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REVIEW

An overview of traumatic brain injury and suicide

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Abstract

Purpose: There is concerning evidence that people with traumatic brain injury (TBI) may be at increased risk for suicide. This paper aims to provide an overview of traumatic brain injury and suicide in order to enhance the ability of professionals to recognize and manage suicidality in patients with TBI.

Methods: First, the association between TBI and suicide is reviewed. Proposed psychological, psychosocial and neuropathological factors are included in the discussion. Next, identifiable risk factors for suicide in TBI are presented. Suicide assessment tools are then discussed. Assessment is emphasized as the mainstay of suicide prevention and clinicians are encouraged to be vigilant for potential suicidality in their patients with TBI. Finally, biopsychosocial interventions for suicidality are reviewed.

Conclusions: This paper concludes that increasing awareness of depression and suicide risk assessment in the TBI population should be aimed towards staff involved in neuro-rehabilitation as well as other professionals who are involved in the care of patients with TBI, because psychoeducation of those most likely to come in contact with at-risk individuals have been shown to increase identification of suicidal patients, lowering suicide rates.

Keywords: Risk factors, suicide, traumatic brain injury

TBI and suicide

In the USA, two million people acquire traumatic brain injury (TBI) every year [1] at a cost of 37.8 billion US dollars [2]. TBI can impact on all aspects of life and may cause significant financial, social and psychological impairment [3]. Of particular concern is evidence that people with TBI may be at increased risk for suicide. A recent study by Simpson and Tate [4] assessing suicidality in outpatients with TBI found that 17% had attempted suicide. Teasdale and Engberg [3] report a 4-fold higher risk of death by suicide in people with TBI. Silver et al. [5] found that in a probability sample of adults, individuals with a history of TBI reported a higher frequency of suicide attempts than those individuals without TBI (8.1% vs. 1.9%). It is striking

that patients with no more than a concussion have been found to have increased rates of suicide [3].

This paper aims to provide a literature review on the association between TBI and suicide, identifiable risk factors, assessment of suicide risk and appropriate interventions in order to enhance the ability of professionals to recognize and manage suicidality in patients with TBI. Clinician awareness plays a fundamental role in the prevention of suicide. Psychoeducation to help recognize psychological distress and suicidal ideation has been shown to increase identification of suicidal patients by 130% [6].

The relationship between TBI and suicide is not entirely clear. Oquendo et al. [7] have hypothesized a stress-diathesis model of TBI-related suicide.

The model suggests that suicidal behaviour is determined by a tendency to act on suicidal ideation and a precipitating stressor determines the timing of such behaviour. TBI may act as a stressor, precipitating psychiatric illness and suicidal behaviour [7]. TBI may also act as a diathesis via disinhibition and impulsivity from frontal lobe injury [7] or through other neuropathological mechanisms.

There is a high incidence of psychiatric disorders in the TBI population. Silver et al. [5] found that 43% of those with a TBI had at least one psychiatric diagnosis compared to 20% of those without a history of brain injury. The study found that 11.1% of those with TBI had a diagnosis of major depression, which was significantly greater than the 5.2% prevalence in the non-head injured population. In another study of patients with TBI, 33% were found to have a diagnosis of major depression, a higher rate than that of the comparable control group [8]. A study by Fann et al. [9] found that 26% of patients with TBI had a current diagnosis of major depression and that there was a 12% occurrence of pre-TBI depression.

Psychiatric disorders associated with TBI are concerned from a suicide risk perspective. At least 90% of suicides in the general population are associated with psychiatric disorders [10] and most of the disorders are untreated at time of death [11]. Mood disorders, principally major depressive disorder and bipolar disorder, are associated with ~60% of suicides [12]. The presence of mental illness makes it 10-times more likely that there will be a suicide attempt [11].

Silver et al. [5] have proposed that the higher rate of psychiatric disorders in TBI could be due to the effects of TBI on brain functioning, the psychological impact of the accident or the psychosocial effects of disabilities resulting from the TBI. There is also some evidence for psychiatric disorders as a predisposing risk factor for TBI. Hibbard et al. [13] found that 51% of TBI patients had pre-injury psychiatric disorders, most commonly major depression or substance use disorders that occurred at double the rates reported in community samples. A case control study by Fann et al. [14] found that 18.2% of cases with TBI had a psychiatric ICD-9-CM diagnosis in the year prior to TBI compared to 9.7% of controls. In a study looking at schizophrenia pedigrees, Malaspina et al. [15] found a higher prevalence of TBI among those with schizophrenia; however, it was difficult to distinguish whether early features of schizophrenia predispose one to TBI or if head injury further increases the risk of expression of schizophrenia in a genetically susceptible individual. A retrospective cohort study of US veterans found that the pre-existence of psychiatric illness, particularly depression, anxiety and conduct

disorder, increased the future risk of developing a TBI [16].

There is limited research that has specifically investigated whether psychiatric conditions present prior to TBI vs those beginning afterwards differentially affect risk for suicide. A Finnish study found that suicide victims with comorbid psychiatric diagnoses present prior to TBI committed suicide significantly earlier than those whose psychiatric disorders manifested post-TBI [17]. This may be because the TBI acts as an acute stressor in individuals predisposed to suicide because of pre-existing psychiatric illness. Regardless of time of onset, management of concurrent psychiatric disorders in TBI is warranted to alleviate distress and prevent suicide.

Because of the high rates of psychiatric illness in patients with TBI, clinicians should have a low threshold for screening for depression. The symptom of hopelessness in particular is thought to be necessary for the development of suicidal intent [18]. However, suicidal ideation may exist outside of a depressive episode. Patients may endorse hopelessness or anhedonia without sufficient accompanying symptoms to meet criteria for depression. In the general population, psychosocial variables independently carry suicide risk, including being single, being unemployed and being in the lowest income quartile [19].

In addition to the psychological impact of TBI, research has started to look at the neurological impact of TBI on mood centres in the brain which may be implicated in suicidal ideation. Some authors assert that the neurological processes that occur in the context of TBI contribute to depression independent of the psychological stress associated with trauma. Jorge et al. [8] found that major depressive disorder and total mood disorders were significantly more frequent in patients with TBI than in patients with similar baseline characteristics who underwent similar levels of stress (e.g. motor vehicle collisions) but who did not sustain brain injury. This may suggest that neuropathological processes associated with TBI act as a diathesis in the development of mood disorders [8]. The study also looked at neuroanatomical differences between patients with TBI. Results showed reduced volumes in left prefrontal gray matter, specifically the ventrolateral and dorsolateral regions, in those with major depression compared to those without depression. Therefore, Jorge et al. [8] hypothesized that TBI may lead to deactivation of the prefrontal cortex and increased activation of limbic and paralimbic structures. However, it is possible that the neuroanatomical differences were in fact due to a pre-existing tendency towards depression rather than pathophysiological mechanisms as a result of TBI.

Although much less common, failed suicide attempts may be the actual cause of TBI. In a study including 48 298 cases of TBI, 369 (0.8%) were seen to have been self-inflicted [3]. It is recognized that suicide attempters have an increased rate of TBI in comparison with patients with no history of suicide attempts [20].

Risk factors

There is indication in the literature that the connection between TBI and suicide is more complex than a causal relationship, since TBI and suicide share many of the same antecedent risk factors. Young age, male gender, substance abuse and aggressiveness have been shown to be risk factors for both [3, 5].

Substance use

Substance use is well recognized as a risk factor for both suicide and TBI [3]. TBI frequently occurs during intoxication [7] and substance abuse is documented in 5–25% of all suicides [21]. The literature suggests that a pattern of substance abuse prior to TBI puts patients at higher risk for suicide. Achte et al. [22] observed that a history of alcohol misuse occurred with greater frequency among their brain injury patients who committed suicide. Teasdale and Engberg [3] found that among patients with TBI, a co-morbid diagnosis of substance abuse at admission markedly raised the risk of suicide.

Aggressiveness

Impulsivity and aggressiveness are associated with both TBI and suicidal behaviour [7, 20]. Impulsivity and aggressiveness may be pre-existing traits that put patients at risk for TBI and suicide or they may be the result of disinhibiting effects of frontal lobe damage. A study by Oquendo et al. [7] highlights aggression and hostility as risk factors for suicidality in TBI patients. Results showed that depressed patients with TBI were significantly more aggressive and hostile than depressed patients without TBI. Of the TBI patients, suicide attempters had significantly higher aggression scores and hostility as compared to non-suicide attempters. In addition, there was evidence that TBI patients were aggressive before age 12 compared with depressed patients with no TBI history. These results lend support to the theory of aggression as an antecedent risk factor; however, the authors concede that increases in aggression following TBI further contribute to suicide risk.

Severity of TBI

The severity of TBI may also influence the risk of suicide. A Danish study including over 140 000 TBI patients from a population registry found that those who suffered cerebral contusions or traumatic intracranial haemorrhages had significantly greater risk of suicide compared to those with a concussion or a cranial fracture [3]. Standardized mortality ratios for suicide in the concussion and fracture group were triple population rates and quadruple population rates for the lesion group. The study also found that the suicide rates within the lesion group tended to increase with the severity of injury, indicated by the length of stay in hospital. On the other hand, Simpson and Tate [4] found no relationship between severity of head injury and elevated suicidality post-injury in 172 outpatients with TBI.

An association between TBI severity and suicide may be mediated by patients' depression regarding their post-injury level of functioning. Satz et al. [23] found a significant association between TBI severity as assessed by the Glasgow Outcome Scale [24] and symptoms of depression at 6 months post-injury. The Glasgow Outcome Scale is used to describe the severity of TBI according to resultant disability. Patients can be classified as Severe Disability (conscious but dependent upon others for daily activities), Moderate Disability (disabled but independent), or Good Recovery (able to resume normal life, may have minor physical or cognitive deficits). Studies looking at later outcomes show a similar relationship between disability and depression. Whitnall et al. [25] found that persistence of disability 5–7 years post-injury and the development of disability after previous recovery were significantly associated with depression, anxiety and low self-esteem.

Timing

The timing of suicide in relation to TBI is of interest because knowledge of high risk periods could assist in prevention. Using a Finnish suicide database, Mainio et al. [17] found that the median time interval between injury and suicide was 8 (range 2–12) years for those with a lesion and 11 (range 4–19) years for those with a concussion. They found that 60% of those with a lesion and 40% of those with a concussion committed suicide within 3 years of injury. The results differed from those of Teasdale and Engberg [3] who found that the median times from injury to suicide were ~3–3.5 years for all diagnostic groups (concussion, cranial fracture and cerebral contusion/intracranial haemorrhage) and did not differ significantly. The Danish population study

did not find evidence of a specific risk period for suicide after injury. They concluded that the risk is relatively constant following injury for at least 15 years (the follow-up period in the study).

The increased suicide risk in those who sustained merely a concussion compared to the general population is surprising since these patients do not suffer the same long-term effects as those recovering from more severe TBI. It is thought that the association arises from pre-morbid or concomitant characteristics and not the consequences of the head injury *per se* [3]. Mainio et al. [17] found that 41% of suicide victims with concussion had undergone hospital treatment for an alcohol related disorder, 24.1% for depression and 10.8% for schizophrenia.

Assessment

With increased awareness of the risk factors for suicide in patients with TBI, clinicians should be vigilant for potential suicidality when seeing these patients. Patients with TBI should be assessed for suicide risk, as assessment is the mainstay of suicide prevention. Follow-up examinations are recommended as a patient may present with depression and suicidality at variable times following the initial TBI [3]. Indeed, the full impact of the consequences of TBI may not be felt until patients experience several disappointments over the years and finally realize that they will not return to their former functioning [3]. Therefore, it is important to reassess patients as they continue to come to an understanding of the full implications of their TBI.

There are multiple tools available for the assessment of suicide risk. The Beck Scale for Suicide Ideation (BSS) [26] and the Positive and Negative Suicide Ideation Inventory (PANSI) [27] are validated suicide assessment tools [28]. The BSS is a self-report measure with a 19-item scale preceded by five screening items. It is intended to assess a patient's thoughts, plans and intent to commit suicide. As with the PANSI, there are no specific cut-off scores to categorize severity or guide management. Higher scores reflect greater suicide risk and any positive response warrants investigation [26].

The SAD PERSONS Scale [29] and the Suicide Risk Factor Scale [30] include evaluation scales that can further assist in estimating the likelihood of suicide.

The SAD PERSONS Scale assigns points for different parameters: Sex, Age, Depression, Previous attempts, Excessive alcohol, Rational thinking loss, Separated or divorced, Organized or serious attempt, No social support and Stated future intent. A score of 0–5 indicates that the patient may be safe to discharge depending on the circumstances. A score

of 6–8 indicates that emergency psychiatric consultation is required. A score of 9–14 indicates that the patient probably requires hospitalization.

The Suicide Risk Factor Scale includes five parameters: suicidal thoughts, recent bereavement, delusions, chronic mental illness (for >5 years) and suicide committed by a first degree relative. If all five risk factors are present, the risk of suicide is 30–40%. If three or four risk factors are present, the suicide risk is >5%. If two risk factors are present or if delusions, chronic mental illness and one other risk are present, the risk is 1–5%.

The use of these specific suicide assessment tools has not yet been studied in patients with TBI. One is awaiting data regarding the efficacy of such assessment tools in this population. One obvious caveat is that the ability to correctly predict who will commit suicide is impaired by the low base rate of such behaviour. Despite having good sensitivity and specificity, screening tools may have limited positive predictive value owing to the low prevalence of suicide, leading to a high proportion of false positive results [31]. Nevertheless, clinicians are encouraged to use measures to aid them in assessing suicide risk post-TBI. Clinical rating scales alone cannot predict suicide in the individual; however, they can be a valuable adjunct to suicide risk assessment [28].

The literature on suicide risk assessment is extensive and it is not the scope of this paper to cover the breadth of assessment. With regards to assessment of suicide risk in patients with TBI, emphasis should be on physician awareness of risk factors and vigilance for suicidality.

Intervention

Once risk of suicide has been assessed, various interventions can be initiated to reduce this risk. Using a biopsychosocial model, an effort should be made to address the various factors that perpetuate suicide risk and to bolster the protective factors against suicide. Strategies may involve rehabilitation following TBI, the treatment of clinical depression and alleviating social isolation.

Efficacy of interventions is challenging to evaluate as suicide has a low prevalence in the general population [31]. Even among high risk groups, suicide is a rare outcome. Documenting incremental benefit compared to standard care has been challenging, in part because most studies do not have sufficient power to detect significant differences [31]. In addition, most studies have used specific populations with increased risk such as borderline personality disorder, making it difficult to generalize [31]. Despite this limitation, there is support in the literature for the benefit of specific interventions.

Psycho-pharmacological intervention

There are relatively few studies that have looked directly at the effect of medication on suicidal behaviour. Traditionally, potentially suicidal patients have been excluded from drug trials [32]. Therefore, much of the evidence for efficacy of pharmacotherapy is indirect. However, one study has demonstrated that antidepressants are more effective than placebo in decreasing suicidal ideation [33].

Since major depression is a significant risk factor for suicide, it is theorized that antidepressant use may lead to decreased rates of suicide [34]. Correlational data suggests that this is the case. Patient population studies report lower suicide attempt rates in adults treated with antidepressants [35]. In Finland, after increases in suicide rates in the 1960s, 1970s and 1980s, a decrease in male suicide rate coincided with the introduction and increased sale of SSRIs [36]. However, meta-analyses of randomized control trials have not detected a positive effect of antidepressants on suicidal behaviour [37], perhaps because of the low base rate and inadequate screening [34].

The Canadian Psychiatric Association and the Canadian Network for Mood and Anxiety Treatments (CANMAT) have published guidelines for the treatment of depression in the general population [38]. According to these CANMAT guidelines, SSRIs and the novel antidepressants (which include bupropion, mirtazapine and venlafaxine) are recommended as first line agents (level I evidence). Although there is limited data on pharmacotherapy of depression following TBI, it appears that the SSRIs offer a similar benefit as for idiopathic depression [39]. When antidepressants are initiated, the recommendation is to start at low doses and titrate slowly, since patients with TBI are often on other medications that can cause drug–drug interactions [39]. Sertraline has been found to be the most effective and tolerable among the SSRIs used for depression related to TBI. One study found that out of 15 patients diagnosed with major depression between 3–24 months after mild TBI, 13 patients responded and 10 had a remission in their depression by 8 weeks of treatment with sertraline [40].

There is evidence to suggest that fluoxetine may also be of some benefit in the treatment of depression in patients with TBI. In an open-label trial by Cassidy [41], there was marked improvement in two of the eight patients with severe TBI and depression treated with fluoxetine and moderate improvement in three patients. An open-label study by Horsfield et al. [42] including five patients with TBI and various levels of depression found that fluoxetine conferred improvement in mood

symptoms as well as cognition. When considering starting fluoxetine, clinicians should be cognizant of its potential for drug interactions with commonly prescribed medications.

Citalopram is theoretically a good option for treatment of depression in TBI. It has a tolerable side-effect profile, limited drug–drug interactions and a relatively short half-life. However, there is limited data on the use of citalopram in patients with TBI. Escitalopram is similar in its profile to citalopram and consequently may also be beneficial in the treatment of post-TBI depression, but there are no studies to date of its use in patients with TBI [39].

If treatment with an SSRI fails in the treatment of post-TBI depression, augmentation with a stimulant such as methylphenidate or switching to an antidepressant with a different mechanism may be required [39].

Tricyclic and tetracyclic anti-depressants (TCAs) are not recommended as first line agents in the treatment of TBI-related depression. TCAs appear to be less effective for depression following TBI than for idiopathic depression. Saran [43] found that, after 4 weeks of treatment with amitriptyline, there was no improvement in participants with depression and TBI, although there was improvement in all depressed participants without TBI. The anti-cholinergic effects of TCAs also make them less appealing for use in TBI because of the potential of further impairing attention, concentration and memory [39]. Among the class, nortriptyline and desipramine have relatively less anti-cholinergic properties. Physicians should also be aware that TCAs have the potential to increase seizure rates among patients with TBI [44].

Novel antidepressants such as bupropion, venlafaxine and mirtazapine appear to be useful in the treatment of depression in patients with TBI based on clinical experience. However, there are no studies that have looked at the effectiveness and adverse effects of the novel antidepressants in this population.

SSRIs may also be effective in improving other neuropsychiatric symptoms that result from TBI including irritability, aggression, anxiety and poor impulse control [39]. The reduction in aggression and impulse control are noteworthy as this may address additional risk factors for suicide.

One caveat is the difficulty of maintaining consistent medication regimes in patients who have suffered a severe TBI because of resultant memory impairment. Medication cannot be effective in the absence of compliance. Use of dosettes may help assist patients as well as assistance from family members when possible.

Psychological intervention

Psychotherapy alone or in combination with an antidepressant can be an effective treatment for depression and suicidal ideation in the general population [11]. It can also be effective in preventing new attempts after an initial suicide attempt [11]. According to the CANMAT clinical guidelines, cognitive behavioural therapy and interpersonal therapy are as effective as antidepressants in mild-to-moderate depression [38]. These therapies can be recommended as first-line treatment (level I evidence) [38].

Problem-solving therapy, cognitive behavioural therapy (CBT), interpersonal therapy (IPT) and intensive care plus outreach have been shown to reduce suicidal behaviour compared to standard aftercare following a suicide attempt [34]. Meta-analyses have shown that problem-solving therapy is associated with improved mood, decreased hopelessness and improvement in problems [45]. A cohort study found that CBT decreased suicidal ideation after an episode of deliberate self-harm [46] and one randomized control trial found IPT was associated with decreased suicidal ideation [47].

Clinicians should keep in mind that patients who have psychiatric disorders and brain injury may require additional cognitive and psychotherapeutic interventions not usually offered to patients who only have psychiatric diagnoses [5].

Psychosocial intervention

Depressed patients with TBI tend to require more emotional support than they can achieve with their own resources [48]. Therefore, psychosocial interventions appear to be an important component in suicide prevention in this population [49]. One means of maintaining social networks is through support groups. Support groups can facilitate meaningful communication between people by teaching skills that are conducive to building friendships such as listening, expressing emotion and empathy and sharing of experiences [50, 51]. Also beneficial may be interventions that aim to strengthen or re-establish familial relationships, thereby creating a stronger support system. Social skills training can help facilitate societal integration and vocational counselling can assist patients in moving forward in their lives [50, 51].

In the general population of mentally ill patients, one of the solutions for social isolation is *befriending*. This process involves volunteers who spend time one-on-one with patients. The relationship between the volunteer and the patient is distinct from a professional/client relationship and is generally initiated and overseen by an agency. Volunteers help patients improve social skills and broaden their

social network. Used in conjunction with therapy, this has been shown to be effective in decreasing isolation [50, 51]. This strategy has yet to be studied in the TBI population; however, it may be of benefit in providing TBI patients with additional support.

Rehabilitation

That the persistence of disability has been found to be strongly associated with depressive symptoms [25] suggests that neuro-rehabilitation may be important in decreasing suicide risk as it improves functional ability. The neuro-rehab staff may also play a significant part in suicide prevention. When Kuipers and Lancaster [49] interviewed individuals with TBI in order to develop a patient-centred suicide prevention programme, it was apparent that patients feel the issues they face are substantially different from those of non-injured depressed or suicidal individuals. A number of participants emphasized that an understanding of brain injury issues would be integral to helping them if they were to become suicidal [49]. This finding suggests that neuro-rehabilitation services could have a potentially significant role in suicide prevention in the TBI population.

Substance abuse treatment

Treating substance abuse is an important component of suicide prevention, since the presence of substance misuse is associated with increased suicide rates in all diagnoses of TBI (concussion, lesion and haemorrhage) [3]. Mainio et al. [17] found that alcohol disorders were 2- and 3-times more prevalent in suicide victims with lesions or concussion compared to those with no TBI. Unfortunately, clinicians have found it challenging to engage and retain those with substance abuse and TBI in treatment [52]. Research indicates that using concrete incentives early in substance abuse treatment improves attendance and reduces the chance of termination [53].

Environmental measures

Restricting access to lethal methods such as toxic chemicals and guns has been shown to be very effective in reducing suicide rates in the general population [34]. Clinicians may want to speak with patients and family regarding this sensitive topic. In the event that clinicians are not comfortable having this discussion, involvement of psychiatry may be appropriate.

Emergency intervention

When a doctor assesses that a suicide attempt is imminent in the next 24–48 hours, emergency

Table I. Suicide prevention strategies in the treatment of patients with traumatic brain injury (TBI).*

| Level of intervention | Management |
|---|--|
| All patients with TBI | Assess hopelessness and suicidal ideation <ul style="list-style-type: none"> ● may use assessment tools such as BSS, SAD PERSONS Monitor for warning signs that increase risk level <ul style="list-style-type: none"> ● mood disorder, substance abuse, aggression Decrease social isolation Involve in neuro-rehabilitation Decrease social isolation Involve in neuro-rehabilitation |
| Patients with TBI with additional risk factors for suicide | Treat patients with psychiatric conditions <ul style="list-style-type: none"> ● Psychotherapy: CBT, IPT for depression ● Pharmacotherapy: SSRIs for depression, aggression ● Substance abuse treatment |
| Patients with TBI who have expressed suicidal ideation or made an attempt | Reduce access to lethal means Psychotherapy to reduce suicidal behaviour <ul style="list-style-type: none"> ● CBT, IPT, problem-solving therapy If assess that suicide attempt is imminent, send to psychiatric emergency service Closely monitor after discharge from psychiatric unit Support/monitor for at least 12 months after attempt |

Note: *Adapted from the suicide prevention model presented by Simpson and Tate [56].

intervention must be enacted. A patient should be seen by a psychiatry emergency service. Treatment can involve hospitalization, outreach to family and friend networks and the signing of a no-suicide contract [21]. Although there is no empirical evidence that no-suicide contracts are effective [54], they may be beneficial in that they provide clear instructions to the patient on steps to take when he or she feels overwhelmed [55].

Summary and conclusions

The increased rate of suicide in patients with TBI is of clinical concern. In order to address this risk, attempts have been made to elucidate the relationship between suicide and TBI. It is thought that the sequelae of TBI may cause sufficient psychological distress to precipitate depression and consequently suicidal ideation. Another aspect may be that the neuropathological processes that occur as a result of TBI are implicated in depression. In addition, suicide and TBI share antecedent risk factors such as young age, male gender, substance use and aggression. Given the association between suicide and TBI, clinicians should have a low threshold for screening patients with TBI for suicidal ideation. A variety of tools are available for suicide risk assessment. Once patients are identified as being at risk for suicide, biopsychosocial interventions can be initiated. A summary of suicide prevention

strategies in the TBI population is presented in Table I.

Future efforts should be aimed at increasing clinician awareness of depression and suicide risk assessment in the TBI population. Increased training of clinicians most likely to come in contact with at-risk individuals has been shown to increase identification of suicidal patients, lowering suicide rates [34]. Therefore, education on suicide assessment should be geared towards staff involved in neuro-rehabilitation as well as other professionals who are involved in the care of patients with TBI.

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