Improving the Efficiency and Effectiveness of Cognitive Behavioral Therapy: The Utility of a Provider Portal

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ABSTRACT

Concern has been raised over the prevalence of behavioral health disorders in military personnel returning from deployment to the Middle East. Anger, stress, and hostility are commonly associated with post-traumatic stress disorder (PTSD), one of the signature wounds of the current military conflict and an issue in the civilian population as well. Cognitive Behavioral Therapy (CBT) is an evidence-based psychological health treatment technique that teaches patients new skills to deal with anger and stressful situations and has proven successful in treating anger and stress related disorders. On a week-to-week basis, treatment sessions with providers offer an opportunity to review patient progress and day to day homework and techniques that patients apply outside of the formal therapy sessions. Although a great deal of learning occurs during treatment sessions, the bulk of the treatment process is a result of homework given by the therapist. CBT treatment providers therefore have very little information about patient progress throughout the week and must rely on subjective patient-reported information from homework documents. Providers could benefit from an innovative, technology-enabled provider portal that collects and summarizes data from multiple remote patient mobile devices and physiological sensors to track patient progress outside of therapy sessions. A CBT provider needs analysis was conducted to determine end user profiles and to drive requirements for a provider portal. Based on those requirements, a prototype provider portal system was then developed and tested with a prototype patient mobile system and physiological sensors. The portal allows for management of multiple patients as well as setup and customization of treatment such as appointment times, reminders to be sent to the patient mobile device, and the ability to select either stress or anger treatment. In addition, the provider portal displays summary data of anger and stress patterns from subjective (self-report) and objective (physiological sensor) ratings mapped over time and geographic locations. Anger and stress trigger identification data is also presented, along with biofeedback and mitigation strategies used (such as breathing techniques or music), and their perceived effectiveness. Providers can also send and receive data such as homework and daily reflections to track patient progress in between therapy sessions. The provider portal has the potential to improve the CBT provider's ability to see patterns and triggers of anger and stress events and determine the most appropriate mitigation strategies for individual patients as well as reducing the time to review homework and other documents. This prototype system will undergo usability and clinical trials and is expected to demonstrate a significant improvement therapy effectiveness and efficiency. Such a system can easily be transitioned to a number of different applications such as depression and anxiety treatment, at-home caregiver treatment management, physical therapy, symptom tracking for clinical drug research studies, cancer and chronic disease treatment management, and facilitating adherence/compliance to medication and other treatment regimens.

1.0   COGNITIVE BEHAVIOR THERAPY PROCESS AND NEEDS

Cognitive Behavioral Therapy teaches patients new ways, techniques, and skills to deal with anger and stressful situations. When applying the therapy, patients begin learning how to identify their negative thoughts and behaviors starting with the first treatment session. As treatment progresses, patients learn different skills and techniques to help identify, prevent, and react to situations that lead to increased levels of anger and stress. On a week to week basis, treatment sessions with providers offer an opportunity to review patient progress and day to day homework and techniques that patients apply outside of the formal therapy sessions. Although a great deal of learning occurs during treatment sessions, the bulk of the treatment process is a result of homework given by the therapist [1].

The CBT process can be broken down into 4 stages. These four stages build upon each other as the patient progresses but are also iteratively performed to reinforce the goals of each. The goal of the first stage (initial evaluation and assessment) is to identify and diagnose stress and anger issues and introduce the patient to the purpose, expectations, and goals of the treatment process. The data collected at this stage provides the provider with an opportunity to begin to structure the treatment process around a goal-oriented approach. At this stage the treatment provider and the patient begin to engage in preliminary discussions aimed at identifying the main issues the patient has in regards to dealing with anger and stress. Based on these discussions, the treatment provider constructs a blueprint of a cognitive model that fits the particular patient and a plan for the care provided in the next stages [2]. The second goal of the initial stage of the CBT process is to introduce the concepts of Self-Monitoring and Homework to the patient. Self-Monitoring is key in the CBT process, as it requires the patient to take concepts learned in treatment and apply them in between sessions. Although this homework is designed to support the next week's session by outlining events, cues, and triggers that cause increases in anger and stress, it also serves as a method for patients to self-monitor and adjust their automatic responses. Key data that the provider uses at this stage includes background data on the patient, including past mental health records and initial assessments, and ratings of the patients anger/stress levels throughout the week.

The second stage of the CBT process focuses on educating the patient in the origins, causes, and results of anger and stress. This is the opportunity for the treatment provider to break down anger and stress in a manner that the patient can grasp the deeper cause of their anger and stress. The treatment provider will often use the concept of Events and Cues, which describe the events that cause anger and stress and the cues that occur in response to a given event [3]. During sessions, patients complete a check-in process that reviews their levels of stress and anger through the week, triggers of the high arousal situations, and techniques that they used to mitigate them. After this check-in process, the practitioners review homework with them and begin teaching them new techniques and strategies to cope with negative situations. Although practitioners track their progress at a high level they generally do not have enough data to objectively show patients patterns of their increased levels of stress and anger during these weeks. Practitioners state that by collecting and presenting this type of data to patients during sessions where it can be discussed, it would be easier to demonstrate the root causes of stress and anger. The goal of educating the patient on this key element behind anger and stress is to help them identify and explain in detail moments of anger and stress outside the treatment sessions. Although current CBT processes do train patients on how to cope with increased levels of stress and anger using various techniques, they rely on the patient to detect when they should apply them to avoid negative states. Although biofeedback devices such as breathing coaches and relaxation tools are available for patient use, the patient is generally required to locate and leverage them when they think they need them. Although it is the ultimate goal of the CBT process to train patients on how to detect occurrences and causes of stress and anger, integrated tools could support this process by initially guiding them in this detection of negative states and appropriate times to apply a mitigation technique.   In addition to educating the patient on the triggers to anger and stress, an anger control plan is also developed at this stage. The anger control plan includes both immediate and preventive strategies to help

patients mitigate the negative effects of high arousal moments. During this stage of care, the provider leverages context and cues about conditions that cause increases in anger and stress levels as well as methods applied to mitigate the effects of anger and stress and the effectiveness of those strategies.

The third stage of the CBT process focuses on changing and restructuring the cognitive thought process. This is also referred to as thought stopping. "Thought stopping provides an immediate and direct strategy for helping people manage the beliefs that cause their anger to escalate" [3]. Thought stopping and cognitive restructuring aim at evaluating and changing the core beliefs about the underlying causes of their anger and stress. The goal is to shift these beliefs from a maladaptive and irrational perspective to a manageable and healthy way to approach angry and stressful situations. Changing and Restructuring the cognitive model is an important step in the CBT process, as it provides a method to resolve core causes of anger and stress to ensure that trigger situations don't escalate. During this stage of care, the practitioner can leverage long-term data regarding shifts in automatic thoughts and patient responses when stressful situations occur.

The final stage of the CBT process focuses on reinforcing and reviewing the topics learned throughout the treatment process. This is where the key elements of the treatment are viewed and the trainee progress is evaluated. Cognitive Behavioral Therapy is very agenda driven, meaning that all of the time in-session and between session is focused on advancing the patients progress based on their current state. To ensure progress is made, it is essential that tasks and homework provided by therapists are completed before the next session. Often, compliance with homework is a good predictor of the outcome in the treatment process [4]. Once the patient has proved that all concepts and issues have been addressed, the formal treatment process is concluded. To support this, the provider requires weekly summary updates to compare to initial and prior week progress. In addition, a summary of how well the patient is applying the skills and strategies provided will help guide where future sessions should focus to optimize treatment.

1.1 Cognitive Behavioural Therapy Common Gaps and Needs

A needs analysis was carried out in order to determine how technology solutions can support the CBT process for healthcare providers and patients. Specifically, interviews were conducted to determine the tasks that were most difficult to complete for patients and providers at each stage of the CBT process. During this process, common problems that are encountered during CBT were also outlined in order to drive the development of functional requirements for CBT technology support solutions. Table 1 outlines the most critical support needs that were identified based on this analysis. The six technology support gaps outlined below are a summarization of twenty detailed functional needs that were documented in the analysis carried out with CBT providers. Of all of the needs outlined during the analysis the single most critical need for patients were the capability to continuously monitor and mitigate stress in realtime and the most critical need for providers is to summarize data collected between sessions in a way that allows providers to quickly evaluate the progress that has been made by patients and what anger/stress triggers should be focused on during sessions.

Table 1: Critical CBT Support Needs

Technology Support Gap 1: Nonintrusively record patient stress and anger levels and context
The mobile device should objectively measure and track the patients' state of stress and anger through the day using nonintrusive sensors. When increased levels of stress or anger are detected, the context that caused that state should be recorded.
Technology Support Gap 2: Provide stress and anger mitigations in real time
When the mobile device detects increased levels of stress and anger, mitigations should be available to provide real-time support to patients. After use, the patient should be allowed to evaluate the effectiveness of each mitigation to optimize the options available in the future.
Technology Support Gap 3: Summarize and present patient stress/anger patterns to providers
The system should provide a summary of the details about the patient's levels of stress and anger throughout the week. This data shall be in a format that is easily presented to evaluate patterns.
Technology Support Gap 4: Allow customization
The system should allow the patient to customize the mobile device to denote when they want to complete homework and modify the type of support that they require.
Technology Support Gap 5: Support end of day reflections and homework
The system should allow providers to add homework for the patient to complete on their mobile device and present the results of homework to providers prior to the patients weekly therapy sessions.
Technology Support Gap 6: Compare patient ratings with objective measurements of stress and anger
The system should guide patients to rate their levels of stress/anger when they are detected so providers can compare the objective measures with subjective ratings in order to determine if patients are effective at rating their own levels of stress and anger.

2.0 MOBILE CBT AND PROVIDER PORTAL DESIGN

Based on the analysis conducted with healthcare providers, an iterative design process was followed where conceptual designs of CBT support systems were developed, presented to providers and subject matter experts, evaluated for usability, and refined based on guidance and input provided. By following this iterative process from the early stages of design it is possible to effectively integrate modifications that improve the system at a very low cost.

Based on the technology gaps outlined in Table 1, it was important to create an interactive system that consists of a mobile patient support tool and a provider portal that communicate with each other to support the CBT process both within therapy sessions and throughout the week (see Figure 1). The resulting mobile support tool collects data regarding the patients stress and anger levels, provides real-time mitigation support, and guides them through completing homework assigned by the practitioner. The practitioner portal presents a summary of the conditions that cause anger and stress to providers in formats that allow them to quickly detect patterns to drive what triggers are focused on in therapy and monitor the progress of the patient.
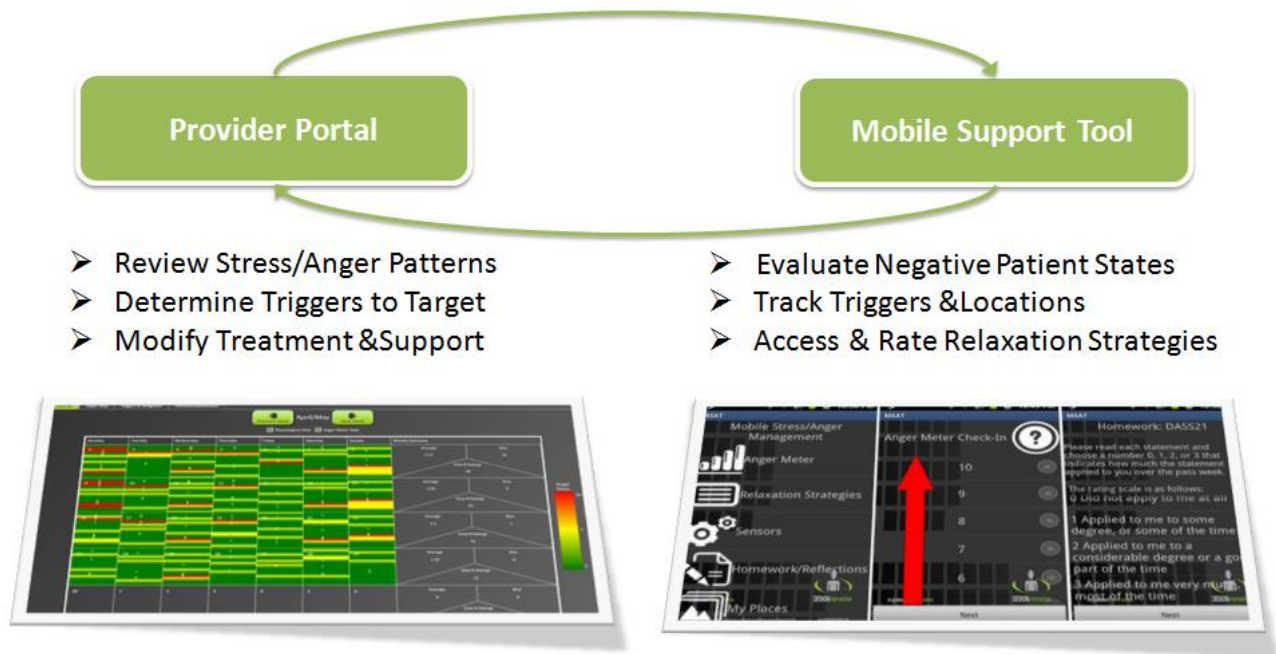
Figure 1: Integrate MSAT Design

2.1 MSAT Mobile Tool Design

The MSAT Mobile Tool application is designed to be installed on a patient's Android based smart phone and will assist the patient throughout the CBT process. Patients can access components of the application through the Mobile Stress and Anger Management main menu. This menu has several options for the user to choose from, including the Anger Meter rating scale (or Stress Meter rating scale for stress treatment patients), Relaxation Strategies, Sensors management, Homework/Reflections management, and My Places. One of the primary functions of the mobile device is to allow (and direct) patients to evaluate their stress/anger levels throughout the day. Based on the review of current methods to evaluate anger, the Anger Meter is a simple way to monitor anger levels using a 1 to 10 scale. The meter is designed to input anger levels with two clicks on the mobile device. As patients progress in therapy to a point where they can effectively evaluate the cause of their anger or stress they are then directed to a screen to select (or input) the cause of their current anger/stress level (see Figure 2). Based on the results of interviews with providers, it was critical for the design to allow providers to select whether patients were prompted to select an anger/stress event trigger.
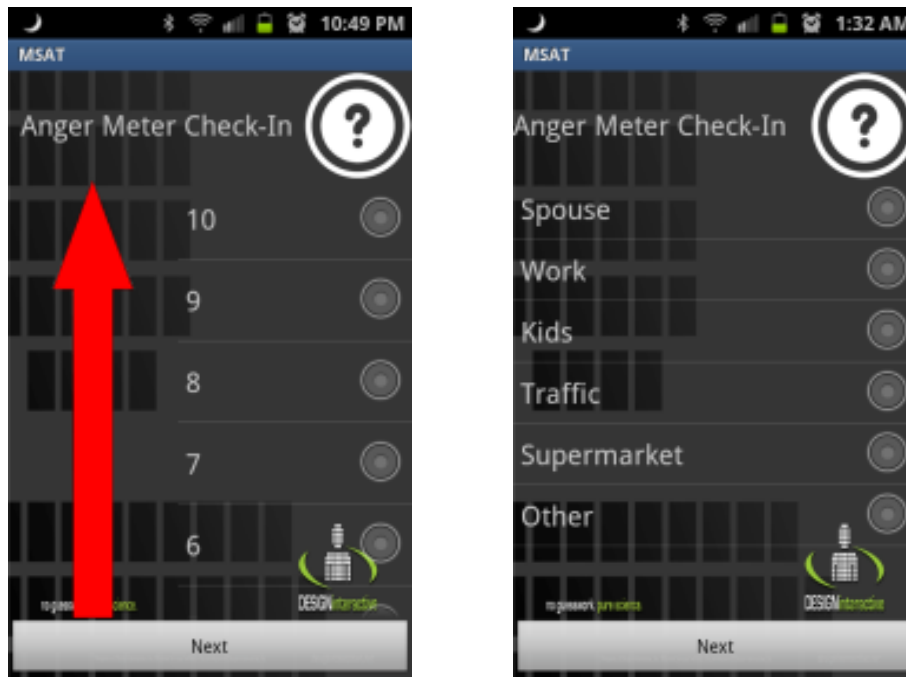
Figure 2: MSAT Mobile Electronic Anger Meter, and Trigger Selection Screens

Although the goal of the MSAT tool is to train patients to effectively detect and cope with the onset of stress and anger events proactively, the system is designed to support new patients in the detection process. Leveraging a combination of heart rate and GSR sensors that are connected through a wireless Bluetooth® connection the system is designed to detect combinations of elevated heart rate, heart rate variability, and GSR levels and cue the patient to the potential onset of an anger event which activates the anger meter check-in tool described above. This combination of heart rate and GSR sensors were selected as inputs into an anger/stress classification algorithm based on their ability to classify stress levels which has been recorded as accurate as 97% [5]. This objective evaluation and prompted subjective rating capability is designed to meet Technology Gap 1 from Table 1 above.

In addition to allowing patients to track stress events, the MSAT mobile tool also guides them through mitigating the negative effects of stress. Relaxation strategies can either be suggested by the system when high levels of stress/anger are detected or selected from the MSAT mobile main menu. Once the option is selected, a list of available relaxation strategies are presented. Although the system is designed using a modular approach that allows additional strategies, those that were initially integrated into the MSAT system are Breathing, Distraction, Timeout, and Call a Friend (see Figure 3). These strategies were selected for integration because they are commonly used throughout the CBT community and are generally considered effective for most patients. The guided breathing relaxation strategy allows the patient to either read and follow along with the breathing technique or listen to an audio recording of the technique to follow along. By providing the options of text or audio, the patient is allowed more flexibility to use the technique under different contexts. While using this technique, patients are provided with biofeedback through presentation of their current heart rate and a trend of their heart rate so they can learn how to effectively control this physiological state.

The distraction technique involves distracting the patient with music and videos. This relaxation strategy links to a list of songs or videos on the patient's phone that they have deemed as relaxing following support from their

provider. The timeout relaxation strategy is similar to the breathing technique where instructions are provided on the screen to guide the patient through the timeout process that is traditionally taught within CBT. The instructions can be read or presented via an audio recording to follow along. The call a friend relaxation strategy accesses a select group of contacts on the patient's smart phone to suggest the best people in the patient's life to reduce anger. As patients continue to progress through therapy, they are provided with the capability to rate the effectiveness of each relaxation strategy (on a scale of 1 to 5) to optimize those that they use in the future.

When developing the mobile mitigation techniques, mixed feedback was received regarding the utility of each mitigation technique. For example, the distraction technique was supported by some providers as it is important to practice in real world settings while others suggested that the key to CBT is to support the detection and mitigation of negative thoughts, and that a distraction technique that targets calming could be detrimental. Because of this, the system was redesigned to allow providers to select the strategies that were available to each patient based on their approach to therapy and the patient needs.
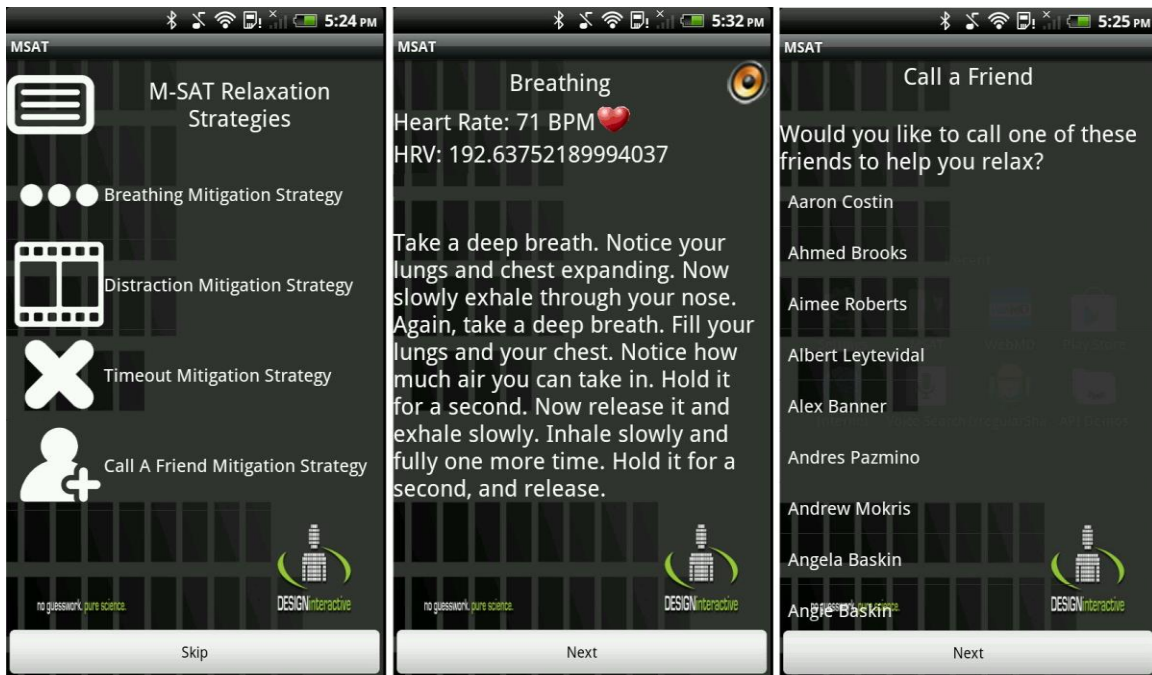

Figure 3: MSAT Mobile Relaxation Strategies Menu, Breathing Interface, and Call a Friend Option

The Homework/Reflections management menu serves as a resource for the patient to view/change reminder times for weekly homework and daily reflections, view homework documents sent by the provider, view the daily focus point sent by the provider, and complete the daily reflections questions. One weekly homework questionnaire that is integrated into the MSAT mobile proof of concept system is an electronic version of the DASS21 anger and stress inventory (see Figure 4). This tool was selected as the weekly homework because it is commonly used by CBT practitioners and is ideally recorded by the patient on a weekly basis. On a daily basis, patients are asked to complete the end of day reflections. At a time in the evening specified by the patient, a reminder will pop up and ask the patient if they are ready to complete the daily reflections. The patient then has the opportunity to complete the reflections or select "10 minutes" to be reminded again in 10 minutes. This

process of looking back on anger events after calming down is an important technique in the CBT process and daily reflections and diary upkeep was one area that providers consistently find that patients don't effectively complete. Thus, this homework capability is designed to meet technology gap 5 outlined in Table 1 above.
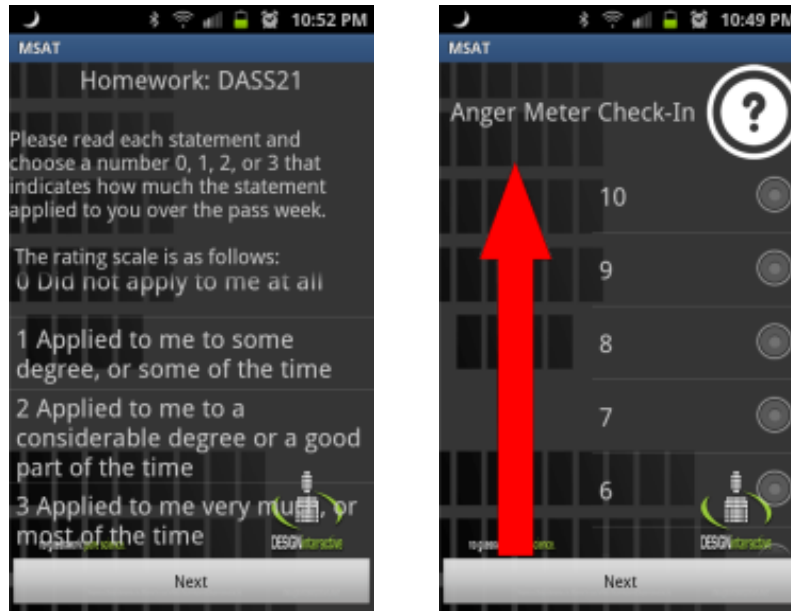

Figure 4: MSAT Mobile Homework and Daily Reflections Check-In Screens

The capability provided in the MSAT mobile support tool allows for the objective and subjective evaluation of stress/anger, real-time mitigation, customization, and the completion of end-of-day homework and reflections. Although these critical capabilities provide CBT guidance to patients between formal sessions with a healthcare provider, they also continuously collect information that is critical for providers to determine anger/stress patterns and triggers thereof, so they can be targeted in future sessions. Leveraging a provider portal such as the one described below provides the essential data to providers and allows them to modify the support provided on the mobile device based on the effectiveness of the system and included mitigations.

2.2 Provider Portal Design

The capability to track stress/anger triggers throughout a week provides critical diagnostic data for healthcare provider to use when creating and modifying a treatment plan for patients. The need for a system that provides an objective view of negative states and triggers that occur during the time between sessions was the most critical need outlined by healthcare providers during the needs analysis (see Technology Gap 3 from Table 1). The criticality of this need stems from the limitations of current best practices in CBT. Specifically, stress/anger events are traditionally tracked through diaries, thought records and other weekly homework that is completed by patients. Following this approach, it is common for patients to try to complete a week of diary entries on the day of the weekly session with a provider, leading to inaccurate evaluations of day to day conditions. Even when patients complete diaries daily, there is a tendency to misattribute the causes of stress and anger events or modify the rating of the intensity of the event when reviewing during a calm state later in the day. Finally, even when completely accurate, current approaches of reviewing thought records and daily diaries to determine

patterns of stress/anger triggers requires providers to organize individual events into patterns in order to determine the triggers that are most important to focus on during sessions. This is a process that has the potential to be very time-intensive and extends the patient check-in process. Given these common drawbacks associated with reviewing series of thought records and diary entries, a critical need was defined for a provider portal interface that provides summaries of anger events and common triggers, supports the evaluation of therapy progression and supports the modification of therapy and homework through a single intuitive interface.

To support the need for summary data, a provider portal was designed that organizes the data collected on the mobile patient device described above. The core provider support provided by the portal lies in the capability to sort anger/stress events across time and space in order to allow providers to quickly determine patterns of conditions that trigger negative states between sessions. Based on guidance provided by CBT practitioners, a calendar view was added to the portal to summarize anger and stress events across time. This capability graphs 1) the anger/stress level detected using the physiological sensors integrated into the MSAT mobile tool and 2) the anger/stress level that is input into the meters by the patient. The calendar view provides a summary of the times/days that led to increased levels of anger in the past month and provides a tool for the practitioner to detect patterns in the spikes in anger. To provider measures of therapy progress and improvement, the calendar view also presents a summary of average for all anger meter ratings, weekly maximum of all anger meter ratings, and the total number of anger meter ratings for each week presented (see Figure 5).

Figure 5: Provider Monthly Calendar View: Weekly Day View

To support the process of pattern detection, the providers can sort how information is presented on the calendar view. One presentation method that is supported is weekly day view. By selecting a particular day (Monday through Sunday) from the calendar view, the past five weeks of anger classification on that day are presented side by side (see Figure 6) to allow the provider to quickly glean the patterns of stress/anger that occur on the selected day. In addition to displaying the anger/stress state of the patient that is continuously classified using the physiological sensors, the system also plots the user-defined anger events to provide context into the cause of the patterns of anger. By presenting the patient evaluated anger levels over the physiological state based anger levels, the practitioner can gauge how well the patient is evaluating their own anger/stress levels. Providing this capability to quickly detect patterns of negative events over time based on physiological and user input

classifications of stress allows providers to quickly determine patterns of stressors as they naturally reoccur throughout weeks of therapy.

Figure 6: Provider Weekly Day View

In order to allow anger and stress patterns to be reviewed across physical space, an Anger Map has also been developed. The Anger Map was developed based on guidance from providers that suggested that when determining the context of stressors, it is beneficial to determine locations that commonly lead to negative events. This interface plots anger meter rating data onto a map using color-coded points based on level of anger reported by the patient (See Figure 7). This capability allows the provider to quickly look at the map and associate anger ratings with the locations that cause them. By determining locations that commonly trigger stress/anger events, the practitioner can support the patient in preparing for the stressors at that location.
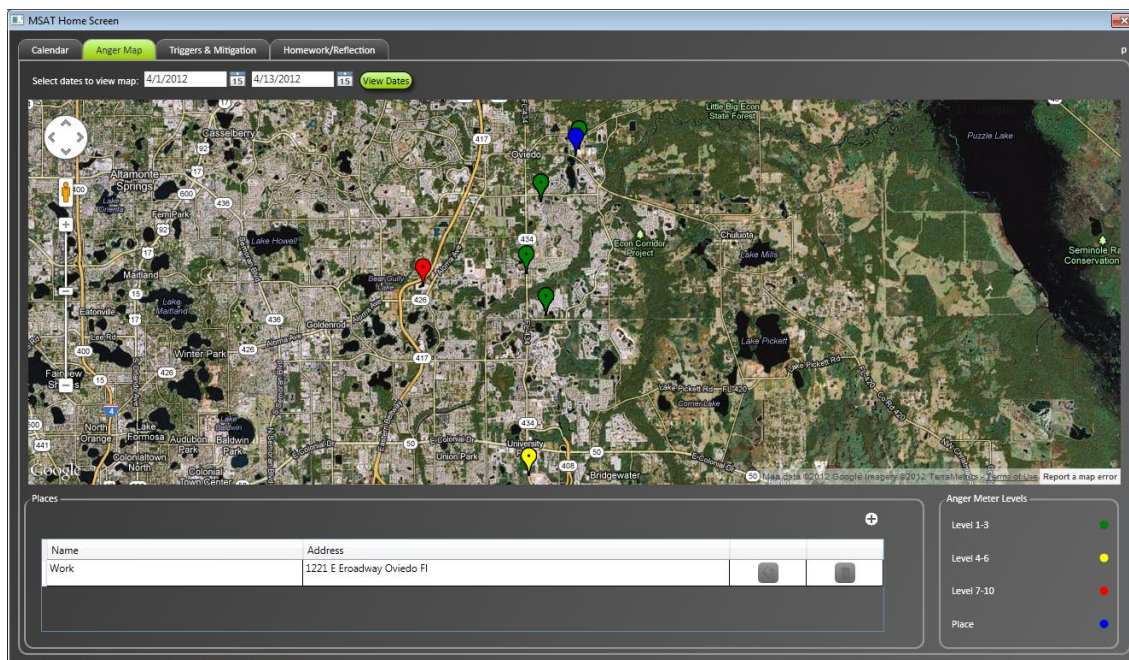
Figure 7: Practitioner Anger Map

In addition to supporting the evaluation of patient anger event occurrence, the practitioner portal provides a method to analyze the triggers of stress and anger events. To support this final piece of context evaluation, the Triggers and Mitigations management portal allows the provider to view a comprehensive collection of patient reported triggers, the anger data associated with these triggers, mitigation strategies (relaxation strategies) used with each trigger. A pie chart is provided to summarize the strategies that are most commonly used by the patient. The data provided on this interface allows the practitioner to quickly determine what the most common causes of stress/anger events are, what triggers lead to the most intense negative responses, and the methods that patients are using to deal with the increased levels of stress and anger. Ultimately, this data allows the practitioner to prioritize the triggers that are focused on in their weekly sessions.

3.0   FUTURE RESEARCH, APPLICATIONS, AND BOUNDARIES

The process of eliciting functional needs and developing a telehealth system to support the process of cognitive behavioural therapy outlines the potential to align with practitioner and patient support gaps with appropriate technology and an intuitive user experience. The key to the development of this novel design lies in the iterative design process that elicited feedback from the user group of healthcare providers during all stages of design from the needs analysis to final system evaluation. Although this iterative process was followed to ensure that the system could seamlessly integrate into current CBT practices without requiring significant changes in the process, a critical next step that is currently being planned for the MSAT tool is a evidence-based evaluation targeted at evaluating the efficacy and efficiency of leveraging the tool in practice. Prior to completing this evaluation, research is being conducted to develop a detailed physiological response model of stress and anger in the context of various activity levels.

Additional future research is required to determine what other applications in therapy a tool that can measure the context of negative events can be applied. Beyond other applications of CBT, there are a wide array of

outpatient treatments that can leverage the framework designed for the application described herein. The primary boundary to the wide application of telehealth/teletherapy support tools that the capability outlined herein describes is the modification of a healthcare system that supports the use at all levels from the classification and storage of public and protected health data to billing procedures for telehealth support tools. Although there is currently a great deal of momentum in the telehealth market, these boundaries continue to slow the mass use of technology that could effectively serve as a force multiplier for the currently strained workforce in the mental health and counselling arenas.

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