

Long-Term Consequences of Severe TBI

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ABSTRACT

Severe Traumatic Brain Injury (TBI) leads to some extent of disability in all those who suffer from the condition. Impairments span physical, cognitive, emotional, and behavioral domains and significantly affect functioning and quality of life. Lack of consensus on treatment approach poses a challenge to effectively managing these patients as well as to developing accurate prognoses. Nonetheless, optimizing health-related outcomes and minimizing suffering requires that severe TBI patients receive the appropriate type and level of care throughout the duration of their lives.

Keywords: Traumatic brain injury; Neurological consequences; Physical; Glasgow coma score; Stress ulcers

INTRODUCTION

Traumatic Brain Injury (TBI), which poses major health and socioeconomic challenges worldwide, occurs when normal brain functioning is disrupted by a bump, jolt, blow, or penetrating wound to the head [1,2]. Accidents, falls, and violence account for the majority of TBIs.

TBI is the primary cause of mortality and disability in young people in high-income countries. In low and middle-income countries, the TBI incidence is rising, largely owing to increases in motor-vehicle use. In most cases, the neurological consequences of brain injury lead to the mortality and morbidity associated with TBI [3-5]. However, other complications, such as those affecting the cardiovascular, respiratory, and immune system can also occur.

Fortunately, about 75% of TBIs are mild and considered concussions [1,2]. Nonetheless, more than 3 in 10 injury-related deaths involve a TBI diagnosis, and it is estimated that more than 5 million U.S. residents are living with TBI-related disabilities. Though mortality rates in patients with severe TBI

have decreased by nearly 50% over the past 150 years, those suffering TBI still have at least a 35% chance of dying because of their injuries [6-8]. Furthermore, all of those who survive are considered disabled to some extent [8].

To maximize functioning, avoid complications, and optimize quality of life, it is critical that patients with severe TBI are afforded the proper type and amount of care. Here we review the long-term effects and prognosis of severe TBI, as well as the latest treatment and management strategies.

SEVERE TBI IS ASSOCIATED WITH LONG-LASTING EFFECTS ACROSS SEVERAL DOMAINS OF LIFE

Most people with severe TBI suffer long-term impairments in physical, cognitive, emotional, and behavioral domains [9]. As a result, their social lives and productivity are compromised, adversely affecting quality of life. While much of the literature focuses on the effects of severe TBI in the 5 years following injury, new disabilities arising after that period have also been reported [10-12].

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Received: 04-Sep-2023, Manuscript No. JPMR-23-26501; **Editor assigned:** 08-Sep-2023, PreQC No. JPMR-23-26501 (PQ); **Reviewed:** 22-Sep-2023, QC No. JPMR-23-26501; **Revised:** 29-Sep-2023, Manuscript No. JPMR-23-26501 (R); **Published:** 06-Oct-2023, DOI: 10.35248/2329-9096.23.11.693

Citation: Lichtblau CH, Raffa S, Assadi K, Warburton C, Meli G, Gorman A (2023) Long-Term Consequences of Severe TBI. Int J Phys Med Rehabil. 11:693.

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Physical

People who have suffered severe TBI often have a host of physical injuries, which vary across individuals. However, a common physical complication that arises from TBI is post-traumatic epilepsy [9]. This condition occurs in 20% of TBI survivors and also accounts for 20% of the symptomatic epilepsy that is observed in the general population. Some people experience epilepsy in the week following the injury, whereas others do not suffer seizures until more time has passed [13].

Cognitive

Those who suffer severe TBI are at high risk for cognitive impairments, which are associated with future disability [14]. Approximately 2 out of 3 severe TBI patients continue to suffer cognitive deficits 3 months after their injury [15]. Specifically, the aspects of cognition that tend to be impacted include attention, memory, information processing speed, and executive function [16-19].

Emotional

Emotional disturbances in severe TBI are common and psychiatric conditions often emerge in the year following severe TBI. Most notably, anxiety and depression are prevalent, occurring in roughly one in five and one in three patients, respectively [9,20]. Though substance depression and other mood disorders, as well as substance abuse, fail to improve significantly over time, anxiety disorders are more likely to resolve to some extent.

Behavioral

As the impact of severe TBI on physical, cognitive, and emotional domains of life persist, the resulting behaviors and lack of independence often lead to the breakdown of social relationships, loss of employment, and a reduction in leisure activity participation [21,22]. Critical behaviors like shopping and managing money are often compromised [23]. Unlike some individual symptoms in other domains, the neurobehavioral consequences of severe TBI often do not resolve, and the distress they cause to both patients and caregivers may in fact increase over time [24,25].

A LACK OF CLEAR GUIDANCE COMPLICATES SEVERE TBI TREATMENT

The ultimate goal of treatment for those who have suffered severe TBI is to ensure a meaningful existence with a reasonable quality of life [9]. From a clinical perspective, the most important objectives for achieving these ends initially in the intensive care unit are reducing the influence of secondary brain injury mechanisms following TBI [26].

Ideally, treatment for severe TBI is tailored to each patient, addressing the specific mechanisms of brain damage that are present in the individual [27]. Unfortunately, a paucity of high-quality clinical trial data has led to a lack of evidence-based

guidance for treating severe TBI, and wide variability in relevant clinical practice in the U.S. ensues [26]. There is consensus, however, that it is critical to alleviate intracranial pressure and to avoid hypotension and hypoxia in those who have suffered severe TBI [13,26,28,29]. It is also agreed that preventing seizures and venous thromboembolism are important goals for this patient population.

Other treatment approaches are more controversial. For instance, there is contradictory data on the clinical benefit of progesterone in severe TBI patients, with some data suggesting that it may be neuroprotective [30,31]. More research is needed on the potential benefits of induced hypothermia and hyperoxia as well as on decompressive craniectomy [6]. Translational research has also begun identifying biomarker candidates that could aid in the treatment of severe TBI [6,32].

THERE ARE A FEW ESTABLISHED PREDICTORS OF SURVIVAL AND LONG-TERM OUTCOMES

Prognosticating in those with severe TBI can be difficult because of the heterogeneity of the disease, as well as the variations in injury mechanisms and pathologies [33]. Nonetheless, predicting outcomes is important both for clinical practice and planning, as well as for counseling patients and their relatives.

There are several factors that have been shown to predict mortality in those with severe TBI. For example, age, initial Glasgow Coma Score (GCS), and general health independent of the TBI are all relevant to patient outcomes [3,34]. Additionally, genetic variations underlying inflammatory responses are predictive of short-term outcomes in severe TBI patients [8].

Because older adults have fewer physiological reserves, they tend to be more susceptible to TBI [26]. In this patient population, systolic blood pressure and the presence of brainstem injury are predictive of poorer outcomes, including increased permanent functional deficits [35].

There are also several established factors that predict morbidity following severe TBI. For instance, while Acute Kidney Injury (AKI) and hypotension in those with low GCS scores do predict mortality, most other non-neurological complications are associated only with morbidity [3]. Similarly, psychiatric symptoms and cognitive functioning at the time of discharge predict risk of long-term unemployment [36,37].

There are predictive models, including one developed in Japan and presented at the 23rd Annual National Neurotrauma Symposium in Washington D.C., that employ these factors, as well as others such as extensive subarachnoid hemorrhage, intracranial pressure, midline shift, and a lack of light reflex. These models have been shown to be valuable for clinical decision making and family counseling [13,38]. One model that incorporates 7 basic factors: Age, motor score, hypotension, hypoxia, pupillary reactivity, traumatic subarachnoid hemorrhage, and computed tomography classification has specifically demonstrated utility in predicting outcomes 6 months following severe TBI [39]. Details of this model and its

use are published in a scientific Journal, Volume 22(10), pages 1025-1039.

COSTLY AND UNPLEASANT COMPLICATIONS ACCUMULATE WITHOUT PROPER CARE

While the immediate aftermath of TBI and the direct costs associated with that care are the focus of much research and attention, the indirect costs that accumulate from long-term consequences of TBI are much larger [10]. In addition, because these consequences and complications unfold over time, they are harder to predict at the time of injury.

In addition to the normal sequelae of severe TBI and the impact on physical activity, mental and cognitive health, and behavior, there are also specific health-related complications that are common in those with severe TBI [13].

Pain

Pain frequently occurs because of mechanical ventilation, endotracheal intubation, surgical interventions, and other procedures. Pain must be properly managed with preventative measures and medication.

Venous thromboembolic events

Severe TBI patients are at high risk for both Deep Vein Thrombosis (DVT) and pulmonary embolism. Without prophylactic measures, the risk is estimated at 20%.

Stress ulcers

Early enteral feeding and prophylaxis with pharmaceuticals can help mitigate the enhanced risk that severe TBI patients face for stress ulcers.

Malnutrition

Malnutrition increases mortality in TBI patients, and those with severe TBI are at risk for malnutrition because of their altered gastrointestinal functioning and the fact that they tend to be in a hypermetabolic, hypercatabolic, and hyperglycemic state.

Stress hyperglycemia

Stress hyperglycemia is associated with poor neurological outcomes and is a common secondary effect of severe TBI.

DISCUSSION

Both preventing and managing these complications can be costly, and costs tend to fall on the patient and their family, compounding caregiver burden that is common in the context of severe TBI [40].

Multidisciplinary teams that properly manage severe TBI patients can help to stave off complications and to intervene rapidly when complications occur. Doing so reduces the harm, patient pain and suffering, and economic hardship that arise

with complications. These teams include but are not limited to physiatrists, neurologists, neurosurgeons, respiratory therapists, nurses, and other healthcare practitioners [13].

CONCLUSION

Severe TBI is debilitating and common across the globe. The long-term consequences of the condition adversely affect patients and their caregivers and can be even more costly than the initial care required upon injury. Proper treatment in the intensive care unit as well as for the duration of life after discharge is critical for optimizing health, quality of life, and cost burden associated with severe TBI.

Patients that have suffered severe TBI who are immobile are at increased risk for deep vein thrombosis, pulmonary emboli, urinary tract infection, cellulitis, and osteomyelitis. In addition, due to their brain injury, they are also at great risk for seizures. As a result, these patients require an appropriate amount and level of aid and attendant care (RN, LPN, or LVN) to increase quality of life and decrease morbidity and mortality.

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