

Traumatic brain injury rehabilitation for warfighters with post-traumatic stress

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Abstract.

BACKGROUND: While there is extensive empirical support and clinical guidance for the treatment of mild traumatic brain injury (mTBI) and post-traumatic stress disorder (PTSD) individually, less is known about treating the comorbid presentation of both conditions.

OBJECTIVE: The purpose of this review article is to provide information on the mental health treatment needs of service members (SMs) engaged in traumatic brain injury (TBI) rehabilitation. It also aims to offer a framework for an integrated treatment approach to address the cognitive and psychological health needs of warfighters.

METHODS: We review the prevalence and outcomes associated with comorbid TBI and PTSD and present relevant access to care considerations. Additionally, we identify an integrated approach to TBI treatment which takes psychological trauma into consideration. We introduce a trauma-informed care (TIC) model with specified diagnostic and treatment considerations for the service member and veteran (SM/V) communities. TIC is a strengths-based framework that raises the system-wide awareness of treatment facilities to the impact of psychological trauma on behavioral health.

RESULTS: A comprehensive diagnostic approach is recommended with considerations for symptom etiology. Clinical considerations derived from available guidelines are identified to meet critical treatment needs for SM/Vs presenting for TBI treatment with a remote history of mTBI and psychological trauma or known PTSD. Clinical practice guidelines are used to inform an integrated TBI treatment model and maximize rehabilitation efforts for warfighters.

CONCLUSION: Given the prevalence of comorbid TBI and PTSD among SM/Vs and its impact on outcomes, this review presents the integration of appropriate diagnostics and treatment practices, including the incorporation of clinical practice guidelines (CPGs) into TBI rehabilitation.

Keywords: Traumatic brain injury, post-traumatic stress disorder, rehabilitation, military, post-concussive symptoms, treatment model, concussion, head trauma, post-concussion syndrome, trauma

1. Introduction

Post-traumatic stress disorder (PTSD) is highly prevalent among service members and veterans (SM/Vs) with a history of traumatic brain injury (TBI). In a large scale study with over 44,000 SMs

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with a TBI history, 36% had co-occurring PTSD, 22% had a mood disorder, and 22% had an anxiety disorder (Hai, Agimi, & Stout, 2023). This is consistent with other studies that report an approximately 40% comorbidity rate for TBI and PTSD in SM/V populations (Hoge et al., 2008; O'Neil et al., 2021). A meta-analysis that focused specifically on active duty service members (SMs) who experienced a TBI observed that 37% were also diagnosed with PTSD, which is substantially higher than the 16% prevalence of PTSD among civilians with a TBI history (Loignon, Ouellet, & Belleville, 2020). While there has been a 9% observed rate of new onset PTSD one year following admission to a Level I Trauma unit for mTBI, this rate is over 40% for combat-related mTBI (Bryant et al., 2010; Stein et al., 2015). Elevated rates of comorbid PTSD and TBI in military populations reflect greater levels of exposure to psychological trauma. As described by Vasterling et al. (2018), TBIs sustained during deployed settings commonly occur within the context of war which comes with its associated psychological trauma exposure. The nature of a military career also puts SMs at risk for multiple mTBIs, as well as prolonged and repeated exposures to psychologically traumatic and highly stressful situations. Exposure to combat and wartime atrocities is a key factor in the development of PTSD (Berntsen et al., 2012). Whether or not the psychological trauma was directly related to the event which caused the head injury (e.g., blast exposure) or the role one had during combat operations that is later questioned (i.e., moral injury), co-occurring PTSD or post-traumatic stress (PTS) is prominent in SM/Vs receiving treatment for mTBI and negatively impacts rehabilitation efforts.

The psychological toll from Operation Iraqi Freedom (OIF) and Operation Enduring Freedom (OEF) was recognized early as a significant issue (Tanielian, 2008). The 2008 National Defense Authorization Act (NDAA) Section 1618 directed the United States Department of Defense (DOD) to have a "comprehensive plan on prevention, diagnosis, mitigation, treatment, and rehabilitation of and research on TBI, PTSD, and other mental health conditions in members of the armed forces" and establishment of Centers of Excellence for PTSD, TBI and vision (Section 1624; <https://www.health.mil/Military-Health-Topics/Centers-of-Excellence/NICoE>). The National Intrepid Center of Excellence (NICoE) was opened in 2010 with the mission to treat and provide care for both TBI and PTSD. Since then, NICoE and the related Intrepid Spirit Centers (ISC), collectively

known as the Defense Intrepid Network (DIN), expanded to 10 TBI specialty multidisciplinary clinics across the United States with the goal of providing optimal TBI care for active-duty military personnel. The DIN treatment model involves an interdisciplinary approach delivered from the point of intake to discharge. Experts from TBI-focused specialty disciplines provide diagnostic evaluations, communicate findings to the interdisciplinary treatment team, and collaboratively construct an individualized care plan for each patient. Therapies traditionally available in DOD TBI rehabilitation settings including occupational, speech, physical, and vestibular therapy; as well as complementary and alternative medicine (CAM) modalities, also referred to as integrative medicine techniques (DeGraba et al., 2021). While trauma-focused psychotherapy is not widely available through DIN, CAM (including art therapy, music therapy, yoga, meditation, acupuncture, and even animal-assisted therapy) is used to address comorbid mental health conditions and post-concussive symptoms (PCS).

Despite concentrated treatment efforts within the DOD, a notable subset of SMs with a history of mTBI continue to report symptoms following extensive TBI rehabilitation efforts. For example, almost a quarter of SMs who complete NICoE's 4-week intensive outpatient program (IOP) did not report a reduction in overall neurobehavioral symptom burden (DeGraba et al., 2021). The rates of treatment failure were even higher in mental health domains where 54% did not show significant improvement in PTS, 50% did not have a reduction in anxiety symptoms, and 52% had no reduction in depressive symptoms. Treatment resistance at Intrepid Spirit Center (ISC) may be related to these mental health factors. In a study focused at the ISC in Camp Pendleton, SMs who entered mTBI rehabilitation with elevated symptoms of hyperarousal and avoidance were less likely to exhibit improved PTS, depressive and neurobehavioral symptoms (Remigio-Baker et al., 2022). This is consistent with longitudinal studies which have demonstrated that the severity of mental health issues at one year from injury are more powerful predictors of long-term functioning in SM/Vs than the severity of the brain injury itself as many as 10 years post-TBI (Lange, French, Lippa, Bailie, & Brickell, 2020). Pastorek and colleagues (2019) identified that mental health conditions were more deleterious to overall quality of life than mTBI; this was particularly true for SM/Vs who had a combat-related mTBI (Pastorek, Petska, Duchnick, Chard, & Belanger, 2019).

It is also noteworthy that PTS not only limits the effectiveness of TBI rehabilitation for military populations, but it also has a negative impact on the cost of treatment. An independent evaluation of three DOD TBI rehabilitation programs was conducted in 2019 by Center for Naval Analysis, CNA (Levy, 2019). The Navy's Bureau of Medicine and Surgery tasked CNA to evaluate the TBI programs' efficacy with a specific focus on the costs of care to individuals. A key finding of that investigation was related to PTSD. The average cost of care for SMs undergoing TBI rehabilitation who also had PTSD was 67.5 percent higher than SMs without PTSD. This large cost accounted for the independent effects of other key variables such as substance use disorders. It is postulated that time in treatment may be the root cause underlying this increased cost of care. SMs with mTBI and PTSD do not have the same reduction in symptoms with rehabilitation, resulting in treating providers adding and extending services. A secondary analysis of previously published data (Remigio-Baker et al., 2022) showed that SMs who had elevated PTS at the end of TBI rehabilitation had significantly longer durations of treatment with an average of 59 more days; approximately 25% longer than those without elevated PTS.

Ensuring that TBI rehabilitation treatment programs adequately address the mental health needs of the patient population is important considering active duty SMs are at twice the risk for suicide than the civilian population (DOD Suicide Event Report, 2021; Centers for Disease Control and Prevention, 2019). According to the DOD annual suicide report, in 2020 SM suicide rates were 28.7 per 100,000, an increase from the rate of 18.7 per 100,000 in 2011 (*Annual Report on Suicide in the Military*, 2021). After separation from the military, these statistics remain concerning. According to the 2020 VA suicide report, after adjusting for age and sex differences, the suicide rate for Veterans was 57.3% greater than for non-Veteran U.S. adults (U.S. Department of Veterans Affairs, Office of Mental Health and Suicide Prevention, 2022 National Veteran Suicide Prevention Annual Report. Retrieved in 2023 from <https://www.mentalhealth.va.gov>). Rates of suicide for those separated from the military in 2019 ranged from 34.4 to 58.3 per 100,000 for the four branches of military service. To put it in perspective, this rate was 14.5 per 100,000 for the U.S. population in 2019 and 22.3 per 100,000 for the U.S. male population (Centers for Disease Control and Prevention, CDC). There are many factors that impact suicide among SM/Vs

beyond TBI but this extends beyond the scope of this manuscript.

Given the impact PTSD can have on outcomes and warfighter readiness, integration of effective treatment within interdisciplinary TBI rehabilitation for active duty seems vital. It is concerning that, under current treatment pathways, PTSD may be considered "managed," yet it often remains inadequately addressed even after extensive rehabilitation efforts. A preliminary report by the Traumatic Brain Injury Center of Excellence (TBICoE)/Defense and Veterans Brain Injury Center (DVBIC) 15 Year Natural History of TBI study showed that 49.2% of SM/Vs with a history of mTBI indicated they wanted help with managing their mood and stress but were unable to obtain mental health treatment. Integration of treatments may also help address the larger issue related to SM/Vs access to mental health treatment. Access to mental health treatment is a problem across the DOD that expands beyond TBI. DOD's Office of Inspector General reported that the DOD did not consistently meet outpatient mental health access to care standards for active duty SMs and their families between December 2018 and June 2019 (*Evaluation of Access to Mental Health Care in the Department of Defense* 2020). Fifty-three percent of all active duty service members identified needing mental health treatment and referred to civilian treatment facilities or "purchased care system" in the surrounding community did not receive the mental health care they were evaluated to need (*Evaluation of Access to Mental Health Care in the Department of Defense* 2020). Additionally, mental health referrals are regularly sent out to the purchased care system due to lack of DOD resources for mental health. This presents a secondary issue that when referred out to purchased care, often times these encounters are not tracked in the military health system. TBI rehabilitation, particularly the DIN, may be a critical access point where active duty SMs with psychological trauma histories can receive appropriate care, aligning with its original mission of treating *both* invisible wounds of war.

The Veterans Affairs' Polytrauma System of Care (VA PSC) is another large treatment program addressing TBI rehabilitation for SM/Vs. Some of the VA PSC's programs were originally set up to treat moderate to severe TBI and comorbid polytrauma. However, in response to the needs of the OIF/OEF wars and the patient population, the VA PSC extended their services to treat SM/Vs with mTBI and comorbid mental health conditions (Pugh et al., 2016). The VA PSC's PTSD-TBI residential treatment pro-

gram has shown efficacy in post-concussive symptom reduction despite treatment primarily focused on PTSD (Walter, Kiefer, & Chard, 2012). Although the VA's PSC programs were originally set up to address more severe physical injuries, the health care system has responded to the needs of veterans by expanding its scope to mTBI and treating PTSD as the primary focus of intervention in some of the programs (Pastorek et al., 2019). A consideration for current DOD TBI rehabilitation programs may be to adapt to the needs of its patient demographics who are over 82% mTBI (*DoD numbers for traumatic brain injury worldwide – totals 2000-2021. Technical report*), presenting with a similar PCS profile. Although NICoE's original mission was to treat TBI and PTSD, it has since focused on TBI and brain health (with a cognitive rehabilitation over psychological health focus), potentially leaving a major treatment gap for the active duty population.

In instances where psychological trauma exposure history is known and impacting the clinical presentation, mTBI rehabilitation can be enhanced with evidence-based treatment for PTSD. PTSD treatment has been suggested to be the first line of treatment for comorbid TBI and PTSD presentation given the evidence of mental health etiology in persistent PCS (Crocker et al., 2019). Furthermore, literature review for chronic PCS demonstrated psychotherapy to be 5 to 6 times more potent in reducing chronic PCS compared with cognitive rehabilitation (Vanderploeg, Belanger, Curtiss, Bowles, & Cooper, 2019). Authors for this literature review suggest a reconceptualization of treatment approaches for TBI to consider the factors that underlie chronic PCS related to mental health and recommend cognitive behavioral therapy (CBT) as essential, not adjunctive, treatment approach for chronic PCS. Considerations for the integration of trauma-focused care within multidisciplinary TBI rehabilitation settings is detailed below.

2. Trauma-informed care (TIC)

TIC is an approach to providing support and services that recognizes and responds to the impact of psychological trauma on an individual's life. It is particularly relevant in healthcare, social services, education, and other fields where people may have experienced traumatic events. Various models for adaptation of TIC which primarily highlight the need for organizations and/or treatment settings to recog-

nize that traumatic experiences and their sequelae tie closely into behavioral health problems, front-line professionals and treatment-based programs are advised to build a trauma-informed environment across the continuum of care (National Center for PTSD, US Department of Veterans Affairs). *Health Care Provider's Guide to Trauma-informed Care* defines TIC as a strengths-based treatment framework requiring providers to recognize, understand and respond to the pervasive impact of trauma summarized by: 1. realizing the prevalence; 2. recognizing the impact; 3. responding appropriately; and 4. promoting resilience through skill-building (Psychological Health Center of Excellence, 2018). Adopting or translating to a trauma-informed model of care for DOD TBI rehabilitation settings has the potential to make a large impact on clinical outcomes. More information can be found at the Trauma-Informed Care Implementation Resource Center (traumainformedcare.chcs.org). The National Veterans Foundations discussed new approaches to Veteran care by adopting TIC methods and changing organizational culture to account for how psychological trauma impacts the population (nvf.org). Implementation of TIC within healthcare systems has been reviewed with successful models for implementation identified (Goldstein et al., 2024).

3. Diagnostic considerations

One of the most salient challenges regarding the clinical presentation of comorbid TBI and PTS is the topic of differential diagnosis, etiology and attribution of symptoms. Although symptoms following moderate to severe TBI, particularly in the acute stage of injury, can clearly be linked to the head trauma, as alluded to above, the etiological determination for nonspecific symptoms of mTBI(s) can be more challenging and depends on many factors. Anxiety, loss of interest, sleep disturbance, irritability, risky behaviors, poor concentration, and fatigue are examples of non-specific symptoms, frequently seen with both TBI and PTSD (Alosco, Supelana, & Vasterling, 2017; *Post-traumatic Stress Disorder*, 2023). A review by Pastorek et al. (2019) highlights the high degree of symptom overlap between TBI and PTSD, noting there are few symptoms that are unique or pathognomonic to TBI as opposed to PTSD. In those with chronic symptoms related to mTBI and PTS, it may be unrealistic to expect a provider to ascertain the primary etiology or relative contribution of

psychological versus neurological mechanisms that may perpetuate symptoms. However, identifying psychological trauma exposure in the context of mTBI rehabilitation is critical to treatment success. Some of the most effective interventions for PTSD, such as exposure-based therapy and cognitive restructuring, require clinician awareness of the trauma (*Post-traumatic Stress Disorder*, 2023; Vasterling, Jacob, & Rasmussen, 2018). Specific PTS symptoms are also unlikely to improve without treatment and can exacerbate or mimic many of the symptoms patients might misattribute to their mTBI (Kenna et al., 2012; Vasterling et al., 2018). There is a strong tendency for SM/Vs to over attribute their symptoms to TBI as opposed to mental health (Pastorek et al., 2019). For example, a SM/V who is struggling with anxiety and irritability will tend to identify a remote concussion as causing their symptoms as opposed to PTSD; in these scenarios this misattribution may derail treatment access as well as the therapeutic relationship between the SM/V and provider (Cogan & Bailie, 2023).

A structured interview approach is recommended for identification of PTSD for SMs enrolling for TBI care (Rosen & Ayers, 2020). Clinician-Administered PTSD Scale for DSM-5 (CAPS-5) is recommended as part of the TBI diagnostic framework. This is particularly important during the intake process at a multidisciplinary TBI treatment setting where the known comorbidity of PTSD exists and presents with significant degree of overlapping symptoms. The National Center for PTSD recommends using the PCL-5 to identify a cut-off score (31-33 reported as a recommended value) and further assess with tools such as the CAPS-5 to confirm a diagnosis of PTSD (*Using the PTSD Checklist for DSM-5 (PCL-5)*). Additionally, the CAPS-5 can be beneficial in capturing salient symptoms of trauma such as re-experiencing a traumatic event and avoidance behaviors (Vasterling et al., 2018), which, once identified, can be treated with more targeted treatment approaches. If a PTSD diagnosis has already been rendered by a licensed professional, a structured interview approach is important to characterize the condition such as determining which symptoms are actively present and how symptoms may be affecting everyday functioning (e.g., work performance, social relationships, ability to meet basic needs). Details related to the clinical presentation of the disorder or constellation of symptoms related to PTS can be gathered at this setting with a licensed mental health provider. Particularly given the prevalence of

other mental health conditions including mood and anxiety disorders (Howlett, Nelson, & Stein, 2022; Wojtowicz et al., 2017), providers with competency in psychopathology are advised to be part of the interdisciplinary team making initial contact with patients determining treatment needs.

Caution is advised with over-reliance on non-specific symptom inventories such as the PTSD Checklist (PCL) due to the measure's lack of specificity with other conditions, notably mTBI. Self-reported questionnaires are considered screening tools and not recommended for determining diagnosis or severity. There is also a high rate of correlation between commonly used self-report measures administered within DOD interdisciplinary TBI treatment settings, whereby those with elevated PTSD symptoms are likely to exhibit elevations across measures of psychological functioning (Hoover et al., 2022; O'Neil et al., 2021). For example, elevations across screening tools does not imply that a SM has depression, anxiety and PTSD. Rather, it is possible that one of the conditions may be driving elevated symptom reports in all domains.

The interviewer should consider the timing of symptoms to include initial symptom onset, symptom progression and times of exacerbation. TBI-related symptoms are most prominent shortly after an event and will gradually lessen over time. In contrast, PTSD symptoms may have a delayed onset and remain stable or worsen over time, exacerbated by triggers or life events. Should symptoms attributed to a mTBI worsen or persist post-treatment, it is probable that PTSD or other psychological sequelae may be contributing to them (<https://www.ptsd.va.gov>). Research has shown the SM/Vs with a TBI will have notable variability in both their neurobehavioral and PTSD symptoms overtime which will improve or worsen over the years at atypical rates (Lange, Brickell, Ivins, Vanderploeg, & French, 2013; Lange et al., 2020). These changes are less likely to be related to changes in the TBI and more likely to be attributable to co-morbid psychological factors which are more susceptible to temporal variability. Monitoring temporal variations in symptoms may be clinically useful in assessing the need for mental health services. It should be noted that this distinction is more complicated with a career-long history of multiple TBIs and blast-related exposures (Turner, Sloley, Bailie, Babakhyan, & Gregory, 2022). Nevertheless, a comprehensive interview to gather details such as mechanism of exposure/injury, symptom onset, symptom exacerbation, life events to include

loss and deployments, and treatment response should be understood by the treating medical providers.

4. Treatment considerations

There are no clinical practice guidelines (CPGs) for the treatment of comorbid PTSD and TBI. Each diagnostic presentation has clear parameters for their individual condition. CPGs for the Management and Rehabilitation of Post-Acute Mild Traumatic Brain Injury warn that given the association of mTBI with mental health disorders, providers should assess for these conditions and consult related VA/DoD CPGs. Therefore, for comorbid PTSD and TBI, providers should defer to CPGs developed for PTSD. Current CPGs for PTSD specify the preference for trauma-focused psychotherapy as the first-line treatment for PTSD and endorsed over psychopharmacological intervention (VA/DOD Clinical Practice Guideline for PTSD). Following CPGs for treatment of PTSD entails inclusion of trauma-focused psychotherapy during interdisciplinary TBI rehabilitation when: 1) PTSD diagnosis is made or identified in the medical records; and 2) symptoms are active and interfering with everyday life. These CPGs also advise providers to consider the underlying diagnoses, patient preferences, co-occurring conditions, and available treatment modalities.

Psychotherapy does not necessarily need to be modified for mTBI and studies have shown evidence-based trauma-focused therapies being effective for SM/Vs (Chard, Schumm, McIlvain, Bailey, & Parkinson, 2011; Wolf et al., 2015). If a patient can retain information, then a trauma-focused treatment remains important and appropriate for treating PTSD. This should make it appropriate for the majority of SM/Vs as cognitive deficits, when present, are typically mild in nature (Belanger, Spiegel, & Vanderploeg, 2010). Should neuropsychological evaluation reveal cognitive deficits which may impede treatment, protocol-consistent modifications are available (ptsd.va.gov) to:

- a. Provide external memory aids such as written calendars or smartphone reminders to prompt for homework completion or session attendance.
- b. Reinforce concepts by simplifying worksheets, using visual or written descriptions of concepts, encouraging recording of sessions, extending session time—especially for cognitively chal-

lenging work—or using teach-back methods to gauge understanding.

- c. Modify sessions by using repetition, increasing the structure of session content, or taking breaks within sessions.
- d. Problem-solve to address cognitive deficits if they continue to interfere.
- e. Include supportive individual in sessions when appropriate. If family or close friends can learn about PTSD and TBI, they may feel validation of their experiences, better understand their significant other, and be more able to assist in the recovery process in various ways, including reinforcing therapy homework or material.
- f. Conduct imaginal exposure during Prolonged Exposure using the existing fragments of memory organized into a cohesive memory, even if there is not a full, cohesive trauma memory (Ragsdale et al., 2018).

Collaborating with other members of the health care team, to include speech-language pathologists, physical therapists, occupational therapists, and/or case managers, and encouraging a consistent narrative of recovery to convey the expectation that conditions can improve is also important for the rehabilitation setting (Corrigan, 2021). Additionally, when PTSD is suspected, or there is a known psychological trauma, clinicians can convey to the patient that some symptoms may not be solely related to a mTBI. In these cases, treatment of PTSD may significantly help with both PTSD and non-specific symptoms (Jak et al., 2019; Walter et al., 2012). Providers can educate patients about the overlapping PTSD and mTBI symptoms and explain that PTSD treatment can help address cognitive difficulties. If residual cognitive difficulties are present after evidence-based PTSD treatment, it can then be addressed by the cognitive rehabilitation specialists (National Center for PTSD).

A previously identified approach to outpatient care for PTSD with comorbid TBI involved 4 main principles to include the following: (1) treat PTSD with appropriate psychopharmacologic and psychotherapeutic modalities; (2) identify and treat any comorbid neuropsychiatric conditions or substance use disorders; (3) identify and treat any associated medical comorbidities; and (4) directly address cognitive sequelae of TBI. As the model prioritized treatment needs for PTSD and TBI, addressing the cognitive sequela is the last priority with co-occurring PTSD (Capehart & Bass, 2012).

5. Conclusions

Mental health challenges associated with TBI rehabilitation are common, particularly due to the high rate of comorbidity with mTBI and PTSD. Unmet mental health treatment needs associated with psychological trauma negatively impacts TBI rehabilitation efforts and ultimately warfighter readiness. Current clinical practices can be improved with adaptation to or translation of a trauma-informed mTBI rehabilitation model of care. Multidisciplinary military TBI treatment settings spending the bulk of their time treating post-concussive symptoms associated with chronic mTBI are encouraged to adopt evidence-based practices for PTSD per CPGs as well as a cultural shift to trauma-informed care in an effort to maximize neurorehabilitation treatment efforts and better support our warfighters.

Disclaimer

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Conflict of interest

The authors declare no conflicts of interest.

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