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**PTSD AND THE WARFIGHTER:
A TECHNOLOGY-BASED APPROACH TO THERAPY**

by

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**PTSD AND THE WARFIGHTER: A TECHNOLOGY-BASED APPROACH
TO THERAPY**

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ABSTRACT

The missions in support of Global War on Terrorism may have concluded throughout the Middle East, but the residual effects of the sustained combat operations remain present and continue to influence the lives of so many combat Veterans. Advances in technology, such as health monitoring and wearable devices, could improve the treatment of the warfighters and the approach adopted by the Defense Health Agency and the U.S. Department of Veterans Affairs. The U.S. Navy and U.S. Marine Corps have policies established to remove their respective Sailors and Marines from their standard deployable status to a Limited Duty (LIMDU) position, which are limited to six-month periods and two concurrent periods before personnel must go before a Medical Review Board, where they are susceptible to medical separation or medical retirement. It is important to explore additional treatment options so the victims can obtain a renewed sense of purpose, eliminate suicidal thoughts and ideations, and if preferred, continue their military service and share their valued experiences with the next generation. This research explores nontraditional methods of PTSD treatment, to include technology, mood tracking, and sleep data, and how these data points influence one another.

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LIST OF ACRONYMS AND ABBREVIATIONS

CONUS	Continental United States of America
DHA	Defense Health Agency
DOD	Department of Defense
EHR	Electronic Health Record
LIMDU	Limited Duty
MHS	Military Health System
MTF	Military Treatment Facility
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
PCM	Primary Care Manager
PHI	Personal Health Information
PII	Personal Identifiable Information
PTSD	Post-traumatic stress disorder
USMC	United States Marine Corps
USN	United States Navy
VA	Department of Veteran Affairs

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I. INTRODUCTION

This thesis will explore the integration of *mood tracking* and *sleep data* for the treatment of post-traumatic stress disorder (PTSD), which the Defense Health Agency (DHA) could incorporate to assist its Primary Care Managers (PCM) to diagnose and treat U.S. service members. Many treatment options today rely on medication, scheduled therapy, service animals, or a combination thereof. The integration of journaling one's mental state, thoughts or emotions, and sleep creates a sense of ownership for the service members on the path to recovery. The specific areas of interest for this research are mood-tracking and the DHA's sleep tracking device with its internal software application.

PTSD has plagued many warfighters, and likely spans the existence of mankind. PTSD is a relatively new term, previous iterations included *combat stress*, *shellshock*, *battle fatigue*, and *combat exhaustion*, depending on the respective war in question (i.e., World War I, World War II, Vietnam, Desert Storm, or the Global War on Terrorism). In 1980, the Diagnostic and Statistical Manual of Mental Disorders (3rd edition) or DSM-III officially recognized and published post-traumatic stress disorder. While this disorder is not limited to warfighters, as anyone who has perceived a certain event as a threat to their life, livelihood, or wellbeing, the sample will consider combat veterans exclusively.

The Global War on Terrorism (GWOT) recently concluded, creating a unique opportunity for the DOD to capitalize and focus on post-war medical treatment with advanced digital capabilities to resolve the war-induced conditions and improve the overall wellbeing of its service members. They may continue their service or prepare for a seamless transition into the civilian sector, whichever option provides the best environment and chance to return to their former selves.

A. PROBLEM STATEMENT

The Twenty-Year War required extensive manpower to support concurrent operations throughout Iraq [Operation Iraqi Freedom (OIF)] and Afghanistan [Operation Enduring Freedom (OEF)] from 2003–2021. While a small presence remained in Iraq

after the significant redeployment in 2011, the majority of the “boots on ground” deployments were dedicated to OEF, where combat operations extended from Afghanistan to Pakistan, Syria, Oman, Yemen, the Philippines, and the Horn of Africa. The problem, which DOD and service men and women have endured since combat operations commenced, is a treatment plan to effectively overcome the debilitating symptoms of PTSD through traditional treatment methods. Experiences varied amongst service members based on country, enemy and respective capabilities, service branch, unit, and mission set, to name a few. Unlike traditional battle wounds, the psychological strain that these experiences are capable of causing are not easily identifiable, nor does a particular event create the same response amongst the individual witnesses.

PTSD presents a wide range of challenges, such as sleep disturbances and insomnia, detachment and isolation, strain on relationships and marriages, domestic violence, self-harm, and suicidal ideations. Despite these challenging psychological symptoms, service members’ access to the traditional treatment model remains a significant hindrance. Insomnia, for instance, was clinically significant amongst 92% active-duty personnel with PTSD, while only 28% in personnel without medical history of PTSD (Seelig et al., 2010). With the high usability and acceptance rate by providers and patients in the burgeoning field of mobile technology (Bush et al., 2014), the integration of mobile health apps could bridge access to care and enhance treatment by service members with PTSD.

B. PURPOSE STATEMENT

The purpose of the rationalist methodology is to explore and evaluate the significance of incorporating a mood-tracking application and consistent sleep regimen to assess its value and capabilities to supplement traditional treatment methods for PTSD. The Web and Mobile Technology (WMT) Program Management Office, a sector of the Defense Health Agency Solution Division, has incorporated modern technologies to develop a multitude of applications to support the service member and their families, Warfighters, and Health Care Professionals. Not all applications are yet available on both iOS and Android; however, once released, these applications have the potential to

provide reference, care instructions, exercises, and resources to everyone with a personal electronic device (PED), such as smart phone, tablet, or computer. A mood-tracking application can capture emotions surrounding anxiety, depression, head injury, stress, PTSD, and general wellness in real-time. The significance of the outcome of this research is important as it has the potential to improve the mental state of U.S. Military service members, provide a resource between scheduled appointments and create a sense of ownership within their treatment plan.

C. SCOPE AND LIMITATIONS

The potential benefits from this study include expanding PTSD treatment options for Active Duty and Reserve Components and Veterans struggling with PTSD from combat operations. The process begins with understanding PTSD and its victims from a comprehensive approach. Symptoms will vary from one person to the next, but to gain a deeper understanding of triggers and remedies, everyone must be assessed individually as no solution is one-size-fits-all. Additionally, the scope of this research is limited to Combat Veterans diagnosed with PTSD or experiencing its symptoms.

Limitations include the sensitive nature of the data involving Personal Identifiable Information (PII) and Personal Health Information (PHI). Additionally, the aftermath of the COVID-19 environment had crafted prolonged restrictions with physical meetings, which can hinder research with the appropriately trained clinicians.

D. RESEARCH QUESTIONS

- How can Defense Health Agency (DHA) make the mood-tracking application (web-based) applicable to the operator (including those forward deployed with limited to no connectivity)?
- Interoperability exists amongst the DOD, VA, and civilian health care networks. What solution(s) can DHA utilize to bridge or upload the service member's entries to their Primary Care Manager (PCM) and Electronic Health Record (EHR)?

- Could incorporating blockchain potentially allow the mood-tracking application to receive automatic, wireless input from the sleep-tracking device or software?
- From cyber security perspective, is personally identifiable information (PII) and personal health information (PHI) encrypted and impervious from data becoming compromised?
- How significant of a role does sleep, both quantity and quality, impact the overall mood of the warfighter (i.e., Medication-induced v. intermittent, non-medicated sleep)?

II. LITERATURE REVIEW

A. HISTORY OF POST-TRAUMATIC STRESS DISORDER

The terrorist events of September 11, 2001, changed the world for the unforeseeable future. The impact of these terrorist attacks directly influenced the lives of nearly every American—resulting in emotions ranging from an unfamiliar vulnerability, sorrow, and anguish to revenge, and ultimately, the pursuit for justice. What was not understood, at least initially, were the long-lasting impacts from sustained combat operations throughout the Middle East that would follow. Over 1.65 million individuals (about the population of West Virginia) have served in military efforts in Afghanistan as part of Operation Enduring Freedom (OEF) or Iraq as part of Operation Iraqi Freedom (OIF) and have experienced major stressors, which may contribute to various mental health problems today (Possemato et al., 2015). Over two-thirds of the OEF/OIF veterans (approx. 69%) seeking services at Veterans’ Administration (VA) medical centers have screened positive for at least one mental health problem (Seal et al., 2010, as cited in Possemato et al., 2015), with PTSD as the most common, approximately 20%.

Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) provided the opportunities to seek retribution for Marines, Soldiers, Sailors, Airmen, and civilians alike. Since 2001, approximately “2.5 million service members have deployed to the Middle East” (Wangelin & Tuerk, 2014). Estimates of those disturbed by PTSD will vary, but the VA evaluates 11–20% of those with combat experience in OIF, OEF, or both, suffer from PTSD (U.S. Department of Veterans Affairs, 2022).

PTSD has plagued many warfighters, and likely spans the existence of mankind. PTSD is a relatively new term. Previous iterations, dependent upon the era, include combat stress, shellshock, battle fatigue, and combat exhaustion. It was not until 1980 that the Diagnostic and Statistical Manual of Mental Disorders (3rd edition) or DSM-III officially accepted and published PTSD. While this disorder is not limited to warfighters, since any individual or group that has perceived a certain event as a threat to their life or

wellbeing is more than capable of developing signs or symptoms of post-traumatic stress, this thesis will explore combat veterans exclusively.

B. POST-TRAUMATIC STRESS DISORDER

“Post-traumatic stress disorder (PTSD) is a psychiatric disorder that may occur in people who have experienced or witnessed a traumatic event, series of events or set of circumstances.” (American Psychiatric Association, 2023).

Lawson (2014) likens these operations to the Vietnam era in terms of quantity of troops, duration of exposure, and repeat deployments to sustain the missions—with estimates upwards of 300,000 military personnel affected from sustained combat operations throughout the Middle East (OIF and OEF). Common signs (internal) and symptoms (observable) are outlined in Table 1.

Table 1. PTSD signs and symptoms

Signs	Symptoms
Avoidance of thoughts	Difficulty sleeping
Poor memory recollection	Nightmares
Anhedonia (inability to experience joy or pleasure)	Night terrors **
Detached	Irritability
Flashbacks	Anger
Intrusive thoughts	Hypervigilance
Hypervigilance	Depression

** Night terrors differ from dreams and nightmares, in that the person relives their trauma(s) with the inability to wake (Pacheco & Dimitriu, 2023).

A remarkable case study from World War II, where England was vulnerable to an aerial assault from Nazi Germany, sheds light on a population that was able to continue its day-to-day functions, regardless of the consistent threat to its livelihood. In 1940, the bombing had begun for a period of eight months, resulting in 40,000 deaths and 46,000+ injured, not to mention the damages in infrastructure (Gladwell, 2013, p. 128). The

British Government, under the direction of Winston Churchill, and the British Military warned its citizens to evacuate prior to the commencement of the attacks; strangely, most of the people opted to stay put. A specific report described:

Every hundred yards or so, it seemed, there was a bomb crater or wreckage of what had once been a house or shop. The siren blew its warning and I looked to see what would happen. A nun seized the hand of a child she was escorting a hurried on. She and I seemed to be the only ones who had heard the warning. Small boys continued to play all over the pavements, shoppers went on haggling, a policeman directed traffic in majestic boredom and the bicyclists defied death and the traffic laws. No one, so far as I could see, even looked into the sky. (“English Psychiatrist,” as cited in Gladwell, 2013, p. 129–30)

The notion that generations of families, especially children that typically do not yet understand how to accept or conquer fear, were continuing about their lives is almost implausible.

Similarly, the Armed Services and its warfighters employ a tactic to constantly assess their environment and make the appropriate decisions in real-time. The courses of action (COAs) are discussed prior to the actual patrol, in the planning phase, to identify the primary and subsequent objective(s), if applicable. The order of effects resulting from the missions can be categorized as *primary*, *secondary*, and *tertiary*. U.S. service members are trained and equipped to consistently analyze the environment for cover and/or concealment—the environment, terrain, structures, etc., will determine viable options. Cover provides protection from enemy munitions, whereas concealment reduces detection by decreasing visibility and often providing little to no protection. This process is better known as the OODA Loop (*Observe, Orient, Decide, Act*) (United States Marine Corps, n.d., p. 9). The citizens of England during World War II seem to have unofficially incorporated their own OODA loop, allowing them to put their fears aside, and adjust accordingly to carry out their respective responsibilities.

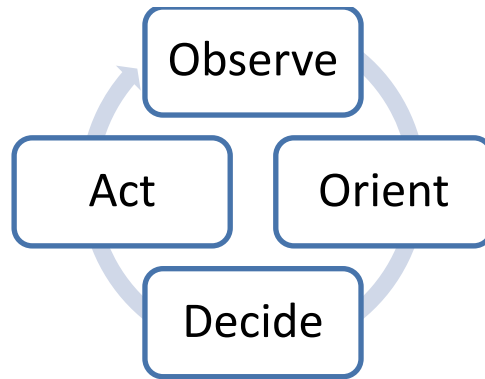





Figure 1. OODA loop. Source: USMC (n.d., p. 9).

The Russia-Ukraine conflict is the most recent war-oriented event capable of inducing PTSD. Approximately one-million Ukrainians have left their residences and fled to Poland and surrounding eastern European countries (Javanbakht, 2022). Unlike U.S. wars, this conflict has affected children and adults of all ages, where many undoubtedly lost members of their families from Russian military operations and indirect fires (IDF). While the concepts of wars and conflicts are nothing new, what exactly has changed to produce these unprecedented levels of PTSD diagnoses amongst U.S. service members throughout the Global War on Terrorism (GWOT)? PTSD symptoms can improve or worsen with time, varying from human to human. The list is not exhaustive, and can present themselves individually or several simultaneously, or a combination in sequential pattern.

Improvised explosive devices (IEDs) were introduced in 2003 during the Iraqi conflict. Because these bombs are made with assorted materials and different makers with varying levels of expertise, it is not possible to definitively identify the device. Table 2 shows the housing materials that have been reported throughout the Middle East. The Afghan and Iraqi militants have been known to place hidden IEDs within trash and dead animals on the side of the road—anything to conceal the true nature of the explosives.

Table 2. Improvised explosive devices (IEDs) and respective blast radius.
 Source: The National Academies and Department of Homeland Security
 (n.d., p. 2).

Threat	Threat Description	Explosive Capacity	Building Evacuation Distance	Outdoor Evacuation Distance
	Small Package/letter	1 lb	40 ft	900 ft
	Pipe Bomb	5 lb	70 ft	1,200 ft
	FedEx Package	10 lb	90 ft	1,080 ft
	Vest/Container Bombs	20 lb	110 ft	1,700 ft
	Parcel Package	50 lb	150 ft	1,850 ft
	Compact Car	500 lb	320 ft	1,900 ft
	Full Size Car/Minivan	1,000 lb	400 ft	2,400 ft
	Van/SUV/Pickup Truck	4,000 lb	640 ft	3,800 ft
	Delivery Truck	10,000 lb	860 ft	5,100 ft

1. Types of PTSD

A study, in conjunction with the Virtual Reality Medical Center, listed the following types of PTSD experienced by the warfighter (Cahill & Pontoski, 2008):

- Acute Stress Disorder
- Chronic PTSD
- Delayed Onset PTSD
- Simple v. Complex PTSD

a. *Acute Stress Disorder*

Acute Stress Disorder (ASD) is a combination of hyperarousal, dissociative, and reliving symptoms immediately following the event in question (Zoellner et al., 2003).

These symptoms can endure anywhere between 48 hours and 30 days. According to the Department of Veteran Affairs (2023), anywhere from 6% to 33% of individuals can develop ASD within one month of a traumatic event. The first step in the treatment of ASD is often referred to as *psychological first aid* (Nash & Watson, 2011).

b. Chronic PTSD

ASD transitions to *chronic PTSD* once the symptoms extend beyond one month. ASD and chronic PTSD are nearly identical, aside from the duration of the symptoms and behavioral changes. In determining ASD v. chronic PTSD, the triggering event is not nearly as relevant, as the individual's response and ability to cope. Exceptions to these categories are *delayed onset PTSD* and *simple or complex PTSD*.

c. Delayed Onset PTSD

Delayed onset PTSD is the “onset of symptoms occurring at least 6 months after the traumatic event” (Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), 1994). This occurs less frequently than ASD, but still exists, however rare. Delayed onset PTSD symptoms were prominent with service members that were *boots on ground* in Iraq and Afghanistan (Hines et al., 2014). The DOD's Post-Deployment Health Re-Assessment (DD 2900) was designed to capture the outliers and diagnose the delayed onset as soon as possible, before the development of greater consequences. Most service members, to some extent, will endure an adjustment period after returning home.

d. Simple v. Complex PTSD

Another aspect of PTSD is its complexity, simple PTSD is correlated to an isolated event. Individuals with no history of mental health problems tend to have a better probability of recovery than someone with complex PTSD (CPTSD). Signs and symptoms of CPTSD include “difficulties in regulating emotions; beliefs about oneself as diminished, defeated or worthless; and difficulties in sustaining relationships” (Matheson and Weightman, 2019). Contrary to simple PTSD, individuals with a history of mental health problems are predisposed to CPTSD, which is particularly worrisome for combat veterans with multiple deployments and remain cleared for operational duty.

2. PTSD Diagnosis

PTSD must be diagnosed through a clinical interview with a mental health professional. Assessment begins by identifying a specific traumatic event or a target trauma experienced and hunting the patient within the past 2 to 4 weeks. Once a specific event is identified, then an examination of the symptoms of PTSD will occur, including all 20 symptoms in the four clusters in the DSM-5 (Rothbaum & Rauch, 2020). According to the *DSM-5*, there are four clusters of PTSD, to include “intrusion, avoidance, negative alterations in cognition and mood, and alterations in arousal and reactivity” (Fenn & Jose, 2020). Examining all four clusters in relationship to a specific target trauma is needed to accurately assess and diagnose PTSD. These clusters are not exclusive to any one stage, but apply to all types of PTSD (i.e., ASD, CPTSD, delayed onset, simple, and complex) (Veterans Health Council, 2018). The best approach for healthcare providers is to conduct clinical interviews to aid in the assessment and improve the reliability and accuracy of diagnoses. The most common screenings include The Clinician-Administered PTSD Scale for DSM-5 (CAP-5) and the PTSD Symptom Scale Interview for DSM-5 (PSSI-5) are the most common screenings (Weathers et al., 2018). Questionnaires are also available to patients to self-assess, such as the PTSD Checklist for DSM-5 (PCL-5) and the Posttraumatic Diagnostic Scale for DSM-5 (PDS-5) (Weathers et al., 2018).

C. TREATMENT

Due to PTSD’s high co-morbidity with the onset of additional mental and physical conditions, treatment can be challenging. Treatment available for PTSD includes medications, psychotherapies, and cognitive behavioral therapy. However, research findings support the effectiveness of technology when augmented in the treatment of combat-related PTSD (Institute of Medicine et al., 2009).

1. Medication

Pharmaceuticals consist of selective serotonin re-uptake inhibitors (SSRIs) and serotonin-norepinephrine re-uptake inhibitors (SNRIs), which are both primarily used to improve depression, anxiety, mood, sleep, or a combination thereof (Villines, 2020).

- Zoloft (sertraline)
- Paxil (paroxetine)
- Prozac (fluoxetine)
- Effexor XR (venlafaxine)

This is not an all-inclusive list, as individual symptoms and needs will vary amongst the patient. Medication can be a standalone treatment or used in combination with any of the therapies below (psychotherapies and/or cognitive behavioral therapy).

The reuptake inhibitors assist the body by blocking or at least slowing the absorption rate of the naturally produced substances, like serotonin and norepinephrine (Cleveland Clinic, 2023). Figure 2 illustrates how SSRIs block the serotonin channel, inhibiting cells' ability to absorb the serotonin within the synapse (space between two cells) and the serotonin receptors. More specifically, serotonin is categorized as a neurotransmitter or hormone that is responsible for one's overall mood and emotions (McIntosh & Lewis, 2022). A chronic lack of serotonin can result in “the pathophysiology of psychiatric disorders ranging from general depression, anxiety, obsessive–compulsive disorder [OCD] to eating disorders and dependence” (Jonnakuty & Gagnoli, 2008). Alternatively, one must not attempt to obtain these prescription medications outside the guidance of a licensed provider, as certain combinations of these drugs can cause *serotonin syndrome*—a condition that, if untreated, may result in death (Mayo Clinic Staff, 2023).

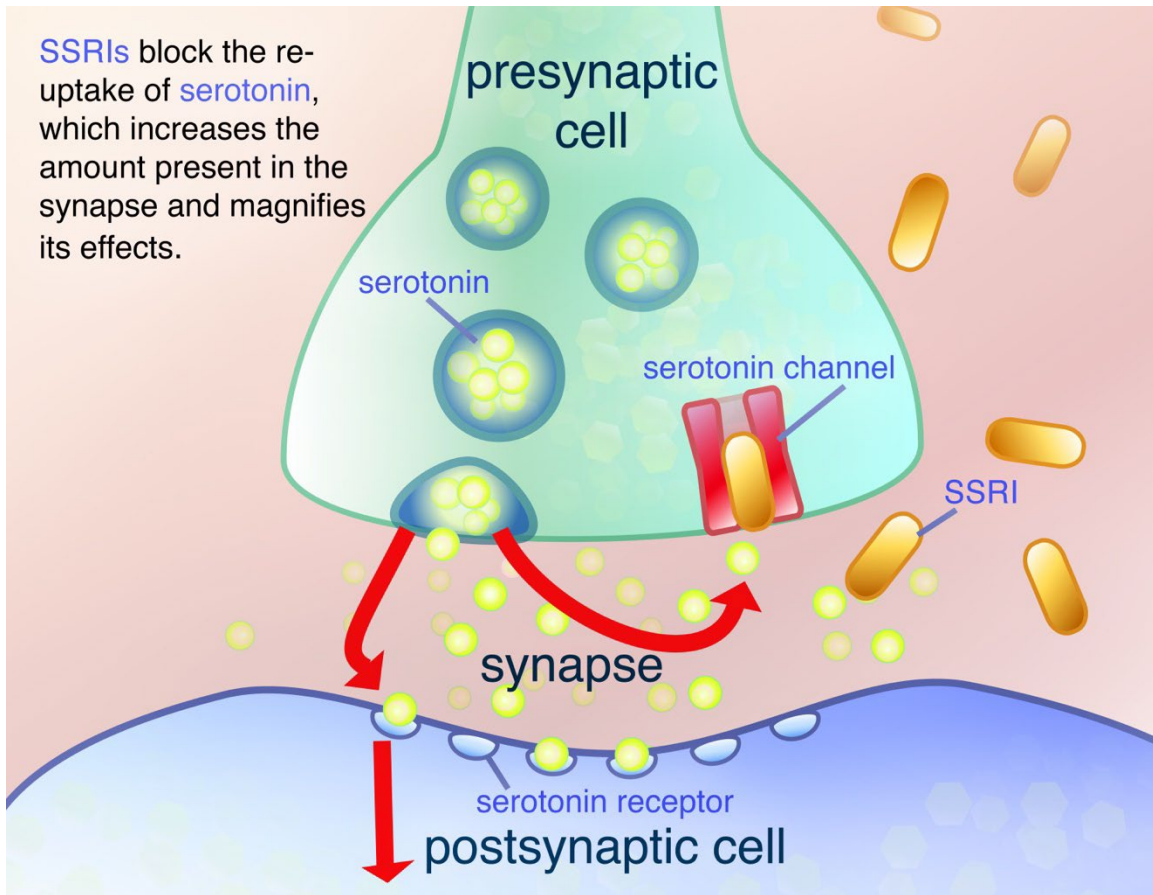


Figure 2. SSRI effects on presynaptic and postsynaptic cells. Source: Liou (2010).

The VA/DOD Clinical Practice Guidelines recommend SSRIs as initial treatment for PTSD, while the FDA has approved 2 SSRIs in the treatment of PTSD (recommended minimum of 12 months).

2. Psychotherapy

Psychotherapy is “conducted by a licensed mental health professional, such as a psychologist [or] psychiatrist” (Mayo Clinic, 2023), where the patient can privately discuss the cues that trigger thoughts, emotions, behaviors, or responses. Psychotherapy serves as an umbrella for several specific therapy methods. According to Sharpless and Barber (2011, pp. 10-11), these options include:

a. *Prolonged Exposure*

Prolonged Exposure (PE) is advised by the American Psychological Association, the Department of Defense, and the Department of Veteran Affairs for the treatment of PTSD. PE has extensive documentation of its efficacy in comparison to alternate approaches in the treatment of PTSD (Maples-Keller et al., 2017). The goal of PE therapy can be quite challenging—requiring the patient to intentionally confront the event(s) of their past, and the associated emotions and fears—objectively understanding that the event did occur, while reducing the physiological *fight-or-flight* response (Rauch et al., 2009). A meta-analysis study supported, with overwhelming evidence, PE’s high efficacy rates in PTSD treatment (Cusack et al., 2016). PE was one of two psychotherapies exclusively selected by the VA and DOD for widespread dissemination (Sharpless & Barber, 2011).

b. *Cognitive Processing Therapy*

CPT is a trauma-focused cognitive therapy based on questioning the assumptions and beliefs arising from traumatic events (APA, 2017). It uses a twelve-session protocol, where each session typically lasts 60 minutes at weekly intervals, which involves identifying, challenging, and replacing unhelpful and distorted thoughts and beliefs about oneself and the traumatic experience with more helpful thoughts. Research suggests that CPT effectively treated PTSD amongst veterans who had served in Vietnam, Iraq, and Afghanistan (Chard et al., 2010). CPT is the second psychotherapy endorsed by DOD and VA (Sharpless & Barber, 2011).

c. *Eye Movement Desensitization and Reprocessing (EMDR)*

EMDR confronts the traumatic event(s) directly and is somewhat controversial in the psychology community (Deville, 2002). It is comprised of eight key stages, where the individual seeking treatment is required to:

Identify multiple aspects of the traumatic memory, including the images associated with the event, the affective and physiological response elements, the negative self-representation, induced by the traumatic experience (for PTSD), and an alternate, desired, positive self-representation. (Chemtob et al., 2000, p. 1)

EMDR was originally designed to help those specifically with PTSD, where the methodology has expanded to other psychotherapies like psychodynamics, cognitive-behavioral and integrative approaches (Shapiro, 2017, p. 19-23). EMDR has exhibited little success in combat veterans (Deville, 2002, p. 132), but been included within psychotherapies due its value in treatment amongst PTSD stemming from other sources or events.

d. Stress Inoculation Training (SIT)

Originally developed as a coping mechanism, Stress Inoculation Training assists clients experiencing physical pain, anger, and phobic reactions (Meichenbaum et al., 1989, as cited in Saunders et al., 1996). SIT later evolved to address anxiety and its effects on performance amongst military pilots, athletes, police officers, and other professions frequently operating in high stressed environments (Meichenbaum and Cameron, 1989, p. 116). Thus, providing an ideal scenario to test SIT and its efficacy. SIT consists of three phases: (1) educational, (2) skills training, and (3) application (Saunders et al., 1996). The premise requires a credentialed professional to *inoculate* or inject stress into an environment and observe how the subject(s) respond. Anxiety and the ensuing emotions typically have a negative connotation amongst the public. The intent is to induce anxiety and tweak the elicited response in a controlled environment so that the individual may overcome the consequences and pivot to perform under pressure. Because combat troops also operate in highly stressful environments, SIT could prove helpful in their recovery and eventual re-deployment to combat, if necessary.

e. Relaxation Training

Like the other *psychotherapy* methods, *relaxation training* was originally incorporated to combat and reduce anxiety. Examples include meditation, intentional or *boxed breathing*, or simple breaks from a scenario or environment, or more specifically, any behavior (mental or physical) that creates a relaxation response and passively ignoring distracting thoughts (Manzoni et al., 2008). These methods are attractive to patients and medical professionals alike, due to their low-risk properties (i.e., breathing, closing eyes, or walking) and ability to accomplish almost anywhere at any time

(Manzoni et al., 2008). With specific step-by-step directions and often welcoming user interfaces, technology has ensured these methods are more convenient than ever with smart phones/devices. Examples of these applications include Headspace, Calm, Buddhify, Waking Up, and Oak, providing a wide range of functionality, depending upon budget, as subscription is required after the brief introductory trial period. Each application has its own niche (i.e., meditation, sleep, breathing, or spirituality) with claims to reduce stress, improve sleep quality, and lower blood pressure (Scotland-Coogan & Davis, 2016). Regarding PTSD, *relaxation training* is best paired with additional therapies.

f. Interpersonal Psychotherapy (IPT)

Much of IPT's success has stemmed from the treatment of varying personality disorders and manic depression (Bleiberg & Markowitz, 2019). Since PTSD can significantly alter the day-to-day interactions with affected individuals and their friends, families, colleagues, and even casual conversations, IPT was applied to those diagnosed with PTSD. The results were comparable to those that underwent exposure therapy (Bleiberg and Markowitz, (2019). One of the commonly reported symptoms of PTSD is the distant emotions the victim experiences. IPT poses the opportunity to reconnect the warfighters with their friends and family, eliminating the additional stressor of not having a connection with their loved ones.

g. Dialectical Behavior Therapy (DBT)

DBT is a cognitive-behavioral therapy associated with patients diagnosed with borderline personality disorder (BPD) and those with suicidal ideations or tendencies (Dimeff et al., 2020, p. 3). Patients of this magnitude can often find it difficult to communicate their thoughts or needs, making it increasingly challenging to seek the help they need when time is limited. DBT is used to treat PTSD, but is not a standalone treatment option, often referred to as *integrated DBT* to effectively convey its supplemental treatment properties (Becker & Zayfert, 2001).

h. Psychodynamic Psychotherapy

The VA has adopted *trauma-focused psychodynamic psychotherapy (TFPP)* in its treatment of Combat Veterans diagnosed with PTSD, which differs from traditional *psychodynamic psychotherapy* because it specifically addresses the origin of trauma (Busch et al., 2019). One specific case study followed a U.S. Army Veteran, Patrick, from his return from Afghanistan, separation from service, and six months of TFPP treatment. Patrick suffered from “daily panic attacks, with tachycardia [rapid heartrate], shortness of breath, feelings of loss of control, and racing thoughts lasting approximately two hours ... night terrors ... and feelings of helplessness” (Busch et al., 2019). This method, however, must continue to be studied in PTSD cases to determine its overall efficacy before official consideration for PTSD treatment (Fonagy, 2015).

i. Hypnosis

Hypnosis was first introduced in the 18th century by a German physician by the name of Franz Mesmer, which he coined as *mesmerism*—citing the balance of magnetic power within the human body (Kotera, 2018). Skepticism has surrounded the practice since it was discredited approximately ten years after Mesmer’s discovery, but interest endured throughout the medical industry from ophthalmologists, physicians, psychologists, including Sigmund Freud, and American psychiatrist, Milton Erickson, before the American Psychological Association (APA) officially established its own division in the late 1900s (Kotera, 2018). Hypnosis in the west has been compared to meditation in the eastern hemisphere due to the nearly identical physiological responses within the body (Facco, 2017).

The principle of hypnosis is that it focuses on the “abnormalities in the brain’s default mode network (DMN)—a network of interconnected brain regions which is most active during low-demand tasks such as daydreaming and self-absorbed thinking and when not attending to outside stimuli” (Szigethy & Vermetten, 2018). These abnormalities, like PTSD, can interfere with sleep (insomnia) due to an interference with the DMN and Szigethy and Vermetten (2018) believe the practice of hypnosis is under-utilized in the treatment of PTSD patients experiencing insomnia.

j. Cognitive Behavioral Group Therapies

Group therapy is used to treat a slew of anxiety disorders, to include generalized anxiety disorder (GAD), panic attacks, social phobia, obsessive-compulsive disorder (OCD), and PTSD (Wolgensinger, 2015). Group therapy is particularly beneficial to Combat Veterans because of their shared experiences. The participants do not have to expound upon acronyms, military jargon and terminology, defensive postures, patrol tactics and maneuvers, etc., and may communicate unimpeded with the facilitator and peers. Group therapy was incorporated during the Global War on Terrorism, although the DOD and VA have not recognized this technique as an initial treatment option (Sloan et al. 2012, p. 689).

3. Cognitive Behavioral Therapy

Cognitive Behavioral Therapy (CBT) is the third type of treatment for PTSD, endorsed by the American Psychological Association, Department of Defense, and the Department of Veteran Affairs. CBT has been proven effective across the spectrum of PTSD (acute, chronic, simple, and complex). There is robust evidence that CBT can reduce PTSD depressive symptoms and even result in a loss of PTSD diagnosis (Forman-Hoffman et al., 2018).

While these methods (medication v. psychotherapy v. cognitive behavioral therapy) contrast in varying degrees, these techniques essentially focus on the trigger(s) of PTSD to allow the patient, under the supervision of a provider, to confront the memory and the associated response to reduce the fear and identify the onset of symptoms. The Department of Veteran Affairs (VA) has included many of these therapies in the treatment of PTSD, and like the medications, these can be used in isolation or compounded manner.

4. Technology-based Treatment

Recent research suggests that military personnel with therapy-resistant PTSD are receptive to technological treatment for mental health (Bisson & Olf, 2021). Technologies like the XR (Extended Reality) platform, which includes virtual reality

(VR), augmented reality (AR), and mixed reality (Kaplan et al., 2021, p. 706), provides an alternative approach to PTSD treatment, when compared to the traditional methods of pharmacology, psychotherapy, and CBT (Difede et al., 2007). The XR platform provides an innovative approach to PTSD treatment by delivering exposure therapies for PTSD. VR allows the users to fully immerse themselves “into a non-natural, digital world, facilitated by a head-mounted display (HMD) that provides sensory input (i.e., images and sound)” (López-Ojeda & Hurley, 2022). Augmented Reality (AR) combines virtual elements that are overlaid with reality (the physical environment). AR enables users to experience their own reality in real-time (Ventura et al., 2018). MR is a type of VR that combines real and virtual milieus along a “virtuality continuum” (see Figure 3). A study on randomized control of the use of virtual reality technology with graded exposure treatment reported a significant decrease in PTSD symptoms severity inactive duty military compared to a traditional form of therapy (Wood et al., 2021).

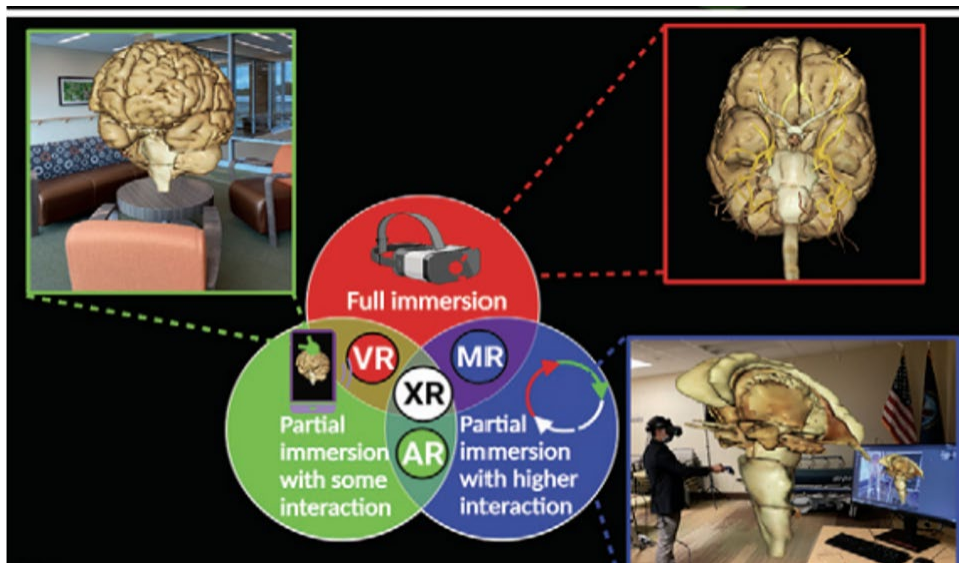


Figure 3. Mixed reality integrating an artificial world. Source: López-Ojeda and Hurley (2022).

a. Virtual Reality (VR) Exposure Therapy

Even though different literature supports the high efficacy rate of psychotherapy treatments like PE and CPT, the challenges of these therapies are attributed to the

patients' inability to visualize the traumatic event, resulting in treatment failure and disinterest. Hoge et al. (2004) emphasized using VR as an alternate treatment to appeal to the tech-savvy, younger military population to address the ongoing concern with the stigma associated with seeking treatment for mental health. Virtual Reality Exposure Therapy (VRET) has been highlighted as potentially effective in treating PTSD by using VR to mimic reality and conduct exposure therapy. Research utilizing VRET on non-OEF/OIF PTSD who were unresponsive to other psychotherapy treatments was positive (Difede et al., 2007). The first VRET data was published in 1992; however, with the advent of head-mounted units (goggles) and sensor pairing, VRET environments are considerably more realistic and the potential as a viable treatment option is that much greater (Aboujaoude et al., 2015). The overall effectiveness of VRET in treating PTSD in service members, found that service members treated with VRET immersion therapies reported a dramatic decrease in PTSD symptoms (Reger et al., 2011). McLay et al.'s (2011) case study involved 20 Operation Iraqi Freedom (OIF) Veterans, where 10 veterans with combat-related PTSD underwent VR-graded exposure therapy, and the other half underwent traditional treatment. After 10 weeks, the study determined that 70% of the VRET sample demonstrated remarkable improvement, where only one improved with the traditional technique.

b. Video Conferencing

Video-conferencing technology allows the clinician and patient to connect virtually to provide psychotherapy treatments for PTSD. According to an analysis of emerging treatment for PTSD, clinical video teleconferencing (CVT) helps address stigma and accessibility related to seeking mental health care by service members (Cukor et al., 2009). CVT achieved similar results when compared to in-person treatment (Backhaus et al., 2012). Germain et al. (2009) published a study, where half of the individuals received CBT therapy in-person and the half conducted their therapy via videoconferencing, finding that after several months, there was virtually no difference between the benefits achieved.

5. Telemental Health Technology

The National Defense Authorization Act (NDAA) FY-17 outlined additional requirements pertaining to telehealth capabilities throughout the Military Health System (MHS). (U.S. Senate Armed Services Committee, 2017). The military, however, has been somewhat hesitant to these measures, often referencing concerns with the integrity and confidentiality of the data. The COVID-19 pandemic revolutionized patients' access to care, specifically the mental health community, by conducting meetings over the phone or webcams (Hepner et al., 2022). Technology is ubiquitous in society—from smart phones, tablets, and computers to watches, thermostats, lighting, and vehicles—and now mental health applications. The resources that technology offers creates subsequent avenues to enhance mental health services by creating innovative pipelines for to deliver evidence-based practices (Ben-Zeev, 2017). Only a fraction of the individuals that could benefit with psychological care seek treatment (Kazdin & Blase, 2011). Technology can remove many of the common barriers to care (i.e., convenience or scheduling conflicts) and provide additional opportunities to care between physical appointments (Substance Abuse and Mental Health Services Administration, 2015, p. 3) The advancement of technology has created the capacity to engage with people digitally in real time and in real place. It has created the ability to record objective behavior and functioning in unobtrusive, invisible ways by using sensors that are embedded in people's personal technologies or that are positioned throughout an inpatient unit. The introduction of technology into mental health allows for self-assessment and self-management, offering users the opportunity to modify and tailor mental health treatments to their individual goals and needs as they change over time. In an era where web-based or downloadable mental health support can be accessed 24/7 from anywhere on the planet with Internet connectivity the long wait list of access to mental healthcare can become a relic of the past.

A report from IQVIA Institute for Human Data Science (2018) found more than 300,000 health applications and approximately 340 consumer wearable devices available throughout the world; applications that addressed mental health and behavioral disorders constituted 28% of all disease-specific apps (5). Furthermore, 45% of the respondents to

an anonymous, online depression screening tool offered by Mental Health America (MHA) in 2016 stated that they would be interested in receiving online- or mobile-based support from MHA for mental health issues (only 18% would accept referral for a face-to-face interview). Technology companies are increasingly realizing that patients cannot have good health without addressing mental health. And though face-to-face encounters are still at the core of psychiatry, it is not suitable—or even affordable—for many. Barriers such as cost, time, and transportation prevent those from seeking these face-to-face encounters and the use of technology addresses this. Figure 4 illustrates how technological platforms push intervention to patients in the healthcare industry.

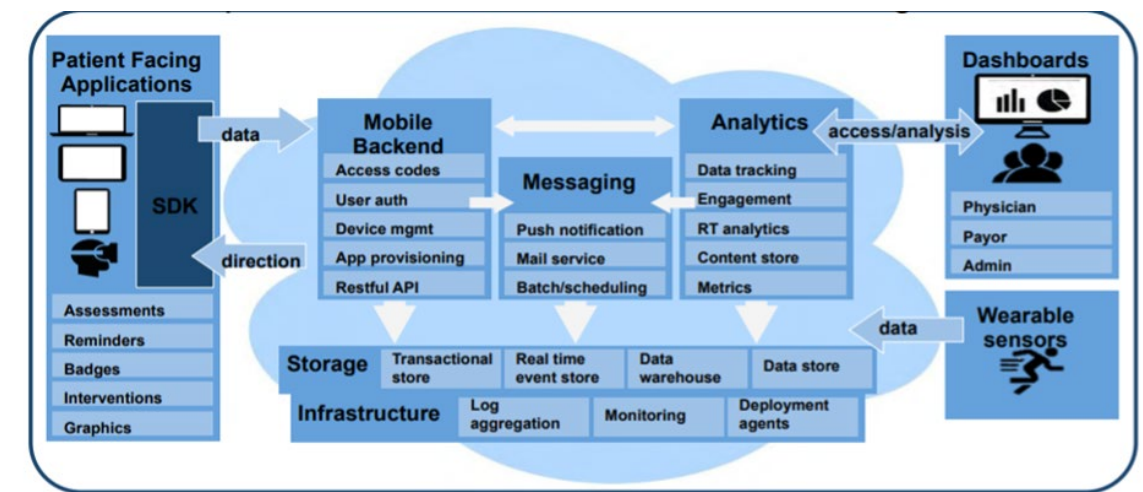


Figure 4. Health technology platform (HTP). Source: Greenleaf (2017).

a. *Mobile Health Applications*

“Rapid advances in health technologies require clinicians to have a general working knowledge of consumer technologies, specifically mobile health apps, and to understand how these tools are used for patient monitoring, education and treatment.” (Armstrong et al., 2017, p. 3)

In part, several initiatives have been embarked on by the Defense Department to leverage technology through mobile health to enhance the rollout of mental healthcare (Kosaraju et al., 2010). Nearly every service member owns a smart electronic device, even in a signal degraded environment, the increased functionality of these devices

enables entertainment features like music, electronic books, and photography (Erbes et al., 2014). One study suggests that service members have an overwhelming preference of sharing their private contact information (mobile phones and personal email) in lieu of their professional email accounts and office phone numbers with their respective medical care teams, especially when mental health is involved (Stanfill et al., 2014).

b. Mobile Health Benefits and Barriers

Armstrong et al. (2017) listed the following benefits and barriers to mobile health technology; see Table 3.

Table 3. Benefits of mobile health applications

Benefit	Description
Access	“Reduces barriers to accessing care” (Donker et al., 2013)
Extension of care	“Expands [healthcare] beyond face-to-face visits” (Bush et al., 2013).
Efficiency	Improves efficiency of care (Ventola, 2014).
Compliance	Increases engagement with care (Regar et al., 2013).
Geographic	Supplements physical care, especially those in remote areas (Poropatich et al., 2013).
Cost	Eases financial constraints (Cortez, 2013).
Quality of data	Improve the validity of patient records with symptom tracking in real-time (Bush et al., 2014).
Research	Potential to reach those individuals that avoid physical visits due to confidentiality concerns or stigma associated (Kuhn et al., 2014).
Best practice	“Identified as a best practice by front-line clinicians” (Fernandez & Short, 2014).

a. These inherent benefits would extend medical capabilities beyond the traditional proximity radiuses.

b. These aspects would increase convenience across a multitude of service members between professional and personal obligations.

Table 4. Barriers of mobile health applications

Barrier	Description
Utilization gap	Use amongst primary care managers is significantly low when compared to service members (Bush & Wheeler, 2015).
Provider perception	Privacy/safety concerns, and lack of awareness, evidence-based treatments, and baseline understanding with the community (Gagnon et al., 2016).
Technology limitations	Technology infrastructure at MTFs cannot support mobile health applications in the delivery of care (Armstrong et al., 2017).

Barriers specific to Military Medicine

c. Evidence-based DOD/VA Mobile Health Applications for Mental Health

These mobile applications are the first to offer an empirical evidence base with service members and veterans. Each of these mobile applications is available free and offers anonymous use on iOS and/or Android platforms. Military service members, veterans, and civilians can download the applications from public marketplaces (Apple Store and Google Play) to their personally owned mobile devices.

(1) PTSD Coach

The PTSD Coach mobile application was established to reach those service members and veterans who, for whatever reason, were not ready to pursue traditional therapy (Sayers et al., 2021). This application’s intent is to inform its users about PTSD, professional care, self-assessments, and methods to cope with the various daily stressors of life. A study found that Veterans reported high satisfaction and acceptability rate, with overall findings showing that the PTSD Coach was suitable for the management of PTSD symptoms (Kuhn et al., 2014). A cross-sectional study by Owen et al. (2015) found that PTSD coaches reached over 10,600 active monthly users with a 10% retention rate after one year of use. The PTSD Coach application is available on both iOS and Google Play (Android).

(2) PE Coach 2

The PE Coach 2 application helps by addressing barriers, such as difficulty recording sessions, appointment avoidance, and low homework compliance rate, common inhibition factors in PE implementation among service members (Scott et al., 2015). The application assists with appointment reminders, audio recording and playback of the traumatic event, and homework accessibility between treatment sessions (Reger et al., 2013). A clinician survey of the application utilization showed enhancement of PE implementation with a PE coach (Kuhn et al., 2015). Another study demonstrated a positive perception of the application among patients compared to a traditional paper-based approach (Reger et al., 2015). The application is available both on iOS and Google Play (Android).

(3) CPT Coach

A similar mobile application is CPT (Cognitive Processing Therapy) Coach, which was developed by the VA to support individuals already participating in evidence-based treatment for PTSD with a mental health provider (Department of Veteran Affairs, 2022). The application is available on both iOS and Google Play (Android) and is exclusively a tool to supplement patients between actual scheduled sessions.

(4) Virtual Hope Box

The Virtual Hope Box (VHB) application is a modern tactic to the traditional physical *hope box*. The notion is that the patient places items important to them, which can essentially provide a snapshot of what the owner values when negative thoughts (including suicidal ideations) arise (Berk et al., 2004). The application has exhibited high value in identifying mental health-related behaviors and emotional regulations (Wenzel et al., 2009). The application is available on both iOS and Google Play (Android).

6. Wearable Technology

Wearable technologies (WT) have boomed since leaders of the tech industry have begun their own internal research and development. The hardware associated with a WT is typically worn around the user's wrist (similar to a watch) to collect data from the

radial pulse; however, some manufacturers, such as Oura Ring and Whoop, have released products to be worn around the finger or upper arm. Garmin was one of the pioneer developers of the combination of watch and activity tracking, but other companies, such as Apple (Apple Watch), Google (FitBit—recently acquired by Google), and Samsung (Galaxy) have since created their own devices to mesh with their respective ecosystems. Wearable devices connect to smartphones, often via Bluetooth Low Energy (BLE) (Figure 5) and to transmit various data points of interest (Cilliers, 2020, p. 150).

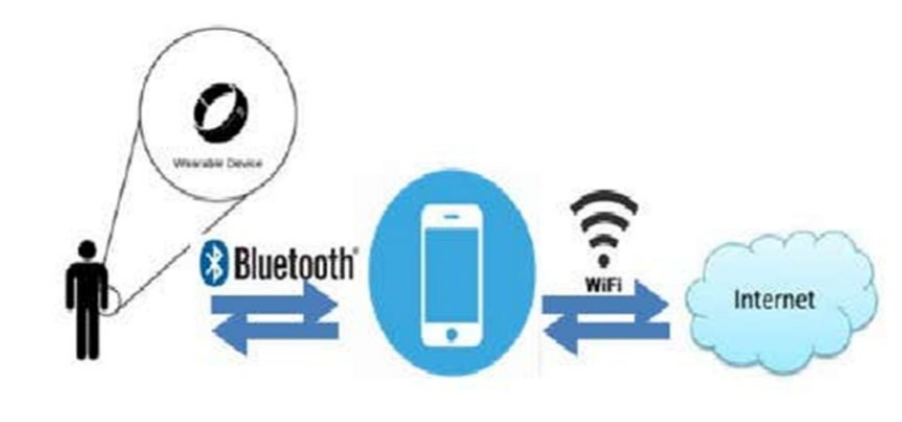


Figure 5. Data acquisition architecture in wearable technologies. Source: Ching and Singh (2016).

The devices vary in aesthetics, but internally encompass many of the same traits, such as pulse, activity, blood oxygen (SpO₂), and sleep duration/quality. The latest advances include the device's ability to conduct electrocardiograms (EKG or ECG depending on the nation). The primary technology relies upon photoplethysmography, or PPG, which utilizes a light source and sensor (photodetector) that senses the change in the volume blood flow or perfusion of the tissues (Sun & Thakor, 2015). When volume increases, the device computes the wearer's pulse (anywhere from 60–100 times per minute in an average adult).

U.S. Army Veteran, First Sergeant Robert Guithues had his own questions if technology could assist his sleep disturbances that tormented him every night. The

integration of his iPhone, Apple Watch and NightWare (third-party application) was able to effectively disrupt his recurring nightmares.

NightWare uses information from the Apple Watch heart rate sensor, accelerometer, and gyroscope to detect a nightmare and ... disrupt ... through haptic feedback, generating gentle pulses on the wrist that gradually increase until the user is roused from the nightmare, but not from sleep. (Apple Newsroom, 2022)

NightWare was U.S. Food and Drug Administration (FDA) approved in 2020 and is categorized as a prescription digital therapeutic (NightWare, 2023). The NightWare application incorporates artificial intelligence (AI) to determine if interference is necessary (shown in Figure 6). The unique aspect of NightWare's Intervention Cycle is its ability to bypass the 4th stage if the analysis of the data does not warrant intervention, allowing the user to continue their natural sleep cycle uninterrupted.

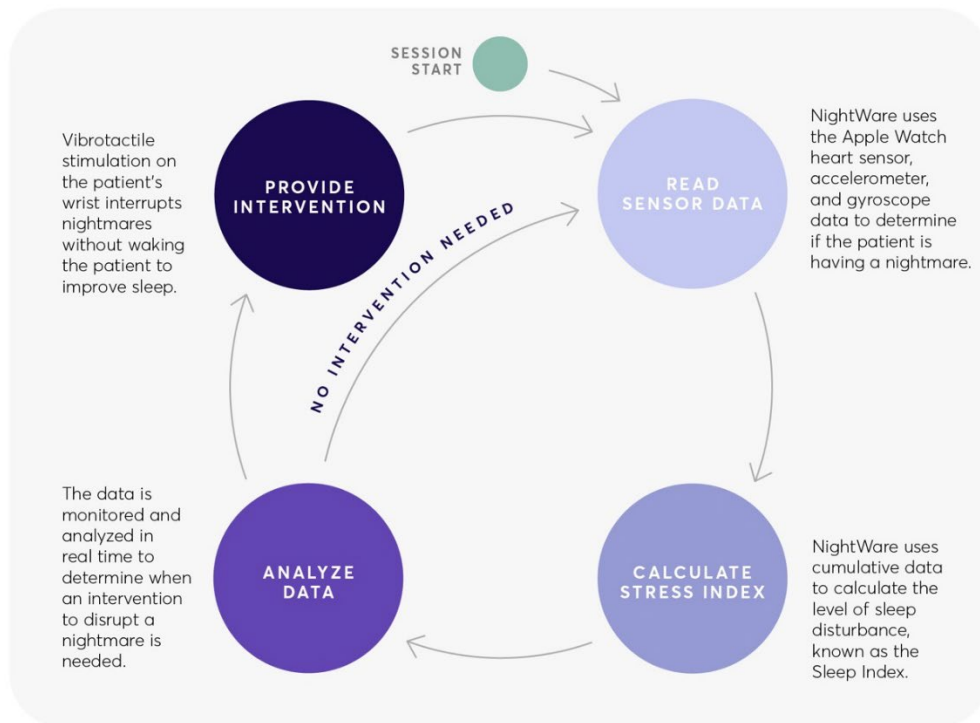


Figure 6. NightWare Intervention Cycle [Version 4]. Source: NightWare (2023).

D. MOOD TRACKING

The benefits of mood tracking are well documented throughout the world. Before the more recent advent of digital applications, a similar practice required journaling, to track emotions and mood, identify negative thoughts and behaviors, and self-improvement via self-assessment (University of Rochester Medical Center, 2023). Additionally, both yoga and meditation practices stimulate the mind and body to create a sense of mindfulness, the concept of living in the present moment and not diverting one's attention to the past or present. The application of mood tracking to Combat Veterans, however, is a tall task and often easier said than done. Because mindfulness is an entirely conscious aspect, how does one transition mindfulness to the subconsciousness?

The Defense Health Agency is currently sponsoring the research and development (R&D) of the *T2 Mood Tracker* application to assist the user with observing and cataloguing their moods and behaviors. The application incorporates six categories, "anxiety, stress, depression, brain injury, PTSD, and general well-being" (Defense Health Agency, 2020, p. 6). The entries are compiled to create a graphical display, increasing the likelihood of pattern recognition. Patients' failure to routinely record their experiences distorts the objective nature of mood tracking, which reduces significantly when recorded on mobile devices (Dale & Hagen, 2007). Mood Tracker has the internal functionality to capture notes for any changes to life, such as events, prescriptions, and any treatments that may be responsible for mood changes. The accuracy of this information can significantly benefit the health care providers' treatment decisions.

E. IMPORTANCE OF SLEEP

Sleep is crucial for all mammals, including humans. The numerous benefits include a strengthened immune system, maintaining a healthy body composition, prevention of hypertension (high blood pressure) and heart attacks, improved mood and memory, and increased energy (SCL Health, 2018). PTSD is likely to result in insomnia, which interferes with these benefits, which can quickly escalate to a vicious cycle of recurring thoughts, weight gain, increased susceptibility to illness, lack of physical activity, and if untreated for an extended period, heart disease.

While in-depth studies and explanations surround the physiology of sleep and the internal activities, this thesis will address the waveltops and how some of the popular sleep treatment options do not provide the desirable long-term benefits. Research suggests PTSD interferes with the regions of the brain (hippocampus, amygdala, and cortex) that causes the warfighter to experience flashbacks, nightmares, and state of hyperarousal (Pacheco & Dimitriu, 2023).

Veterans may choose to avoid seeking professional medical help and alternatively opt to self-medicate. The substance of choice is often alcohol given its widespread availability and legal to those 21 years of age and older. PTSD patients with no affiliation to DOD, have also been known to use illegal substances, such as opioids (heroin), stimulants (cocaine), and non-prescribed pharmaceuticals, to help cope with their mental health. For the most part, DOD's zero tolerance drug policy prevents Active-Duty service members from spiraling down this path. However, a fine line exists between drinking alcohol socially and abusing the substance. When one becomes dependent on alcohol to cope and induce sleep, the quality of that sleep is diminished significantly. Reason being, alcohol counteracts the natural endorphin withdrawal after a traumatic experience, simply by increasing endorphin activity (Volpicelli et al., 1999). To combat insomnia, authorized treatment options include OTC (over the counter) sleep aids like diphenhydramine (Benadryl), melatonin, ginkgo biloba, valerian root, and lavender, or prescription sleep medications, such as Ambien, Lunesta, and Zaleplon (trade names). All medications have their inherent side effects and may be contraindicated based on an individual's medical history, current medications, and personal behaviors (i.e., substance abuse).

F. PTSD AND SUICIDE

Globally, suicide is responsible for approximately one million deaths every year (Naghavi, 2019, as cited in Stanley et al., 2021). Research suggests that individuals with PTSD are more susceptible to suicide (Panagioti et al., 2012). Research by Hendin and Haas (1991) examined combat-related PTSD amongst combat veterans of the Vietnam War, where it was discovered that survivor's guilt or remorse was the primary factor in suicidal ideations and attempts. Since the Vietnam-era, many veterans to continue to

experience the unwanted thoughts or emotions surrounding their combat experiences (Department of Veteran Affairs, 2022), which can significantly alter the veterans' abilities to reason and appropriately conduct the necessary therapy.

Suicide prevention is at the forefront of PTSD treatment, the inability to address this aspect will continue to end lives prematurely and eliminate all hope of recovery (Stanley et al., 2021). Suicide rates have progressively increased across the U.S. Armed Services since the inception of the Global War on Terrorism (Ramchand et al., 2015). Former Arizona Senator John McCain was a champion for U.S. Veterans and supported the need for congressional intervention, stating, "It is unacceptable that an estimated 22 American veterans commit suicide every day" (McCain & Blumenthal, 2015). Figure 7 shows the noteworthy increase in the use of the Crisis Response Network.

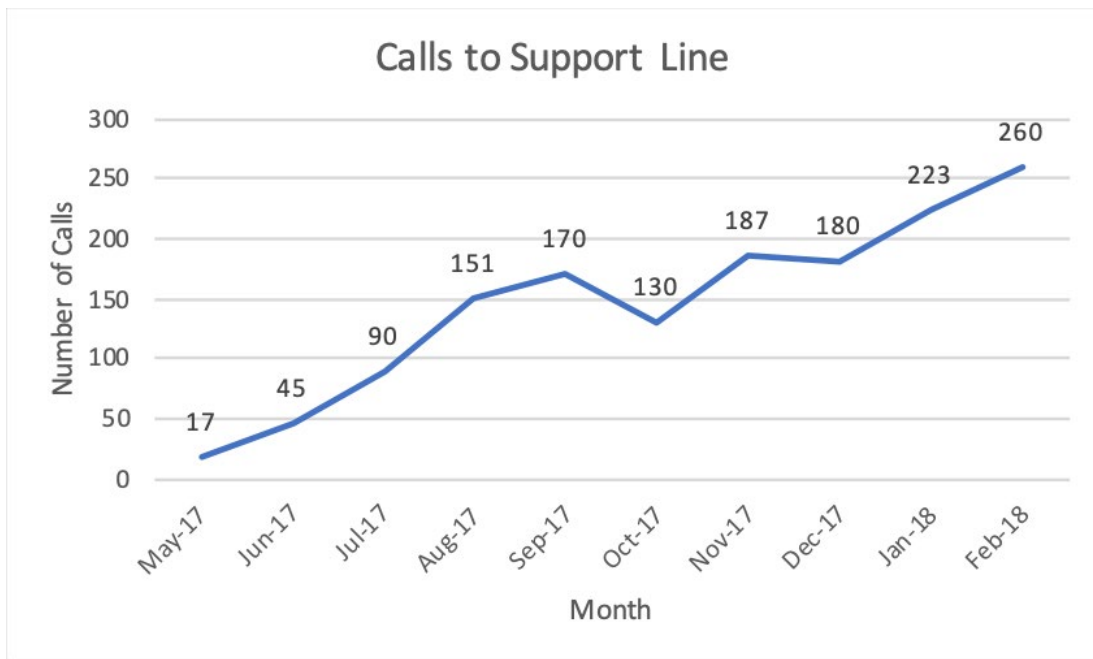


Figure 7. Phone calls from veterans to Crisis Response Network. Source: Phillips (n.d., p. 15).

G. DIGITAL TWIN

1. History

Its origin stems from NASA’s Apollo program with creation of two identical space vehicles—did not constitute a digital twin as the vehicles were physical models (Bilberg & Malik, 2019, p. 1). This, however, laid the foundation for the digital twins of today. The term Digital Twin has been known by many names over the years, but the consensus attributes the University of Michigan with its creation of Product Life cycle Management (PLM) in 2002, where the term was used to describe two systems, the actual system itself and the mirrored image or copy, the digital twin (Grieves & Vickers, 2017, p. 93). Some debate surrounds the difference between digital twins and models, citing the two concepts are one in the same. While on the surface this may be true, models are unable to account for changes in real-time or in a predictive manner.

2. Advancements

Since its inception, many industries have integrated digital twins within their respective sectors to mimic, diagnose, and improve decision-making capabilities. NASA, for instance, “A Digital Twin is an integrated Multiphysics, multiscale, probabilistic simulation of an as-built vehicle or system that uses the best available physical models, sensor updates, fleet history, etc., to mirror the like of its corresponding flying twin” (Liu et al., 2019).

3. Applicability in Healthcare

Medical professionals have identified the value in digital twins and many organizations have incorporated its existence within their resident physicians and medical students. The various simulators present identical signs and symptoms as actual case studies for the physician to assess, diagnose, and treat, if necessary, without the multitude of risks associated with actual surgery. Furthermore, because the risk to life is removed from the equation, the event has lesser consequences, while maintaining the same upside to the educational aspect. Digital twin health care data (DTH data) is comprised of physical object, virtual object, service, and fusion data (Liu et al., 2019).

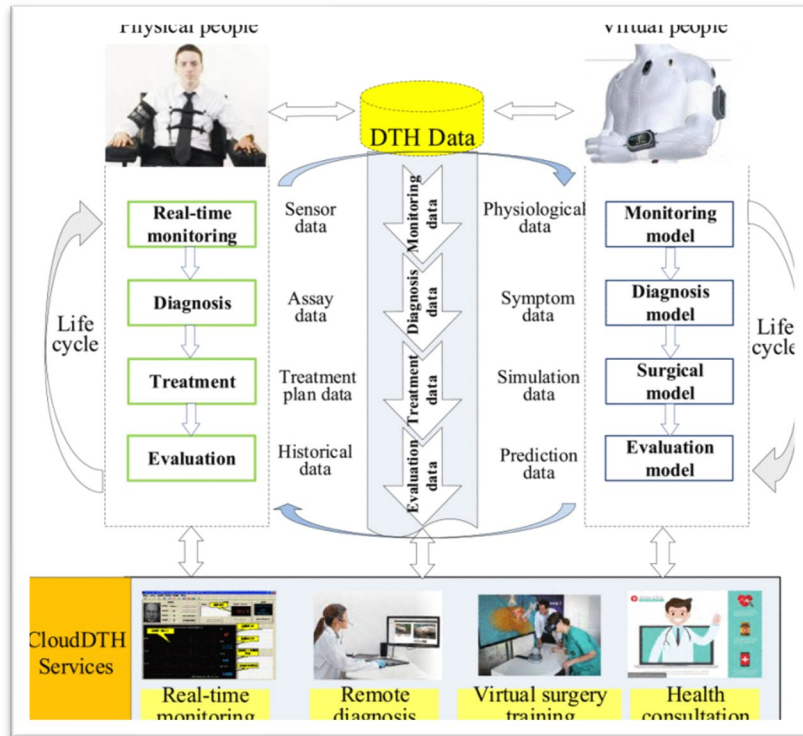


Figure 8. “Personal health management in the life cycle of the elderly.”

Source: Liu et al. (2019).

4. Advantages of Digital Twins in PTSD Treatment

From an economic standpoint, it is simply not feasible to construct a digital twin of every service member across each branch of the Armed Services. DOD and DHA may elect to explore templates by incorporating demographics (i.e., socioeconomic status, predisposition to PTSD via childhood trauma, Armed Services Vocational Aptitude Battery (ASVAB) scores, education levels). This practice, while not perfect as no two individuals are exactly alike, would allow the military to adopt this new technology to treat PTSD more accurately and efficiently.

If pursued, these digital twin models would integrate the individual or combination of treatment options that have produced success in the past. Thus, alleviating the need to conduct the initial trial and error period that is often replicated with each case. The result: more efficient treatment, quicker reduction in signs and symptoms, and overall, a faster recovery and ability to return to operational duty.

H. CYBER SECURITY AND PATIENT PRIVACY

1. HIPAA

The rapid expansion of technology within healthcare, whether it be electronic health records (EHR) or personal health information (PHI) on a mobile application, has only increased the significance of HIPAA (Health Insurance Portability and Accountability Act of 1996). HIPAA safeguards data (written, verbal, and electronic) and its transmission, and applies to all organizations and employees involved with the use of healthcare records, regardless of size (Edemekong et al., 2022). All individuals that have sought and received care within the United States are granted these protections concerning their confidentiality and privacy.

2. Blockchain (BC) Technology

“Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network” (IBM, 2023). Because the data (blockchains) are decentralized, it carries less risk than previous means of data collection and storage, and the digital ledger prevents tampering and eliminates anonymity (Shobanadevi et al., 2021). The four primary characteristics in blockchain technology affecting healthcare are decentralization, persistency, anonymity and auditable (Zheng et al., 2017). Each block within a blockchain can be classified as public, private or consortium based on the access policy (Oracle, 2023).

Blockchain helps secure patient data to the point that seamless exchange of information between providers and patients is more practical, promoting interoperability while bolstering HIPAA compliance. The long-term vision is that blockchain technology will provide patients access to their entire medical history, regardless of location, to share with current and future healthcare providers. BC technology “makes electronic medical records more efficient, disintermediated, and secure. It also makes health information exchanges (HIE) more secure, efficient, and interoperable” (Sadiku et al., 2018, p. 156). The primary advantages of blockchain in the healthcare sector are improved data interoperability, enhanced security, efficiency, and accessibility. Blockchain technology incorporates complex encryption algorithms, increasing security and safeguarding the

respective information. The decentralized model affords its users consistent access to their health information (shown in Figure 9), while simultaneously eliminating concerns about data tampering (Elangoven et al., 2022).

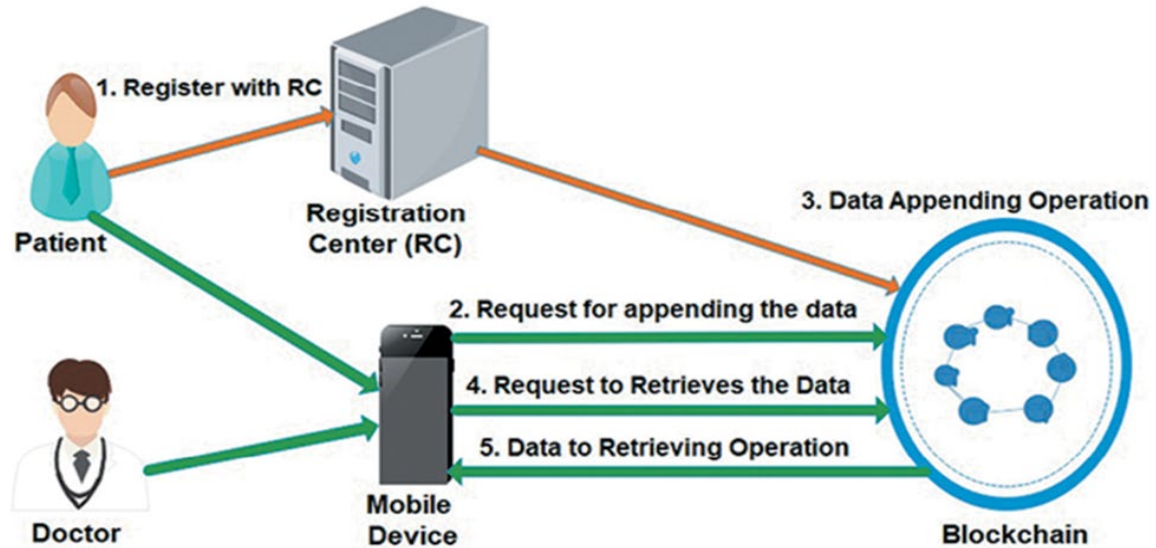


Figure 9. Flow of blockchain transaction in healthcare. Source: Ramani et al. (2018).

I. DEPARTMENT OF DEFENSE AND DEFENSE HEALTH AGENCY

The conclusion of the Global War on Terrorism creates a unique opportunity for the Defense Department to focus on post-war medical treatment with the advanced digital capabilities to resolve the war-induced conditions and improve the overall health of its service members. While it is the service members prerogative to continue their service or prepare their transition to the civilian sector as seamless as possible. A more comprehensive approach has the following potential advantages:

- Reduce the number of medical discharges and VA disability claims across all services.
- Establish a new standard of PTSD treatment, allowing the military healthcare system to expand the duration of its treatment beyond the pre-deployment/immediate post-deployment phase.

- Provide prolonged consistent monitoring and forming the ability for the service members to return to combat operations for any conflict on the horizon.

The DOD Deployment Health Assessment Program requires all personnel deploying for 30 days or more complete deployment health assessments. The assessments consist of the DD 2795 Pre-Deployment Health Assessment (to be completed within 120 days to start of deployment), the DD 2796 Post Deployment Health Assessment (to be completed within 30 days of redeployment or 30 days after), and the DD 2900 Post Deployment Re-Assessment (PDHRA) (to be completed 90 to 180 days after redeployment) (Navy Medicine, 2023). The data from these reports are entered into the electronic Deployment Health Assessment (EDHA) system to allow DOD to monitor and assess each service member's physical and mental health for a period of three years after returning from deployment. These assessments, however, are primarily subjective, meaning a service member can answer the question in a manner to avoid the requisite follow-up appointments had they responded truthfully. A certain stigma, whether justified or not, exists amongst U.S. service members that if they are completely honest about their health, especially their mental health, it could negatively impact their careers. Hypothetically, an individual placed on Limited Duty (LIMDU) while assigned to Sea Duty or deployable platform, requires Permanent Change of Authority (PCA) orders to a command within the area that is deemed Shore Duty with the primary focus of attending their medical appointments. BUPERSINST 1610.10E, the Navy's EVAL and FITREP instruction, requires an official detachment evaluation or fitness report upon transfer—creating a paper trail for review at promotion boards. Quality of life and longevity are certainly more important than a career. This logic, however, can become hazy if an individual's focus and goals are 100% aligned with serving their respective organization for 20+ years.

The Defense Health Agency (DHA) understands the significance of PTSD on service members and has designated June as PTSD Awareness Month with the slogan NOT ALL WOUNDS ARE VISIBLE. This, however, has gained little traction as it perennially competes with Lesbian, Gay, Bisexual, Transgender, Queer and Questioning

(LGBTQ+) Pride month (Lowery, 2022). This is not limited to the civilian sector, as many military organizations and units have solicited for volunteers at LGBTQ Pride parades and provided links to purchase educational seminar tickets to address LGBTQ+/Sexual Orientation, Gender Identity, and Expression (SOGIE) (HealthWest Events and Trainings, 2022, as cited in Lowery, 2022). While it is important to note that equal treatment of all regardless of their demographic, the Department of Defense (DOD) and DHA must discover a balance between the shared awareness groups to not diminish those suffering from war-induced PTSD. Service members experiencing “invisible combat wounds” have likely either entered a Limited Duty (LIMDU) status and removed from their parent units or suffering in silence—struggling to improve their state of minds through resources and outlets immediately available to them.

The United States Marine Corps (USMC) is a frontrunner in its care and availability to its Marines with the establishment of its Wounded Warrior Battalions East and West, Camp Lejeune and Camp Pendleton respectively. Wounded Warrior Battalion (WWBn)—East is responsible for Veterans located east of the Mississippi River, Texas, and Germany, while WWBn—West canvases the families west of the Mississippi, Hawaii, and Okinawa. By opening and providing these services to families is especially significant considering nobody knows the service member and their personalities quite like their loved ones, usually encompassing their childhood, adolescence, and young adult stages. Care is available if services and care providers are available (Wounded Warrior, 2022).

J. PREVENTION AND COMPARATIVE STUDY

1. Preventive Measures

Limited research surrounds the preventive measures of PTSD. One of the earliest interventions was the administration of Military Acute Concussion Evaluation (MACE) exams at the point of entry into Afghanistan. As the name suggests, this was integrated given the frequency of detonations, such as improvised explosive devices (IEDs) and rocket propelled grenades (RPGs), vehicle rollovers, and falls capable of inducing head trauma (i.e., Hindu Kush Mountains, turret gunners in High Mobility Multipurpose

Wheeled Vehicle (HMMWV)—commonly referred to as Humvee) and Mine-Resistant Ambush Protected (MRAP) vehicles, and/or Forward Operating Base (FOB) security towers). While head injuries may not always produce PTSD, they are indicative of enemy activity and acts of terrorism—key factors in a PTSD diagnosis. Furthermore, U.S. Marines and Fleet Marine Force (FMF) Corpsman assigned to Embedded Training Teams assigned to Regional Command Southwest (RC-SW) Afghanistan were further exposed on mounted patrols via M1114 Light Protected HMMWVs, while the Afghan National Army (ANA) had received M1151 “up armored” HMMWVs, which were significantly stronger and capable of sustaining much larger munitions.

The operational tempo (OPTEMPO) throughout the campaigns in the Middle East placed added stress on service members and their families, with the U.S. Army deploying for periods of 15 months at a time. As of November 10, 2021, the Defense Department has standardized dwell time post-deployment across the Services at 1:3 ratio (Myers, 2021). The directive was signed after the withdrawal of U.S. troops from Afghanistan to “establish policy for a consistent set of standards to ... prevent personnel’s overexposure to deployments and time away from their homeport, station, or base” and provides guidance to the Combatant Commanders “to ensure that individual service members, regardless of unit assignment, are not repeatedly exposed to combat [and] do not experience disproportionate deployments” (Acting Under Secretary of Defense for Personnel and Readiness, 2021, p. 1-2).

2. Traumatic Brain Injuries (TBIs)

The most prevalent traumatic brain injuries (TBIs) amongst the U.S. population are likely those observed on Sundays throughout the National Football League (NFL) season, often deemed as the most popular sport in America. The intent is not to imply that warfighters are NFL professional athletes or vice-versa, simply highlighting the long-term effects of sustained head injuries at severe intensity. The National Football League Players Association (NFLPA) has and continues to research the factors surrounding *chronic traumatic encephalopathy* (CTE)—the condition attributed to the repetitive head collisions or traumas that the NFL athletes are exposed to throughout their careers, which

often begin as young teenagers. Historically, boxers were the only athletes suspected of predisposition to long-term brain and neurological functions. “CTE is a disease, a progressive neurodegenerative disease, where end stage leaves tau protein deposition in distinctive areas of the brain in distinctive locations that separate this disease from any other, like Alzheimer’s or some other dementia” (Cantu, 2013). Figure 10 reveals the stark contrast between a normal brain versus a brain with advanced CTE.

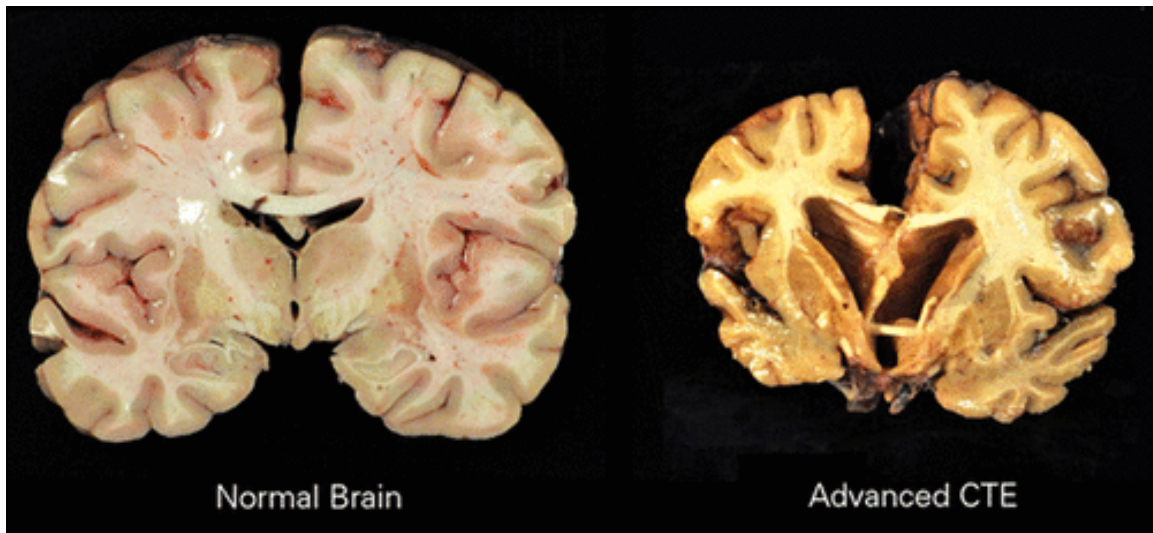


Figure 10. “Advanced CTE brain (on right).” Source: Lindsley (2017).

Symptoms of CTE include depression, memory loss, aggressive behavior, agitation, and suicidal ideations and tendencies. Documentary films like *Concussion* (released 2015), Netflix’s *Concussed: The American Dream* (released 2021), and PBS FRONTLINE’s *League of Denial: The NFL’s Concussion Crisis* (2013) explore the relatively brief history and Dr. Omalu’s discovery of CTE, its similarities to Alzheimer’s disease, and exposing these inherent dangers to retired and current players, parents and their children, and the American public. The tell-tale sign of CTE is the presence of collection of *tau proteins* in the brain matter. CTE cannot be detected with computed tomography (CT) scans or magnetic resonance imaging (MRI). The only way to definitively diagnose CTE is posthumously with cross-sectional cuts of the brain to view under a microscope. Deceased NFL players with confirmed CTE include Mike Webster,

Terry Long, Junior Seau, Tom McHale, and growing. After receiving multiple concussions each, quarterbacks Troy Aikman (Dallas Cowboys) and Steve Young (San Francisco 49ers) retired due to medical concerns, both ending their NFL careers prematurely. A neuropsychologist at Boston University, Dr. Robert Stearn (2013) details:

In football, one has to expect that almost every play of every game, every practice, they're going to be hitting their heads against each other. That's the nature of the game, those things seem to happen around a thousand to 1,500 times a year. Each time that happens, it's around 20 G or more, that's the equivalent of driving a car at 35 miles per hour into a brick wall—a thousand to 1,500 times a year.

This condition is no longer isolated to NFL players—the devastation has trickled down to college and high school athletes. It is imperative to understand that these head traumas do not begin after the NFL draft, but from the moment the athlete begins their football career, whether it be Pop Warner, High School, or NCAA. Owen Daniel Brearly Thomas, a 21-year-old defensive end (DE) and team captain at the University of Pennsylvania had hanged himself. He had zero diagnosed concussions, no history of violence nor suicidal ideations. Eric Pelling, a high school football player (18 years old) died after sustaining his fourth diagnosed concussion (Kirk, 2013). Like the case made for PTSD, “why does one person get it [CTE] and another does not?” (Stearn, 2013).

John Hopkins University had conducted similar studies in Combat Veterans that had been exposed to blast injuries that later died from other causes. Like the presence of tau proteins in the NFL players, the blast survivors had developed a peculiar collection of small lesions that have never been seen in a human brain before.

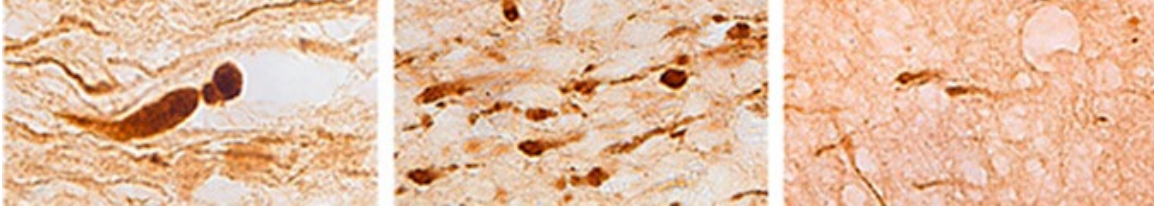


Figure 11. “Brain sections from three different individuals show (left) axons with large, bulb-shaped lesions characteristic of a motor vehicle crash; (center) many smaller lesions characteristic of a blast injury; and (right) fewer lesions characteristic of an opiate overdose.” Source: Koliatsos (2015).

Pre-deployment training for units and Tactical Combat Casualty Care (TCCC) included scenarios based on current tactics employed by the enemy, shared experiences from the designated instructors and facilitators, simulations (including smoke machines to mimic fog of war), and the use of paintballs to replicate small-arms fire. A phrase quite popular amongst military ranks is *Train like you fight and fight like you train*. This may be the best practice to ensure actions are predictable as possible given the nature of military deployments in a kinetic environment. Of course, there is a vast difference between simply stating and embodying the phrase.

III. RESEARCH METHODS

This chapter outlines the research design and methods. In addition to the Literature Review, the rationalist methodology incorporated the history of PTSD and the Department of the Navy's records of medical discharges from calendar years (CY) 2010 to 2021.

A. RATIONALIST METHODOLOGY

The *rationalist* methodology or approach is best described by isolating each term and defining the collective concept afterwards. “*Rationalism* is a way of thinking, which basically states that knowledge can be obtained deductively by appealing to mental constructs such as concepts, laws, or theories” (Nonaka & Takeuchi, 1995, as cited in Sousa-Poza et al., 2011, p. 2). The intent of this methodology is to research additional opportunities that may supplement or enhance PTSD treatment across the DOD and its warfighters, both past and present.

B. DATA COLLECTION

The data was retrieved from Walter Reed Army Institute of Research (WRAIR) from CY2010 to CY2021 (the latter half of the Global War on Terrorism) for the following reasons:

- (1) This is most recent sample of the residual effects of combat exposure,
- (2) this demographic will be the most familiar with the technology required to expand potential PTSD treatment,
- (3) any active-duty service members living with PTSD stemming from combat experience would have been deployed in support of the Global War on Terrorism.

While Freedom of Information Act (FOIA) requests were submitted to several entities, the requests can be classified as one of two categories, unfulfilled or incomplete. WRAIR had the most complete records in quantifying the magnitude of this issue across U.S. service men and women.

C. OBSERVATIONS

1. Mood Tracker via Microsoft Azure

Mood Tracker is an application, organic to DHA, that incorporates the selection of varying emotions to accurately track the individual's feeling over the course of an extended period. The built-in *Post-traumatic Stress (PTS)* feature provides 20 emotions across the range of 10 spectrums. Regardless of the diagnosis (or assessment type), each option displays a series of indicators on horizontal scroll bars with opposing emotions as the range limits. The concept shares the same foundation as the practice of *journaling* but may be slightly easier to use for those with less experience, requiring prompted assessments and less time commitment. The obvious hurdle to Mood Tracker versus traditional journaling is the need for Wi-Fi or ethernet connection, as journaling requires very little with a pen and notebook.

2. Wearable Devices and Technology

The Defense Health Agency (DHA) has currently endorsed several devices to work in concert with one another to effectively record and upload to Microsoft Azure and Google Chrome. The first component is the Espruino Bangle watch, like many smart watches on the market today, displaying the following capabilities:

- IP67 Waterproof Rating
- GPS, Compass, and Accelerometer
- Air Pressure, Heart rate, and Vibration
- 64MHz ARM Cortex M4
- 9MB Flash Memory and 256kB RAM

It is important to note that the Bangle.js watch is not a competitor to the Apple Watch or Samsung Watch. The website provides the following disclaimer, “While the watch is solid and well built, it cannot compete with an Apple Watch costing 5x as much, and it is not intended to” (Espruino Shop, 2023). The watch connects to a Bluetooth-enabled web

browser, where the user can access firmware updates (if applicable), language settings, Android, and iOS Integration to forward notifications from one’s phone to the Bangle watch.

The second item is a BLE pulse oximeter, or commonly referred to as Pulse Ox, to measure an individual’s oxygen saturation levels (SpO₂). The make and model used throughout the duration of our testing was the Berry Pulse Oximeter BM1000 by Shanghai Berry Electronic Tech Co., Ltd. This device uses BLE (Bluetooth Low Energy) technology to communicate with the OxiCare application, which is available on both Apple’s iOS App Store and Google Play.

Lastly, Espruino’s puck.js, which will be referred to as simply the “puck” from this point forward, is a circular device, about the size of a quarter-dollar. Figure 12 illustrates how the devices integrate to capture and record sleep data. Per Espruino (2021), “Puck.js is a low energy Bluetooth smart button that be programmed wirelessly with JavaScript ... with Bluetooth LE, NFC, Magnetometer, Accelerometer, Gyro, Temperature Sensor, RGB LEDs, Infrared transmitter and much more, all enclosed in a tiny silicone case.”



Figure 12. Components of DHA miniature sleep lab. Source: DHA (2023).

3. Network Requirements and Considerations

The utilization of these devices would require electricity to charge the Bangle watch. The puck and Pulse Ox use disposable batteries—(1) CR2032 Lithium Cell 3V and (2) 1.5V AAA alkaline batteries, respectively, and require stable internet and Bluetooth connections to upload and view the records. Theoretically, service members experiencing PTSD signs or symptoms should not be deployed to such austere environments, as they traditionally lack these key requirements and capabilities.

IV. OBSERVATIONS AND FINDINGS

This chapter contains the results from the analysis of the open-source data and records made available. The Department of Veterans Affairs (VA) and the Department of Defense (DOD) have possessed a close relationship with one another to ensure transitioning service members maintain continuity of care as they convert from an active-duty or Reserve status to veteran or civilian status. The number of personnel affected by PTSD by service and fiscal year is shown in Table 5. The total number of discharges across the Armed Services is 88,836 service men and women. This table does not account for those that have separated voluntarily, transferred to the Fleet Reserve, retired, or discharged involuntarily.

In addition to PTSD, the Walter Reed Army Institute of Research also tracked dorsopathies (diseases of the spine and vertebral tissues), limited range of motion, arthritis, and paralysis. Data was not available beyond FY-2010. The U.S. Army experienced the most PTSD casualties, likely due its number of personnel, duration of deployments, and the nature of its mission (ground forces conducting mounted and dismounted patrols). The U.S. Marine Corps ranked second in personnel affected with PTSD, as they share a similar mission set as the Army. The Marines were the primary service tasked with the Embedded Training Team (ETT) concept, where they would integrate small teams with Afghan forces (i.e., Afghan National Army [ANA] or Afghan National Police [ANP]) to train skills, tactics, and mission planning. The Air Force positioned third with its steady control of Bagram Airfield (BAF). Lastly, the U.S. Navy reported the lowest PTSD numbers, as its only personnel with *boots on ground* were those assigned in support of joint operations (i.e., Hospital Corpsmen, Seabees, Personnel Specialists, and Religious Program Specialists) or Special Operations (i.e., Navy SEALs and Explosive Ordinance Disposal [EOD] Technicians). Presumably, had Al-Qaeda, the Taliban, or ISIS had a navy and its corresponding capabilities, these numbers would have likely seen a dramatic increase.

Table 5. Total personnel discharged for PTSD from 2010 to 2021. Adapted from Walter Reed Army Institute of Research (2022).

Service	Unfitting Conditions	FY21	FY20	FY19	FY18	FY17	FY16	FY15	FY14	FY13	FY12	FY11	FY10	Total Fiscal Years (2010-21)
ARMY	PTSD	5145	5917	5637	4862	1816	7707	11340	8939	7361	4630	3878	3688	70920
	Dorsoparthritis													0
	Limitation of Motion													0
	Arthritis													0
	Paralysis													0
	Total													0
NAVY	PTSD	806	190	464	513	285	190	302	403	352	465	174	72	4216
	Mood Disorder													0
	Limitation of Motion													0
	Dorsoparthritis													0
	Joint Disorders and Inflammation													0
	Total													0
MARINE CORPS	PTSD	255	400	432	623	618	564	471	1161	1100	1360	346	176	7506
	Mood Disorder													0
	Limitation of Motion													0
	Dorsoparthritis													0
	Anxiety Disorder													0
	Total													0
AIR FORCE	PTSD	745	809	883	673	74	153	653	761	466	275	245	457	6194
	Mood Disorder													0
	Paralysis													0
	Dorsoparthritis													0
	Limitation of Motion													0
	Total													0
DOD	TOTALS	6951	7316	7416	6671	2793	8614	12766	11264	9279	6730	4643	4393	88836

A. MOOD TRACKER

The Mood Tracker application is the most helpful resource to record a Service Member’s thoughts and emotions over the course of weeks, months, or years to identify any potential patterns of concern. Mood Tracker can be accessed via Microsoft Azure. At the time of publication, this required specific access from the developers, as it is still considered to be in its beta phase. Figure 13 conveys the Main Menu within the Mood Tracker application to address anxiety, depression, general well-being, head injury, PTS (post-traumatic stress), and/or stress. Figure 14 displays the actual assessment to gauge the user’s emotions. Victims of PTSD could experience the additional mental health issues (i.e., anxiety, depression, and stress). By completing Mood Tracker’s additional questionnaires, the patient can catalogue the frequency and severity of these underlying symptoms with the opportunity to share with their respective PCM.

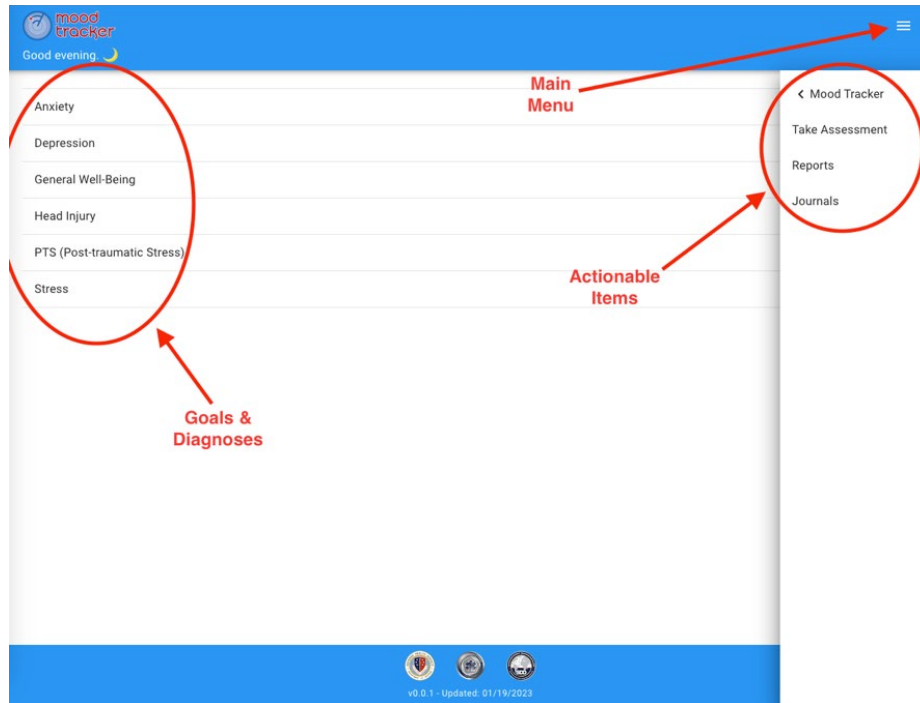


Figure 13. Assessment options within Mood Tracker. Source: DHA (2023).

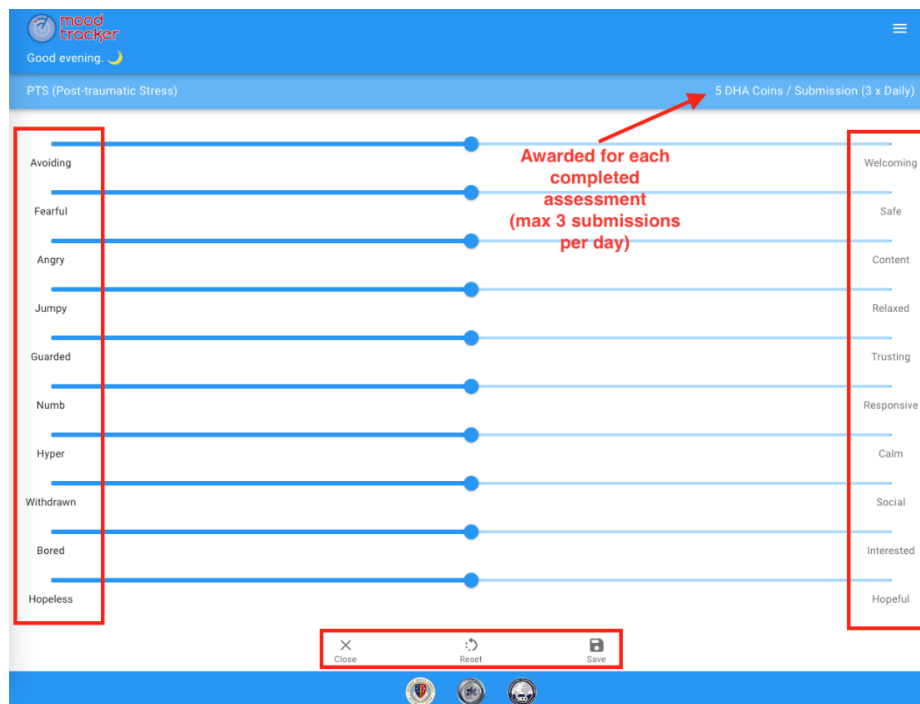


Figure 14. Post-traumatic Stress Assessment. Source: DHA (2023).

B. SLEEP DATA

The *Mini Sleep Lab* captures various data points and creates a graphical user interface (GUI) or a dashboard. At the time of publication, the Mini Sleep Lab can only display individual sleep sessions, as opposed to trends across a range of periods of sleep. The multiple data points include (see Figure 15):

- Average oxygen saturation (SpO₂) per various sleep positions
- Number of position changes
- Sleep position breakdown (pie chart)
- Lowest SpO₂ throughout the entire event
- Minor movement or shifts in each sleep position.

The primary takeaway is the objectivity of the user's favored sleep position and which position provides the least amount of movement. The anonymous user below favors sleeping on their stomach and did not register any shifts while in this position. When the pulse oximeter lost connection to the puck and watch, the SpO₂ registered zero.

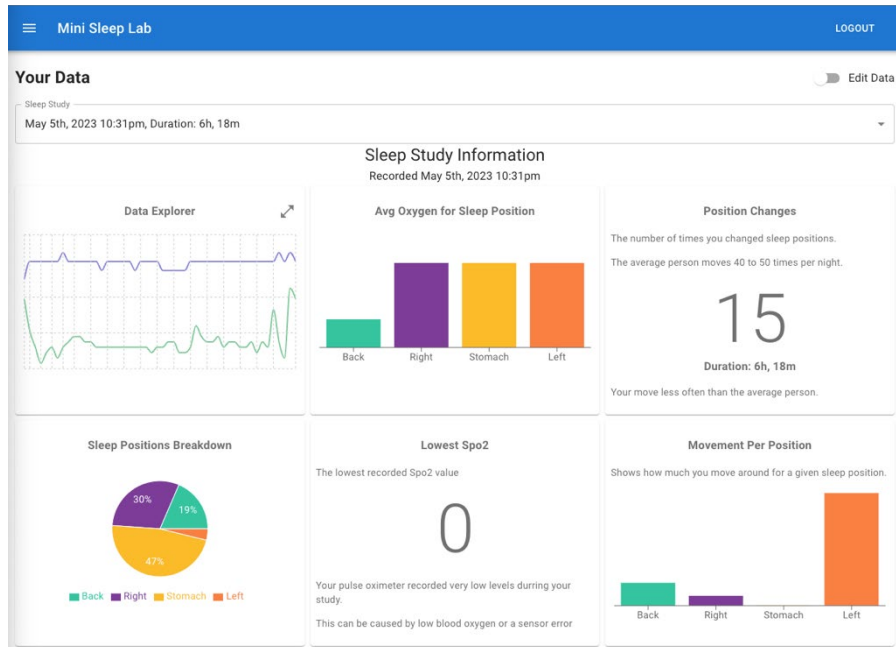


Figure 15. Mini Sleep Lab. Source: Espruino (2023).

C. MODEL FOR THOSE SUFFERING FROM PTSD

The intent of this portion is not to insinuate that PTSD and HIV are comparable, but rather discuss the policies and practices surrounding the careers and futures of those affected. Department of Defense Instruction 6485.01: *Human Immunodeficiency Virus (HIV) in Military Service Members* (2013) states:

Individuals who have been identified as HIV-positive, are asymptomatic [the absence of symptoms], and who have a clinically confirmed undetectable viral load will have no restriction applied to their deployability or to their ability to commission while a Service member solely on the basis of their HIV-positive status. Nor will such individuals be discharged or separated solely on the basis of their HIV-positive status.

An HIV positive result does not preclude service members from routine deployment rotations; however, evaluations are conducted on a case-by-case basis. Per OPNAVINST 1300.20 (2018, p. 3), sailors are placed on temporary limited duty (TLD) and transferred to a *shore command* to obtain the necessary counseling and potential treatments.

Once TLD status is removed, the service member has the option to complete an Operational Screening to execute OCONUS or operational duty (*MILPERSMAN 1300-*

1300: *Assignment of Active Duty Personnel with Bloodborne Pathogens (BBP)*, 2021, p. 3). A chronic HIV infection that is asymptomatic can last 10 to 15 years without HIV treatment, such as antiretroviral therapy, or more commonly known as *ART* (HIV.gov, 2022). If an individual does not wish to screen for operational duty, he/she is able to convert to a more shore intensive rate for the enlisted, while officers can *lateral transfer* to an administrative duty (Navy Bloodborne Infection Management Center, 2021, p. 3). Navy Enlisted Classifications (NECs) or more commonly referred to as *rates*, determine the role and responsibilities an enlisted Sailor will endure. The shore-intensive rates available for transfer are Hospital Corpsman (HM), Yeoman (YN), and Personnel Specialist (PS), to name a few. These occupations may entail a larger volume of administrative tasks; however, all three frequently deployed in support of the Global War on Terrorism throughout the Middle East.

Hospital Corpsmen are the sole medical providers (Role 1) amongst U.S. Marines outside of Role 2 Medical Facility. Taking this into consideration, this practice places an increased burden amongst the HIV negative service members regarding deployment frequencies, time away from homeport and families for pre-deployment training, and increased risk of acquiring PTSD. Personnel that are HIV positive remain subject to high year tenure (HYT), Continuation Boards and Selected Early Retirement Boards (SERB) (Navy Bloodborne Infection Management Center, 2021, p. 3).

Many warfighters that are currently suffering from PTSD were serving their country and following the orders of those appointed over them. While DOD and DHA explore the technology aspect of treatment, these combat veterans ought to have the opportunity to extend their service, whether that requires an extended LIMDU status, rate conversion, or an undefined aspect that still benefits the Armed Services and its mission. Nearly 90,000 men and women have been discharged from service over the course of a decade, not accounting for the first half of the Global War on Terrorism (2001–2009). While a medical discharge may sound appealing on paper, the separation can leave the individual feeling further detached, withdrawn, or even abandoned. Granted, some cases are non-negotiable, but for the others, they simply want to continue their service and extend their patriotic duty.

V. CONCLUSION AND RECOMMENDATIONS

The *Twenty-Year War* officially concluded on August 30, 2021, when the United States withdrew the remainder of its combat troops from Afghanistan. The residual effects of war have made a lasting impact on the men and women of the Armed Services. The casualties of war are nothing new and have endured since the beginning of mankind. The cost of war, as Major General Smedley Butler (1935) stated, is “newly placed gravestones. Mangled bodies. Shattered minds. Broken hearts and homes. Economic instability. Depression and all its attendant miseries.” Although his quote dates to his experiences from the first World War, the signs and symptoms experienced by Combat Veterans remains true today. Is technology the missing piece of PTSD treatment? It is too early to tell, but the advances in technology have radically improved the services and care rendered by healthcare professionals throughout the world. Technology-based therapy is still in its infancy as DHA and developers continue to improve its capabilities. Time and anecdotes of individual cases will provide the honest feedback necessary to determine the future course of PTSD treatment.

Currently, the Department of Defense relies upon the Medical Evaluation Board (MEB) process, an administrative tool used to assess an individual’s long-term health ailments or conditions to determine eligibility for continued service (Military Health System & Defense Health Agency, 2023). The MEB process is directly linked to the Disability Evaluation System (DES), to assess whether the individual is “Fit for Duty.” Post-service benefits vary based on the severity of symptoms persistent throughout an individual’s career. To those Veterans that meet eligibility, the U.S. Department of Veterans Affairs (VA) provides (1) Health care, (2) Compensation or payments based on disability rating (percentage), and (3) Subsequent treatment for PTSD symptoms. The VA defines traumatic events as anyone that “suffered a serious injury, personal or sexual trauma, or sexual violation, or were threatened with injury, sexual assault, or death.” (U.S. Department of Veterans Affairs, 2022). The VA disability ratings vary from 0% to 100% and require the service members to file an official claim for disability compensation.

In addition to conducting further testing and analysis of the wearable technologies, DHA may consider providing the devices to a Wounded Warrior Battalion or other unit with a high concentration of LIMDU personnel for PTSD. This sample size is the key demographic and would represent reality. Their involvement would also assist identifying the key features of Mood Tracker and the *Mini Sleep Lab*. Future research must target combat veterans to accurately assess the benefit of technology, when supplementing traditional therapies. This endeavor would also require access to clinical psychologists and Institutional Review Board (IRB) approval to test and assess human subjects.

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