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Traumatic Brain Injury and Behavioral Health Treatment

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Abstract

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 behavioral health treatment of utmost importance. Not only does TBI cause behavioral health problems, associated deficits can undermine the effectiveness of behavioral health treatments. 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 while simultaneously introducing key concepts for accommodating the effects of TBI in behavioral health care.

Introduction

In 2013, the most recent year for which U.S. data are available, TBI resulted in 2.8 million emergency department visits, hospitalizations, or deaths.¹ This incidence accounted for almost 2% of the annual injury and non-injury-related similar medical encounters in the US. Among these encounters, approximately 89.3% (2.5 million) were treated and released from emergency departments, another 10% (282,000) were hospitalized and discharged alive, and approximately 2% (56,000) died. The number of TBI-related emergency room visits 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. Of the almost \$8 billion annual cost to society of neurological conditions, TBIs accounted for more than 10%.² While the prevalence of disability caused by TBI are 1.1% among U.S. adults, when all sources of long-term consequences are considered the prevalence rate is substantially higher.^{3,4}

While 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, understanding its implications for behavioral health conditions, and active consideration of treatment implications. This overview is intended as an initial attempt to briefly summarize key elements of the disorder and elucidate the multiple points of convergence with behavioral health concerns. These descriptions are followed by a very brief presentation of possible mechanisms which 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.

What is TBI

A TBI is “...an alteration in brain function, or other evidence of brain pathology, caused by an external force”⁵. The relevant 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. 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 cerebral vascular accidents (*e.g.*, stroke), anoxia/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 a TBI from injury to the head alone, like abrasions or contusions to the face or scalp. The utility 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 that 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 both being dazed or confused as well as losing consciousness (*i.e.*, knocked out) for up to 30 minutes.⁶ Moderate severity ranges from 30 minutes to 24 hours of lost consciousness; while severe TBI involves being unconscious for more than 24 hours and generally includes being in a coma.⁵

While 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 occurs in contact sports or during combat. While more questions remain than have been answered, it may not be the actual number of injuries or even the forces exerted on the brain from multiple mild TBIs that determine residual consequences as much as it is the time between injuries.^{7,8} Incurring a second TBI, even if mild, while the brain is still accommodating the first 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 very early-life TBIs;^{9,10} while 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, Alway, and Gould.¹⁵

Retrospective, cross-sectional, and prospective studies of TBI cohorts were reviewed for major classes of behavioral health conditions, including depression, anxiety, post-traumatic stress disorders, psychotic spectrum disorders, and substance use disorders. The authors compared rates

among cohorts defined by the occurrence of a medically treated TBI—typically more severe TBI—with general population rates of psychiatric conditions.

Weaknesses in this approach are beyond the scope of the current article, but the primary concern is the treatment of a selected TBI as if it is the only injury in the person's life. Indeed, previous studies of hospital-treated persons with TBI have found that childhood and early adult TBIs often precede more severe injuries requiring higher levels of care.¹⁶ This caveat aside, Ponsford and colleagues concluded that depressive and anxiety disorders, as well as post-traumatic stress disorder, emerged at elevated rates soon after injury. Preinjury behavioral health problems predisposed individuals to post-injury diagnoses, but new onset affective disorders exceeded expectations for their natural development in an uninjured population. 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 described below. Because of the high incidence of pre-existing substance use disorders in injury populations, and the tendency for some of the most severely injured to be prevented from resuming substance misuse, these authors concluded there was a decline in prevalence, a conclusion that 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 there are significant associations, even though causality cannot be ascertained. Sariaslan and colleagues¹¹ compiled medical, behavioral health, and social service records for 1.1 million Swedish citizens born between 1973 and 1983 who were subsequently accessed through 2013. All persons with a TBI medically diagnosed before the age of 25 were evaluated for the likelihood of receiving any psychiatric services or being hospitalized for a psychiatric diagnosis. Compared to 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 highest achieved education levels, parental income, parental lifetime criminal and psychiatric histories, and being raised in a single mother head-of-household. When compared to siblings who did not have a TBI, the relative likelihood of receiving psychiatric services or being hospitalized declined only slightly to 31% and 57%, respectively.

A population-based study in Denmark¹⁸ analyzed medical and psychiatric registry data for 1.4 million citizens born from 1977 to 2000, and followed until 2011. There were 114,000 individuals with a hospital record for a TBI, and no prior psychiatric history. After controlling 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 be diagnosed with schizophrenia, 59% more likely to be diagnosed with depression, and 28% more likely to be diagnosed with bipolar disorder. When compared to persons who had fractures not involving the skull or spine, the likelihood of schizophrenia and 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, while causality cannot be ascertained, the strength of the relationship while controlling for multiple social factors, as well as the greater association than those with orthopedic injuries or uninjured siblings increase the suspicion of a causal relationship.

Multiple, large scale studies of suicide have identified TBI as a significant risk factor.¹⁹ Fazel and colleagues 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; when compared to uninjured siblings they were still more than twice as likely.²⁰ A population study of 7.4 million Danish residents found that those with a history of TBI were more than two and one-half times more likely to commit suicide. If the TBI was severe, this likelihood rose to almost three and one-half times more likely.²¹ A review of electronic health records from eight large healthcare systems in the U.S. found that those 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 There was no other medical condition with a higher likelihood of suicide.

Corrigan and Adams²³ 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; as many as 70% of persons receiving inpatient rehabilitation for a primary diagnosis of TBI received an opioid during their hospital stay.²⁴⁻²⁷ Compounding this greater likelihood of being prescribed an opiate is the greater vulnerability to substance use disorder,^{14,17} including opioid misuse,²⁸ and greater challenges in substance use disorder treatment (see below). Corrigan and Adams 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.” (p. 144).

Why Would TBI Cause Behavioral Health Problems?

The “fingerprint” of TBI is that frontal areas of the brain, including the frontal lobes, are the most likely to be injured, regardless of the point of impact to the head. Once there is enough force from a blow to the head, shaking or 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 mid-brain, basal ganglia, and prefrontal cortex also occurs if there is sufficient force to the brain, regardless of the actual point of impact.³¹ Together, 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 here that anoxic and hypoxic brain injury, such as 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 to adult substance use disorders.^{14,17} Weil and colleagues found that female juvenile injured mice showed a marked preference for alcohol as adults.¹³ These investigators have proposed that one mechanism of this effect may be disruption of the dopaminergic system during an adolescence, a key period in its development.³² Activity of the

dopaminergic system is a well-known substrate of substance use disorders.³³ While Weil and colleagues allow that there can be direct damage to the neural projections into the prefrontal cortex, they posit that a more likely consequence is initial hyper-stimulation of dopaminergic function caused by the injury, followed by chronic suppression of dopamine expression persisting into adulthood.³⁴ This effect may parallel the suspected mechanism of vulnerability to addiction caused by early life exposure to alcohol and other drugs.

These investigators have also posited that in some cases neuro-inflammatory processes caused by the injury do not return to normal levels, creating a cyclic effect whereby neuro-inflammation depresses dopaminergic function which increases the drive for alcohol, consumption of which increases neuro-inflammation, etc. Weil, Karelina, and Corrigan concluded that strong evidence from animal studies for an underlying mechanism, combined with moderate strength 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.¹⁷ Cannella, McGary, and Ramirez came to a similar conclusion with regard to adult substance use disorders more broadly.¹⁴ They too posited a key role of TBI in adolescence interrupting the development of the dopaminergic system, resulting in adult predisposition to addiction. While this work provides substantial evidence for a link between TBI and substance use disorders, other work examining how persistent neuro-inflammation interacts with stress has concluded that it can cause depression and anxiety, if not psychotic spectrum disorders.³⁵

Recommendations for Behavioral Health Treatment Providers

1. Behavioral health professionals should screen for lifetime exposure to TBI.

The unique fingerprint of TBI described above makes clear that this condition has a significant interaction with the occurrence, manifestation, and recovery from behavioral health disorders. Minimally, this 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.³⁶ Underpinning the three recommendations which follow is the assumption that every behavioral health professional should know the extent of a client's lifetime exposure to TBI as one critical component of client history. With that information, program administrators and individual clinicians should incorporate the following recommendations into routine behavioral health care.

2. Treatment must accommodate neurobehavioral deficits due to TBI.

Perhaps the single most important implication of TBI for behavioral health treatment is that professionals recognize neurobehavioral deficits that can arise from executive function impairment and accommodate these weaknesses in their treatment planning and execution. Neurobehavioral consequences of TBI do not have to undermine the ability for clients to participate in and benefit from the vast majority of conventional treatments.

Among several specific issues to address is recognition of the “cognitive load” that some treatments require. What does the treatment approach expect in terms of new learning—facts, rules, or routines? How can you assist a client with TBI who may have attention or memory

problems to acquire this information, and recall 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, 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? Even though much behavioral health treatment relies on group interventions, we must assure 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 clients may have neurobehavioral deficits is misattribution of their behavior by both peers and professionals. For instance, the 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”. We tend to assume that people recognize the impact of their behavior on others, but for clients with a history of TBI that has altered their social cognition, this awareness may not be there. 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 non-compliance reflects a client’s motivation to change. For a person with a history of TBI, a late arrival or missed appointment could as easily result from poor memory, organization or planning, as it can from low commitment to treatment. The source of non-compliance must be evaluated before a conclusion is reached or a consequence is determined. When non-compliance 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.

3. *Treatment must be holistic in order to address co-morbid conditions.*

Persons with TBI are often experiencing other medical conditions as well as multiple behavioral health disorders. Common health problems among persons with TBI include headache³⁷, fatigue³⁸, sleep disturbance³⁹, balance problems⁴⁰, pituitary dysfunction⁴¹, seizure disorders,⁴² and vision abnormalities.⁴³ It is typical for these health problems to necessitate medication, often presenting additional considerations when initiating medication-based treatment for a behavioral health problem. Further complicating the presence of multiple medications may be an increased sensitivity to side effects, such as sedation, which will in turn, have a disproportionate effect on alertness, cognitive function, and behavioral control. Many of these co-morbid medical conditions also will exacerbate with 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 one-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 mental health conditions, including affective disorders, suicidal behavior, hallucinations, and 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 of persons receiving treatment who are dually diagnosed with severe mental illness and substance use disorders have been found to have a high prevalence of TBI—60% of clients in a study of largely homeless, dually diagnosed treatment recipients 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 post-traumatic stress disorder. More than 70% of treatment recipients in a rural dual diagnosis program had at least one TBI with loss of consciousness.⁵⁰ In this cohort, personality disorders were significantly more likely among those with TBI.

4. Improvement gained by insight must be supplanted by other therapeutic supports

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. While most treatment start by seeking insight into the need to change behavior, behavioral health care also recognizes the importance of a person's social environment for encouraging and sustaining changed behavior, the role of internal states (impulses, drives, stress) for improving the chances of successful change, and the critical role that sustaining changed behavior plays in consolidating treatment gains.

All of these factors—environmental influences, internal states and time—play an even more important role for successful behavior change in the patient with neurobehavioral deficits due to TBI. A study of patients enrolled in one Integrated Dual Diagnosis Treatment program 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 on-going community supports among those with a positive history. While 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. The practical implications for behavioral healthcare are that medication-based treatments may be even more important. Further, more time will be required to weaken stimulus-response patterns and consolidate healthy lifestyle changes.

While a review of pharmacological approaches to behavioral health treatment 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. This advice may seem banal but, in current treatment for substance use disorders, medication-based treatment may not be routine.⁵¹ Because of the greater influence of internal states on behavior, persons with TBI will also require more time for healthy lifestyle changes to become habitual. Similarly,

it will take longer for susceptibility to stress or relapse to decline, so that medications may need more time before consideration of weaning.

Conclusions

A TBI is damage to the brain caused by an external force. While 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 the professional to determine if a client has a sufficient history of TBI 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 of these rates are more than twice what would be expected among non-institutionalized 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 impaired “executive” functions that regulate thinking, behavior, and emotional expression and are critical to success in treatment. A follow-up investigation to the Match Study found that persons with cognitive impairments such as those described in this article were more likely to prematurely terminate treatment, often classified as non-compliant.⁵² 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 undermine the expectation of benefit from treatment.

While the recommendations suggested in this article are not evidence-based, they are suggested as best practices that can be incorporated into treatment until such time as the research evidence can be compiled. 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 a sentiment like “at least I'm not dumb” or “I thought I was just bad”.

Identification often serves to increase motivation to make changes while allowing implementation by professionals of the other recommendations.

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.

As the previous paragraph underscores, there is much need for research on the interaction between TBI and behavioral health. Continuing to study the underlying mechanism between injury and vulnerability has the potential of resulting 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.^{53,54} 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.

There is a substantial public health burden arising from TBI. As indicated above, the annual cost to society of TBI 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 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.

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A TBI is "...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

Figure 1. Definition of TBI

1. Behavioral health professionals should screen for lifetime exposure to TBI.
2. Treatment must accommodate neurobehavioral deficits due to TBI.
3. Treatment must be holistic in order to address co-morbid conditions.
4. Improvement gained by insight must be supplanted by other therapeutic supports

Figure 2. Recommendations for Behavioral Health Treatment