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Current Opinion in Psychology

Suicide and traumatic brain injury: a review by clinical researchers from the National Institute for Disability and Independent Living Rehabilitation Research (NIDILRR) and Veterans Health Administration Traumatic Brain Injury Model Systems

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Research among a wide range of cohorts (e.g. civilian, military) has increasingly highlighted traumatic brain injury (TBI) as a risk factor for suicidal thoughts and behaviors, including death by suicide. With this recognition, subsequent changes in clinical practice, such as TBI screenings among individuals seeking mental health services, as well as suicide risk assessment among individuals seeking rehabilitation services are essential. Information provided below is aimed at highlighting key and emerging findings regarding suicide and TBI, with the goal of encouraging providers and researchers to explore changing and expanding evidence-based clinical practices to match the needs of those living with a history of TBI.

Current Opinion in Psychology 2018, **22**:73–78

This review comes from a themed issue on **Suicide**

Edited by **Michael Anestis** and **Daniel Capron**

doi:10.1016/j.copsyc.2017.08.030

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Introduction

Traumatic brain injury (TBI) is a significant public health concern among civilian, military, and Veteran populations. According to the Centers for Disease Control (CDC), in 2010, over two and a half million TBIs were sustain in the United States [1]. Moreover, a history of TBI is associated with negative physical and mental health outcomes, including suicidal ideation (SI) and behaviors (suicide attempts [SA] and deaths) [2–4]. In this review, recent work in the area of TBI and suicide will be discussed, with emphasis on the important role of both mental health and rehabilitation clinicians addressing suicide risk among this cohort.

Suicide-related nomenclature

Within this review, several terms related to suicide will be utilized. Definitions are as follows: firstly, Suicide: 'Behavior that is self-directed and deliberately results in [death]. There is evidence, whether implicit or explicit of suicidal intent'; secondly, Suicide Attempt (SA): 'Behavior that is self-directed and deliberately results in injury or the potential for injury to oneself. There is evidence, whether implicit or explicit, of suicidal intent'; thirdly, Suicidal Ideation (SI): 'Thoughts of engaging in suicide-related behavior'; fourthly, Suicidal Intent: 'There is past or present evidence (implicit or explicit) that an individual wishes to die, means to kill him/herself, and understands the probable consequences of his/her actions or potential actions. Suicidal intent can be determined retrospectively and in the absence of suicidal

behavior'; and finally, Suicide Ideation-Related Behavior (SIRB): Thoughts related to wishing to die where the evidence of suicidal intent is undetermined. For example, endorsement of item 9 on Patient Health Questionnare-9 (PHQ-9), a frequently used measure of depression ('Thoughts that you would be better off dead or of hurting yourself in some way') [5,6]. For more information regarding suicide-related nomenclature see: https://www.mirecc.va.gov/visn19/education/nomenclature.asp [7].

TBI

According to the definition put forward by the CDC 'a [Traumatic Brain Injury] TBI is caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain,' [8]. Injury severity is classified according to the disruption of brain function post-injury; see Table 1 for criteria associated with mild, moderate, and severe TBI [9]. The vast majority of civilian and military injuries sustained are mild in nature, with a return to baseline function generally occurring within a year post-injury. However, more severe injuries may result in lifelong impairment, with associated challenges in functioning (e.g. communication, physical, psychosocial). History of TBI (all severity levels) is also associated with increased rates of new onset psychiatric conditions, including mood-related and anxiety-related diagnoses [10,11]. Although psychiatric conditions are commonly conceptualized as risk factors for suicidal behavior; research also suggests that history of TBI independently increases risk for suicide above and beyond frequently co-occurring mental health conditions [2]. However, the mechanism of increased risk for SI, SA, and death among those with a history of TBI is unknown and remains an area for future research. Given differential functional outcomes associated with mild versus moderate/severe TBI, it has been hypothesized that mechanisms of risk may be contingent upon severity of injury. Specifically, among those with a history of mild TBI, a propensity toward risky behaviors may be associated with both sustaining TBI's and engaging in suicidal behavior, as well as other risky behaviors (e.g. substance abuse, violence, erratic driving); however, this hypothesis may not hold for those who sustain TBI's in the line of duty (e.g. military personnel). Alternately, among those with more severe injuries, suicide-related thoughts and behaviors may be associated with injury-related executive dysfunction (e.g. impulsivity, poor decision making), as well as psychosocial challenges (e.g. financial burden, employment or relationship-related changes).

Death by suicide

According to a systematic review by Bahraini *et al.*, robust evidence has been identified regarding the association between history of TBI and elevated risk for suicide among both Veteran and civilian cohorts [2,3,10,12]. This risk is present across all levels of injury severity (mild, moderate, and severe) and does not appear to decrease, even many years post-injury [2,3,12]. In 2011, seminal work in this area was published by Teasdale and Engberg who found that individuals with a history of TBI (mild, moderate, and severe) were at 2.7–4.1 times greater risk for death by suicide than members of the general population [3]. Since 2001, work by Harrison-Felix *et al.* and Brenner *et al.* replicated these findings in United States civilian and military cohorts [2,13]. Most recently, in a 41-year Swedish population study, Fazel *et al.* identified a threefold increase for death by suicide among patients with TBI [14].

Suicidal ideation (SI) and suicide attempts (SA)

Less definitive work has been conducted regarding rates of SI and SA among those with a history of TBI [12]. This is in part related to notable challenges associated with measuring SI/SA, reliance on retrospective data (e.g. existing medical records), the relatively low base-rate of suicidal behaviors, variable follow-up periods, and wide-ranging strategies for measuring outcomes. Nonetheless, Mackelprang *et al.* [15••] recently published a seminal article regarding rates and predictors of suicide-ideation related behavior (SIRB) during the first year post-TBI. The authors found that among individuals admitted to Harborview Medical Center post-injury, 25% reported SIRB during one or more assessment periods in the year following TBI. Findings were similar to those published by Tsaousides and colleagues who used retrospective data and identified a SI prevalence rate of 28.3% among those with mild and moderate/severe injuries [4]. Finally, Fisher and colleagues [16•] evaluated rates of SIRB (in the past two weeks) using the National Institute for Disability and Independent Living Rehabilitation

Table 1

VA/DOD TBI severity criteria [9].

TBI severity	Glasgow Coma Scale (GCS)	Loss of consciousness (LOS)	Post traumatic amnesia (PTA)	Computed tomography (CT)/ magnetic resonance imaging (MRI)
Mild	13–15	Less than or equal to 30 min	0–1 day	Normal
Moderate	9–12	>30 min and <24 hours	>1 day and <7 days	Normal or abnormal
Severe	Greater than 9	Greater than 24 hours	>7 days	Normal or abnormal

GCS is a 15-point scale measuring response to stimuli such as eye opening, verbal and motor response; PTA the period post-injury during which the individuals is not forming new memories; CT/MRI imaging techniques are use used to examine brain structures.