VA mobile apps for PTSD and related problems: public health resources for veterans and those who care for them

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Abstract: Many public health agencies, including the U.S. Department of Veterans Affairs (VA), have identified the use of mobile technologies as an essential part of a larger strategy to address major public health challenges. The VA's National Center for PTSD (NCPTSD), in collaboration with VA's Office of Mental Health and Suicide Prevention and the Defense Health Agency inside the U.S. Department of Defense (DoD), has been involved in the development, evaluation, and testing of 15 mobile apps designed specifically to address the needs and concerns of veterans and others experiencing symptoms of posttraumatic stress disorder (PTSD). These applications include seven treatment-companion apps (designed to be used with a provider, in conjunction with an evidence-based therapy) and eight self-management apps (designed to be used independently or as an adjunct or extender of traditional care). There is growing evidence for the efficacy of several of these apps for reducing PTSD and other symptoms, and studies of providers demonstrate that the apps are engaging, easy-to-use, and provide a relative advantage to traditional care without apps. While publicly available apps do not collect or share personal data, VA has created research-enabled versions of many of its mental health apps to enable ongoing product enhancement and continuous measurement of the value of these tools to veterans and frontline providers. VA and DoD are also collaborating on provider-based implementation networks to enable clinicians to optimize implementation of mobile technologies in care. Although there are many challenges to developing and integrating mHealth into care, including cost, privacy, and the need for additional research, mobile mental health technologies are likely here to stay and have the potential to reach large numbers of those with unmet mental health needs, including PTSD-related concerns.

Keywords: Mobile apps; posttraumatic stress disorder (PTSD); mental health; veterans

Introduction

Public health agencies are charged with maximizing the health and well-being of entire populations of people (1,2), often with scant resources allocated specifically to mental health (3,4). The U.S. Department of Veterans Affairs (VA) is responsible for addressing the physical and mental health needs of veterans of the U.S. military, and posttraumatic stress disorder (PTSD) is both highly prevalent among veterans (5) and strongly associated with healthcare utilization and costs (6,7). Addressing complex public health

problems, like PTSD, requires weighing the best possible evidence and standards of care (8) with the challenges of providing mental health care across populations (9), including declining funding rates as a proportion of overall health care (10,11), stigma (12), lack of providers (13), and other major barriers to delivering mental health care (14,15). For veterans receiving VA healthcare, VA offers screening, treatment, and follow-up care for those with PTSD and has developed training and implementation services to support the use of evidence-based treatments. Even with these efforts, VA faces ongoing challenges in delivering measurement-based care (16), reducing treatment dropout (17), and continuing to improve treatment outcomes (18,19).

For PTSD in particular, evidence-based approaches to treating PTSD are not available for the vast majority of individuals who experience it (20,21). Resources are also particularly scarce for the large numbers of those who experience moderate or high levels of PTSD symptoms but do not meet full diagnostic criteria (22). Both public and private mental health care delivery systems face challenges in keeping up with demand (15), and recent changes to both the Affordable Care Act, 42 U.S.C. §18001 [2010], and the Veterans Access, Choice, and Accountability Act, Public Law 113–146 [2014], are likely to place even greater pressures on under resourced community and private mental health providers and county and state public health agencies to address PTSD-related problems.

To address potential gaps in PTSD-related care, there have been many efforts to use technology to reach veterans, and others with PTSD who are not able or willing to use evidence-based approaches to PTSD treatment. VA is a world-leader in the diagnosis and treatment of PTSD, treating 619,493 veterans with PTSD in 2016 alone (23) since 2011, the VA's National Center for PTSD, in collaboration with VA's Office of Mental Health and Suicide Prevention (OMHSP) and the U.S. Department of Defense's Defense Health Agency, has been involved in the development and evaluation of 15 mobile apps designed to provide support for evidence-based treatments and self-management strategies for individuals living with PTSD symptoms or related problems. Mobile applications are well-suited for addressing many of the challenges in meeting unmet mental health needs, though they are likely to be most effective when used as part of a broader mental health strategy. The ubiquity of mobile devices is a key benefit in extending reach: smartphones are used by 77% of the U.S. population (24) and 82% of active duty service members (25). Moreover, smartphones are nearly always both on and on your person (26). Furthermore, the apps are both tolerable and desirable: veterans have high levels of interest in using mobile apps for mental health-related concerns (27). Mobile technologies have been deployed successfully to reduce mental health problems, such as suicidal ideation (28), depression (29), sleep (30), and PTSD (31) to name a few. Moreover, mobile apps can be used to address PTSD-related needs at many different points of contact with the healthcare system: for use in screening for mental health conditions or tracking changes over time (32), as a means of providing immediate assistance while a patient is waiting for a higher level of care, for use in supporting the delivery of evidence-based treatment (33), for providing between-session homework exercises (34,35), to provide post-treatment support, and as a way to reach those who might not otherwise access mental health services. It follows that various large public health agencies have made policy to systematically increase the use of mobile apps to address public health problems. For example, VA's 2018–2024 strategic objectives are to modernize VA service delivery, including the delivery of information and services through mobile apps and other technologies (36).

This paper will describe the history, rationale, evidence, and application of a public mHealth portfolio for addressing the needs and concerns of veterans and others experiencing symptoms of post-traumatic stress and PTSD.

History of VA mobile mental health

In 2009, a team of psychologists who had been working on congressionally mandated web products for service members and veterans at the National Center for PTSD (NCPTSD) Dissemination and Training Division proposed building a mobile app to provide psychoeducation and self-management tools for PTSD in response to veteran feedback. By the fall of 2010, early builds of the app (PTSD Coach) were shared with VA leadership, who were impressed with its elegant, simple design, and solid execution of features (e.g., self-assessment and coping tools) and considered it an exceptional demonstration of innovative technology in government. In April 2011, PTSD Coach was released to the App Store becoming VA's first publicly available mobile app. Almost immediately, PTSD Coach showed robust download numbers and began receiving acclaim from users, the press, professional organizations, and won national recognition (e.g.,

promotion by the official White House Blog, the FCC's Chairman's Award for Accessibility). Concurrently, VA leadership invited the NCPTSD team to submit a proposal to develop a mobile apps program for PTSD (and related conditions) and to serve as a resource hub for other VA entities considering mobile app development and research. The proposal included a comprehensive, coherent strategy to develop, maintain, evaluate, distribute, and support a suite of mobile apps that aligned with VA's mission to disseminate, implement, and improve delivery of sound mental health information and evidence-based treatments (EBTs) for mental health conditions. In October, 2011 the mobile apps program began, which included a full-time mobile apps lead, an evaluator/researcher, and a program coordinator. It also included resources to support the design and development of three new apps each year and the maintenance of existing apps. Since then, the program has expanded to include additional part- and full-time team members. With the success of this program, in 2014, VA leadership established a national mobile health program within Mental Health Services that would work in close partnership with the NCPTSD team, in order to broaden the benefit mobile options could confer across many other presenting mental health problems and populations.

Need for public mobile mental health resources

Most large public health agencies have utilized mobile apps to address population-health challenges. For example, the English National Health Service (NHS) offers over 40 consumer-facing mobile apps and web applications (37), including 11 apps specific to mental health (e.g., Cove, Chill Panda, Stress and Anxiety Companion). The U.S. Center for Disease Control (CDC) offers 11 consumer-facing and 9 provider-facing apps addressing everything from dental health to dietary recommendations to vaccine schedules. However, across all of these other public health agencies, there are currently no mobile apps specific to PTSD, only a handful that are specific to anxiety, depression, or stress management, and none that are specific to the needs of trauma survivors or integrate with existing systems of care.

In general, private-sector mobile mental health apps offer promise (38) but very few have been developed specifically for trauma survivors or veterans. Moreover, there are several major problems with the use of private-sector apps to address mental health concerns at the public health level, including: cost, privacy, stability, and responsiveness to stakeholders' needs. With respect to cost, some of the best-studied mobile mental health applications are prohibitively expensive and could not be accessed by many of those who most need services (38). For example, Sleepio has shown substantial promise for reducing insomnia severity but costs several hundred dollars (39). Other evidence-informed apps, like Pacifica, Calm, Breathe, and Headspace, offer some free content, but require users' personal information and limit most content to those who are able to pay a monthly fee. With respect to privacy, many private mental health apps collect, and reserve the right to share, personally-identifying and health information. Additionally, privacy policies for many mobile health apps can be difficult to find and even more difficult to understand (40). With respect to stability, the availability and long-term reliability of many private-sector mental health applications tends to be limited over time. There is high turn-over of technologies (e.g., yearly updates to mobile operating systems), many unique combinations of mobile app platforms and devices, high testing demands, and other challenges that require extensive and ongoing maintenance resources (41). Finally, with respect to responsiveness, private sector technologies are answerable to shareholders and investors and may be more heavily optimized for monetization than for addressing users' mental health needs (42). The extent to which private mobile mental health apps are responsive to scientific investigation or user input is unclear, and many commercial mobile apps for mental health do not employ evidence-based behavior-change strategies (43).

Public health approaches to mobile mental health have the potential to address each of these limitations. First, because public health agencies are not constrained by profit motive, their apps can be offered at no cost to users and can therefore reach much broader audiences. Second, public health agencies like VA address privacy with the full protections of federal privacy laws, regulations, and policies. Because mental health-related concerns are inherently private and often highly stigmatizing, there is a need for resources that do not collect personally-identifiable information or pose privacy risks to users (44). VA mobile mental health apps do not ask for or store personally-identifying information of any kind. As described in more detail below, VA mobile mental health apps have been maintained over time, have a research base, and are responsive to stakeholder input.

VA mobile mental health portfolio

The VA's mobile mental health portfolio consists of self-

management apps and treatment-companion apps.

Self-management apps are designed to be used by anyone living with PTSD or trying to better understand PTSD, regardless of whether they are currently connected to care. There are currently eight self-management apps: PTSD Coach for PTSD-related self-care, PTSD Family Coach for loved ones of those with PTSD, Mindfulness Coach for learning and practicing skills in mindfulness, Anger and Irritability Management Skills (AIMS) for tracking and managing anger, VetChange for tracking and managing alcohol use, Parenting2Go for readjusting to parenting after being deployed, Moving Forward for problem-solving, & Concussion Coach for self-care related to mild traumatic brain injuries (see *Table 1*). These applications provide extensive educational content, interactive tools for skills-training and stress management, assessment and self-tracking features, and resources for connecting with support and finding professional care.

Treatment-companion apps are patient-facing and are designed to be used in conjunction with traditional therapist-guided evidence-based treatments (EBTs). There are currently seven treatment-companion apps to support the delivery of Prolonged Exposure therapy (PE Coach) for PTSD, Cognitive-Processing Therapy (CPT Coach) for PTSD, Cognitive-Behavioral Therapy for Insomnia (CBT-i Coach), Acceptance and Commitment Therapy (ACT Coach) for anxiety and depression, Integrated Care for Smoking Cessation (Stay Quit Coach), Skills Training in Affect and Interpersonal Regulation (STAIR Coach) for PTSD, and Behavioral Activation for depression (Mood Coach; see *Table 2*). These apps make it easy for providers to demonstrate and encourage practice of key skills specific to each EBT, such as identifying and completing *in vivo* and imaginal exposure exercises, completing sleep diaries or thought records, and practicing relaxation exercises. Additionally, the apps contain handouts, worksheets, and explanations that are routinely used in the delivery treatment. Providers are able to demonstrate and use the apps in session, and the patient can use them between sessions and even after discharge to extend the benefits of treatment.

Evidence for VA mobile mental health resources

Evidence for the potential benefits of VA mobile mental health apps is accumulating across several important research fronts (see *Table 3*). These include studies showing support for their value as helpful psychoeducational self-help tools, powerful adjuncts to clinical care, and advantageous tools that are being widely used and appreciated by providers.

Regarding evidence for self-management of PTSD symptoms, PTSD Coach has been the subject of several studies. The first among these was an acceptability study with veterans in VA residential PTSD treatment (45). After using PTSD Coach for three days, participants (N=45) reported high satisfaction with the app and believed it was moderately to very helpful for managing their PTSD symptoms. In a pilot randomized controlled trial (RCT) among community trauma survivors with significant PTSD symptoms (N=49), those assigned to use PTSD Coach for one month showed significant improvement in their PTSD symptoms, whereas those assigned to a waitlist control condition did not (46). However, there was no significant difference in symptom change between conditions. In a follow-up, full-scale RCT with a larger community sample (N=120) and 3-month intervention period, significant treatment effects were found favoring PTSD Coach relative to a waitlist control condition on improvements in PTSD symptoms, depression symptoms, and psychosocial functioning (31). A variant of PTSD Coach called Cancer Distress Coach, which was specifically designed for cancer survivors, has also shown promise. In a pre-post trial with 31 cancer survivors experiencing significant PTSD symptoms, nearly half (48.4%) reported a reliable improvement in their symptoms and almost a third (32.3%) evidenced clinically meaningful improvements (47). A study conducted by independent investigators (i.e., those not involved in the development of PTSD Coach) using a pre-post design with college students with significant PTSD symptoms (N=53) demonstrated that app use was associated with PTSD symptom improvement (48). Finally, to assess the reach, impact, use, and perceptions of the publicly available PTSD Coach, Owen and colleagues (49) examined aggregate usage data from over 150K downloads of PTSD Coach and 156 App Store and Google Play user reviews. They found that PTSD Coach was reaching those with elevated PTSD symptoms, use of symptom management tools was associated with reduced distress ratings, and that users appreciated the availability of the app and being able to use it during moments of need.

VA apps have also shown promise as well in the context of clinical care, particularly when used by patients in evidence-based psychotherapies for PTSD and common comorbidities (i.e., insomnia and smoking). This includes findings from a case-series with two patients enrolled

Table 1 VA mobile mental health portfolio: self-management apps

App	App store description	Platform	Research version available?	Target population
PTSD Coach	This app provides you with education about PTSD, information about professional care, a self-assessment for PTSD, opportunities to find support, and tools that can help you manage the stresses of daily life with PTSD. Tools range from relaxation skills and positive self-talk to anger management and other common self-help strategies. You can customize tools based on your preferences and can integrate your own contacts, photos, and music. This app can be used by people who are in treatment as well as those who are not	iOS, Android	Y	PTSD Coach was designed for those who have, or may have, posttraumatic stress disorder (PTSD)
PTSD Family Coach	The app provides extensive information about PTSD, how to take care of yourself, how to take care of your relationship with your loved one or with children, and how to help your loved one get the treatment they deserve. The app also provides a great deal of information that is specific to veterans and active duty members of the military. Living with a family member who has PTSD can be incredibly stressful, and PTSD Family Coach includes 24 unique tools to help you manage this stress, including mindfulness exercises, tools to help you re-build your social networks, and tools to help with difficult thoughts and emotions you may be experiencing. The app also provides a way for you to track your stress level over time, using scientifically valid measures, and can provide specific feedback about your progress. Finally, PTSD Family Coach offers a number of ways for you, and your loved one, to connect with support	iOS, Android	Y	PTSD Family Coach is for family members of those living with posttraumatic stress disorder (PTSD)
Mindfulness Coach	Mindfulness means noticing and paying attention to what is going on in the present moment, without passing judgment on it. Mindfulness has been shown to be effective for reducing stress, improving emotional balance, increasing self-awareness, helping with anxiety and depression, and coping more effectively with chronic pain. The app provides a gradual, self-guided training program designed to help you understand and adopt a simple mindfulness practice. Mindfulness Coach also offers a library of information about mindfulness (for example "What is Mindfulness?", "How to Anchor Your Attention"), 12 audio-guided mindfulness exercises and a growing catalog of additional exercises available for free download, goal-setting and tracking, a mindfulness mastery assessment to help you track your progress over time, customizable reminders, and access to other support and crisis resources. Mindfulness Coach is free, doesn't take or share any of your personal information, and doesn't require add-on purchases	iOS, Android	Y	Mindfulness Coach 2.0 was developed to help veterans, service members, and others learn how to practice mindfulness
Anger & Irritability Management (AIMS)	The AIMS app is based on the Anger and Irritability Management Skills online self-help course (http://www.veterantraining.va.gov/aims/). The app provides users with education about anger, opportunities for finding support, the ability to create an anger management plan, anger tracking, and tools to help manage angry reactions. Users can also create custom tools based on their preferences, and can integrate their own contacts, photos, and music. The AIMS app may be used alone, or in combination with the online course or in-person therapy. AIMS was created by VA's National Center for PTSD and VA's Mental Health Services	iOS, Android	Y	AIMS is designed for veterans and military service members but can be used by anyone coping with anger problems

Table 1 (*continued*)

Table 1 (*continued*)

App	App store description	Platform	Research version available?	Target population
Concussion Coach	This app provides users with information about concussion, a self-assessment instrument for symptoms and their severity, tools to help users build resilience and manage symptoms, and recommendations for community-based resources and support. Users can customize tools based on their references and can integrate their own contacts, photos, and music. This app can be used by itself, but it may be more effective in combination with treatment by a healthcare professional	iOS, Android	Y	Concussion Coach was designed for veterans, Service members, and other individuals who experience physical, cognitive, and emotional symptoms that may be related to mild to moderate traumatic brain injury
VetChange	This app provides tools for cutting down or quitting drinking, tools for managing stress symptoms, education about alcohol use and how it relates to PTSD symptoms, and guidance to find professional treatment. You can use VetChange alone or in combination with counseling. Please tell your healthcare provider if you are using the app while you are in counseling. The app is not intended to replace professional treatment. VetChange is based on the VetChange web intervention	iOS	Y	VetChange is an app for veterans and Service members who are concerned about their drinking and how it relates to posttraumatic stress after deployment, and for all people who are interested in developing healthier drinking behaviors
Parenting2Go	The app can be used alone or in combination with the online Parenting for Service Members & veterans course. Parents can find quick parenting advice; relaxation tools to use when frustrated or stressed; tools to improve their relationship with their children through positive communication; and strategies to switch gears between military life and home. The app addresses challenges that come with parenting children of all ages and backgrounds. The app also offers guidance for seeking professional help and access to additional resources	iOS	N	Parenting2Go helps veterans and Service members reconnect with their children and provides convenient tools to strengthen parenting skills
Moving Forward	Moving Forward provides on-the-go tools and teaches problem solving skills to overcome obstacles and deal with stress. It is especially helpful in managing challenges such as: returning to civilian life, balancing school and family life, financial difficulties, relationship problems, difficult career decisions, and coping with physical injuries. It may be used alone or in combination with the Moving Forward online course (www.veterantraining.va.gov/movingforward)	iOS	N	The app is designed for veterans and Service members, but is useful for anyone with stressful problems

Table 2 VA mobile mental health portfolio: treatment-companion apps

App	App description	Platform	Research version available?	Target population
PE Coach	The app will guide you through the exercises assigned by your therapist and allows you to track and record your progress. In addition, the app provides techniques such as controlled breathing that will help you tolerate and decrease your distress. PE Coach will help you remember and track your upcoming therapy sessions. You will be able to audio record your sessions directly onto your phone so you can review them later as part of your treatment. By itself this app is not sufficient to treat PTSD. However, those who are receiving PE treatment can work together with their therapist to use the tools in this app	iOS, Android	Y	PE Coach is designed to be used during therapy for posttraumatic stress disorder (PTSD) with a health professional who is trained in Prolonged Exposure (PE) therapy
CPT Coach	This app contains support materials for a complete course of CPT to help patients manage their treatment, including between session assignments, readings, PTSD symptom monitoring, and mobile versions of CPT worksheets. CPT Coach is not intended to be used as self-help without the guidance of a professional mental healthcare provider	iOS, Android	N	CPT Coach is for veterans, Service members, and others with PTSD who are participating in Cognitive Processing Therapy (CPT) with a professional mental healthcare provider
CBT-i Coach	The app will guide users through the process of learning about sleep, developing positive sleep routines, and improving their sleep environments. It provides a structured program that teaches strategies proven to improve sleep and help alleviate symptoms of insomnia. CBT-i Coach is intended to augment face-to-face care with a healthcare professional. It can be used on its own, but it is not intended to replace therapy for those who need it. CBT-i Coach is based on the therapy manual, Cognitive Behavioral Therapy for Insomnia in veterans. CBT-i has been shown to be efficacious for insomnia for both veterans and civilians	iOS, Android	Y	CBT-i Coach is for people who are engaged in Cognitive Behavioral Therapy for Insomnia with a health provider, or who have experienced symptoms of insomnia and would like to improve their sleep habits
ACT Coach	ACT Coach offers exercises, tools, information, and tracking logs so you can practice what you're learning in your daily life. Acceptance and Commitment Therapy (ACT) aims to help you live with unpleasant thoughts, feelings, and impulses without avoiding them or being controlled by them. In ACT, you are encouraged to commit to actions so that you can live your life by your values, even in the face of these unpleasant experiences	iOS, Android	N	ACT Coach was developed for veterans, service members, and other people who are in Acceptance and Commitment Therapy in consultation with a therapist
Stay Quit Coach	This app is intended to serve as a source of readily available support and information for adults who are already in treatment to quit smoking - to help them stay quit even after treatment ends. The app guides users in creating a tailored plan that takes into account their personal reasons for quitting. It provides information about smoking and quitting, interactive tools to help users cope with urges to smoke, and motivational messages and support contacts to help users stay smoke-free. Stay Quit Coach is based on the smoking treatment manual "Integrated Care for Smoking Cessation: Treatment for veterans with PTSD." This treatment is based on evidence-based clinical practices, and has been shown to double quit rates of military veterans with PTSD	iOS, Android	N	Stay Quit Coach is designed for veterans, service members, and other people who need assistance with quitting smoking

Table 2 (*continued*)

Table 2 (*continued*)

App	App description	Platform	Research version available?	Target population
STAIR Coach	Skills Training in Affective and Interpersonal Regulation (STAIR) is an evidence-based psychotherapy that uses cognitive and behavioral techniques to help with managing emotions and relationships. The app includes in-depth psychoeducation, interactive tools for emotion and behavior management, customizable reminders and quick links to support	iOS	N	STAIR Coach is designed to supplement in-person psychotherapy using Skills Training in Affective & Interpersonal Regulation (STAIR) but has tools that could be helpful for anyone who has experienced trauma
Mood Coach	This app is designed to help you boost your mood through participation in positive activities. You can make a plan with positive activities and track your progress. This app provides: • Scheduling of positive activities for your selected values • An activity log for tracking your progress • A daily mood rating tool • Education about depression, posttraumatic stress disorder, and behavioral activation • The PHQ-9 assessment for tracking symptoms of depression Mood Coach can be used on its own by those who would like mood management tools, or to augment face-to-face care with a healthcare professional. It is not intended to replace therapy for those who need it	iOS	N	Mood Coach was developed for veterans, service members, and other people who are using Behavioral Activation in consultation with a mental health provider. Behavioral Activation is an evidence-based treatment for depression

PE, prolonged exposure therapy; CPT, cognitive processing therapy; CBT-i, cognitive-behavioral therapy for insomnia; ACT, acceptance and commitment therapy.

in PE therapy who were assigned in a counterbalanced fashion to or not use PE Coach for four of their eight sessions (50). Both patients reported greater satisfaction with care while using PE Coach, compared to when they did not use the app. It also includes a small-scale RCT of four veterans with insomnia and cannabis use disorder randomly assigned to use CBT-i Coach or a mood-tracking app (placebo control) for two weeks (51). Both participants assigned to CBT-i Coach reported improved sleep efficiency and reduced cannabis use while one participant in the control condition dropped out and the other had improved sleep efficiency but increased cannabis use. CBT-i Coach was also examined in a pilot RCT where CBT-i patients (N=18) were randomly assigned to use or not use the app during care (52). Findings supported the app's feasibility (i.e., participants routinely used the app) and acceptability (i.e., app features were perceived as helpful), and a large treatment effect (although not statistically significant) was found for improved provider-rated patient adherence to the protocol.

Similar research has been conducted with Stay Quit Coach, the companion app for the Integrated Care for Smoking Cessation for PTSD protocol (53). A pilot RCT (N=11) with smokers with PTSD found that Stay Quit Coach was feasible and acceptable when used after a quit attempt (54). Likewise, findings of an open trial evaluating Stay Quit Coach among veteran smokers with PTSD (N=20) demonstrated that the app was feasible and acceptable, and treatment attendance and rate of bio-verified smoking abstinence appeared to be improved over what was found in the original trial [i.e., (53,55)]. Finally, in a novel application of integrating an app in care, Possemato and colleagues developed an intervention for VA primary care patients with PTSD coupling PTSD Coach with four brief sessions (i.e., 20–30 minutes) of clinician support (56) intended to address PTSD symptoms and increase the likelihood of accepting a referral to PTSD specialty care. A pilot RCT comparing this intervention to PTSD Coach use without support among VA primary care patients with PTSD (N=20)

Table 3 Peer-reviewed studies of VA mobile mental health apps, by app

First author [year]	Study population (n)	Research design	Results & key findings
PTSD Coach			
Kuhn [2014]	Veterans in a residential PTSD treatment program (n=45)	Observational treatment study (no control group)	89% of those who used PTSD Coach were at least moderately satisfied with the app
			Qualitative analysis suggests that the app is used as intended by the developers
Miner [2016]	Adults with moderate to high PTSD symptoms (n=49)	Randomized controlled trial (wait-list control)	No time × condition interaction effects for PTSD symptoms
			Significant reduction in PTSD symptoms for those in PTSD Coach group, but no significant reduction in PTSD symptoms for wait-list control
			Qualitative analyses suggest high levels of perceived helpfulness of PTSD Coach, particularly the app's self-management tools
Kuhn [2017]	Adults with high PTSD symptoms (n=120)	Randomized controlled trial (wait-list control)	Significant time × condition interaction effects benefiting PTSD Coach for: — PTSD symptoms — Depression symptoms — Interpersonal functioning
			No interaction effects for PTSD coping self-efficacy
Keen [2017]	Undergraduates with PTSD symptoms (n=382)	Observational treatment study (no control group)	Use of the PTSD Coach app predicted change in PTSD symptoms
			PTSD symptoms at baseline did not predict PTSD Coach app use
Owen [2015]	Users of the PTSD Coach mobile app (n=153,834) and public reviewers (n=156)	Cross-sectional and qualitative	PTSD Coach reached over 10,600 active monthly users
			The app is associated with relatively high rates of retention, with over 10% continuing to use the app 1-year post-download
			Users average 6 sessions and over 5 minutes of time spent using the app
			First-time and return users differ in how they use the app, with first-time users being more likely to explore multiple content areas of the app and return users more likely to use one key feature of the app
			Momentary distress scores decrease significantly for those who use a symptom management tool and rate distress before and after using the tool
Possemato [2016]	Veterans with moderate to high PTSD symptoms (n=20)	Pilot randomized controlled trial (alternative treatment control)	High levels of provider satisfaction with clinician-supported (CS)-PTSD Coach
			High levels of PTSD Coach use among veterans
			No significant difference between treatment conditions on PTSD symptoms across time
			Those in the CS-PTSD Coach condition were significantly more likely to accept a mental health referral
			Trends benefiting CS-PTSD Coach for clinically significant improvement in PTSD symptoms, psychological quality of life, and social quality of life

Table 3 (*continued*)

Table 3 (continued)

First author [year]	Study population (n)	Research design	Results & key findings
Possemato [2017]	Providers delivering clinician-supported PTSD Coach (CS-PTSD; n=3); Veterans who have completed CS-PTSD Coach (n=9)	Qualitative	100% of veterans reported good to excellent satisfaction with CS-PTSD Coach
			78% of veterans reported that CS-PTSD Coach met all or most of their needs
			Providers had generally positive perceptions of CS-PTSD Coach but identified a number of potential improvements, including collaborative goal-setting and accommodating personal needs of each Veteran
PE Coach			
Kuhn [2014]	VA mental health providers trained in Prolonged Exposure therapy (PE) (n=163)	Cross-sectional study	Provider perceptions were modestly positive towards the PE Coach app, although the full app was not yet available for providers to download
			Providers were willing to use the PE Coach app and to recommend it to colleagues
Kuhn [2015]	VA providers delivering Prolonged Exposure therapy (PE)	Cross-sectional study	50% of PE providers reported using the PE Coach app in treatment and reported favorable perceptions of the app. 94% of providers who use the app intended to continue using the app
			Providers who used PE Coach used it with 33% of their patients
			76% of providers who did not use PE Coach reported intending to use it in the future
Reger [2015, 2017]	VA providers who have used PE Coach as part of Prolonged Exposure therapy (n=25)	Qualitative	Facilitators of use of the PE Coach app: — PE materials available from a single, convenient source — Convenience for patients — Ease of delivering PE treatment Barriers to use of the PE Coach app: — Technical challenges — Specific knowledge about how to best use the app — Time to learn all of the app's features
CBT-i Coach			
Babson [2015]	Veterans with sleep disturbance, cannabis use disorder, and interest in making a quit attempt (n=4)	Pilot randomized trial (attention placebo control)	Veterans reported daily use of the CBTi Coach app, with an average session duration of 5–10 minutes
			Veterans reported the app to be helpful for improving sleep
			Veterans were most satisfied with the app's sleep logs and exercises for improving sleep
Koffel [2018]	Veterans referred for Cognitive Behavioral Therapy for Insomnia (CBT-i; n=18)	Pilot randomized trial (active treatment control) and qualitative	Very high levels of satisfaction with the CBT-i Coach app
			High levels of use of the sleep diary, educational materials, relaxation exercises, and reminders
			No significant effects of app on homework completion or completion of sleep diaries
			Trend benefiting CBT-i Coach group for adherence and completed sleep diaries

Table 3 (continued)

Table 3 (*continued*)

First author [year]	Study population (n)	Research design	Results & key findings
Kuhn [2016]	VA providers trained to deliver CBT-i (n_1=138, n_2=176)	Cohort study, pre-post release of CBT-i Coach app	High levels of interest in CBT-i Coach app among providers, with 96% expressing relative advantage, 70% reporting time-saving, compared with no app
			After release of the app, 45% of providers were actively using the CBT-i Coach app. Providers who use the app, use it with over half of their patients
Miller [2017]	VA providers trained to deliver CBT-i (n=163)	Cross-sectional study and qualitative	47% of providers are using the CBT-i Coach app, and nearly all of the providers intended to continue using CBT-i Coach.
			83% of providers not using CBT-i Coach intended to use the app in the future
			Providers identified key benefits of the app, including patient motivation and improved treatment compliance
			Barriers to use included access to technology & information about how to best use the app
Stay Quit Coach			
Hicks [2017]	Adult smokers with PTSD (n=11)	Randomized controlled trial (alternative treatment control)	Smokers who received the Stay Quit Coach app trended towards improved adherence
			No effects of Stay Quit Coach on post-treatment abstinence from tobacco use
			Smokers were satisfied with the Stay Quit Coach app, particularly the tools for helping to quit smoking, to remain quit, and for providing support and education relevant to quitting
Herbst [2018]	Veteran smokers with PTSD (n=20)	Observational treatment study (no control group)	Veterans used Stay Quit Coach between 2 and 3 times per week during the observation period
			Veterans' ratings of the usability of the app was consistent with "moderate usability"
			Veterans were more engaged in face-to-face care than in previous samples that did not receive the Stay Quit Coach app

found that both conditions showed significant reductions in PTSD severity over eight weeks, with seven in the clinician-supported versus three in the self-managed groups reporting clinically significant improvements. Clinician-supported PTSD Coach also resulted in significantly more specialty PTSD care use over the 16-week follow-up period (57).

Another area of study has examined the clinical adoption, use, and perceived benefits of companion apps for EBTs from VA providers' perspectives. Before releasing PE Coach, PE providers' (N=163) perceptions of and intention to use the app were assessed following review of a brief, objective description of its core features and functions (58). Providers had favorable perceptions of the app's relative advantage over existing PE practices, compatibility with their practice, and ease of use, with 75% agreeing that they would use it when it became available. One year after the app release, VA PE providers (N=217) were surveyed again to assess their perceptions and use of PE Coach (59). Perceptions of the app were equally favorable and half of the sample reported having used it with their PE patients, with 94% reporting intention to continue using it. Similar research has been conducted among VA CBT-i providers yielding comparable findings for CBT-i Coach (48,49). Finally, a qualitative study of 25 VA PE providers (who reported using PE Coach with 450 of their patients) found that providers appreciated that the app enhanced treatment credibility, "side-by-side" collaboration, and having forms and resources consolidated in the app, but did not appreciate lack of parity between Android and iOS versions

of the app and not being able to readily access data stored in the app (60).

Tailoring the portfolio to veterans and those who care for them

Human-centered design (HCD) methodologies offer a promising way to ensure that evidence-based public health interventions, like mobile apps, can be effectively implemented in real-world settings (61,62). Although there are many distinct methodologies that are used in HCD, they all attempt to better understand, incorporate, and prioritize the end users' needs, experiences, and desires (63,64). VA has incorporated HCD into its mobile products, by evaluating veterans' needs and preferences and integrating them into apps (45,49,65). Additionally, VA has undertaken a program of user experience testing and has actively sought out and incorporated input from key stakeholders, including policy makers, frontline providers, veterans, and their family members. To date, VA has conducted interviews and user experience tests with hundreds of providers and veterans, across a variety of mobile applications, to better understand how apps are integrated into care, how they can be made to more easily support clinical interventions, and how they can better address unmet mental health needs. User input has been critical to identifying new psychoeducational materials, interactive tools, resources for providing additional support, graphic design improvements, and ways to make it easier for users to navigate the apps. By emphasizing input from veterans and those that provide care for veterans, it has made it possible to ensure that these apps are optimized for the purpose of facilitating recovery from PTSD. When it has not been possible, because of financial, personnel, or other constraints, to address needs identified by veterans and providers, such needs are documented and catalogued so that they might be included in future updates for existing apps.

Training providers in the use of mobile mental health

A number of implementation science-based strategies have been proposed for rapidly disseminating evidence-informed interventions, including learning collaboratives, task-sharing, and therapist-level implementation strategies (66). Public health care-focused organizations such as VA and DoD pose both opportunities and challenges for implementation of new practices such as integrating mobile apps into clinical care. The value of apps

as clinician-extenders is obvious in public-sector settings that are often under-staffed. However, large organizations can also stifle adoption of new practices and technologies through risk-averse regulations, stringent compatibility requirements, and bureaucratic cultures. The Practice-Based Implementation (PBI) Network was established jointly in VA and the DoD to serve as a field laboratory for implementing these types of innovative and emerging implementation science practices (67). The PBI Network offers providers with training and implementation support for practice changes and collects lessons learned to inform research and larger-scale implementation efforts.

With the emergence of mobile apps in the last decade, clinical integration of mobile mental health applications represents a relatively new frontier for many mental health providers. Providers have reported favorable attitudes towards mobile mental health (25,68), but adoption can be impeded by a variety of barriers including lack of familiarity with available technologies and limited training in how to successfully integrated tools into care (69,70). To address this unmet training need for military providers, DoD began offering workshops to support providers' implementation of mobile health interventions in clinical practice beginning in 2014. To date, DoD has trained over 700 providers and has identified five core training competencies: evidence base, clinical integration, security and privacy, ethics, and cultural competence (71). In a 2017 pilot, VA providers were trained using DoD's training model. One of the lessons learned from the PBI Network is that training alone is often not sufficient for sustained practice change. Therefore, in addition to training, providers were also offered twelve weeks of mHealth implementation support via a virtual community of practice (i.e., weekly call with other providers, facilitation, access to experts, and resource support). Providers were also given one-on-one support for creating therapist-level implementation plans and task-sharing for patient education materials and brief interventions. Since the end of the pilot, and in response to participants' feedback and demand from the field, the PBI Network has created an ongoing monthly "Tech Into Care" community of practice conference call open to any VA provider interested in integrating mHealth into care. Virtual trainings and consultation are also now being requested and offered throughout VA. PBI-based implementation strategies for mobile mental health are co-occurring with an increase in rate of downloads of VA mobile mental health apps, suggesting the success of these types of strategies. As of February 2018, VA mobile mental health apps have been

downloaded over 1.1 million times (72).

In addition to training providers on how to integrate mobile apps into the delivery of mental health care, efforts to widely disseminate the mobile app portfolio are both necessary and ongoing. Searching for an app to treat a specific mental health issue can be overwhelming, given the hundreds of options that appear when using search terms such as, "depression" or "anxiety" (73). The VA has worked to establish the "Coach" brand (e.g., "PTSD Coach") to make searching for and recognizing these apps easier. However, how users first learn about these apps may impact whether or not they decide to use them (74). In consideration of the various ways in which people might be introduced to them, the National Center for PTSD (NCPTSD) has begun to flesh out a suite of dissemination materials for each app, including a basic marketing flyer and rack card, a more clinically-styled tri-fold brochure, a user guide for more detailed information (especially helpful for telehealth providers and patients), social media posts highlighting features within the app, and a video demonstrating use of the app. Materials are designed to be engaging but brief, and to convey practical information. While these materials are intended to be shared electronically, outreach efforts and physical presence at VA and in the community have also increased. Implementation and outreach initiatives to support the use of VA mobile technologies also highlight the fact that stakeholder feedback is welcomed, including concerns and suggestions for improvement from veterans, providers, and other users. Contact information for VA mobile mental health staff has been widely shared with VA provider communities of practice (e.g., CBT-i, PE, ACT).

Research & clinical infrastructure for mobile mental health

VA mobile mental health apps are designed to facilitate both scientific investigation and use in clinical settings. Research (i.e., "instrumented") versions of apps (see *Tables 1,2*) capture user data to support use in qualifying research studies, and include many of the apps in the portfolio, such as PTSD Coach, PTSD Family Coach, Mindfulness Coach, CBT-i Coach, and VetChange. These research apps collect fully de-identified, user-generated data, such as which areas of the app were visited, assessment data, and timestamps associated with key app-related activities, and these user-generated data can then be linked

with other data sources, such as surveys or interviews. While VA policy and information technology requirements limit direct integration of app-generated data into the electronic health record, several working prototypes of provider-facing web-based dashboards have been developed, including for CBT-i Coach, PTSD Coach, PE Coach, and VetChange. Additionally, VA mobile mental health apps are designed to provide discrete elements of intervention (26,75), so that public mental health experts and providers anywhere can contribute suggestions for tools, psychoeducational content, assessments, or other features that could be readily integrated into existing applications. VA has established mechanisms for interested investigators and providers to best make use of this research and clinical infrastructure and to share suggestions or requests for collaboration (72).

Challenges

There are several challenges to implementing mHealth as a means to supply evidence-based mental health interventions to those experiencing symptoms of PTSD. Privacy is a paramount concern, and VA privacy standards are extremely rigorous and do not allow for collection or sharing of personally-identifying information (76). However, many of the most commonly-used software development kits (SDKs) for mobile apps rely on companies that do not make explicit how users' information is handled or shared. Another major challenge is that federal guidelines with respect to use of new technologies, such as cloud storage, are constantly evolving but remain behind the field, making it difficult to develop applications that can take advantage of the latest innovations in technology. Additionally, native mobile applications are difficult, costly, and require extensive human resources for initial development, maintenance, and updating. Mobile apps need to evolve over time to be responsive to providers' and users' expectations and needs, so the public release of a mobile app does not represent a finish line but is instead one step in a lengthy process of creating and supporting an ongoing public health resource. VA must also balance the federal mandate that its apps are fully accessible to those with auditory or visual impairments with the need to create products that are every bit as engaging and innovative as private sector mental health apps. The need for mobile apps to be fully compliant with section 508 of the Americans with Disabilities Act (ADA) and to comply with strict privacy protections makes it difficult for these apps to use many of

the same features and tools that are commonplace among other apps. Finally, there remain only a limited number of trials and other studies of the use of mobile apps to deliver evidence-informed and evidence-based strategies for treating PTSD-related symptoms. Additional research is needed to better understand how to optimize mobile mental health applications for use in both self-management and treatment-companion contexts and to evaluate if such apps are having a broader public health impact.

Vision for the future

From a public health perspective, mobile mental health apps offer great promise for helping to alleviate mental health disparities. Apps can be designed to meet the specific needs of populations (e.g., veterans experiencing posttraumatic stress), downloaded at low or no cost by millions of people, and used *in situ* at the exact moment they are needed. Apps can be used by individuals who are not connected with adequate healthcare or do not meet full criteria for a mental health diagnosis, but can also be used to support and extend EBTs. VA's portfolio of mobile mental health apps has been widely used among VA providers, and many providers report feeling a sense of trust in these apps because they are designed to support evidence-based care, they are perceived as originating from a trustworthy and knowledgeable source, they are free to use, and they offer privacy to users. Although apps may not be the right or best solution for all unmet mental health needs, the first "generation" of mobile apps developed by the National Center for PTSD has demonstrated the utility and helpfulness of venturing into the mobile health space and providing veterans and others with an additional set of tools that can be used to address these needs. As mobile health technology has evolved, so has the potential for developing mental health apps that are engaging, effective, and impactful. For example, mobile mental health apps may be used in conjunction with virtual reality [e.g., (77)], automated conversational agents [e.g., (78)], or the apps may utilize active and passively gathered data (e.g., step count, location) to deliver tailored, context-specific interventions. If these mental health products are developed and leveraged by public health-focused agencies, they may be able to better reach underserved populations by designing engaging apps that truly meet the needs of the target population. With respect to veterans and PTSD, novel apps may be the first critical step in obtaining VA care, may be used to deliver or support evidence-based treatment, or may be a tool that helps

ensure veterans and their families have the resources they need to thrive in their communities, right at their fingertips.

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Footnote

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