# Traumatic Brain Injury and Treatment of Behavioral Health Conditions

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Traumatic brain injury (TBI) is a common neurological condition that results from an external force altering normal brain function, whether temporarily or permanently. A concussion is one type of TBI. TBIs vary greatly in severity, which concomitantly creates tremendous variability in their manifestation. The fingerprint of TBI is damage to the frontal areas of the brain, which, with sufficient magnitude, results in impairment of a person's ability to regulate cognition, emotion, and behavior. These consequences of TBI make recognition in the context of treating behavioral health conditions of utmost importance. TBI not only causes behavioral health problems but also produces associated deficits that can undermine the effectiveness of treatment for a behavioral health condition. This overview delineates key characteristics of TBI and describes its association with behavioral health conditions. Mechanisms underlying the relationship between TBI and behavioral health are presented, and a series of recommendations for professionals are proposed. This article is intended to raise awareness about TBI and simultaneously introduce key concepts for accommodating the effects of TBI in behavioral health care.

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In 2013, the most recent year for which U.S. data are available, traumatic brain injury (TBI) resulted in 2.8 million emergency department visits, hospitalizations, or deaths (1), accounting for almost 2% of similar medical encounters in the United States. Among these encounters, approximately 89.3% of patients (N=2.5 million) were treated and released from emergency departments, another 10% (N=282,000) were hospitalized and discharged alive, and approximately 2% (N=56,000) died. The number of TBI-related emergency room visits had increased by more than 50% since 2007. Heightened public awareness of TBI due to publicity about sports-related concussions and TBIs incurred in combat in Iraq and Afghanistan contributed to the increase in medically treated TBIs. However, the greatest increase was in the rate of fall-related TBIs among older adults. The annual cost to society of neurological conditions was almost $8 billion, of which TBIs accounted for more than 10% (2). The prevalence of disability caused by TBIs is 1.1% among U.S. adults, but when all sources of long-term consequences are considered, the prevalence rate is substantially higher (3, 4).

Although public awareness of TBI has shifted dramatically since it was dubbed "a silent epidemic" in 1980, appreciation of its effects has not garnered the attention of professionals outside of rehabilitation. Particularly among behavioral health specialists, a gap remains in knowledge about TBI, the understanding of its implications for behavioral health conditions, and active consideration of treatment implications. This overview is intended as an initial attempt to summarize the key elements of the disorder and to elucidate the multiple points of convergence with behavioral health concerns. These descriptions are followed by a very brief presentation of possible mechanisms that underlie the relationship between TBI and behavioral health concerns. The final sections of this overview include recommendations based on clinical experience about how behavioral health programs and professionals can better meet the needs of their clients who also have had a TBI.

**HIGHLIGHTS**

- Traumatic brain injury (TBI) is prevalent among persons with behavioral health problems.
- The fingerprint of TBI is damage to the frontal areas of the brain, regardless of where the blow to the head occurs.
- Damage to frontal areas cause cognitive and executive functioning deficits that both increase the likelihood of behavioral health problems and make treatment more difficult.
- The behavioral health workforce needs to secure the knowledge and skills to identify patients' problematic histories of TBI and accommodate the resulting neurological effects in treatment.

TBI is defined as follows:

> An alteration in brain function, or other evidence of brain pathology, caused by an external force. External forces include the head being struck by an object; the head striking an object; the head accelerating or decelerating without direct external trauma (as occurs in shaken baby syndrome); a foreign body penetrating the brain; or energy generated from events such as a blast or explosion. (5)

## WHAT IS TBI?

A TBI is "an alteration in brain function, or other evidence of brain pathology, caused by an external force" (5). The requirement for TBI to be due to an external force clearly separates it from other brain injuries that occur in the prenatal period (e.g., cerebral palsy) or those with onset after birth, such as injuries due to cerebral vascular accidents (e.g., stroke), anoxia or hypoxia (e.g., when the heart stops beating), or electrical shock. Furthermore, the requirement that TBI include both an external force and alteration in brain function distinguishes it from injuries to the head alone, such as abrasions or contusions to the face or scalp. The usefulness of distinguishing TBI from other types of brain injury will become clearer when mechanisms for the association with behavioral health conditions are described below.

The effects of TBI vary greatly, ranging from a brief, temporary disruption in thinking, which is experienced as being dazed or confused, to being in a coma, during which the brain is not able to respond reflexively to pain or other strong stimuli. This range of effects parallels definitions of the severity of the injury. Mild TBI includes being dazed or confused or losing consciousness (i.e., knocked out) for up to 30 minutes (6). Moderate severity ranges from 30 minutes to 24 hours of lost consciousness, whereas severe TBI involves being unconscious for more than 24 hours and generally involves being in a coma (5).

Although the severity of the initial injury is a major determinant of the eventual residual consequences, other characteristics of the injury can influence effects, even when the injury is mild. For instance, much attention has been given to repeated mild TBI as it occurs in contact sports or during combat. Although more questions remain than have been answered, the actual number of injuries, and even the forces exerted on the brain from multiple mild TBIs, may not determine residual consequences as much as the time between injuries does (7, 8). Incurring a second TBI, even if mild, while the brain is still accommodating the first injury may create vulnerabilities that underlie long-term effects (7).

Another circumstance in which mild TBIs may carry greater consequence is childhood injury. Several studies have observed later consequences from TBIs in very early life (9, 10), whereas other studies have suggested that onset during adolescence has the greatest chance of creating later consequences (11, 12). It is notable that childhood injuries may be particularly responsible for adult behavioral health problems, an observation that has additional support in animal models (13, 14).

## TBI AND BEHAVIORAL HEALTH PROBLEMS

There have been multiple reviews of the behavioral health consequences that develop after TBI, including a recent comprehensive investigation by Ponsford and colleagues (15). Retrospective, cross-sectional, and prospective studies of TBI cohorts were reviewed for major classes of behavioral health conditions, including depression, anxiety, posttraumatic stress disorder, psychotic spectrum disorders, and substance use disorders. The authors compared rates among cohorts defined by the occurrence of a medically treated, and typically more severe, TBI with rates of psychiatric conditions in the general population.

Weaknesses in this approach are beyond the scope of this article, but the primary concern is the treatment of a selected TBI as if it were the only injury in the person's life. Indeed, previous studies of persons with a TBI treated in a hospital have found that TBI in childhood and early adulthood often precede more severe injuries requiring higher levels of care (16). This caveat aside, Ponsford and colleagues (15) concluded that depression and anxiety disorders, as well as posttraumatic stress disorder, emerged at elevated rates soon after injury. Preinjury behavioral health problems predisposed individuals to postinjury diagnoses, but development of new-onset affective disorders exceeded expectations. These investigators also concluded that the frequency of psychotic spectrum disorders did not exceed what would be expected in the general population, although this finding is at odds with population-based studies, as described below. Because of the high incidence of preexisting substance use disorders in injury populations and because some of the most severely injured individuals are prevented from resuming substance misuse, the authors concluded that there was a decline in incidence, which is also at odds with epidemiological studies that account for TBIs across the life span (17).

Population-based studies examining behavioral health disorders that occur after onset of a person's first TBI suggest that there are significant associations, although causality cannot be ascertained. Sariaslan and colleagues (11) compiled medical, behavioral health, and social service records for 1.1 million Swedish citizens born between 1973 and 1983, which were subsequently accessed through 2013. All persons who were medically diagnosed as having a TBI before age 25 were evaluated for the likelihood of receiving any psychiatric services or being hospitalized for a psychiatric diagnosis. Compared with the general population, those with a history of TBI were 37% more likely to receive psychiatric services and 69% more likely to be hospitalized than persons without TBI, after controlling for gender, birth order, birth year, individual and parental educational achievement levels, parental income, parental lifetime criminal and psychiatric histories, and being raised with a single mother as the head of household. When these individuals were compared with siblings who did not

have a TBI, the relative likelihood of receiving psychiatric services or of being hospitalized declined only slightly to 31% and 57%, respectively.

A population-based study in Denmark (18) analyzed medical and psychiatric registry data for 1.4 million citizens born between 1977 and 2000 and followed their cases until 2011. In total, 114,000 individuals had a hospital record for a TBI and no previous psychiatric history. After the study controlled for gender, age, year, presence of a family psychiatric history, epilepsy, infections, and autoimmune diseases, those with a history of TBI were 65% more likely to receive a diagnosis of schizophrenia, 59% more likely to receive a diagnosis of depression, and 28% more likely to receive a diagnosis of bipolar disorder. When individuals with a history of TBI were compared with persons who had fractures that did not involve the skull or spine, their likelihood of receiving a diagnosis of schizophrenia or depression remained significantly higher. Thus, together, these large, population-based studies indicate that multiple behavioral health problems are associated with an early-life TBI, particularly in childhood and as a young adult. Again, although causality cannot be ascertained, the strength of the relationship while controlling for multiple social factors and the greater association with behavioral health problems than for individuals with orthopedic injuries or uninjured siblings increases suspicion of a causal relationship.

Multiple, large-scale studies of suicide have identified TBI as a significant risk factor (19). Fazel and colleagues (20) reported that, among 2.6 million Swedish citizens, those with a history of medically attended TBI were more than three times more likely to commit suicide compared with persons with no history of TBI; when compared with uninjured siblings, they were still more than twice as likely. A population study of 7.4 million Danish residents found that those with a history of TBI were more than 2.5 times more likely to commit suicide compared with persons with no history of TBI. If the TBI was severe, this likelihood rose to almost 3.5 times more likely (21). A review of electronic health records from eight large U.S. health care systems found that individuals with a diagnosis of TBI were almost nine times more likely to commit suicide than other enrollees of similar age, sex, psychiatric diagnosis, and history of substance use disorder (22). No other medical condition had a higher likelihood of suicide.

Corrigan and Adams (23) recently described how the opioid epidemic created a "perfect storm" for persons with TBI. Several studies of veterans have found that those with TBI were more likely to be prescribed opioids than those without TBI; as many as 70% of persons receiving inpatient rehabilitation for a primary diagnosis of TBI received an opioid during his or her hospital stay (24–27). Compounding this greater likelihood of being prescribed an opioid is the greater vulnerability to substance use disorder (14, 17), including opioid misuse (28), and greater challenges in substance use disorder treatment, as discussed below. Corrigan and Adams (23) concluded that "clinical practitioners can proactively mitigate potential opioid use problems by identifying high risk populations, which we argue, includes individuals with a lifetime history of TBI."

## WHY WOULD TBI CAUSE BEHAVIORAL HEALTH PROBLEMS?

The fingerprint of TBI is that the frontal areas of the brain, including the frontal lobes, are the most likely to be injured, regardless of the location of the point of impact to the head. Once there is enough force from a blow to the head, from shaking, or from a blast to cause the brain to jiggle within the cranial vault, then bony ridges on the undersurface of the skull cause damage to the frontal lobes and anterior tips of the temporal lobes (29, 30). Shearing and tearing of neuronal pathways connecting the midbrain, basal ganglia, and prefrontal cortex also occur if there is sufficient force to the brain, regardless of the actual point of impact (31). Thus, whether because of contusion or shearing, and wherever else there may be damage to the brain, there is also damage in the frontal areas. The frontal lobes of the brain are essential to uniquely human functions, including the executive functions that regulate thinking, behavior, and emotional expression. These functions include attention and processing speed, learning and memory, problem solving, initiation, inhibition of impulse, planning and organization, mental flexibility, and self-awareness. Executive functions are essential to learning a new skill, initiating behavior change, or regulating one's feelings and actions. It is worth noting that anoxic and hypoxic brain injury, such as that which occurs in drug overdoses or choking during intimate partner violence, also cause weaknesses in executive functions (23).

Several groups of investigators have found evidence from animal studies that TBI, particularly in childhood, may predispose individuals to adult substance use disorders (14, 17). Karelina and colleagues (32) proposed that one mechanism of this effect may be disruption of the dopaminergic system during adolescence, a key period in its development. Activity of the dopaminergic system is a well-known substrate of substance use disorders (33). Although Weil and Karelina (34) allowed that there can be direct damage to the neural projections into the prefrontal cortex, they posited that a more likely consequence is initial hyperstimulation of dopaminergic function caused by the injury, followed by chronic suppression of dopamine expression persisting into adulthood. This effect may parallel the suspected mechanism of vulnerability to addiction caused by exposure to alcohol and other drugs early in life. These investigators have also posited that, in some cases, neuroinflammatory processes caused by the injury do not return to normal levels, creating a cyclic effect whereby neuroinflammation depresses dopaminergic function, which increases the drive for alcohol, the consumption of which increases neuroinflammation.

Weil and colleagues (17) concluded that strong evidence from animal studies for an underlying mechanism, combined with moderately strong evidence of an association in

human epidemiologic studies, support the conclusion that TBI occurring early in life can increase the incidence of alcohol use disorders. Cannella and colleagues (14) came to a similar conclusion with regard to adult substance use disorders more broadly. They, too, posited that TBI in adolescence has a key role in interrupting the development of the dopaminergic system, resulting in adult predisposition to addiction. This work provides substantial evidence for a link between TBI and substance use disorders; however, the effect of TBI may not be limited to addictive behaviors. Other studies examining how persistent neuroinflammation interacts with stress have concluded that neuroinflammation can cause depression and anxiety and, possibly, psychotic spectrum disorders (35).

## TBI IN TREATMENT OF BEHAVIORAL HEALTH CONDITIONS

Persons with TBI often experience other medical conditions as well as multiple behavioral health disorders (36). Common health problems among persons with TBI include headaches (37), fatigue (38), sleep disturbance (39), balance problems (40), pituitary dysfunction (41), seizure disorders (42), and vision abnormalities (43). These health problems typically necessitate medication, often presenting additional considerations when initiating pharmacologic treatment for a behavioral health problem. Increased sensitivity to side effects, such as sedation, may complicate the presence of multiple medications and, in turn, may have a disproportionate effect on alertness, cognitive function, and behavioral control. Many of these comorbid medical conditions also will be exacerbated by stress (e.g., headache, sleep disturbance, seizure regulation), introducing additional complications during times of crisis. A holistic approach to a client's medical presentation and, particularly, pharmacologic requirements may be essential.

It is well established that persons with substance use disorders and TBI are also quite likely to be experiencing other psychiatric conditions. Several years ago, a study was conducted in one state's substance use disorder system in which all clients statewide entering treatment during a 1-year period were screened for a lifetime history of loss of consciousness due to TBI (44). For the almost 8,000 clients screened, as the number of TBIs increased, so did the likelihood of having mental health conditions, including affective disorders, suicidal behavior, and hallucinations, and of being on a prescription medication for a psychiatric diagnosis. Multiple studies before and since have confirmed these findings (45–48). Consistent with this relationship, studies have found that persons receiving treatment for co-occurring severe mental illness and substance use disorders tend to have a high prevalence of TBI: 60% of clients in a study of largely homeless recipients of treatment for co-occurring conditions had at least one TBI with loss of consciousness in their lifetime (49). Despite the marked morbidity in this population, those with a history of TBI had worse psychiatric symptomatology and greater likelihood of co-occurring personality disorders and posttraumatic stress disorder. More than 70% of treatment recipients in a rural program for co-occurring disorders had at least one TBI with loss of consciousness (50). In this cohort, personality disorders were significantly more likely among those with TBI.

A study of patients enrolled in one integrated treatment program for co-occurring disorders found that clients with a history of TBI were as likely to benefit from enrollment as clients without such a history (50). However, professional staff expressed lower prognostic expectations for clients with a TBI history if the programmatic structure was removed. Staff unaware of the clients' history of TBI identified a greater need for ongoing community supports among those with a positive history. Although it is good practice to identify what elements of a person's environment—social and physical—may enhance or impede improvement, this evaluation is essential for persons with TBI. Explicitly addressing these influences in treatment planning and identifying long-term natural supports that will assist with sustaining positive change must be incorporated into the treatment approach.

The corollary to the greater influence of the external environment is the recognition that clients with a history of TBI will also be more susceptible to internal states that enhance or detract from successful behavior change. For instance, a recent study of methamphetamine-induced cravings found that the effectiveness of naltrexone increased with diminished higher-level thinking skills (51). The practical implications for behavioral health care are that medication-based treatments may be even more important. Furthermore, more time will be required to weaken stimulus-response patterns and consolidate healthy lifestyle changes. Although a review of pharmacologic approaches to treatment of behavioral health conditions is beyond the scope of the present article, clients with TBI who have behavioral health conditions for which there is evidence of pharmacologic benefit should be given the opportunity of a trial (52).

## WORKFORCE IMPLICATIONS

The unique fingerprint of TBI described earlier makes clear that this condition has a significant interaction with the occurrence, manifestation, and recovery from behavioral health disorders. A pressing policy implication is to improve the skill set of the behavioral health workforce to better identify the presence of TBI and be able to respond to common neurologic impairments. Specific skills are the ability to screen for a history of TBI as a routine component of initial evaluations; recognize the behavioral consequences of TBI; and accommodate executive functioning weaknesses in communication, relationship building, and treatment planning.

Minimally, TBI is a condition that requires identification by behavioral health professionals. Several brief, easy-to-use, reliable, valid, and standardized methods are available for eliciting a client's lifetime history of TBI (53). Screening

techniques can be taught in 1-hour training sessions. Free training sessions are available online. Specific techniques, most of which are also available at no cost, can require as little as 3–5 minutes to administer (53). Identification underpins the ability to accommodate the effects of TBI; thus, every behavioral health professional should know the extent of a client's lifetime exposure to TBI as one critical component of client history.

Perhaps the single most important implication of TBI for treatment of behavioral health conditions is that professionals recognize neurobehavioral deficits that can arise from impairment to executive function and accommodate these weaknesses in their treatment planning and execution. Among several specific issues to address is recognition of the "cognitive load" that some treatments require. What is expected from the treatment approach in terms of new learning—facts, rules, or routines? How can a clinician assist a client with TBI who may have attention or memory problems in acquiring this information and recalling it when needed? Is orally presented information reinforced with written materials? Is the environment noisy or busy and, thus, a source of distraction for a client with problems sustaining attention? How long are treatment activities, whether individual sessions or groups, and do they accommodate a person with a limited attention span? Is information presented or discussed at a pace that allows someone with slower information-processing abilities to stay abreast? Although much treatment of behavioral health conditions relies on group interventions, professionals must ensure that the structure and content remain accessible to all group members, especially those with relative weaknesses in concentration, learning, and memory.

Another consequence of not recognizing that client behavior may arise from neurological deficits is misattribution of a client's behavior by both peers and professionals. For instance, a client with a TBI who is unaware that she or he talks too much in group may elicit the conclusion from a peer that "she thinks her problems are more important than mine" or "he's just trying to waste our time." Clinicians, like most people, tend to assume that individuals recognize the impact of their behavior on others, but clients with a history of TBI that has altered their social cognition may not have this awareness. The negative misattribution arises from the assumption that the client is persisting with the behavior despite its impact on others. Another common misattribution among professionals is to assume that treatment noncompliance reflects a client's motivation to change. For a person with a history of TBI, a late arrival or missed appointment could just as easily result from poor memory, organization, or planning as it can from low commitment to treatment. The source of noncompliance must be evaluated before a conclusion is reached or a consequence is determined. When noncompliance arises from executive function weaknesses, the relationship with a treating professional will be better served by problem solving to figure out a compensatory strategy than by a consequence that presumes low motivation.

The accommodations to treatment suggested here reflect broad principles that are known to enhance treatment in general and are likely to also benefit clients who have not had TBIs. Examining our treatment procedures and settings to identify how cognitive weaknesses might be barriers to treatment will benefit many clients in community programs. Recognizing that not all behavior is a function of motivation but can sometimes arise from neurological deficits is a needed insight in professional practice. Many clients in community programs have multiple medical and behavioral health conditions. Thinking and treating holistically will benefit complicated cases; recognizing that TBI is a source of complication is a positive step. Finally, thinking more systematically about how we can support insight with positive internal and external influences is best practice, regardless of a client's risk factors.

## DISCUSSION

A TBI is damage to the brain caused by an external force. Although it is most common for the head to be struck by or against an object, being shaken violently or exposed to an explosion can also cause a TBI. The general public now knows that TBI and concussions exist, although they may not know that a concussion is a TBI. Because of the public's poor understanding, it is incumbent upon professionals to determine whether a client has a sufficient history of TBI such that he or she may be experiencing consequences that will affect the treatment process. This expectation of professionals is particularly salient among behavioral health professionals. It is reasonable to expect that half of the adult clients treated in community mental health programs will have had at least one TBI with loss of consciousness in their lifetime, and one in six will have had a moderate or severe TBI (47). Both rates are more than twice what would be expected among noninstitutionalized adults.

The high prevalence of TBI in behavioral health settings alone should be reason for improving our ability to recognize it among our clients. Furthermore, the magnitude of increased risk for suicide and the confluence with the opioid epidemic also should motivate us to better identify clients with a history of TBI. However, as briefly described in this article, the connection with behavioral health does not stop with vulnerability; the proclivity for damage to the frontal areas of the brain interacts with our treatment approaches such that treatment is less effective for these clients.

The fingerprint of TBI is damage to the frontal areas of the brain, which impairs executive functions that regulate thinking, behavior, and emotional expression and that are critical to success in treatment. A follow-up investigation to Project MATCH (Matching Alcoholism Treatments to Client Heterogeneity) found that persons with cognitive impairments such as those described in this article were more likely to prematurely terminate treatment and are often classified as noncompliant (54). Treatment termination was often preceded by low expectations for benefiting from

treatment, which is often evident clinically when the cognitive demands of treatment exceed a client's capabilities. It is also plausible that misattribution of motives by peers and professionals undermines the expectation of benefit from treatment.

The recommendations made here for workforce training are derived from evidence and are suggested as best practices that can make systemic improvements in the treatment of persons with TBI and behavioral health conditions. The recommendations have low potential for iatrogenic effects. Clinical experience indicates that identifying a history of TBI is viewed positively by most clients, who often express sentiments such as, "At least I'm not dumb" or "I thought I was just bad." Identification often increases motivation to make changes while allowing professionals to implement the other recommendations.

Additional research is needed on the interaction between TBI and behavioral health. Continuing to study the underlying mechanism between injury and vulnerability has the potential to result in the discovery of new treatments to either prevent or ameliorate the underlying source of risk. There are multiple opportunities to study how proven behavioral health interventions may need to be modified to better serve persons with TBI. Research on screening and brief intervention for persons with TBI is a case in point that demonstrates how treatment can be improved (55, 56). Medication-based treatment would seem to be a high-priority area for understanding how TBI may affect proven approaches. Evaluation research is also needed to confirm that the skills that will be needed among behavioral health professionals can be conveyed through training and that outcomes actually improve as a result.

TBI poses a substantial public health burden. As indicated, the annual cost of TBI to society is estimated to approach $1 billion (2) but is certainly substantially higher (3, 4). A better understanding of how mild TBIs in childhood can affect adult health and behavior could cause this estimate to skyrocket. As an example, Sariaslan and colleagues (11) estimated that the population-attributable fraction (the proportional reduction in morbidity that would occur if a risk factor were eliminated) was 5.5% for psychiatric hospitalizations and 3.1% for any psychiatric visit. These implied costs to society are reason enough for behavioral health care to systematically address TBI, but the potential benefit for a substantial portion of clients is even more compelling.

Among behavioral health providers who treat persons with TBI, it is recognized that the disconnect between the intention to change behavior and success in doing so is even greater than for clients without a history of TBI. Whereas most treatments start by seeking insight into the need to change behavior, behavioral health care also recognizes the importance of a person's social environment in encouraging and sustaining changed behavior, the role of internal states (impulses, drives, stress) in improving the chances of successful change, and the critical role that sustaining changed behavior plays in consolidating treatment gains.

## CONCLUSIONS

TBI occurs when brain function is disrupted by an external force to the head. It is prevalent in society and even more common among persons with behavioral health problems. This association is evident for affective, psychotic spectrum, and substance use disorders. Regardless of where the blow to the head occurs, the fingerprint of TBI is damage to the frontal areas of the brain, which frequently results in impaired cognitive abilities and higher-level executive functioning deficits. These deficits reduce success in treatment for people with a sufficient history of TBI. The behavioral health workforce needs additional knowledge and skills to improve outcomes for this population, including the ability to identify problematic histories of TBI and to accommodate neurological deficits in treatment.

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