

Kayla Praino

Jareb/Moras

HN300-C

30 April 2020

A Multidisciplinary Analysis of the Efficacy of Physical Therapy Intervention on Traumatic
Brain Injuries and the Ethical Considerations

Worldwide, traumatic brain injuries (TBIs) are becoming a global health crisis as they are reaching the leading cause of death and disability and have become the third leading cause in injury-related deaths.¹ Traumatic brain injuries are characterized as the result of a blow or force to the head that disrupts normal brain functioning.^{3,8} These disruptions to normal brain function can lead to severe impairments that may affect quality of life, or even lead to death. In the United States alone, approximately 1.4 million TBI's occur per year, 1.1million of those resulting in emergency room visit and 50,000 resulting in death.¹⁻³ Globally, 10 million traumatic brain injuries cause death or hospitalization per year.¹ Though both men and women are both susceptible to such injuries, the prevalence of TBIs tend to be higher in males compared to females.^{1-2,8} From 2004-2014, the number of TBI related emergency room visits, hospitalizations and deaths increased in the United states by 53%.⁸ In TBI's a range of medical services are required, including physical therapy. Physical therapy treatment for patients with traumatic brain injuries is subjective to each case and has specific goals for each patient based on their abilities.^{4,7} Physical therapy intervention has been found to be of increasing importance for physical activity and cognitive ability in TBI patients.¹ However, with any medical treatment, the ethical issues must be addressed to ensure proper patient care, especially given a population where decision making capabilities may be impacted. Additionally, the burden of caregivers of

this population must also be addressed. This role of this paper is to investigate the efficacy of physical therapy intervention in treatment of acute traumatic brain injury and the ethical dilemmas that may arise during treatment.

Prior to examining the effects of TBIs and the rehabilitation associated, it is important to highlight the safeguards and principles that are put in place within medical care facilities, specifically physical therapy rehabilitation offices, to ensure that the proper care and conduct is being followed for each patient. When working in the medical field, providers must follow a specific code of rules and regulations that guide them in their practices to ensure that no boundaries are crossed.⁵ Similar to any other medical profession, physical therapists are required to adhere to a code of ethics, or moral principles in which they follow in their day to day practice. According to the American Physical Therapy Association (APTA), the code of ethics for physical therapists serves 5 purposes:

- 1) “Define the ethical principles that form the foundation of physical therapist practice in patient/client management, consultation, education, research, and administration.”
- 2) “Provide standards of behavior and performance that form the basis of professional accountability to the public”
- 3) “Provide guidance for physical therapists facing ethical challenges, regardless of their professional roles or responsibilities.”
- 4) “Educate physical therapists, students, other health care professionals, regulators, and the public regarding the core values, ethical principles, and standards that guide the professional conduct of the physical therapist.”
- 5) “Establish the standards by which the American Physical Therapy Association can determine if a physical therapist has engaged in unethical conduct.”⁵

When looking at the purposes of the creation of an ethical code for physical therapists, patients can take comfort in knowing that there are safeguards in place for themselves, and their loved ones, to ensure that their care is appropriate and moral. Given that patients who suffer from TBI injuries can lack autonomy (ability to make decisions for ones-self) and awareness of their surroundings or state of being, these codes of ethics are crucial to ensure that physicians and healthcare providers implement care in a moral and proper way.

Before examining how each of these ethical codes apply in the case of traumatic brain injury, the definition, etiology, and symptoms of a TBI must be understood. A traumatic brain injury (TBI), also referred to as an acquired brain injury (ABI), is characterized as a severe brain injury causing alteration to the brain function or pathology, usually caused by an external force.³ These injuries are classified on a scale from mild to severe based on the etiology of the injury and the severity.^{1,3,8} Common causes that result in these types of injuries include blows by or against the head, motor vehicle accidents (MVA), falls, blasts (in war zones), penetration by foreign objects, and rapid acceleration or deceleration of the brain.^{2,3} Though these injuries are seen in all age groups, those more likely to sustain a traumatic brain injury fall between the ages zero and four years of age and 15-19 years of age. However, the population most likely to be hospitalized for traumatic brain injuries are those 75 years of age and older.² Given the critical function of the brain in everyday life, injuries to the brain can cause a range of issues and sequelae based on the severity of the injury. TBIs, in the moderate to severe category, often cause impairments to motor, sensory, behavior, and cognitive abilities that hinder operations of daily life.^{1-3,8} Furthermore, the injuries may result in decreased levels of consciousness, altered mental state, memory lapses, and neurological deficits.³ Additionally, not all effects of TBIs/ABIs are apparent to the naked eye. Those who suffer from these injuries are susceptible to

other health conditions and issues. One to three years post-injury, TBI victims are 11 times more likely to develop epilepsy and 1.3 times more likely to suffer from depression. Those who suffer from moderate and severe TBIs are 2.3 and 4.5 times more likely to develop Alzheimer's Disease, respectively.² However, the long-term effects of TBIs rely heavily on the severity of the injury and the portion of the brain in which the TBI occurred.

Traumatic Brain Injuries range in severity, from mild to severe, based on the area affected, the force of impact, and the nature of the injury.⁸⁻⁹ A mild traumatic brain injury (MTBI), often referred to as a concussion, are events resulting from mild blows to the head that causes temporary symptoms affecting cognition, physical health, emotional health, and sleep, including difficulty concentrating, dizziness, irritability, and increased sleep habits, respectively.⁸ Other issues resulting from an MTBI include loss of consciousness, headaches, or temporary memory loss, also referred to as amnesia.⁹ These symptoms of a concussion/MTBI are usually self-limiting. However, people who have experienced an MTBI are found at higher risk for psychiatric issues in the future.³ Furthermore, correlations have been made between the occurrence of multiple MTBIs over time and permanent alteration to brain function.⁸⁻⁹

Moderate and Severe TBIs are generally more serious than an MTBI due to the potential for life-long effects and alterations to brain function. However, certain criteria are often used to discern between the two classifications of TBI as they can initially appear similar. Moderate TBIs often result in loss of consciousness anywhere from 30 minutes post-injury to 24 hours post injury and often suffer from post-traumatic amnesia ranging from 1-7 days post-injury. In comparison, severe TBIs often result in loss of consciousness for 24 hours or longer and suffer from post-traumatic amnesia longer than 7 days.⁹

Though these symptoms and durations often characterize their respective injuries, TBI symptoms can be variable. Therefore, a standard scale, known as the Glasgow Coma Scale (GCS), is often used to classify brain injuries and is used with 24 hours of initial injury.^{1,6, 8-10} The GCS evaluates three types of responses from the patient: eye response, verbal response, and motor response. Each response type is given different scenarios that are assigned a score from 1-4, 1-5, and 1-6 respectively; a score of 1 would be given if the patient had no response and the highest score would result if the patient gave a normal response. Once each response type has been scored, the values are added up to create a composite/overall score that can range from 3-15. This composite score is used to classify the TBI. Overall GCS scores of 13-15 are classified as a mild TBI; scores of 9-12 are classified as a moderate TBI; scores of 3-8 are classified as a severe TBI.^{1,9-10}

The long-term effects and life changes that occur post-TBI depend heavily on the classification of the injury and the area of the brain that is impacted by the forces. There are high-risk regions in the brain that are highly vulnerable to TBI injuries. However, it should be noted, that any injury to the brain can cause possible disruption in functions that the effected part of the brain is associated with.⁹ Within the frontal subcortical circuit, there are three areas that control social behaviors that are often affected by head injuries; the dorsolateral prefrontal cortex, the orbitofrontal cortex, and the anterior cingulate. Damage caused to these areas often result in issues such as personality changes, irritability, impulsivity, lack of awareness and so much more. The dorsolateral prefrontal cortex is an area in the front of the brain that is thought to be responsible for “executive functions” that include working memory, decision making skills, and problem solving.³ Therefore, damages to this area of the brain often cause issues such as short-term memory, speech and language impairment, and impulse control

difficulties. The orbitofrontal cortex, another prefrontal circuit that is susceptible to TBIs, controls important social behaviors such as proper social response and self-correcting in real time; damage to this area could alter these functions. One of the other areas of the prefrontal cortex that controls nonmotor functions is the anterior cingulate. This area controls reward-related behaviors. So any damage or disorder to this circuit can disrupt motivated behaviors leading to apathy.³ Many of these changes in daily behaviors, post-injury, may not be noticeable to the individual themselves but definitely raise concern from family and friends.³ These are only some examples of the nonmotor areas of the brain that can be affected by a traumatic brain injury. TBIs often are paired with injuries to the motor controlling areas of the brain resulting in paralysis, coordination control, and balance issues. When these areas are affected, the intervention of a physical therapists, occupational therapists, and even respiratory specialists are necessary to improve quality life and hopefully regain/relearn some functions.

For patients who suffer any sort of TBI physical therapy is a critical portion of their rehabilitation in regaining motor skills, comprehension skills, and even some complex cognitive functions. It has been found that in all period of recovery, physical therapy is important, however in the beginning stages of TBIs (i.e acute rehabilitation) physical therapy treatment is crucial. Physical therapy intervention for patients suffering from traumatic brain injuries is geared towards balance training, postural control, gait training, overall coordination during movement, motor function improvement, and cognition improvement.^{1-2,6} Depending on the severity of the TBI, based on the GCS, as well as coma duration, the effectiveness of physical therapy intervention varies. Therefore, a physical therapist must assess the independent needs of the patient, rather than following a standard or traditional treatment program.⁶ Not only do physical therapists need to account for the physical movement impairments and cognitive impairments,

they also need to think about the patient and what environments will aid in a more efficient outcome.⁴

Research has been conducted to test the efficacy of physical therapy for a variety of different TBI patients and scenarios. One of the most fundamental aspects that physical therapists look to correct and improve is postural stability, coordination, and gait patterns in many patients. A study was conducted to test the effectiveness of physical therapy intervention including postural stability components paired with upper and lower extremity movements; the study was specifically geared to those with mild to moderate TBIs who were medically stable and could stand quietly, unsupported for a minimum of two minutes.⁶ This study also incorporated use of the GCS to identify mild to moderate TBIs.^{3,6} Exercises included in this trial targeted full body coordination, defined as the ability to initiate, continue, and terminate movements in several limbs simultaneously, as well as posture and gait. The exercises were progressive, meaning that they started in a lying position and, as patient improvement occurred, would move onto the execution of similar motion but sitting, then standing, eventually executing the movement while walking. Examples of exercises that the patients executed include, in supine (lying on back) “bending both legs and straighten them back out while keeping ankles together...,sit on a swiss ball slowly rocking from side to side, back and forth... stand on one leg: with and/or without arm movements... and walk up and down the stairs one step at a time, placing one foot on each step, with and without the railing.”⁶ Results illustrated that each patient in the trial reported motor and function improvements of their subjective conditions. Programs such as these are used every day and effective exercise programs in restoring postural and coordination control in the TBI population.⁶

Not only do the types of exercises impact the efficacy of physical therapy treatment, but also the severity of the TBI in the patient. Researchers have sought to determine whether coma duration for TBI patients has an effect on their success in physical therapy treatment.¹ A study was conducted on patients with moderate to severe TBIs, who had experienced a coma for duration of 1-4 weeks, to determine if coma duration had any effect on the rehabilitation process. The study comprised of 2 groups of people, all ranged from a score of 3 to 8 on GCS; group one consisted of patients who were in a coma up to one week, group two consisted of patients who were in a coma for longer than 2 weeks but up to 4 weeks. Both groups underwent acute rehabilitation and post-acute rehabilitation. The exercises were tailored to each patient in terms of complexity, repetition, and intensity based on the individual's motor impairments and cognitive impairments, and age. However, all the programs worked to strengthen limb and trunk muscles, increase range of motion (ROM), and improve coordination and balance. Throughout treatment, the patients would be tested to assess motor skill and mental skill improvement using the Motor Assessment Scale (MAS) and Mini-Mental State Examination (MMSE), respectively.¹ Results showed that in the acute rehabilitation period, the group with a shorter coma duration had *more* improvement in motor function than group two, based on the MAS; better motor skills such as walking and upper extremity improvement were seen in group one.¹ Additionally, the ability to perform complex tasks between groups varied, again showing more improve in group one than group two. In post-acute rehabilitation, both groups responded well to treatment; no significant changes in motor recovery seen, suggesting that initial rehabilitation following a TBI and coma is key to function recovery.¹ Overall, the least amount of motor improvement, for both groups, was observed in the execution of complex hand movements; group one regained some of these abilities in post-acute rehabilitation.

Regarding cognitive recovery status, significant strides were made with both groups. Orientation to time was improved significantly in all patients, however group one still had a better orientation to time compared to group two.¹ Additionally, evaluation of attention using the MMSE revealed that group one had significantly better scores, being able to recognize the means of physical therapy, and perform word repetition. The group with a smaller duration of coma time were able to perform tasks associated with time and place orientation, object recall, and word repetition; group two still made strides, but they were less significant. This study illustrated a connection between duration of coma and motor and mental recovery through physical therapy, indicating that those with lesser coma durations experienced more improvement than those with longer coma durations in acute rehabilitation¹. However, in a post-acute rehabilitation setting, no significant differences were observed.

In these cases, traditional physical therapy interventions were used to help in the recovery of function and improvement in quality of life. However, other physical therapists have found ways to take unconventional approaches, using modern technology to treat TBI patients. Virtual reality (VR) has been integrated into rehabilitation due to its facilitation of multi-sensory integration and its necessity for many different ranges of brain function.⁴ Additionally, VR use on patients has been found to "...improve self-awareness and social behavior and cause changes in cortical activation to promote neuroplasticity."⁴ Taking all of these factors into account, it makes sense to use technology that stimulates mental processes during rehabilitation in TBI patients.

In one particular case analyzed, virtual reality (VR) was used to treat a patient who suffered a gunshot wound (GSW) to the back of the head, resulting in a TBI.⁴ Surviving injuries such as GSW's to the head are extremely rare. Research shows that, "less than a third of the victims of GSW to the head survive to be taken to the hospital and only half of them survive

hospital intervention...Those who do survive...experience significant physical and psychological impairment requiring extensive rehabilitation to maximize independent mobility and reduce the burden of care on family members and caregivers.”⁴ For the patient analyzed, the location of the wound caused deficits in the occipital and suboccipital regions of his brain. His ability to balance was poor, his comprehension skills were less than normal, his peripheral field of vision was limited, and he experience neck pain and fatigue. Furthermore, the patient stated expressed a fear of walking in public places because he was “unable to turn his head when walking, unable to cross streets, and spent most of his time at home because populated areas...brought on dizziness and headaches.”⁴ With the use of head-mounted VR device the physical therapists, were able to integrate the patient into street walking and community walking virtually, before doing so in a real world setting. The goal of this specific study was to “maximize the recovery of higher level of functions, increase tolerance of busy environments while multi-tasking, as well as improve balance an visual processing deficits, in order to facilitate community reintegration.”⁴ The therapists immersed the patient into two different virtual settings with street crossings and traffic patterns. The first setting included standing at a two-way pedestrian crossing with crossing signals, and the second setting included stance on a traffic island between two-way, double-lane streets. After intervention, the patient self-reported his street crossing and multi-tasking abilities, being higher than pre-intervention.⁴ Though there were some complications in consistent intervention, due to lack of transportation from the patient, an improvement was still seen in the patient’s posture, gait control, and confidence. The patient continued exercises at home when he was not the at clinic working on aspects such as balance and community integration; he reintroduced himself to parks and shopping malls by going frequently with friends and family, who also saw improvements in the patient’s overall abilities.⁴

After examining the various ways in which physical rehabilitation can aid in the recovery of function after a traumatic brain injury, the ethical principles and safeguards that physical therapists follow can be examined to understand how each principle correlates and applies to TBI patients. Recall, the five codes of ethics put in place by the APTA serve five distinct purposes:

- 1) “Define the ethical principles that form the foundation of physical therapist practice in patient/client management, consultation, education, research, and administration.”
- 2) “Provide standards of behavior and performance that form the basis of professional accountability to the public”
- 3) “Provide guidance for physical therapists facing ethical challenges, regardless of their professional roles or responsibilities.”
- 4) “Educate physical therapists, students, other health care professionals, regulators, and the public regarding the core values, ethical principles, and standards that guide the professional conduct of the physical therapist.”
- 5) “Establish the standards by which the American Physical Therapy Association can determine if a physical therapist has engaged in unethical conduct.”⁵

The first principle in the Code of Ethics for Physical Therapists states, “Physical Therapists shall respect the inherent dignity and rights of all individuals.”⁵ This is a key concept that must be taken into account in healthcare of mentally stable patients as well as those who lack a mental capacity, considering that those with less mental capacity may not be aware of the human rights. This first principle has subsections stating that physical therapists must not discriminate against any person, for any reason, and they must put all biases aside and treat as any other healthcare professional.⁵ Specifically with TBI patients, there is much that is unknown

about the effects of their conditions and what interventions will work in treatment, considering each case is subjective. Therefore, patients and their families rely on physical therapists to use their professional judgement of the situation and medical knowledge in attempts to provide the best possible care. It is for this reason that the second and third ethical principles were introduced. The second principle in the Code of Ethics for Physical Therapists discusses the core values of altruism, compassion, and professional duty by stating, “Physical therapists shall be trustworthy and compassionate in addressing the rights and needs of patients/clients.”⁵ The third principle builds on this topic by stating, “Physical Therapists shall be accountable for making sound professional judgement.”⁵ These two principles help to ensure a good provider/client relationship instill trust that is necessary in any rehabilitation and medical services.⁵ One other key principle that can be applied to TBI patients in the code of ethics for physical therapists is ethical principle four. This principle states, “Physical therapists shall demonstrate integrity in their relationships with patients/clients, families, colleagues, students, research participants, other health care providers, employers, payers, and the public.”⁵ This core value helps to keep physical therapists in check, by ensuring that they are providing their clients with accurate information regarding the reason for interventions and how they may apply to that client’s specific case. It can be seen that the role of ethics plays a crucial role within the rehabilitation clinic and the care of the patients. However, the ethics and moral principles surrounding TBI’s does not only exist within the rehabilitation setting, but also within the home.

An aspect of ethics in healthcare, that is often overlooked, is the burden that is felt by family and friends to become caregivers. Many people who suffer from the effects of TBI’s or other disabilities are often released into the care of a loved one. Though it may be more comfortable for the individual in a non-medical setting, they are being placed into the care of

those who may not be in the financial position to afford the care of a properly trained caregiver. Therefore, these individuals are provided care from those who are underqualified to execute the highly dependable task of being a caregiver. The role of a caregiver is to aid the patient in the execution of basic daily living tasks such as, bathing, dressing, and transfers.⁷ Caregivers sometimes help with other tasks such as medication administration, turning a bed-ridden patient frequently to avoid bed sores, and other more complex tasks.⁷ With that being said, caregivers *should* have a certain level of education on how to effectively provide proper care for disabled patients. Those who are equipped with the proper education to serve the role of a caregiver are known as “formal caregivers.”⁷ People with this title typically are affiliated with a healthcare agency or system and provide the service on a volunteer basis or are a paid employee. However, there are two other classifications of caregivers that are not affiliated with the healthcare system at all, these caregivers are known as “informal caregivers” or “family caregivers.”⁷ Both types of caregivers are typically friends or close family, respectively, and do not have the training of an experienced caregiver. With that being said, many of these type caregivers find themselves overwhelmed with the duties that are asked of them every day. These family and friends put themselves at risk for serious emotional, mental, and physical health issues when fulfilling this role due to the mentally complex and physically taxing situations that they are faced with. It is because these family and friends who take on these roles feel an obligation to care for their loved ones that they put their own health at risk. However, research indicates that 1/3rd of caregivers who are family or friends of the disabled individual continue to provide these high levels of care despite the taxing role it plays on their health and the inadequate support that they receive.⁷ Given the severe burden of care that many of these family members and friends are placed under,

researchers have sought to investigate the role that physical therapy intervention and/or caregiver education would play in reducing this so-called ‘caregiver burden.’⁷

A study in India was conducted to determine whether intervention of physical therapy treatment or caregiver education would help to decrease the burden that caregivers of those with disabilities experienced. The caregivers were split into three groups: a control group, a physical therapy intervention group, and a caregiver education. Caregivers of various disabled patients were asked to complete the Caregiver Burden Scale (CBS) and Caregiver Strain index (CSI) and the respective interventions were administered for one month.⁷ Each caregiver group was asked to complete both the CBS and CSI both one month after intervention as well as two months post-intervention. Data proved inconclusive in finding a significant difference between the groups in terms of intervention and scale score reductions. However, the results did illustrate that over time, all three groups had a significant reduction in score to both the CBS and CSI.⁷ With this being said, one can question whether the role of a caregiver becomes easier as they become acclimated to it. Despite the fact that intervention groups had no statistically significant difference in scale score, research revealed that a greater “trend” of burden reduction was observed in the intervention group.⁷ Therefore, data suggests that there *could* be a possible correlation between physical therapy intervention and the decrease of burden in caregivers.⁷

After doing an extensive amount of research on the topic of Traumatic Brain Injuries, physical therapy interventions for TBI, and the ethical consequences that may arise within the realm of TBI’s, it was most challenging to find resources that analyzed the ethical issues and consequences associated with traumatic brain injuries. Though ethical studies may be harder to execute, given the fact that the subject of ethics is surrounded by “grey areas” and difference in moral principles between people, it is still important to investigate the ethical issues in order to

start conversations and possibly come up with solutions. It is within healthcare that many ethical dilemmas arise. These ethical controversies could arise between family members and/or physicians when deciding the best course of action to take with a mentally incapacitated patient. When these issues arise, they should be discussed, documented, and analyzed in order to provide the public, and future healthcare professionals, cases and examples to work off of, in order to provide better healthcare moving forward. Additionally, it would be beneficial for further research to analyze the effect that different settings of physical therapy such as inpatient rehabilitation, outpatient rehabilitation, and homecare rehabilitation, may have on TBI patients' journey to recovery.

Traumatic Brain Injuries (TBIs) have become of increased prevalence in modern society, becoming the leading cause of death and disability as well as the third leading cause in injury-related deaths.¹ Given that these injuries can cause a host of medical issues ranging from mild to severe and are unique to each individual, the level and types of medical intervention and the ethical dilemmas that arise are subjective. However, research has shown that physical therapy can be an effective tool in regaining and relearning some critical motor functions as well as beneficial for increased cognition.^{1,3,6-7} Therefore, physical therapy has been deemed an essential part in early TBI rehabilitation. While providing intervention for these patients, physical therapists are required to abide by a code of ethics which provide them with basic ethical principles that they must follow and incorporate into their daily practice to ensure the rights of their patients and staff are being upheld.⁵ It is within these physical therapy settings, where the focus is solely on the rights of the patients and the therapists' respect for proper care that patients with TBIs can most effectively work towards regained function and better quality of life.

Acknowledgements:

I would like to thank my mentors, Dr. Moras and Dr. Jareb, for guiding me throughout the research and writing process of this capstone paper. I would also like to thank my friends and family who helped to proofread my work and supported me throughout the writing process.

Sources

1. Lendraitienė E, Petruševičienė D, Savickas R, Žemaitienė I, Mingaila S. The impact of physical therapy in patients with severe traumatic brain injury during acute and post-acute rehabilitation according to coma duration. *J Phys Ther Sci*. 2016;28(7):2048-2054. doi:[10.1589/jpts.28.2048](https://doi.org/10.1589/jpts.28.2048)
2. Langlois JA, Rutland-Brown W, Wald MM. The epidemiology and impact of traumatic brain injury: a brief overview. *J Head Trauma Rehabil*. 2006;21(5):375-378. doi:[10.1097/00001199-200609000-00001](https://doi.org/10.1097/00001199-200609000-00001)
3. McAllister TW. Neurobiological consequences of traumatic brain injury. *Dialogues Clin Neurosci*. 2011;13(3):287-300.
4. Ma L, Tornetta F, Egan W, Wright WG. Virtual reality therapy as adjunct to traditional physical therapy for a TBI patient who suffered a gunshot wound to the head: Case report. In: *2019 International Conference on Virtual Rehabilitation (ICVR)*. ; 2019:1-5. doi:[10.1109/ICVR46560.2019.8994509](https://doi.org/10.1109/ICVR46560.2019.8994509)
5. Code of Ethics. *Physical Therapy*. 2004;84(1):94-98.
6. Ustinova KI, Chernikova LA, Dull A, Perkins J. Physical therapy for correcting postural and coordination deficits in patients with mild-to-moderate traumatic brain injury. *Physiotherapy Theory and Practice*. 2015;31(1):1-7. doi:[10.3109/09593985.2014.945674](https://doi.org/10.3109/09593985.2014.945674)
7. Narekuli A, Raja K, Kumaran S. IMPACT OF PHYSICAL THERAPY ON BURDEN OF CAREGIVERS OF INDIVIDUALS WITH FUNCTIONAL DISABILITY. *DCID*. 2011;22(1):108-119. doi:[10.5463/dcid.v22i1.17](https://doi.org/10.5463/dcid.v22i1.17)
8. Basic Information about Traumatic Brain Injury | Concussion | Traumatic Brain Injury | CDC Injury Center. <https://www.cdc.gov/traumaticbraininjury/basics.html>. Published March 6, 2019. Accessed April 15, 2020.
9. Hubert RJ, VanMeter K. *Gould's Pathophysiology for the Health Professions*. Sixth edition. St. Louis, Missouri: Elsevier; 2018.
10. Brasure M, Lamberty GJ, Sayer NA, et al. Table 1, Criteria used to classify TBI severity. <https://www.ncbi.nlm.nih.gov/books/NBK98986/table/introduction.t1/>. Published June 2012. Accessed April 19, 2020.