: 1.80, 2.68]. Multiple

Authors	Country (Year)	Sample Size[1]	Main Eligibility Criteria	Intervention	Control	Concomitant Therapy	Proportion of Primary Efficacy Outcomes Significant[2]	Proportion of Secondary Efficacy Outcomes Significant[2]	Detailed Study Results
									imputation was used for missing data. Sensitivity analyses were performed.
Borland, Balnford & Benda	Australia (2013)	n= 3530 *	Current Smokers and recent quitters (within the last 2 weeks) 18 years who agreed to join a trial about understanding smoking cessation. Participants were either information seekers (primarily callers to a quitline) or were cold contacted from a marketing research database.	Four active groups: 1) text messages only, 2) a CBT-based, tailored internet – delivered advice program only, 3) both interventions together, or 4) a choice of the 3 prior interventions. Texts were CBT-based and provided strategic advice and motivational messages, which were personalized based upon stage of quitting. Participants could also request messages. Messaging frequency varied based upon quit attempts and reported crises.	Brief information on internet and phone-based cessation services.	Pharmacologic aids encouraged, and other forms of help allowed.	0% (0/3)	33% (3/9)	Use of the assigned interventions was only 43%. At 6-months, self-reported sustained abstinence results for all 3 groups that included text messaging versus control were similar, approximate OR 1.5 [CI: 0.9, 2.3].: The odds of abstinence at 7 months (point prevalence) for the text message only group versus controls was 1.26 [CI: 0.94, 1.68] and for the combined and choice groups versus controls were 1.07 [CI: 0.79, 1.42] and 1.11 [CI: 0.83, 1.49], respectively. The overall follow-up rate was 87% and was similar between groups.
Naughton, Prevost, Gilbert & Sutton	United Kingdom (2012)	n=207	Pregnant smokers 16 years who smoked 7 cigarettes per week. Recruitment was at midwife visits.	Tailored self-help brochure and text messages, starting at 2 per day and tapering to 0, for 11 weeks. The intervention drew upon Social Cognitive Theory, the Perspectives on Change Model and the Elaboration Likelihood Model. Message content included pregnancy-related risk, coping strategies, outcome expectancy, support, money-saving feedback, quit preparation advice, and smoking status. Participants could request texts.	Non-tailored self-help brochure plus text assessments (but no intervention texts)	Not discussed	n/a	13% (1/8)	The intervention was determined to be feasible and acceptable. While 24% of participants in the intervention group found the texts annoying, and 26% felt they had received too many, only 9% of these participants requested that the text messages be stopped (and they discontinued mostly for other reasons). Most outcomes related to cognitive determinants (i.e., self-efficacy, harm beliefs, and motivation) significantly favored the intervention group. Of the smoking efficacy outcomes examined, only setting a quit date was significant (in favor of the intervention group); however, the study was not powered to detect differences in these measures. Follow-up rates were 88% overall, with no differences between groups.
Brendryen & Kraft	Norway (2008)	n=396*	Smokers (recruited from Norwegian newspaper ads) 16 years old, willing to make a quit attempt, smoke 10 cigarettes per day	A 12-month fully-automated digital intervention using the internet, email, phone calls, and texts. Aim interactive voice response-based craving helpline and relapse prevention system was included. Principles from self-regulatory theory, social cognitive theory, CBT, motivational interviewing, and relapse prevention were applied (Brendryen, Kraft & Schaalma	Self-help brochure	Free optional NRT	100% (1/1)	100% (4/4)	Repeated point abstinence rates (defined as no smoking in the past 7 days at 1, 3, 6 and 12 months, based on self-report for the previous week) were 22.3% in the intervention group versus 13.1% in the control group, OR 1.91 [CI: 1.12–3.26]. Twelve-month abstinence rates (point prevalence) also significantly favored the intervention group, 37.6% versus 24.1%, OR 1.89 [CI: 1.23–2.92]. Follow-up at 12 months was 86% and similar between groups. NRT use was 93% in the intervention group versus 87% in the control group (p=.07).

Authors	Country (Year)	Sample Size[1]	Main Eligibility Criteria	Intervention	Control	Concomitant Therapy	Proportion of Primary Efficacy Outcomes Significant[2]	Proportion of Secondary Efficacy Outcomes Significant[2]	Detailed Study Results
									2010; Bramley et al. 2005). Texts were sent 2x per day during weeks 1–2, 3x per day during weeks 3–6, 1–3x per day during weeks 7–8 and 1x per day during weeks 9–54
Brendryen, Drozd & Kraft	Norway (2008)	n=290*	Smokers (recruited from Norwegian newspaper ads) ≥16 years old, willing to make a quit attempt, smoke ≥5 cigarettes per day	Same intervention as for Brendryen & Kraft	Self-help brochure	Allowed except for NRT (although 24% of participants in the intervention group and 10% of controls reported NRT use)	100% (1/1)	75% (3/4)	Repeated point abstinence rates (defined as no smoking in the past 7 days at 1, 3, 6 and 12 months, based on self-report for the previous week) were 20% in the intervention group and 7% in the control group, OR = 3.43 [CI: 1.60–7.34]. Twelve-month abstinence rates (point prevalence) suggested benefit of the intervention but results were not statistically significant: 33% versus 23%, OR 1.66 [CI: 0.99–2.79]. Twelve-month follow-up was 82% in the intervention group versus 74% in controls.
Whittaker, Dorey, Bramley, Bullen, Denny, Elley, Maddison, McRobbie, Parag, Rodgers & Salmon	New Zealand (2011)	n=226	Daily smokers ≥16 years old and ready to quit. Recruitment was targeted at young adults (age 16–25), particularly young Maori.	Six months of video messages from participant-selected role models, who were ex-smokers. Participants also received text messages for 1 week before and on quit day (1/day) and for 4 weeks after (3/day). Afterwards, they received text messages and videos), 1 every other day for 2 weeks and then 1 every 4 days for about 20 weeks. Messages used evidence-based behavior change techniques. Subjects could text "crave" or "relapse" to initiate additional messages.	One video-based general health message every 2 weeks and reminders about the study for 6 months. Control group also set a quit date.	Not discussed in detail, but pharmacologic aids allowed	n/a	0% (0/3)	Only 17% of target enrollment (1300) was achieved. Results of the primary outcome, self-reported continuous abstinence (≤ 5 cigarettes smoked) over 6 months were similar, 26.4% in the intervention group versus 27.6% in controls (p=0.8). No significant differences were found on any of the other abstinence endpoints assessed at other time points. Most participants in the intervention group liked the video messages and the number and timing of video and text messages.
Agyapong, Ahern, McLoughlin & Farren	Ireland (2012)	n=54*	Adults ≥18 years with both Major Depressive Disorder & Alcohol Dependence/Alcohol Abuse per the Structured Clinical Interview for DSM-IV	Three months of fully-automated text messages (twice per day) aimed at stress reduction, maintenance of good mental wellbeing, promotion of alcohol abstinence, craving management, promotion of medication adherence and general support.	1 text every 2 weeks thanking participants for study participation	All consenting participants underwent baseline assessments during the third week of a four week inpatient program. They were not precluded from joining any follow-up program.	0% (0/1)	17% (1/6)	Total days of abstinence over 3 months favored the intervention group but was not statistically significant: 88.3 (SD: 6.2) days versus 79.3 (24.1) days, p=.08. Mean reduction in BDI over 3 months was significantly greater in the intervention group (31.58 (SD: 7.7) to 8.6 (SD: 7.9)) versus controls (31.99 (SD: 9.5) to 16.6 (SD: 9.8)), p=.003. Two secondary alcohol-related 3-month endpoints, the Alcohol Abstinence Self Efficacy Scale (AASES) and units of alcohol per drinking day, also favored the texting group, albeit results were not statistically significant: AASES increased from 38.9 (SD:13.8) to 79.5 (SD: 15.9) in the intervention group versus 43.9 (SD: 9.8) to 72.3 (SD: 14.7) in controls, p=.09; units of alcohol per drinking day decreased from 25.0 (SD: 12.4) to 1.13 (SD: 2.94) in the

Authors	Country (Year)	Sample Size[1]	Main Eligibility Criteria	Intervention	Control	Concomitant Therapy	Proportion of Primary Efficacy Outcomes Significant[2]	Proportion of Secondary Efficacy Outcomes Significant[2]	Detailed Study Results
									intervention group versus 20.7 (SD: 10.8) to 6.9 (SD: 16.6) in controls, p= intervention group versus 20.7 (SD: 10.8) to 6.9 (SD: 16.6) in controls, p= intervention group versus 20.7 (SD: 10.8) to 6.9 (SD: 16.6) in controls, p= intervention group versus 20.7 (SD: 10.8) to 6.9 (SD: 16.6) in controls, p= intervention group versus 20.7 (SD: 10.8) to 6.9 (SD: 16.6) in controls, p=
Agyapong, Milnes, McLoughlin & Farren	Ireland (2013)	n=26	Participants in the intervention group of the Agyapong (2012) RCT	Same as above	n/a	n/a	n/a	n/a	
Suffoletto, Calloway, Kristan, Kraemer & Clark	United States (2012)	n=45	Adults 18–24 years, presenting at one of 3 Emergency Departments, and identified as hazardous drinkers on the Alcohol Use Disorders Identification Test	Twelve weeks of fully-automated text messages sent as a once weekly sequence of text messages. The intervention was personalized based upon whether participants were abstinent or moderate or hazardous drinkers. Messages described safe-drinking guidelines, assessed participants' willingness to set a goal to reduce drinking and provided strategies for reducing drinking or exercises to help decisional balance	2 control groups: 1) weekly text message assessments only or 2) one text message per week reminding participants to complete a final survey	Not discussed	n/a	33% (2/6)	Feasibility was demonstrated. Participants found the intervention useful for reducing their heavy drinking (median 5 on a 7-point Likert scale) and would recommend the program to someone who drinks too much alcohol (median 6/7). Overall follow-up rate was 87%, including 93% in the intervention group, 80% in the assessments group and 87% in the control group. At 3 months, 2/6 exploratory efficacy outcomes significantly favored the intervention versus assessments only group, i.e., change in number of heavy drinking days in the last month and change in drinks per drinking day in the last month.
Irvine, Falconer, Jones, Ricketts, Williams & Crombie	Scotland (2012)	n=34 (only intervention group assessed)	Men 25–44 who had regular episodes of heavy drinking and lived in areas of high social deprivation	Thirty six computer-automated SMS and MMS messages sent over 28 days and that incorporated behavior change techniques based on social cognition models and motivational interviewing. Messages were organized by the stages of the TTM and focused on harm reduction, identifying reasons for drinking, and intentions about future drinking. Some messages requested a response.	n/a	Not discussed	n/a	n/a	Feasibility was demonstrated. Ninety five percent of messages sent during the study were delivered. Eighty eight percent of participants responded via text to 1 of 9 alcohol-related questions and 53% answered 7 of these questions. Most narrative responses were lengthy and demonstrated engagement with the intervention.
Gustafson, McTavish, Chih, Atwood, Johnson, Boyle, Levy, Driscoll, Chisholm, Dillenburg, Isham, & Shah	United States (2014)	n=349*	Adults 18 years with alcohol dependence & who were leaving 1 of 5 residential treatment sites	Eight months of TAU plus a smartphone application and text messaging based on self-determination theory. The text messaging component of the intervention included motivational quotes; messages about recovery experiences, reasons for quitting, and the	TAU, which varied across sites	Other continuing care encouraged	(100%) 1/1	(50%) 1/2	Number of risky drinking days (self reported via phone call in the previous 30, significantly favored the intervention group overall (mean (SE)): (2.75 (0.34) versus 1.39 (0.34) days, p=.003) and at 4 months (3.01 (0.48) versus 1.50 (0.47) days, p=.02) and 12 months (2.60 (0.49 versus 1.13 (0.50) days, p=.03), but not at 8 months (2.65 (0.48) versus 1.54 (0.49) days, p=.10). The odds of self-reported abstinence in the prior 30 days was significantly

Authors	Country (Year)	Sample Size[1]	Main Eligibility Criteria	Intervention	Control	Concomitant Therapy	Proportion of Primary Efficacy Outcomes Significant[2]	Proportion of Secondary Efficacy Outcomes Significant[2]	Detailed Study Results
				ability to communicate with a counselor. Counselors received electronic notice of elevated participant scores on an abbreviated Addiction Monitor (BAM) for follow-up.					vary between groups. Overall follow-up rates at 4, 8 and 12 months were 88%, 85% and 78%, respectively.. Based on informal feedback, the time counselors spent responding to participants in the study was considered minimal.
Reback, Grant, Fletcher, Branson, Shoptaw, Bowers, Charania & Mansergh	United States (2012)	n=52*	Out-of-treatment, methamphetamine-using MSMs age 18–65 years	Two-week intervention with 400 pre-written as well as extemporaneous text messages sent by study staff. Messages were based upon behavioral change theories of Social Support Theory, Health Belief Model, and Social Cognitive Theory. Texts were personalized based upon level of MA use, and responses to study text messages.	n/a	n/a	100% (5/5)	n/a	All primary outcomes pertaining to methamphetamine use were significantly improved at 2-month follow-up, including frequency of MA use, length of time since last used MA, whether injected MA in the previous 2 months, whether stopped having unprotected sex on MA and whether stopped using MA. Additionally, significant reductions were seen in 8 out of 10 outcomes pertaining to high HIV-risk sexual behavior with non-primary partners.
Laursen	Denmark (2010)	n=12	Cannabis users subscribed to one of two text messaging packages, Hashfacts or Restart	Automated texts providing facts about cannabis use (Hashfacts) or oriented toward reduction of use (Restart). Hashfacts messages were sent 2x/day for 3 weeks. Restart messages were divided into four phases with different goals related to reducing use and were sent daily for 10 days and then 2–3 per day for 26 days.	n/a	n/a	n/a	n/a	Text messaging recipients who participated in qualitative interviews strongly preferred facts about cannabis (Hashfacts) to messages oriented toward reducing use (Restart). Hashfacts messages were praised for providing new information and for being simple, direct and easy to understand. Restart messages were criticized for being abstract, soft, and pedagogical.

[1] An asterisk was placed after the sample size for each study in which the primary outcome measure was adequately or nearly adequately powered. The aggregated findings of adequately or nearly adequately powered smoking cessation studies can be found in the discussion section of the main text.

[2] Efficacy outcomes include direct behavioral outcomes (e.g., point prevalence of abstinence and number of quit attempts) and do not include other study outcomes, such as cognitive determinants (e.g., self efficacy) or use of NRT.

[3] An additional 47 randomized participants did not complete an initial online baseline survey in order to begin receiving texts. The software program did not retain their randomization assignment; thus, they could not be included in the ITT analyses.