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The Use of New Communications Technologies to Evaluate and Intervene in Substance Use Disorders

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Abstract

The widespread availability of high speed, mobile cellular telephones and other advances in communication technology have the potential to change the way that interventions for substance use disorders (SUD) are delivered and how progress is monitored. This article reviews recent research on the use of new technology to monitor progress and deliver interventions for SUD. Several studies of telephone-based interventions show positive effects, but sometimes only in certain subgroups. However, other studies produced negative results. Studies support the use of interactive voice response (IVR) and personal digital assistants (PDAs) to conduct assessments, but there is little data on whether IVR- or PDA-based interventions improve outcomes. Text messaging has received comparatively little research, but appears promising as a means to conduct assessments and deliver automated interventions. Finally, smartphone technology provides the widest range of features and interventions and the greatest flexibility, but few intervention studies that use them have been conducted.

Keywords

Substance use disorders; treatment; telephone; smartphone; interactive voice response; texting; SMS; personal digital assistant; communication technology; relapse prevention; monitoring; counseling; computerized; automated; GPS; biosensors; theories of behavior change

Introduction

There is considerable evidence from many high quality randomized studies that a number of behavioral interventions are effective in the treatment of substance use disorders (SUD) (1). However, the effect sizes for these interventions are usually modest, and often there are no differences between active interventions (2). This may reflect limitations in behavioral treatments as they are typically implemented. Treatments for SUD are usually provided in clinic-based sessions that occur from one to three times per week. However, many relapse vulnerability factors can change rapidly—over periods as short as a few hours. These factors include mood, stress, craving, and encountering high-risk situations in the community (3,4). A SUD intervention in which data on relapse risks are obtained only during treatment

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sessions cannot be responsive to sudden shifts in risk level between sessions. This reduces the degree to which treatment can be proactive, or that timely information regarding increases in relapse risk can be communicated to peers and other sources of recovery support.

Because of this limitation, patients are often urged to contact their counselors if they experience increases in relapse triggers or have a relapse episode between regularly scheduled sessions. However, counselors may be busy when the calls are made, and are typically available only during regular clinic hours. Consequently, there are many hours during the week when it is not possible for patients to speak to a counselor. Again, this limits the ability of SUD treatments to proactively address relapse risks and reduce the severity of relapses when they do occur. Finally, patients are urged to call peers in recovery and other supports when they feel at risk for relapse. However, patients may not have the necessary information when they most need it, or they may not be able to reach their contact person.

It may be possible to improve the efficacy of SUD interventions by making greater use of technology that enables patients to get additional help outside of regularly scheduled clinic visits. In that regard, a recent review summarized findings from seven studies in which mobile telephones were used to enhance psychotherapy for behavioral disorders. Most of these were small pilot studies designed to determine feasibility, rather than efficacy. However, in the four studies that did calculate effect sizes, the magnitude of effects favoring the mobile phone interventions was in the moderate-to-large range (d= 0.40 to 1.15). The authors that reviewed these studies concluded that more effective phone-based adjunctive interventions featured (a) better integration of the telephone technology with psychotherapy, (b) mobile telephone protocols that clearly adhered to and supported the goals of the psychotherapy, and (c) face-to-face introductions to the program (5).

The widespread availability of high speed, mobile cellular telephones and other advances in communication technology have the potential to drastically change the way that interventions for SUD and other disorders are delivered and how progress is monitored, by patients, treatment providers, and researchers (6). This article reviews recent research on the use of the telephone, text messaging, interactive voice response (IVR), personal data assistants (PDAs), smartphones, and other mobile technology for monitoring progress and delivering interventions for SUD.

Telephone-Based Interventions

Through the telephone, patients can talk to their counselors or therapists and access other recovery supports from home or other locations, without having to travel to a clinic or program location. This can be particularly advantageous for individuals living in rural areas at considerable distance from the nearest clinic or program, those with work or family responsibilities that preclude regular attendance at a clinic, and those with disabilities that make travel difficult. Here, several studies are reviewed in which a treatment intervention was delivered via the telephone. It should be noted that some patients in these studies used a standard landline telephone to communicate with their counselors, rather than a cell phone or smartphone..

McKay and colleagues developed a telephone-based, patient-centered approach to the long-term management of SUD, which is referred to as Telephone Monitoring and Counseling (TMC). The theoretical basis of TMC comes from Stress and Coping Theory (7), which emphasizes the identification of high-risk situations, increasing self-efficacy, and improving coping strategies; and Social Control Theory (8), which stresses monitoring, structure, and goal direction. These goals are also consistent with the primary goals of the Chronic Care Model, as described by Wagner et al. (9), which include support for patient self-management, links to community resources, interventions to increase self-confidence and skill levels, a focus on goal setting, and the identification of barriers to achieving goals and methods to overcome such barriers. TMC can be delivered via cell phones, or traditional landlines.

An 18-month version of TMC was compared to standard care in intensive outpatient programs (IOP) in 252 patients with current alcohol dependence who had completed 3–4 weeks of IOP. TMC consisted of 20–30 minute telephone calls that were provided weekly for 8 weeks, twice monthly for 10 months, and monthly for the final 6 months. Each call began with a 5-minute structured assessment of risk and protective factors, followed by cognitive-behavioral therapy (CBT) focused on developing coping responses to the most pressing problem identified in the assessment. Although patients could have received as many as 36 TMC contacts, they completed an average of only nine calls.

During the 18-month treatment period, rates of any alcohol use (OR= 1.88, $p< 0.02$) and any heavy alcohol use (OR=1.74, $p< 0.04$) were significantly higher in standard care (TAU) than in TMC. There were significant group x time interactions on the frequency of any alcohol and heavy alcohol use, in which the advantage for TMC over TAU increased over time (10). Subgroup analyses over a 24-month follow up showed effects favoring TMC over TAU on the frequency of drinking that were greater in women (OR=0.47, p=0.04) and patients with prior treatments for alcoholism (OR= 0.59, p= 0.02), social networks that supported continued drinking (OR=0.44, p=0.02), and low readiness to change (OR=0.53, p=0.05) after 3 weeks of IOP (11).

In a similar study with cocaine dependent patients (N=321) who had completed 2–3 weeks of IOP, there were significant interactions between cocaine and alcohol use at baseline and the treatment conditions on the primary outcome, a measure of abstinence from cocaine, other drugs, and heavy alcohol use (confirmed by urine toxicology tests). In patients with any days of cocaine or alcohol use in the week prior to intake or the first 3 weeks of IOP, abstinence rates were higher in TMC than in TAU (using alcohol, OR=2.47, p= 0.007; using cocaine, OR=1.95, p= 0.04). Conversely, in patients with no days of cocaine or alcohol use in this period, there were no treatment effects (12). However, in a second study with cocaine dependent IOP patients, patients randomized to receive a more intensive continuing care intervention that featured both clinic and telephone sessions and was delivered from the beginning of IOP had worse substance use outcomes at 12 months than those who were randomized to IOP only (13).

The effect of four different telephone support protocols on outcomes was examined in a sample of stimulant users who had completed intensive outpatient treatment (14). The four

protocols differed on whether the calls were structured or unstructured and directive or non-directive (i.e., a 2 × 2 design). Each condition provided seven calls over a 12-week period, and a no-telephone-call control was included as a fifth condition. Results indicated that the combination of the four telephone conditions produced better drug use outcomes at three months than the control condition, with the effect being larger in those with some drug use in the 30 days prior to baseline (i.e., during IOP). However, there were no differences between the four telephone support conditions, and no differences between any of the groups at the 12-month follow-up.

Finally, 837 veterans who completed residential treatment for PTSD were randomly assigned to receive six telephone care management calls from a call center over the first three months post discharge or to a treatment-as-usual control condition. Over a 12-month follow up, there were no differences between the two conditions on self-report measures of PTSD symptoms, alcohol use, drug use, or depression (15). The authors noted that the TAU control condition had surprisingly good outcomes, which reduced the likelihood of showing an effect.

Text Messaging Interventions

Mobile phone-based short message service (SMS), or text messaging, has been used to assess progress and deliver interventions for a variety of disorders, with the largest effects observed for smoking cessation and HIV medication adherence (16). One of the big advantages of text messaging over smartphone-based interventions is that the former requires only a standard mobile phone; access to the Internet is not necessary. This lowers the cost of the intervention. Moreover, mobile phones are ubiquitous, and unlike high-speed Internet access, are common in lower socioeconomic status communities (17).

Initial studies on the feasibility of SMS-based interventions are promising. Muench and colleagues (18) found that only two of 125 individuals screened for a study of treatment for substance abuse did not have a mobile phone, and all participants' phones were SMS ready, with 60% having unlimited messaging plans. A second study generated evidence that SMS interventions would be appealing to people in treatment for substance use disorders. Most patients (62%) indicated that they would prefer daily to weekly messages, 80% were willing to report substance use on SMS assessments, 84% were willing to send a "help message" if they were in a high-risk situation, and 78% would want their counselor alerted if they were at risk for relapse (17).

Two small studies tested the impact of text messaging to reduce hazardous drinking. Non treatment-seeking college students (N=40) used PDAs to complete an initial assessment. They were then randomized to receive tailored texts on drinking amounts and consequences based on their level of self-efficacy and expectancies, or to a non-text control condition (19). Students in the texting condition reported fewer drinks per drinking day and lower expectancies of alcohol-related trouble. Suffoletto and colleagues (20) recruited young adult hazardous drinkers (N=45) from the emergency department via a brief alcohol screen and randomly assigned them to receive weekly text messaging-based feedback with goal setting, weekly text messaging assessment only with no feedback, or a no-text-message control.

There was a high rate of participation in the texting protocols: 73% of the participants responded to assessment text messages in all 12 weeks of the protocol. At three-month follow-up, participants in the feedback text messaging group had significantly greater decreases in the number of heavy drinking days and drinks per drinking day than those in the text messaging assessment-only and control conditions.

Interactive Voice Response (IVR) Assessments and Interventions

Interactive Voice Response (IVR) is an automated system that can be used to gather information on status and progress from individuals and to provide information or interventions tailored on the basis of data gathered at the start of treatment or at subsequent points. Typically, participants call in once per day, and answer a series of questions using the keypads on their phones. As is the case with SMS interventions, access to the internet is not necessary with IVR.

IVR was used in two studies to examine the relation of daily mood and craving to alcohol use later that day, and whether genetic factors and medication moderated those effects. In the first study (21), when the evening craving level was relatively high, participants with the Asp40 allele of a polymorphism in *OPRM1*, the gene encoding the mu-opioid receptor, drank more that night than Asn40 homozygotes. However, this effect was attenuated by naltrexone, which is a mu-opioid receptor blocker. In this study, daily reports helped to demonstrate the moderating effects of genetic variation on the relation between desire to drink and actual drinking, and the effects of naltrexone on that phenotype. Interestingly, these effects were not found when measures averaged across the study, rather than daily data, were used in the analyses. In a second study, the effects of sertraline on alcohol use on days characterized by relatively high levels of anxiety varied as a function of genotype at a polymorphism of *SLC6A4* (which encodes the serotonin transporter) and age of alcoholism onset (22).

Hasin and colleagues (23) evaluated the addition of IVR to a brief intervention to reduce drinking in HIV-positive patients. The IVR system gathered daily data on drinking for 30 days, and the information was used to produce personalized feedback, including graphs that showed drinking goals and actual daily drinking. These data were discussed in brief follow-up sessions with a counselor, which occurred at 30 and 60 days. Patients completed 64% of their daily IVR calls over the 60-day follow-up period. Results indicated that the addition of IVR to the brief intervention improved alcohol use outcomes over what was achieved with the brief intervention in those who met criteria for alcohol dependence. Conversely, there was no positive effect for the IVR in patients whose drinking was not severe enough to meet dependence criteria.

Rose and colleagues (24) developed an innovative, IVR-based system to treat AUD (24). This automated program, referred to as Alcohol Therapeutic Interactive Voice Response (ATIVR), provides monitoring, skills practice, and interventions tailored by data obtained from IVR responses. Patients provide daily reports of their mood, confidence in maintaining abstinence, urges to drink, and actual drinking behavior. If a patient reports a relapse or data about a close call, the system delivers additional questions on what coping skills were used

to resist or minimize drinking in the situation, and reasons for either drinking or staying abstinent. The system then recommends one or more relevant CBT skills for practice via the IVR. ATIVR also includes a library of 2–4 minute messages that present coping skills that were learned in treatment, and coping skills practice messages that guide patients through CBT exercises. Finally, at the end of each month, therapists record a personal message to each patient through the IVR, which summarizes progress as indicated by data reported to the IVR, and makes recommendations to improve coping and maintain progress.

In a pilot study of ATIVR, patients called the IVR on an average of 59% of scheduled days over a 90-day period, and 71% continued to call the IVR up to the end of the 90-day protocol. The therapist feedback messages were very popular; all participants accessed these messages at least once. The coping skills review and coping skills practice messages were accessed by 48% and 71% of the patients, respectively (24).

Personal Digital Assistants (PDAs)

PDAs are small computers that are programmed to conduct multiple assessments per day, and are carried around by the patient or research participant. The units can also be activated by the patient to record information about stressful situations or episodes of substance use. This protocol has been referred to as “ecological momentary assessment” or EMA. These devices were used with great success by Shiffman and colleagues in a groundbreaking series of studies on nicotine relapse (4).

Epstein, Preston, and colleagues conducted a series of studies in which EMA procedures were used to study craving and relapse over 20 weeks in patients with opiate and cocaine dependence. Results of the first study indicated that cocaine use was most strongly predicted by reports during the prior five hours of seeing the drug, being tempted to use it out of the blue, wanting to see what would happen if use occurred, and being in a good mood. Heroin craving was predicted by increased sadness or anger in the preceding five hours. Interestingly, none of the variables assessed predicted heroin use or cocaine craving (25). A second study by this group found that smoking and tobacco craving were considerably higher when participants were either using or craving cocaine or heroin, which the authors interpreted as evidence that treatment for smoking cessation should be offered concurrently to treatment for other SUD (26). Finally, these authors reported that periods of cocaine use were associated with negative moods while alone in the afternoons and, unexpectedly, with early morning or late evening work (27).

PDAs have been used to investigate the relation of alcohol and tobacco use. In one study, frequency of alcohol urges went up after smoking. Drinking relapse episodes were predicted by prior PDA ratings of low self-efficacy to resist drinking and high urge to smoke. Smoking relapses were predicted by high urge to smoke and high negative mood (28). In a second study with a non-treatment population, consuming alcohol led to increased pleasure and decreased punishment from smoking. Conversely, smoking was associated with only small gains in pleasure from the last drink (29). A third study examined the relation of substance use to symptom expression in individuals with schizophrenia. The results indicated that

alcohol use was most likely to follow increases in anxious mood or psychotic symptoms (30).

Smartphones

The big advantage that smartphones have over the other mobile technology discussed in this article is the ability to connect to the Internet. Therefore, in addition to providing telephone, IVR, and PDA functions, a smartphone can be used to connect to various applications that are available via the web, including interventions to monitor and treat alcohol and drug use disorders. At this point, though, this is more of a potential benefit than an actuality. Two recent reviews of web applications found that very few “apps” provided empirically based treatments or components of treatments for substance use disorders (31,32).

One notable exception is a program developed by Gustafson and colleagues, which is referred to as the Addiction Comprehensive Health Enhancement Support System, or ACHESS (33). This smartphone-based program provides automated recovery support to individuals with substance use disorders. ACHESS offers easy access anytime and anywhere to a range of services tailored to meet patients’ needs, including:

- Rapid access to family, friends, and others in recovery
- Access to discussion groups, other recovery supports, web links, journaling
- Tailored information regarding coping with stressors to personalize the intervention
- Global Positioning System (GPS) alerts to selected significant others when patients approach risky geographic areas
- Alerts/reminders of appointments
- Relaxation training and games to divert attention from craving and stressors
- Stories of how others remained abstinent
- Ongoing mini assessments and check-ins (monitoring)
- A panic button (patient or GPS activated)

ACHESS services come in text and audio-video formats. Data entered into the system in an initial meeting with the patient and obtained subsequently through daily and weekly assessments are used to provide tailored information to the individual on how to improve coping behaviors.

The ACHESS system is ideally suited to address the primary limitations in current treatment approaches that were outlined at the beginning of this article. Daily assessments of patients’ abstinence confidence, ongoing GPS monitoring, and “panic button” functions provide access to near real-time data that are not available from weekly therapeutic contacts. The other features, including links to family, friends, and peers and tailored tools and information, provide more rapid access to social support and other recovery supports during periods when counselors are not available.

In a controlled trial, alcohol dependent patients (N=349) who had completed residential treatment were randomized to receive adjunctive ACHESS for eight months or standard continuing care only. The participants continued to use the ACHESS system at a high rate through the 8-month period during which it was provided. At the end of 8 months, 70% of subjects were using ACHESS at least weekly; compared to 92% at one month. Overall, participants used the system on 40% of the days that they had access to it. Patients receiving ACHESS reported 49% fewer days of risky drinking in the prior 30 days at the 4-, 8-, and 12-month follow ups (mean of 1.39 days in ACHESS vs. 2.75 days in TAU, p= 0.003), as compared to those in TAU. Rates of alcohol abstinence within the prior 30 days were higher in ACHESS than in TAU at the 8- (78% vs. 67%) and 12- (79% vs. 66%) month follow ups ($p < 0.04$) (34).

Discussion

The studies reviewed in this article provide a mixed picture regarding the use of new mobile communication technology in the treatment of SUD. The most frequently studied approach is the use of the telephone to provide interventions. Several studies show positive effects, but sometimes only in certain subgroups, typically the more severe patients who make poorer initial progress in treatment (10–12,14). However, two recent studies produced negative results (13,15). Studies support the use of IVR and PDA technology to conduct assessments, but there are few data on whether IVR- or PDA-based interventions produce better substance use outcomes. SMS, or text messaging, has received comparatively little research, but appears promising as a means to conduct assessments and deliver automated interventions. Finally, smartphone technology has the potential to provide the widest range of features and interventions and the greatest flexibility, but it requires access to the Internet. The first major controlled study of a smartphone program, ACHESS, indicated that it improved outcomes over treatment as usual (34).

Technology that obtains daily data on substance use risk factors and actual use is a major advance over assessments that occur only in traditional weekly clinic-based counseling sessions, even if the data are provided from home once per day, rather than in the heat of the moment, so to speak. However, for mobile technology recovery support approaches to realize their full potential, individuals with SUD need to bring their mobile communication devices with them in situations where they are most likely to need support, and be willing to report strong cravings to use or actual episodes of use as they are happening.

It may be that in cases where individuals have already decided that they are going to drink or use a drug, they will not use mobile technology to interrupt the process. However, there may be many more situations where substance users are ambivalent about using, or are motivated to remain abstinent but encounter an unexpected high-risk situation that leads to substance use. In those cases, a smartphone or other device that can quickly and automatically connect the individual to suggestions for reducing craving and coping with the situation, as well as provide information on the location of nearby recovery supports such as self-help meetings or supportive friends and family, may be seen as being of value and used in the moment. This suggests that it is advantageous to have the recovery support materials accessible by the individual’s own cell phone, so that he or she is not required to carry around two separate

devices. In addition, ease of operation, reliability, and speed are all highly desirable features. There have been promising results of several recent studies showing that individuals with SUD reported that they would use texting and smartphone recovery support services in the heat of the moment to head off a potential relapse or to prevent one from getting worse. Moreover, the study by Gustafson et al. (34) supports the efficacy of such programs.

One of the cutting edge areas of research on mobile communication technology is the use of various kinds of biosensors that collect information automatically and feed it to smartphones or other devices. Such sensors could essentially bypass reluctance to report stress, craving, or use, and could coordinate with other devices to help lower the risk for relapse. For example, an indication of physiological arousal could be coordinated with GPS functions to develop maps of geographic areas that the individual should avoid. Or, sensors that are able to detect the presence of alcohol or drugs in the person's body could automatically relay that information to designated recovery supports.

Finally, several authors have pointed out that widely used theories of behavior change need to be updated to take full advantage of new technology (6). These theories are particularly limited with regard to informing just-in-time intervention adaptations, which are now made possible by the new mobile technology (35). Theories are needed that address within-person, rather than between-person, behavior change (6,35,36). Essentially, we need theories that guide efforts to tailor or adapt interventions on the basis of information gathered at the beginning of the interventions, as well as at subsequent points in time, as new information on status and progress is gathered by the mobile devices in real time (37,38).

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