

A COMPREHENSIVE REVIEW OF SYMPTOMS AND
SCALES RELATED TO TRAUMATIC BRAIN INJURY AND
THE NEED FOR A NEW TBI SYMPTOM SCALE

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A Comprehensive Review of Symptoms and Scales Related to Traumatic Brain Injury and the
Need for a New TBI Symptom Scale

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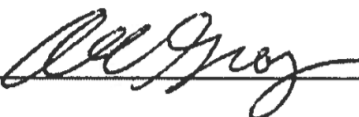

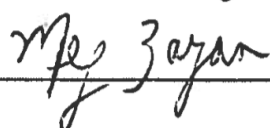
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SCALE

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Approval of The Dissertation

This Dissertation, by (name of student) has been approved by the committee members below, who recommend it be accepted by the University of Bridgeport, College of Health Sciences in partial fulfillment of requirements for the degree of Doctor of Health Sciences (D.H.Sc.)

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ABSTRACT

Traumatic Brain Injury (TBI) is a complex diagnosis with a vast variety of symptoms that can occur. The unique presentations that TBI can have make it particularly difficult to categorize. Currently the most commonly used categorization system for TBI is division between mild, moderate, and severe. The individual experience of TBI can be significantly different based on the symptomatic experience, which can skew the designation of mild, moderate, and/or severe. In evaluation of TBI there are many scales that can be used to evaluate many different aspects of how TBI impacts the individual. These scales include the Glasgow Coma Scale, Rancho Los Amigos scale, Modified Rankin, and Quality of Life After Brain Injury scale. The Glasgow Coma Scale is currently the primary scale being utilized in TBI evaluation. This scale evaluates the distinction between mild, moderate, and severe TBI but does not evaluate the full array of symptoms or how they change over time. Currently the Glasgow Coma Scale only looks at three symptom categories. There is a need for an increased understanding of what symptoms are occurring and how the symptoms change over time for the individual, which is critical for keeping track of progressions and regressions post-injury. Considering the way symptoms are often experienced in TBI and the variance that can be found based on time of day, stress, hormonal fluctuations, etc., a comprehensive evaluation of symptoms would require the input of caregivers. This would require a new evaluation scale to be developed that allows for a thorough review of potential symptoms. Herein there will be a review of the symptoms and current scales in use as well as a proposal of a new scale to fill in the gap of the current scales. This scale will allow for caregivers to provide valuable input in conjunction with health professionals to create a full picture of the presentation of the individuals specific TBI experience.

For Callie, my sister and heroine
All that you do and all that you overcome on a daily basis inspires me to always strive for the
bigger and better in life.
I love you to the moon and back

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A Comprehensive Review of Symptoms and Scales Related to Traumatic Brain Injury and the Need For a New TBI Symptom Scale

Chapter 1: Introduction

Traumatic brain injury (TBI) is a complex diagnosis with as many nuances as the brain has functions. In its most broad sense, TBI is an injury to the brain as the result of an external force that is forceful enough to cause disturbances or disorder in the normal functionality of the brain (Maneewong, et al., 2017; Menon, Schwab, Wright, & Maas, 2010). TBI can have a great impact on a persons' life impacting behavior, cognition, physical ability, and social function (Pagulayan, Temkin, Machamer, & Dikmen, 2006). All of these nuanced elements found within this diagnosis are subdivided into three primary diagnostic categories, (a) mild, (b) moderate, and (c) severe traumatic brain injuries. These categories are based on the amount of time a person with a traumatic brain injury is unconscious post injury or the amount of time that transpires before the person can create new and lasting memories (Rao & Vaishnavi, 2015). This categorization encompasses different forms of TBI as well as a host of different symptomatic presentations of this complex neurological diagnosis.

TBI occurs in two primary forms, open and closed head injury (Schwarzbold, et al., 2008). An open head injury occurs when something enters the skull or the skull becomes open in some way, one of the most common open head injuries occurs when a bullet enters the skull. Open head injuries typically result in damage to specific areas of the brain, those areas being wherever the opening of the skull occurred or penetrating object entered. Closed head injuries differ from open in that the damage to the brain is typically more diffuse. A closed head injury is usually the result of an impact to the head that causes the brain and skull to hit each other with extreme force. The most common areas of injury during a closed head injury are the frontal and

temporal lobes due to their location at the front and back of the brain respectively. Closed head injuries can further damage the brain through injury to the neuronal axons causing communication between parts of the brain to reduce or stop completely. The severity of brain damage as a result of a closed head injury is directly correlated to the intensity of the velocity of the impact to the skull (BrainLine, 2008).

Along with these two types of primary injury, there are two different types of injury that can occur to the central nervous system during TBI called, primary and secondary injury. Primary injuries refer to tissue that has become damaged due to the impact of the TBI, which can cause loss of function, lesions, and injury to the brain. In secondary injury, the tissue is damaged later in response to primary injury or other internal causes that occur post injury onset. Secondary injury to tissue is commonly seen in the form of inflammation and ischemia (Schwarzbold, et al., 2008).

Along with different types of brain injuries and methods by which they occur there are also different forms of damage to the brain that can take place in a brain injury. Some of these types of damage are, bruises, cuts, and skull fractures, bleeding in the brain, pressure on the brain, oxygen deprivation to the brain, and damage to the neurons of the brain. Bruises, cuts, and fractures are most common in a closed head injury and occur during the impact. The brain can become bruised if the impact to the skull causes the brain to hit the skull with such force that the soft tissue is damaged. This type of bruising is often seen in opposite lobes due to the “bouncing” movement the brain tends to go into as it hits back and forth against the skull. Fractures are mostly associated with severe traumatic brain injuries as the impact must be intense enough to cause fracturing. In the case of an open head injury, brain lacerations can occur which can result in fractures as well. Skull fractures in TBI are also associated with instances of both brain

hemorrhages and hematomas. Bleeding in the brain is very dangerous but can be further complicated by the pressure it places on the brain. This level of pressure can increase to a point that the brain herniates or places extreme pressure on the brain stem stopping the flow to the spinal cord. TBI is also commonly associated with damage to axons and neurons in the brain (Rao & Vaishnavi, 2015). This type of damage causes failures in communication throughout the brain and interruptions or failures in functionality. If the damage to the axons is severe enough, diffuse axonal injury can occur. Diffuse axonal injury happens when the rapid intense movement the brain experiences during a closed head, or in some cases an open head injury, is severe enough that the axons tear effectively stopping communication between impacted parts of the brain (Rao & Vaishnavi, 2015).

Diagnostic Methods

The standard method for post-injury determination of TBI level is the Glasgow Coma Scale, which evaluates motor responses, ability to open eyes, and verbal responses. In the case of a child younger than age two, verbal response is typically replaced with cry response. These categories are all provided numerical values based on the observed ability level for each measure (Yao, et al., 2017). Category one, motor response, is scored on a scale from 1 to 6: (1) no motor response, (2) decerebrate, tight and rigid posture, (3) decorticate posture, (4) withdrawal from painful stimulus, (5) purposeful movement in response to painful stimuli, (6) full response to commands. Category two, verbal response, is scored on a scale from 1 to 5. (1) No verbal response, (2) verbal response present but incoherent, (3) verbal response present but inappropriate phrases, (4) verbal response present and coherent with evidence of confusion, (5) full coherent verbal responses. Finally, category three, eye-opening, is scored on a scale from 1 – 4. (1) eyes do not open, (2) eyes open only in response to pain, (3) eyes open in response to

sound, (4) eyes open spontaneously; seen in Table 2.1 (Teasdale, Allen, Brennan, McElhinney, & Mackinnon, 2014). The total score from the three categories then correlates to mild, moderate, or severe TBI. A total score ranging from 1 – 3 equates to a vegetative state, scores from 3-8 equate to severe disability, scores from 9-12 are moderate, and scores from 13-15 are mild. Further, the Glasgow Coma Scale indicates that any individual that remains in a vegetative state for more than one month is designated as being in a persistent vegetative state (BrainLine, 2018).

The Glasgow Coma Scale (Table 2.1) uses this scoring system to then inform providers on what medical decisions should be made and informs how patient outcomes are predicted (Yao, et al., 2017). Despite this scale being used as the standard for determination of the level of TBI, the score may not have significant meaning as it relates to an individual's abilities long-term (National Institute of Child Health and Human Development [NICHD], 2016). Symptoms and consequences of TBI can develop, improve, and change in the long-term meaning that the initial Glasgow Coma Scale ranking of the injury can become antiquated in terms of the reality of the individual's experience. The symptomatic experience of TBI also greatly differs from one individual to the next but overall consists of symptoms covering a much wider range than what the Glasgow Coma Scale evaluates for initial diagnostic purposes. TBI can impact fine and gross motor abilities, sensory abilities, speech, psychosocial functioning, psychological disorders, cognition, behavioral function and more (Guilmette & Paglia, 2004). These areas where symptoms can be experienced are vast and can create a great number of unique events across the TBI diagnoses that are not represented by the findings of a Glasgow Coma Scale ranking.

Impact of TBI

TBI is a massive health problem with an estimated 2.5 million TBI cases occurring in the United States annually and even more instances globally, in developed and developing nations

alike. The World Health Organization has predicted that by the year 2020 TBI will be the third leading cause for death and disability throughout the world (Li & Sirko, 2018). Despite this staggering estimated number of annual cases of TBI this number is presumed to be an underestimate due to the amount of unreported mild TBI (mTBI) cases that go untreated each year (Center for Disease Control [CDC], 2016). TBI is known to occur more often in males and is most common in three age groups, (a) 0 – 4 years, (b) 15 – 19 years, and (c) 75 and up (Langlois, Rutland-Brown, & Wald, 2006). The prevalence of TBI has rapidly increased with the most common traumas being connected to automobile accidents, sports (specifically contact sports), and military service (specifically blast-related injuries). The United States Department of Defense has named blast-related TBI as the signature injury of the wars in Iraq and Afghanistan due to the frequency with which TBI occurs in this type of combat environment (Lucke-Wold, 2014). The increase in TBI has brought this diagnosis to the forefront as a leading cause of neurologic disability but it remains a “silent epidemic” due to its symptoms that are difficult to see and understand by those who are not experiencing it, particularly symptoms related to psychosocial functioning, cognition and behavior (Guilmette & Paglia, 2004). The silent nature of TBI can result in misdiagnosis and misunderstanding of the connection between symptoms.

Those that have incurred a TBI of any severity level may experience symptoms immediately following the injury but can also experience new symptoms as well as changes, both improvement, and regression, in existing symptoms in the long-term. Symptoms can change in the weeks, months, and years following the onset of injury (Bramlett & Dietrich, 2015). Some common long-term symptoms associated with TBI are problems with cognition, specifically, attention span, changes in mood, memory capacity, behavioral changes, and problems associated with thinking (Rao & Vaishnavi, 2015). Behavioral and cognitive changes over time have long-

term consequences of TBI can progress creating symptomatic changes on an internal level, for example, gradual brain atrophy and a higher likelihood of experiencing neurodegenerative disorders, these changes can create new or further exasperate existing symptoms (Bramlett & Dietrich, 2015).

TBI is not only associated with direct symptoms as a result of TBI but, those with TBI are also at a greater risk for comorbid conditions. Epilepsy, depression, and Alzheimer's are all conditions that are more likely to occur in those with TBI than the general population. These symptoms can occur as a result of brain damage from TBI but can also be secondary symptoms caused by changes related to primary symptoms (Langlois, Rutland-Brown, & Wald, 2006). TBI across severity distinctions presents a unique problem in determining and preparing for symptoms due to the complex nature of how symptoms can present, the potential comorbidities both long and short term, and the extraordinarily wide variety of potential symptoms that could be occurring (Prince & Bruhns, 2017). Primary symptoms cannot always be predicted and secondary symptoms can be predicted to an even lower degree of certainty.

The symptomatic experience of TBI, both in the long and short term, is closely related to what areas of the brain have been impacted by the injury. Damage to the orbitofrontal cortex can cause major personality changes. The dorsolateral prefrontal cortex is often impacted by TBI and causes problems with cognitive functioning and can lead to unexpected mood changes. Damage to the thalamus results in confusion and disorientation as well as difficulty maintaining attention. When the temporal lobe is impacted by TBI it can cause problems with vision, hearing, and in severe cases auditory hallucinations, which can mimic symptom experiences of schizophrenia. Damage to the temporal lobe can also result in problems related to memory (Rao & Vaishnavi, 2015). Depressive and anxiety symptoms are often associated with TBI, which is likely

connected to damage in the anterior cingulate cortex. These symptoms are associated with damage to this area as it is responsible for resolving emotional unrest as well as impulse and emotional control (Rao & Vaishnavi, 2015). These are only a few of the areas that can be impacted in the case of a TBI. TBI also can result in diffuse damage causing changes to occur throughout the functions of the brain. The impact of disability is not limited to the area in which the trauma is located. The brain is a heavily interrelated structure meaning that if damage occurs in any area(s) of the brain there can be implications in other parts of the brain as well. This is partially the reason why TBI can often mimic other disorders or conditions that impact the brain.

Statement of the Problem

The focus of this paper is to review the symptoms associated with traumatic brain injury across the mild, moderate, and severe designations. TBIs not only have immediate symptoms and complications but can also have new, worsening, and/or improving symptoms and/or complications that occur over the days, months, or years post onset of injury. In order to better understand the possible symptoms that can occur this paper will compile a comprehensive review of these potential symptoms. This paper will also review the current scales that are used by patients and providers to define TBI. The current scales available for diagnostics in TBI cannot fully portray the scope of symptoms and disability level. This creates a problem for those with TBI when approaching medical, psychological, rehabilitation, and other forms of treatment as it becomes difficult to convey a full understanding of the individual TBI experience.

Purpose of the Research

The purpose of the research is to gather the symptoms across the different measures of TBI. This will be done in order to examine the symptoms and create a comprehensive understanding of how the symptoms are both similar and different across the mild, moderate, and

severe designations. This will be used to move toward the necessity for a more detailed scale for TBI, beyond the most commonly used Glasgow Coma Scale. Other scales, such as the Rancho Los Amigos scale for cognitive functioning, also exist and are beneficial in the assessment and treatment of TBI. However, these scales are not specific to TBI and do not outline the symptomatic experience of the patient. The symptomatic review will lay the groundwork for a scale that can follow TBI patients throughout their lives living with TBI and show both progressions and regressions in how symptoms are experienced. Patients within the commonly distinguished mild, moderate, and severe categories may remain in those loosely defined categorical groupings but may have different presentations of what that diagnostic definition means throughout their lifespan. A new scale that would breakdown symptom experiences may not only assist patients but providers in understanding the symptoms that a patient is experiencing and the symptoms that have improved or become worse over time.

Chapter 2: Review of Literature

Traumatic Brain Injury

Traumatic brain injury is a highly complex diagnosis for the patient, providers, and family to live with, treat, and understand. TBI is most commonly subdivided into three classifications mild, moderate and severe TBI. There are diagnostic difficulties that come with this diagnosis as well as a host of symptoms that can combine to create a relatively unique manifestation of TBI from one patient to another. TBI can occur for many reasons with the most common occurrences being associated with falls, motor vehicle accidents, and contact sports (Lauterbach, Notarangelo, Nichols, Lane, & Koliatsos, 2015).

TBI has been coined as a “silent epidemic” due to limitations on knowledge particularly regarding the symptomatic experience of TBI survivors. Not only is popular knowledge limited as well as misrepresented, but it is additionally confused by some symptoms of TBI being immediately evident where others can become apparent over time (Schwarzbold, et al., 2008). The notion of TBI as a “silent epidemic” is further perpetuated due to the large number of unreported or untreated cases. Since TBI can occur without any physical signs of injury, diagnosis can be more difficult. Children in particular with TBI can be misdiagnosed with learning and behavioral disabilities due to the confusion of symptoms that can mimic other types of disabilities such as, cerebral palsy, psychiatric disorders, and any other disorders that include similar symptomatic make-up. (Harris, Mishkin, & Ross, 2012). An outline of the symptoms reviewed can be found in Appendix A.

Short Term

Improvements in those with TBI across all distinctions typically show improvements over the first six months post-injury before improvements wane. Improvements can continue after the six-month mark occurs, however, the most significant changes have been found to occur during this short-term period of time (Stocchetti & Zanier, 2016).

Long Term

Damage to the brain does not end in the short term, the damage continues to evolve and alter for a long time after the onset of the injury. These changes to the brain in the long term occur in the form of improvements and deteriorations (de Cassia Almeida Vieira, de Oliveria, Teixeira, & Paiva, 2015). There is evidence of improvements in the condition continuing in the long-term for those with TBI however in addition to these improvements there is also evidence of worsening over time. Evidence has shown that in the period of time around approximately a decade after the onset of injury there is a functional loss for an estimated quarter of those who have survived their injuries up to that point (Stocchetti & Zanier, 2016).

In nearly twenty percent of cases of mild TBI the symptoms that a patient experiences will continue to change, and in many cases regress, beyond the first year post-injury (Valente & Fisher, 2011). There is minimal consistent information available in regard to long-term understandings of TBI symptoms, specifically how symptom experiences and therefore outcomes change over time (McMillan, Teasdale, & Steward, 2012). However, despite the lack of information on long-term consequences of TBI, it is estimated that over 6 million TBI survivors are currently living with long-term disabilities (Schwarzbold, et al., 2008).

Distinctions of Severity

Mild

According to recent statistical approximations, 80% of all reported TBIs fall under the distinction of being mild (Vanderploeg, Belanger, Curtiss, Bowles, & Cooper, 2018). This constitutes a vast majority of the estimated 2.5 million TBI cases reported in the United States each year. mTBI is assumed to be heavily unreported statistically as patients do not always seek medical attention following an mTBI despite the known staggering statistic for the number of mTBI per year the reality is that the number is likely much higher (Prince & Bruhns, 2017). mTBI is the lesser of the distinctions of TBI severity however, even in its mild form, TBI can result in long-term cognitive disability. These types of disability can prevent mTBI patients from working and/or living independently (Langlois, Rutland-Brown, & Wald, 2006).

The symptomatic experiences associated with TBI can widely vary from case to case as well as across severity levels. When examining the symptomatic experience a patient will experience with mTBI, it is difficult to pinpoint exactly what will occur. Symptoms of mTBI are dependent on the severity of injury and location in the brain that has been impacted (Valente & Fisher, 2011). Some of the common symptoms of mTBI include headaches, nausea, vertigo, low attention span, lapses in memory, irritability, fatigue, depression, and problems with sensory intake (Vanderploeg, Belanger, Curtiss, Bowles, & Cooper, 2018).

Moderate

Moderate TBI is one of the three distinctions of TBI that are generally recognized in the field, however, studies are rarely done on moderate TBI and how it functionally differs from mild and severe (Einarsen, et al., 2018). When studied, moderate TBI is typically grouped with severe TBI despite the significant difference in fatality rates and disability. Moderate TBI is

associated with significantly lower fatality and less severe disability than severe TBI yet the two distinctions are grouped as one. The majority of patients with moderate TBI require intensive care treatment and nearly half will fall in the category of unfavorable outcomes even a year post injury (Einarsen, et al., 2018). As the title of moderate TBI would imply this injury is not as severe as severe TBI yet not as positive as the outlook for mTBI. However, the title of moderate is misleading as the fatality rate in this category remains in the range of 10-15% (Godoy, Rubiano, Rabinstein, Bullock, & Sahuquillo, 2016).

Symptomatically moderate TBI will often have the same symptoms that are found under the heading of mTBI. In moderate TBI these symptoms will often be worse and there will be the addition of more symptoms compounding possible disabilities long-term (Valente & Fisher, 2011). Some symptoms, for example, talk and die/deteriorate, are associated with moderate TBI due most commonly to a misdiagnosis of severity. In general, however moderate TBI will have a similar bevy of symptoms that may occur to the other TBI distinctions.

Severe

Severe TBI is often a diagnosis plagued by poor outcomes and results. In cases of severe TBI, 39% of patients will die from their injury and 60% will have what are marked as unfavorable outcomes. This leaves a remaining extremely small margin of 1% of patients who survive and are placed in the favorable outcome category following a severe TBI (Rosenfeld, et al., 2012). Survival rates associated with severe TBI are connected to the degree of injury to the brain as well as other factors including, immobilization, incontinence, seizure disorders, level of, or lack of cognition and intellectual function, and ability to swallow (Ślusarz, et al., 2015).

Due to the high mortality and disability rates associated with severe TBI the categories of favorable and unfavorable were created to depict the projected outlook of patients. Unfavorable

is a distinction that is representative of death, vegetative state, or severe disability that at minimum will not allow for an independent lifestyle. A favorable distinction represents moderate disability or in rare cases, a good or full recovery (Maas, Stocchetti, & Bullock, 2008).

Similar to the difference between mild and moderate TBI the symptoms found in mild and moderate can also be found in severe TBI. The symptoms are often more intense or disabling in this designation of TBI and are compounded by further symptoms. In mild and moderate TBI symptoms are often heavily correlated to the areas of the brain impacted by the injury. In severe TBI this can still occur but instances of diffuse widespread brain damage impacting the entire brain become more common. Severe TBI is a long-term diagnosis with symptoms that may improve but only in rare cases will disappear or be fully conquered. Symptoms of severe TBI are commonly physical, cognitive, and psychological in nature. Those with severe TBI will typically have impairments that impact their ability to be independent, to maintain or create relationships, and maintain or acquire employment (Rosenfeld, et al., 2012).

Statistics of fatality in severe TBI have reduced in recent years however nearly 40% of all severe TBI instances are estimated to result in death. For the survivors of severe TBI most cases result in long-term consequences due to physical, cognitive, and psychological disabilities. Severe TBI is also associated with an increased occurrence of additional injuries that occur simultaneously. Often severe TBI is connected to automobile injuries, which due to impact can have a variety of non-neurologic additional consequences such as fractures, lesions, and bodily damage that can act to further compound existing or future deficits suffered as a result of severe TBI (Stocchetti & Zanier, 2016).

Symptom Review

Sensory Related Problems

Sensory problems are commonly found following brain injuries. These problems can include deficits in smell, sight, hearing, taste, equilibrium (Valente & Fisher, 2011). Sensory losses can be due to areas impacted by brain injury or in cases of diffuse damage can occur throughout the brain. The loss of sensory function(s) can be a primary symptom in that the symptom experienced is directly related to the brain injury but it can also be a secondary symptom, occurring if they are related to another problem as the result of the injury. One of the most common reasons sensory loss is found as a secondary symptom is when it is related to the loss of sensory ability in limb or limbs if paralysis has occurred as a result of TBI (Valente & Fisher, 2011). Sensory problems or losses that are often found in TBI are found in vision, hearing, and smell.

Visual. There are a wide variety of visual deficits that can be experienced as a result of TBI. This symptom is seen throughout the severity levels of TBI, however, long-term vision problems are more common in moderate and severe TBI (Rao & Vaishnavi, 2015). The greatest loss among the visual sensory symptoms is the entire loss of vision or blindness. This, as with other symptoms, can be caused by the brain injury itself or other issues surrounding the cause of the brain injury such as visual loss resulting from secondary injury in a motor vehicle accident. In TBI the optic nerve can be damaged as well as areas of the brain where visual receptors function. These types of nerve damage can cause partial or total loss of vision (Harris, Mishkin, & Ross, 2012). In addition to entire loss of vision other visual sensory losses or deficits in TBI can be peripheral vision loss, blind spots, blurred vision, depth perception deficits, difficulty recognizing objects, myopia, sensitivity to light, and dilation of one or both pupils (Rao &

Vaishnavi, 2015; Valente & Fisher, 2011).

There are many changes particularly to the pupils that are found in relationship to TBI. Dilated pupils can be particularly dangerous as a symptom of TBI especially when the pupils are also fixed. Bilateral fixed dilated pupils are associated with high fatality rates with over 80% of patients presenting with this symptom not surviving. Of those who did survive with this symptom present more than 70% were left with at least one long-term visual deficit (Helmy, Kirkpatrick, Seeley, Corteen, Menon, & Hutchinson, 2012). Other problems associated with TBI and dilated pupils are Argyll-Roberson, drug-induced mydriasis, and anoxia mydriasis (Adoni & McNett, 2007). Constricted pupils can also be problematic in TBI making the pupil too small to react to light. This can have several causes in relation to TBI including as a symptom of medication, however, it can also be something more serious such as hemorrhage in the pons of the brainstem (Adoni & McNett, 2007). Pupils can also be uneven which can cause problems with taking in light stimulation due to uneven constriction and dilation patterns. Issues related to pupils that are not equal can include mydriasis, Adie's pupil, and Homer's syndrome. Each of these conditions can have different causes but often relate to problems in the efferent pathway, nerve compressions, or damage in the hypothalamus (Adoni & McNett, 2007). As opposed to unequal pupils there are also instances of visual problems related to equal pupils that produce an unequal response, particularly to light. Hippus and Marcus Gunn pupil are the most common instances of this, most often causing either a too rapid or too slow light-based reaction in the pupils (Adoni & McNett, 2007).

Hearing. Hearing loss or problems with hearing connected to TBI can be related to nerve damage which impacts how the brain processes hearing or by damage or fractures to the structures held within the ear (Harris, Mishkin, & Ross, 2012). The most common occurring

hearing related deficits are hearing loss in one or both ears and tinnitus (Valente & Fisher, 2011). Along with these problems with hearing there can also be more generalized with patients experiencing issues with auditory processing causing sounds to be heard but incorrectly.

Smell. Loss of smell is found in TBI patients with the largest number of patients experiencing this loss having a severe TBI. This particular loss is heavily associated with TBI patients that have injuries located in the frontal lobe of the brain but can also be the result of damage to the olfactory nerve. One notable element of loss of smell in TBI is that when tested patients are often not aware of the extent to which they have lost their sense of smell. In a study when using the standard Alberta Smell Test a significant number of study participants with TBI had an olfactory impairment but did not realize it until presented with the test results (Fortin, Lefebvre & Ptito, 2009).

Physical deficits

Physical deficits come in a variety of severity levels and a variety of ways they impact functioning. This symptom range is often based on the severity of the TBI and/or the areas of the brain that have been impacted. Some of the commonly found physical symptoms are poor muscle coordination, generalized weakness, spasticity, involuntary muscle movement, loss of balance, and apraxia (Harris, Mishkin, & Ross, 2012). In addition to gross motor limitations and disabilities, other common physical symptoms include loss of bladder and sphincter control in association with TBI (Stocchetti & Zanier, 2016). Despite the severity of these commonly occurring symptoms experienced post-TBI, the symptoms can be significantly more severe including quadriplegia, paralysis, and in extreme cases, catatonia (Indorato, 2017).

Physical or gross motor disabilities following TBI are often the result of nerve structure damage that occurs in the areas associated with the physical limitation that is occurring. In some

cases, physical disabilities in TBI can be the result of a co-morbid spinal cord injury (Macciocchi, Seel, Warshowsky, Thompson, & Barlow, 2012). In addition to injuries related to TBI both physical and neurologic, physical disabilities post-TBI have also been associated with long periods of immobilization during long-term hospital stays during post-TBI monitoring, rehabilitation, and treatments (Stocchetti & Zanier, 2016).

Spasticity. Spasticity as a symptom of TBI is most commonly seen in those with severe TBI. Spasticity in TBI typically occurs as a result of damage to the area of the brain that controls volitional movement. The result of spasticity is a continuous contraction of muscles, even during passive movement. This results in stiffness and tension in the impacted areas. High muscle tone and muscle spasms are frequently seen in patients with spasticity. The level of spasticity can range from mild to severe and painful. In some cases, it can reduce movement control and cause continuous muscular weakness. Spasticity can begin as early as one-week post injury and can continue to increase in severity over time. It is one of the most common secondary neurological conditions, occurring as a symptom in a variety of neurologic disorders. Depending on which muscles are impacted, spasticity can cause deficits in movement, speech, and ability to walk. (Bose, Hou, & Thompson, 2015).

Movement disorders. Movement disorders are typically found in severe TBI, and about 20% of these cases will result in some form of movement disorder with half of these persisting to become a long-term symptom. The most commonly occurring movement disorders in TBI are kinetic cerebellar output tremors and dystonia (Krause, 2015). In the case of dystonia, the cause is often unknown, however, it is known that trauma to the brain can be a factor. Dystonia occurs in two primary forms, dystonia that occurs within four weeks of injury and dystonia that is delayed or occurs after four weeks post-injury. In the early occurring form of dystonia, the

symptom is seen specifically in the area where the injury occurred. The delayed form of dystonia is often manifested as hemi-dystonia or dystonia of the upper extremities (Frei, 2017).

Primitive Reflexes

Primitive reflexes are reflexes that are found in infants as automatic responses to certain stimuli. This type of reflex is rooted in the central nervous system but as the infant grows into a child and eventually an adult these reflexes should become suppressed by the development of other parts of the brain that take over reflexive actions. In TBI and several other neurologic disorders such as cerebral palsy and stroke; these primary reflexive actions can begin to reoccur. The reoccurrence of primary reflexes can result in a decrease or decline in brain development and efficiency particularly regarding sensory information processing. Some of the most commonly seen reoccurring primary reflexes in neurological disorders are asymmetrical tonic neck reflex (ATNR), symmetrical tonic neck reflex, tonic labyrinthine reflex, palmar reflex, and Spinal Galant Reflex. ATNR, also known as fencing reflex, causes the body as a result of certain stimuli to enter the position typically held by a fencer with the arm and leg on one side in extension and the opposite arm and leg in flexion while the head and neck are rigid in a tonic turn toward to limbs in extension. Due to this position, ATNR can result in visual disturbances, high tone, and spinal problems (Gieysztor, Choińska, & Paprocka-Borowicz, 2016).

Cognitive deficits

There is a vast range of cognitive deficits that can occur in relation to TBI. Many of these deficits can have a serious impact on the daily functioning of TBI survivors both in the long and short-term (Harris, Mishkin, & Ross, 2012). Issues with cognitive function are some of the most common and the causes of some of the greatest disabilities associated with TBI. The impairments found in cognition can include, but are not limited to problems with memory,

attention, concentration, logical reasoning, and executive functioning (Stocchetti & Zanier, 2016; Valente & Fisher, 2011). These are areas where cognitive deficits can occur, and manifest in many ways causing different types of disabilities that can range from short to long-term (Stocchetti & Zanier, 2016).

The deficits in cognition related to TBI are often related to problems that occur within the delicate system of neurotransmitters that work together to produce many cognitive functions. These neurotransmitters that cognitive functions hinge on are frequently damaged or disrupted during the impact of TBI. This can cause impairment or loss of cognitive function dependent on the level of damage to cognitive neurotransmitters.

Cognitive deficits in TBI are often found in the short and long-term. Problems with cognition in relation to TBI will typically worsen over time. The natural aging process results in neural losses, meaning that TBI or not this will occur, and neurotransmitters related to cognitive skills will decrease in number and/or functionality. Expected age-related loss is frequently found to be worse, with TBI, and on an increased timetable. This can increase the experienced symptoms in cognition for those with TBI as well as accelerating the loss of other cognitive skills in the long-term (Stocchetti & Zanier, 2016).

Memory, Attention, and Concentration. The most commonly experienced symptoms are problems with memory, attention, and concentration. These cognitive losses are reported across all severity levels of TBI. These symptoms while occurring in all severities of TBI can also be found in a wide range of severity. Problems in these types of cognition can fall anywhere from an inability to remain focused for extended periods to loss of ability to concentrate for anything longer than a couple of moments at a time (Harris, Mishkin, & Ross, 2012).

Memory loss following TBI is commonly found. The most common occurrence of memory

loss is short-term loss related to mTBI. In moderate and severe TBI memory loss is also seen and can be short and long-term (Harris, Mishkin, & Ross, 2012). Problems related to memory in TBI are often found because the parts of the brain that are needed for absorbing, holding, and retrieving memory suffer damage in TBI. Depending on the part or parts of memory areas of the brain that are damaged or impaired can cause problems in creating new memories after TBI, recalling memories or making memories after TBI, or recalling memories from before the TBI. It is also possible that all of these areas can be impacted with the symptomatic experience being a loss of pre- and post-injury memory (BrainLine, 2009). TBI is also associated with an increased risk of dementia, which can be related to the damage that occurs to the memory centers of the brain. This increased risk for dementia is associated with all TBI severity levels, but is known to rise with more severe instances of TBI (Stocchetti & Zanier, 2016).

Problems with attention and concentration are often regarded as the single most reported cognitive symptoms associated with TBI. Attention and concentration deficits can range from an inability to pay attention or concentrate for long periods of time to an inability to maintain attention or concentration at all or difficulty with skills such as multitasking. This can cause a range of problems particularly issues relating to maintaining a job or attending school, and problems with social interactions. Children with TBI are at an increased likelihood of developing ADD/ADHD in connection to the attention deficits from TBI. This association between ADHD and TBI is primarily associated with children and severe TBI. The relationship between ADHD and TBI is interesting as TBI increases the likelihood of ADHD but, children with diagnosed ADHD are also found to be at an increased risk of incurring a TBI (Yang, et al., 2016).

Communication disorders

There is a wide range of communication-based disorders that can occur with other symptoms, ranging from stuttering to non-verbal. Common symptoms found within communication disorders are slurred speech, dysarthria, loss of volume control in speech, and difficulty explaining what the person is trying to convey. In most cases communication problems in TBI affecting speech, language skills, or both are related to the area of the brain impacted, TBI patients with communication disorders can have difficulties in expressive and/or receptive language (Harris, Mishkin, & Ross, 2012). This creates the potential for an extraordinarily wide array of communication disorders to occur. These types of problems can be short or long-term. Some will experience short-term communication disorders that subside within the first six months post-injury. If disorders persist beyond the first year while more likely to have a lasting permanent impact the disorder can be relieved in some cases with treatment from a speech-language pathologist. Aphasia is the most severe communication disorder associated with TBI with the loss of verbal skills or receptive language skills and in extreme cases, loss of both. Outside of brain damage to the communication centers of the brain, dysarthria can be a symptom related to muscular weakness that impacts communication ability. In the case of dysarthria, a speech-language pathologist can again be utilized to help regain muscular strength and in turn regain lost verbal skills (Toshniwal & Joshi, 2010).

Aphasia. Aphasia can occur in relation to TBI in two forms, non-fluent and fluent. Non-fluent aphasia refers to a person that experiences difficulty or an inability to produce speech. This form of aphasia can range from an ability to produce short sentences but with a great level of effort to the individual being nonverbal. Fluent aphasia is depicted as a person who has difficulty with receptive language. This can be experienced both in difficulty understanding what

others are saying and in problems with using the correct language in speech. The most commonly seen form of fluent aphasia in TBI is anomia. Anomia refers to difficulty specifically with producing the correct names for objects. The diagnosis of anomia in TBI can be complex as it can be easily confused with a symptomatic memory deficit rather than a communication disorder (Rao & Vaishnavi, 2015).

Post-Traumatic Headache

One of the most frequently reported symptoms following TBI for all severity levels is post-traumatic headache (PTH). As many as 90% of TBI survivors may suffer from PTH at some point following their injury with many of these instances resulting in a persistent headache that lasts more than one-year post-injury (Hoffman, et al., 2011). The regularity of PTH typically will range from several times a week to daily. In other symptoms experienced with TBI as severity level of TBI increases the severity of symptoms increases as well. However, the PTH severity level of TBI was not found to impact the severity or frequency of headache (Hoffman, et al., 2011). PTH is not diagnosed with neuroimaging and cannot be predicted as a potential symptom for a TBI survivor. It is known that PTH can be a direct result of TBI or can be caused by secondary consequences of TBI such as stress, depression, and/or anxiety (Channell, Mueller, & Hahn, 2009). PTH should be monitored as it can result in further neurological changes and dizziness (Harris, Mishkin, & Ross, 2012).

PTH that occurs immediately after injury in cases of severe TBI can be particularly dangerous. Headaches with severe pain can be the result of extremely high pressure in the brain. The level of pressure that causes this type of headache can indicate that the brain has reached a level of pressure that is so high the brainstem can become trapped. It can become fatal if the brainstem is trapped and is not caught quickly enough to alleviate the pressure or prevent the

pressure from continuing to increase (Rao & Vaishnavi, 2015).

Psychological changes

In all severity distinctions of TBI psychological changes and psychiatric disorders can be a common symptom experienced. Within one-year post-injury more than one-fifth of TBI survivors will experience one or more psychiatric disorders (Maneewong, et al., 2017). In instances of mTBI approximately 20% of patients will experience some level of psychosocial problems (Valente & Fisher, 2011). TBI is often connected to depression, anxiety, psychosis, posttraumatic stress disorder, and overall changes in personality (Stocchetti & Zanier, 2016). In mTBI the primary psychosocial changes are associated with mood disorders; anger, inappropriate yelling, physical violence, bipolar disorder, suicide, aggression, aphasia, apathy, mania and anxiety disorders (Valente & Fisher, 2011). Many of these psychological changes are dependent on the area(s) of the brain that has been impacted by the TBI. However, some of the changes are reactive in nature due to the patient's injury and are not directly related to the site of injury.

Psychological symptoms can be both short and long-term in TBI cases. Some of the psychiatric symptoms are temporary while others remain persistent. Symptoms that are found to be temporary will typically abate within the first few weeks following the initial injury (Stocchetti & Zanier, 2016). Long-term symptoms can persist throughout the patient's lifespan.

Psychological symptoms pose a difficult problem in terms of diagnosis. The traditional method of diagnosing is to follow the *Diagnostic and Statistical Manual of Mental Disorders* (DSM) for guidelines on disorders. TBI patients will often be outliers in terms of reflecting what the DSM states in certain disorders. The difficulty is rooted in the similarity of some of the symptoms of TBI with psychiatric disorders. This can complicate a diagnosis when symptoms

are attributed to a neurocognitive disorder (TBI) instead of directly to the psychiatric disorder (Lauterbach, Notarangelo, Nichols, Lane, & Koliatsos, 2015).

Depression. Major depression has been reported in all severity levels of TBI as one of the most common symptoms associated with TBI. Depression can occur as a secondary reaction to living with TBI, but can also occur from injuries incurred during TBI. Neural circuits that rupture in various parts of the brain, changes in neurotransmission systems of hormones such as serotonin and dopamine, and damage to the hippocampus can all be related to causes of depression in TBI survivors. Depression associated with TBI has also been found to have an increased co-morbidity with anxiety. The combination of depression and anxiety is commonly found in TBI patients with right hemispheric injuries while depression without anxiety is more commonly found in left hemisphere-based injuries (Schwarzbold, et al., 2008).

Behavioral Disorders

Behavioral disorders can occur in all severity types of TBI but are most commonly seen in severe TBI. Relatives reporting that the individual with TBI does not seem to behave the same way post injury as they did before is one of the hallmarks of a post-TBI behavioral disorder.

The symptoms of a TBI related behavioral disorder fall into the long and short-term categories with symptoms being noted immediately or within the first-year post-injury and then being maintained beyond five years post-injury. Symptomatically some of the behavioral changes that are observed in TBI are related to higher agitation levels, aggressive behavior, irritability, substance abuse, and apathy (Stéfan & Mathé, 2015).

Impulsivity. Personality changes surrounding TBI are common however, one of the most commonly experienced is changes in impulsivity. This impulsivity is often seen as the individual with TBI acting without concern for the consequences of their actions. Impulsivity has many

possible manifestations in TBI aside from lack of understanding of consequences including urgency and sensation-seeking behavior. These uncontrolled impulses can lead to some of the other behavioral changes associated with TBI (Kocka & Gagnon, 2014).

Agitation. Agitation is a frequently seen behavioral change in relation to all severity levels of TBI. Agitation in relation to TBI refers to an individual experiencing a lower threshold for being agitated. Expression of agitation can vary from self-harm, harm to others particularly caregivers, and generalized upset. These emotional disturbances can impact behavior at times requiring medications to be increased or changed, increased time spent in hospital or rehabilitation settings, and inability to attend therapies. One of the greatest problems, however, relates to agitation levels that prevent independence. In some cases, patients can become agitated so greatly and frequently that independent living can become dangerous both to the patient themselves and others (Williamson, et al., 2016).

Pseudobulbar affect. Pseudobulbar affect is considered an ancillary other TBI symptoms or a primary symptom as a result of the brain injury itself. Fatigue is complicated to define because there is no specific measure for it, and it is often based on self-reporting by the individual. Accommodations are often required in the schedule of TBI survivors as they will tire more quickly from less strenuous activities than before their injury (Harris, Mishkin, & Ross, 2012).

Fatigue

Fatigue can be caused by diffuse axonal injuries and injuries to parts of the brain that relate to arousal, attention, and speed. Fatigue can also be the result of the effort that tasks can take post-injury. For instance, if attention and concentration are impacted by TBI, concentration may cause fatigue post-injury, although it would not have been a factor pre-injury. Fatigue can also

be related to endocrinopathies that can be symptomatic of TBI. Low growth hormone levels in TBI survivors can cause fatigue levels to increase post-injury (Ponsford, n.d.). A deficit in growth hormone is found in nearly one quarter of those with moderate and severe TBI making this a significant problem. Growth hormone replacement therapy has been minimally studied in individuals with TBI but has shown promise in improving cognition and muscular fatigue post-injury (Mossberg, et al., 2017).

Sleep Disorders

Individuals with TBI are three times more likely to develop a sleep disorder than the general population, making it a common symptom associated with TBI. Insomnia, circadian rhythm disorder, sleep apnea, and occasionally narcolepsy are all found in association with TBI (Viola-Saltzman & Watson, 2012). Sleep disorders can be caused by disturbances to the sleep and wake centers of the brain but, can also be symptomatic of existing symptoms. Symptoms of TBI such as depression, fatigue, and pain can cause sleep disorders. Symptoms of TBI causing sleep disorders can also intensify existing TBI symptoms. Sleep deprivation or disturbances can also impact cognitive functioning and emotionality, which can further exacerbate existing symptoms. Sleep disorders occur in all severity levels of TBI and can begin at any time, long or short-term (Rao & Vaishnavi, 2015).

Talk and Die/Deteriorate

“Talk and Die” or “Talk and Deteriorate” are colloquial terms used to explain a particular phenomenon in TBI patients that is associated with moderate TBI (Stanly, Tejasree, Nandini, & Ponnusankar, 2017). Patients who fall in this category originally appear to have a TBI that is survivable but may suddenly deteriorate. Unfortunately, most of these patients die. Patients who speak following injury can earn a positive scoring on the verbal portion of the Glasgow Coma

Scale. The high score in this section results in a ranking of moderate TBI despite other categories being low. Patients with “talk and die” will seemingly have a sudden decline and death although it is being discovered that this may be attributed to delays in care due to the inaccurate moderate TBI ranking (Godoy, Rubiano, Rabinstein, Bullock, & Sahuquillo, 2016). This condition is typically found in patients with TBI who have a delayed bleed that goes unnoticed (Stanly, Tejasree, Nandini, & Ponnusankar, 2017).

Post-Traumatic Epilepsy

Seizures that occur following TBI can occur in three different time period classifications; (a) immediately following or within the first day after TBI, (b) in the early stages or the week following TBI, and (c) late which refers to the first seizure occurring any time after the first-week post-TBI. Seizures that occur in the late category have the highest risk of developing into a seizure disorder. Seizures that occur in the early or immediate stages can also develop into seizure disorders but are more likely to be an isolated occurrence. Due to the nature of seizures and the potential danger that they hold for further disturbances to the brain, developing epilepsy post-TBI can impede recovery or make existing symptoms worse (Rao & Vaishnavi, 2015).

In severe TBI approximately one-quarter of patients will eventually develop post-traumatic epilepsy. Post-traumatic epilepsy can begin weeks, months, or even years after the onset of injury. This form of epilepsy also creates increased vulnerability in the brain particularly the cortical and subcortical areas (Bramlett & Dietrich, 2015). Post-traumatic seizure disorders can also occur in mild and moderate TBI cases however, the instances reduce to approximately five to ten percent of cases. Evidence supports a higher risk of developing post-traumatic epilepsy in cases where the TBI was the result of a penetrating or open injury (Stocchetti & Zanier, 2016).

Endocrinopathies

A common symptom seen across mild, moderate, and severe TBI involves hormonal deficits, and severity can be associated with the degree of the TBI.

Many hormones can be impacted but some of the most commonly reported are growth hormone, gonadotropin, and cortisol (Stocchetti & Zanier, 2016). Statistics show that up to 59% of TBI survivors have been found to have problems with pituitary gland function. Loss of normal regulation in the endocrine system is suspected yet not fully understood at this time (Li & Sirko, 2018). Hormones that are inappropriately produced due to problems or dysfunction in the endocrine system can result in other problems or symptoms experienced by patients with TBI.

Multiple Organ Trauma and Traumatic Lung Injury

Traumatic brain injury is not solely associated with neurologic symptoms; there are non-neurologic symptoms that can be found within this diagnosis as well. One of these types of complications is multiple organ trauma and lung trauma. Nearly 90% of patients with severe TBI will concurrently develop some form of dysfunction in at least one organ. In cases of severe TBI, multiple organ trauma has been found to be connected to a higher risk of developing infections, and slower overall recovery times. Lung trauma is a particularly concerning organ trauma following TBI. This form of organ trauma can occur immediately following the onset of injury but can also occur in the long-term. Lung complications occurring in patients with severe TBI, can increase mortality rates (Baum, Entezami, Shah, & Medhkour, 2016).

Fatality

Fatality is not traditionally a symptom but rather a result of TBI, however in the case of the complexities of TBI, fatality can be the result of other symptoms produced from the TBI. In TBI of any severity, there is an increased mortality risk, not only from the injury itself, but also

from symptoms such as impulsivity, suicidal thoughts, sepsis, and neurodegenerative diseases (Stocchetti & Zanier, 2016). Majority of deaths related to TBI occur within the first two weeks post-injury. A large portion of these deaths appear to be related to not arriving at trauma centers quickly enough, misdiagnosed Glasgow Coma Scale levels, and an inability to clear airways (Gerber, Chiu, Carney, Härtl, & Ghajar, 2013). In severe TBI mortality rates are significantly increased due to high levels of intracranial pressure. Specifically, intracranial pressure that gets too high due to not being appropriately monitored post-injury (Farahvar, et al., 2012). There is a known reduction in lifespan among TBI survivors of six to seven years when compared to those without TBI (Stocchetti & Zanier, 2016).

Traumatic Brain Injury Evaluation Scales

There are a variety of scales that can be used for evaluation and diagnosis of TBI however; each scale comes with its own set of limitations or insufficiencies. The Glasgow Coma Scale is the most commonly used scale with the Rancho Los Amigos Scale of Cognitive Functioning being the second most common (Harris, Mishkin, & Ross, 2012). Other scales can be used to evaluate specific criteria when needed. The Glasgow Coma Scale is the first line scale most often used immediately upon evaluating a patient with TBI to determine status.

Glasgow Coma Scale

The Glasgow Coma Scale is the most regularly used scale for assessment of TBI. In terms of TBI assessment, the Glasgow Coma Scale is simple and can determine current patient status and predict outcome potentials (Opara, Małecka, & Szczygiel, 2014). This scale is used within the first 24 hours following TBI to assess how severe the injury is. The Glasgow Coma Scale uses a numeric scale ranging from one to fifteen with a score that is determined by a patients' ability level in eye, motor, and verbal response tests (Harris, Mishkin, & Ross, 2012).

The specifics of this scale and what the results are interpreted to be can be found in Table 2.1. Following the initial 24-hour time period the Glasgow Coma Scale can be further used to assess a patient's change in status in the critical and immediate stages of the initial TBI (Harris, Mishkin, & Ross, 2012). This allows for some patient's status to improve or decline as their Glasgow rating changes accordingly.

Table 2.1 - Glasgow Coma Scale

	Eye Opening	Verbal Response	Motor Response
1	No response	No response or intubation	No motor response present
2	To Touch/Pressure or pain	Inappropriate response without words, incomprehensible sound	Extension
3	To Sound or verbal command	Inappropriate response but in words	Abnormal Flexion
4	Spontaneous – open with blinking at baseline	Confused but able to answer questions	Normal Flexion or withdrawal from pain
5	N/A	Oriented	Localizing pain
6	N/A	N/A	Obeys Commands
Not Testable	Not Testable	Not Testable	Not Testable

Note. Teasdale, G., Allen, D., Brennan, P., McElhinney, E., & Mackinnon, L. (2014). The Glasgow Coma Scale: An update after 40 years. *Nursing Times*; 110: 12-16. Retrieved from <http://www.nursingtimes.net/Journals/2014/10/10/n/p/1/141015Forty-years-on-updating-the-Glasgow-coma-scale.pdf>

Table 2.1b - Glasgow Coma Scale - Score Interpretation

Severity Level	Total Score
Severe	8 or below
Moderate	9 - 12
Mild	13 - 15

Note. Teasdale, G., Allen, D., Brennan, P., McElhinney, E., & Mackinnon, L. (2014). The Glasgow Coma Scale: An update after 40 years. *Nursing Times*; 110: 12-16. Retrieved from <http://www.nursingtimes.net/Journals/2014/10/10/n/p/1/141015Forty-years-on-updating-the-Glasgow-coma-scale.pdf>

Problems with the Glasgow Coma Scale. The scale is considered to be reliable and valid, and a new scale has yet to be developed that is more reliable or valid (Green, 2011). However, the Glasgow Coma Scale, despite being the gold standard among TBI scales, is fraught with problems and weaknesses. The primary problems with the scale are its inability to accurately predict outcomes and inconsistency in rankings dependent on who performs the scale. TBI can occur independently but frequently occurs simultaneously with other conditions or deficits whether pre-existing or new from the same injury that caused the TBI. When there are co-occurring conditions, the Glasgow Coma Scale can become inaccurate. This can be due to the person performing the ranking miscalculating what occurred as a result of the TBI. For example, a medication that a patient is on, problems with comprehension, and trauma responses can impact how a patient may be ranked. This can result in a person with a mild TBI being ranked as moderate or severe mistakenly due to the simplicity of the categorization in this scale (Opara, Małecka, & Szczygiel, 2014). In addition, results can have a significant change depending on who is administering the scale. For example, nurses with different specialties can produce widely different Glasgow Coma Scale scores (Green, 2011).

The Glasgow Coma Scale also presents problems when it comes to using the scale on patients in the pediatric and geriatric populations. Incidentally, these are two of the most affected age groups with the highest risk for TBI. Patients in the oldest and youngest categories often have different responses to trauma and therefore can have scores on the Glasgow Coma Scale that are not representative of their actual condition at the time the scale is performed. This has been found specifically in the geriatric population when those that receive the highest score on the Glasgow Coma Scale will exhibit worse symptoms over time than younger patients with lower scores (Salottolo, Levy, Slone, Mains, & Bar-Or, 2014).

The Glasgow Coma Scale in its basic use is intended as a triage scale however, it is used as a predictive scale for future outcomes as well. The Glasgow Coma Scale is not accurately predictive for future outcomes of patients. In its function as a triage scale, it can be effective to determine the immediate need for surgical interventions, mortality, and immediate evaluation of injury severity. However, it is weak in its ability to predict actual future outcomes despite its use for this purpose (Green, 2011).

The scale itself was not originally intended to be used in the way it is widely used in current clinical practice. The subscales of verbal, motor, and eye-opening were intended to be separately utilized and not to create a total score (Green, 2011). Using the scale in this manner is problematic as there are 120 possible combinations that the scale can produce. The Glasgow Coma Scale numerical score provides little to no information on what the patients status or future potential are. The variance between the score combination is vast and lacks the necessary precision. A score of 4 on the Glasgow Coma Scale can represent a variety of subscale scores that range from mortality rates of 48 percent to 19 percent, a 29 percent gap applied to one score on the scale (Green, 2011).

Other Scales

Several different scales can be utilized for TBI evaluation depending on what needs to be assessed and the level of disability. It is exceedingly challenging to analyze recovery in patients with TBI due to the vast differences in how patients can present with TBI. The majority of scales are used across mild to severe TBI. Research has been presented that there is perceived benefit to creating separate scales for mTBI and moderate/severe TBI in order to better assess patient improvements and regressions or losses (de Cassia Almeida Viera, de Oliveira, Teixeira, & Paiva, 2015).

Deficit Scales

Deficit scales, as the name implies evaluate a deficit or deficits. These scales are not limited to use in TBI however can be informative particularly when evaluating ability level and rehabilitation needs. The most commonly used deficit scale utilized for TBI patients is the Rancho Los Amigos scale, which is used to evaluate cognitive function.

Rancho Los Amigos. The Rancho Los Amigos scale (Table 2.2) is utilized in TBI cases to assess cognitive functioning. There are eight levels to the scale that represent different degrees of cognition. These levels were created with the understanding that patients can progress through them or remain at a certain level. The levels are organized as follows: (a) level one, no response, (b) level two, generalized, (c) level three, localized, (d) level four, confused and agitated, (e) level five, confused, inappropriate, non-agitated, (f) level six, confused, appropriate, (g) level seven, automatic, appropriate, and (h) level eight, purposeful, appropriate. Each distinction describes reactions and abilities related to cognitive stimulation including, planning, reasoning, awareness, and problem-solving. The purpose of determining a patient's Rancho Los Amigos cognitive functioning level is primarily to aid in creating an appropriate treatment and rehabilitation program (BrainLine, 2010).

In the lowest levels, one through three, responses are not present or abnormal in some way. In level one, a patient exhibits no responses to any type of stimuli. In level two a patient is said to have generalized responses. Generalized response refers to limited responses that are unfocused. When a patient is presented with stimuli multiple times in level two the response types will also tend to be inconsistent. Level three cognitive responses are referred to as being localized. A level three response would be a patient that is delayed in their responses and has inconsistent responses to the same stimuli.

In the next segment of levels, four through six, the stimulus responses improve, and cognitive levels are considerably higher, however, there are still issues with cognition found in these levels. Level four, confused, agitated response is hallmarked by strange behavior from patients. There will often be inappropriate responses to stimuli and/or responses that appear to not have been done with purpose. Level four also shows a short attention span for cognitive tasks and little to no short-term memory of cognitive experiences. Level five, confused, inappropriate, non-agitated responses are slightly improved from the previous level however still non-purposeful. In the case of a patient ranked at level five, their responses to simple commands are consistent but any more complex stimuli are met with seemingly random and unsure responses. At this level, patients have trouble with memory, particularly with taking in new information. Level six again shows improvements from the level before it but still exhibits clear cognitive deficits. At this level, patients have direction in their responses and appropriate reactions to stimuli. Memory continues to be problematic making new tasks difficult to respond to and complete (BrainLine, 2010).

In the final two levels a patient can rank in for the Ranchos Los Amigos scale, there is a great cognitive improvement and clear ability; yet continued problems with judgment and reasoning persist. In level seven, automatic, appropriate response patients have appropriate responses to stimuli, particularly when in a setting that is familiar to them. New tasks can be learned and remembered to some degree however it is lower than the normal cognitive expectation. This level also shows patients despite improving in memory abilities having problems with judgment. Finally, in level eight, purposeful, appropriate response patients will have appropriate responses to stimuli but will have problems with reasoning. New situations will be particularly difficult to understand, and patients will need assistance recognizing new stimuli.

Patients at this level are often aware of their need for assistance and slowed pace for taking on new stimuli (BrainLine, 2010).

Table 2.2 - Rancho Los Amigos Scale

Level	Description
Level I	No response
Level II	No response to external stimulus Generalized response Reacts to external stimulus in nonspecific and inconsistent manner and only exhibits limited responses
Level III	Localized response Specific and inconsistent responses with delay in response to stimulus. Can follow simple commands for motor responses
Level IV	Confused and agitated response Non-purposeful, incoherent, inappropriate behavior. No short-term memory, attention span is short and nonselective
Level V	Confused, inappropriate, non-agitated response Random and non-purposeful responses to complex stimulus. Simple commands can be followed. Memory and selective attention impaired. New information cannot be retained.
Level VI	Confused, appropriate response Gives appropriate responses that are dependent on external input. Carry-over for relearned tasks but not for new tasks. Recent memory problems present
Level VII	Automatic, appropriate response Appropriate responses in familiar settings. Shows carry-over for new learning at lower than normal rates. Initiates social interaction but, shows impaired judgment
Level VIII	Purposeful, appropriate response Oriented and responsive to environment. Abstract reasoning is reduced when compared to premorbid ability

Note. The Center for Outcome Measurement in Brain Injury. (n.d.). Rancho Los Amigos Scale: Level of cognitive functioning scale. Retrieved from <http://www.tbims.org/combi/lcfs/lcfs.pdf>

Functional Scales

Functional scales are used to assess the functional level of patients, particularly the level of independent functioning. These scales typically use information based on how a patient can perform activities of daily living and to what level they require assistance. Commonly assessed areas are the ability to feed, dress, and toilet oneself. These seem to be reasonably simple to assess however the scales can have a significant enough level of variance that there is a necessity to understand all relevant scales (Mlinac & Feng, 2016). The Rankin Scale, and now Modified Rankin Scale, is the most commonly used scale in this category. These scales are not limited to TBI evaluation. Functional scales can be used across a wide range of neurologic or non-neurologic disorders or disabilities. The scales are most commonly used to evaluate the level of assistance a person will require to attain their necessary daily functionality level.

Modified Rankin Scale. The Rankin Scale was first established in 1957 and was later modified and updated in the 1980s to what is currently used today. The Modified Rankin Scale is an evaluation tool that is primarily used in patients following a stroke (Broderick, Adeoye, & Elm, 2017). Its purpose is to utilize seven different ranking levels to evaluate the level of independent functioning in a patient. The scale runs from zero to six with zero representing a patient that is fully functionally independent and six representing a deceased patient (Nuno, Bath, & Gray, 2016). The Modified Rankin is typically considered to be the most commonly used functional scale in TBI cases.

Table 2.3 - Modified Rankin Scale

Score	Functional Level
0	No symptom present
1	No significant disability despite present symptoms. All regular activities can be completed
2	Slight disability – Some assistance needed to complete activities but affairs can be tended to without assistance
3	Moderate disability - able to walk independently but requires help with daily activities
4	Moderate severe disability - unable to walk to attend to bodily needs without assistance
5	Severe disability - incontinent, bedridden, requires constant care and attention
6	Death

Note. Stroke Center. (n.d.). Modified Rankin Scale (MDS). Retrieved from http://www.strokecenter.org/wp-content/uploads/2011/08/modified_rankin.pdf

Katz Index of Independence in Activities of Daily Living. The Modified Rankin Scale is the most frequently used functional scale in TBI but, the Katz Index of Independence in Activities of Daily Living (Katz) scale (See Appendix B) is the most commonly used across diagnoses. This evaluation looks at bathing, continence, feeding, dressing, and toileting. Patients are rated as either dependent or independent in each category. This evaluation is often used for evaluation of long-term disability despite that dependence level can conceivably change over time. The Katz is also commonly used as a measure that can lead to the use of more descriptive measures (Mlinac & Feng, 2016). The basic outline of dependence versus independence that the Katz provides shows a sketch of a person’s functional levels. This can lead to the use of another evaluation, such as the Modified Rankin to discover more information.

Barthel Index. The Barthel Index (See Appendix C) assesses activities of daily living through evaluation of ten categories; (a) feeding, (b) grooming, (c) dressing, (d) bladder, (e) bowel, (f) toilet, (g) bathing, (h) transfers, (i) stairs, and (j) mobility. These categories are assessed for a time period of one to two days by a combination of observation and self-report data. The score applied to each of the categories is determined based on the amount of assistance the individual needs. The total score is out of one hundred points; however, the categories are not all weighted equally. Transfers and stairs are worth a higher number of points as deficits in these categories can have a greater impact on activities of daily living. This measure is considered to be reliable, however it is typically limited to being used for acute treatment settings as the measures do not fully evaluate an accurate depiction of long-term disability (Mlinac & Feng, 2016).

Functional Independence Measure (FIM). The Functional Independence Measure (FIM) (See Appendix D) is a more complex functional evaluation when compared to the Katz and Barthel. The FIM not only evaluates the basic categories of activities of daily living found in the two previously mentioned evaluations but takes the evaluation a step further by adding communication abilities and cognition. This is often used when cognition and communication symptoms are experienced and may alter an existing understanding of a person's functional abilities post-injury. This scale can be used in clinical settings but is also commonly used by the patients and their families to determine functional levels on their own (Mlinac & Feng, 2016). The FIM can be used by caregivers, however it is limited to determining if the individual requires admission to a rehabilitation center or hospital, can be discharged, or has met their goals. This method is effective for determining if a patient requires medical services but, it is not beneficial in tracking the progression of symptom experience. This assessment tool also does not

evaluate the range of all symptoms that are commonly associated with TBI.

Quality of Life Scales

These scales are dependent on the patient, themselves being able to answer the question. Problems often occur in TBI that cause a patient to be incapable of following the assessment, comprehending the assessment, or answer the questions independently. When these problems occur, despite their validity, these scales are omitted due to the inability to appropriately and accurately be administered (Wong, et al., 2014).

Sickness Impact Profile. The Sickness Impact Profile (See Appendix E) is an assessment used to evaluate dysfunction and a person's quality of life or in the case of this assessment, the level to which their life has been impacted, following an illness or disability. The assessment uses a series of Yes and No based questions to evaluate. It assesses areas such as (a) behavior, (b) life participation, (c) mental health status, and (d) relationships. The Sickness Impact Profile is not specific to TBI but is used across diseases and dysfunctions to evaluate a person's perceived quality of life within the illness or dysfunction being experienced. Results are presented in a range from 0 to 100 percent with a score of 0 percent representing a completely healthy person and 100 percent indicating a person with 100 percent dysfunction and complete dependence. The scores are then evaluated to determine to what extent the person's illness or dysfunction impacts their life (Prcic, Aganovic, & Hadziosmanovic, 2013).

Short Form-36. The Short Form-36 (SF-36) is widely used for evaluating health-related quality of life (See Appendix F). The scale can also be used to evaluate health status. This scale evaluates on eight items: (a) physical function, (b) role physical, (c) pain, (d) health in general, (e) vitality, (f) social, (g) role emotional, and (h) mental health (Lins & Carvalho, 2016). The SF-36 is generally considered for health-related quality of life however this evaluation more

specifically looks at limitations in functioning. The eight categories on this scale can also be used as independent measures when needed. For example, in the case of a hip fracture, a patient can be evaluated on the physical functioning scale element. This SF-36 offers the ability to pick and choose which elements are relevant to each specific patient's needs (Bohannon & DePasquale, 2010).

Quality of Life After Brain Injury scale. The Quality of Life after Brain Injury Scale or QOLIBRI (See Appendix G) as with the other quality of life scales described is a health-related quality of life scale that is used post-injury for TBI patients as well as patients with other types of brain injuries. This scale covers: (a) physical condition, (b) cognitive ability, (c) emotions, (d) daily life function, (e) social ability, (f) future prospects and current ability level. The QOLIBRI also has a more concise version that can be used when needed, as patients with TBI often do not hold the stamina to complete a lengthy assessment. The Quality of Life after Brain Injury Overall Scale (QOLIBRI-OS) is validated for TBI patients to assess health-related quality of life post-injury (Wong, et al., 2014).

Chapter 3: Methods and Procedures

Methods

The research for this paper was compiled using the resources found on the University of Bridgeport's Wahlstrom Library's Internet database. Databases including, PubMed, EBSCOhost, books, and websites were used.

Procedures

Search procedure. A careful review of the literature related to traumatic brain injury symptoms was conducted. The review highlighted the following topics: (a) traumatic brain injury, (b) symptoms of traumatic brain injury, (c) traumatic brain injury scales, (d) mTBI symptoms, (e) moderate traumatic brain injury symptoms, (f) severe traumatic brain injury symptoms, (g) traumatic brain injury cognitive symptoms, and (h) traumatic brain injury physical symptoms

Libraries used. The Health Professions Divisions Library at the University of Bridgeport's Wahlstrom Library was the only library used for this research paper.

Search engines and databases used. The following databases were used to search for the sources for this project. The databases used were PubMed, EBSCOhost, and National Institute of Health (NIH).

Search terms. Several search terms were used to identify sources for this project. The search terms included: (a) symptoms of traumatic brain injury, (b) Glasgow Coma Scale, (c) severe traumatic brain injury symptoms, (d) mild traumatic brain injury symptoms, (e) moderate traumatic brain injury symptoms, (f) long-term outcomes of traumatic brain injury and (g) traumatic brain injury symptom changes.

Boolean strings. Boolean strings were considered for the literature search. Four Boolean

strings were used: (a) severe AND traumatic brain injury, (b) moderate AND traumatic brain injury, (c) mild AND traumatic brain injury, and (d) traumatic brain injury AND symptoms

Age of the sources. The significant literature has been reviewed. Sources from the last fifteen years have been considered for inclusion in the review of the literature. Pertinent historical or seminal articles were also considered.

Inclusion criteria. There were four inclusion criteria. The inclusion criteria included (a) literature published since 2004, except historical sources; (b) English-language text; (c) articles related to traumatic brain injury; and (d) Web sites relating to traumatic brain injury.

Exclusion criteria. There were four exclusion criteria. The exclusion criteria included (a) literature published before 2004, except historical sources; (b) text not published in English; (c) articles not related to traumatic brain injury; and (d) Web sites not relating to traumatic brain injury.

Chapter 4: Results

Traumatic brain injury is a substantial health problem throughout the world. The number of people impacted by TBI annually is increasing making this condition a greater concern than ever before. The projection of individuals impact by TBI is suspected to be 3 to 4 times higher than the available data notes. This is due to the number of impacted individuals that either do not have access to care or do not seek care (McCallister, 2008). There are serious health concerns associated with mild, moderate, and severe TBI but in moderate and severe, the outcomes associated with TBI are at an increased risk of being poor (Huijben, et al., 2019). The potential symptomatic experience associated with TBI is incredibly vast. The symptoms reviewed in Chapter Two are some of the most commonly experienced and some of the most debilitating that occur in association with TBI. However, this compellation is not exhaustive and does not include each singular possible symptom that can be found within this diagnosis. TBI can occur in so many different symptomatic combinations that the condition can be as unique as an individual's fingerprint. To further compound the uniqueness of TBI symptoms the symptomatic experience is constantly evolving in the form of both improvements and regressions as well as new symptoms that occur in the long-term following the initial injury. Evidence of change in symptoms is not always clear as it may occur at a quick pace or slowly but subtly (Adoni & McNett, 2007). How TBI is experienced immediately following diagnosis or onset of injury is not necessarily a representation of how the condition will manifest itself in the future. However, the way the TBI is diagnosed can critically impact the outcomes associated with the injury in the future. This means that having a diagnostic tool or scale that is available to be used immediately following injury is necessary. This must also be a tool that can be flexible for use in the future as conditions change or that can be used to complement to a scale that can grow and change with

the patient in the future. The complexity of TBI means that more than one evaluation tool is necessary. However, the lack of an evaluation tool that notes symptoms specifically makes it difficult to measure symptom changes across the number of healthcare providers, caregivers, and clinicians that are involved in treating and caring for those with TBI.

The extraordinarily wide scope of symptoms that have the potential to exist within a TBI diagnosis can be oversimplified. In some cases, symptoms are misrepresented by the scales most commonly used to portray individuals with TBI. The Glasgow Coma Scale is the most commonly used scale for assessment of TBI due to its simplicity and ability to not only immediately assess, but allow for information that can be beneficial. However, it may not be beneficial for predicting future outcomes (Green, 2011; Opara, Małecka, & Szczygiel, 2014). While the Glasgow Coma Scale is held as the most relevant assessment tool for the TBI diagnosis it is primarily used within the first hours to days following the initial injury and typically does not continue to be performed on patients throughout the rest of their lifespan. In its most basic sense, the Glasgow Coma Scale is best used as a triage scale, which is needed for TBI evaluation, but the symptoms of TBI continue to be present and continue to change beyond the time period of hospitalization and rehabilitation (Salottolo, Levy, Slone, Mains, & Bar-Or, 2014). The Glasgow Coma Scale covers three functions: (a) visual, (b) verbal, and (c) motor. While these are three major categories of symptoms experienced following a TBI, these symptoms by no means are the only potential categories. These three categories focus on impairment to the central nervous system, which is important and relevant in TBI cases but does not create an entire picture of a patient's condition (Salottolo, Levy, Slone, Mains, & Bar-Or, 2014). This can cause lapses in care and treatment. Other symptoms experienced can include hearing losses, pupillary changes, spasticity, dystonia, cognitive deficits, communication

disorders, headache, depression, behavioral disorders, sleep disorders, epilepsy, organ trauma, and endocrinopathies. These symptoms are either not represented at all, are represented minimally or as fringe symptoms to the three categories tested.

Within the Glasgow Coma Scale, there are only four to six levels that a patient can be scored within per category. The other scales presented including the Rankin, Ranchos Los Amigos, and others present similar problems due to their narrowed scope. When delving into an evaluation of a condition with such a vast array of symptoms that can be experienced, it is necessary to have a wide range of symptoms and experiences represented on the scales. For immediate post-injury evaluation, it may be acceptable to use a concise version of a scale, but it should not be the only version available for evaluation in the future. As a patient grows and changes within their diagnosis more extensive symptomatic evaluation may be necessary and the existing scales are not broad enough to cover the necessary scope.

The Ranchos Los Amigos Scale explores deficits related to cognition which are not covered by the Glasgow Coma Scale to the extent that the Ranchos Los Amigos covers them. However, this again leaves room for a great number of symptoms to go unranked even if both scales are utilized, as they commonly are. The scaling is again too vague and does not cover what the differences between each ranking mean to the extent needed. Using two separate scales can also leave room for the crossover of one symptom causing another. For instance, a patient may have a sensory sensitivity to sound post-injury due to damage to the ability to process sensory input. This sensitivity causes headaches in response to sound, if headaches are evaluated but sensory is not it may be missed that this is not a case of post-traumatic headache but is instead a sensory processing problem.

The gaps in symptoms not found on TBI scales are problematic, not only from a patient standpoint, but also for family members and providers. Take for example a patient going to a medical appointment with the information given to a healthcare provider that they are experiencing TBI with a Glasgow Coma Scale score of seven and a Rancho Los Amigos Scale level of three. The provider now knows that the patient has severe TBI but little else is known. This score could indicate that there is a high-level verbal response and no motor responses or eye-opening. This could also mean that the patient has eye-opening to sound, no known verbal responses, and abnormal flexion to stimulus. The combinations that can be created are vast and mean a wide variety of different presentations that do not allow for an accurate picture of the patient based on their scale score (Opara, Małecka, & Szczygiel, 2014). The 120 possible combinations of scores from the Glasgow Coma Scale make it difficult to pinpoint what a score on the scale means (Green, 2011). Based on the Rancho Los Amigos Scale the provider is aware that the patient presents with delayed or inconsistent abnormal cognitive responses but can likely follow some motor commands (BrainLine, 2010). This creates a problem particularly for patients that are non-verbal, have severe cognitive deficits, and physical deficits such as quadri- and paraplegia and need providers to have a greater awareness of their condition before attending an appointment. While these items can be explained separately in additional documentation, however, it creates the potential for additional complication with providers and insurance.

For example a patient with severe TBI or their caregiver(s) can provide more details on their exact reasons for their scoring on the Glasgow Coma Scale and Ranchos Los Amigos Scale but may also need to indicate that they have hearing loss, high spasticity and tone, dystonia, low attention span capacity, post-traumatic headache, depression, epilepsy and a sleep disorder, all of which may not be appropriately represented by their scale scores. These symptoms that are

outliers on the scales may also be the cause of some of the items on the scale. Many of the symptoms of TBI cause other symptoms of TBI, take for instance the sensory processing difficulties that can cause headaches or sleep disorders.

Quality of life scales can also be used to evaluate TBI such as the Sickness Impact Profile, Short-form 36, and QOLIBRI. These scales tend to look at a wider range of ways that TBI can impact a person's life including emotional impact, future prospects, and how their symptoms of TBI impact their life on a daily basis (Wong, et al., 2014). The problem with this scale category is similar to the others, it does not include a wide range of symptoms. There is minimal coverage of what is being experienced on a daily basis. Presenting a provider with a score on the QOLIBRI still does not depict an accurate picture of what that individual's TBI presentation looks like. These scales can also be problematic as a non-verbal TBI patient, for instance, may not be able to participate in this type of scale due to their inability to answer the questions presented. This scale can also vary day to day as TBI can present differently on different days without warning. For example, a patient dealing with endocrinopathies can be further exacerbated by a female's menstrual cycle. A female going through an evaluation may score inaccurately if she is experiencing symptomatic endocrinopathies that are worsened by hormonal changes related to her menstrual cycle (Appelbaum & Acharya, 2011). This could make evaluation scores differ greatly depending on the day they are conducted.

The complicated diagnosis of TBI typically requires the involvement of caregivers for the individual with TBI. Most often these caregivers will be parents, spouses, or siblings (Qadeer, et al., 2017). The caregivers will typically be the people who know the care-recipient the best and have the most access to information on symptoms. Not only on the symptoms themselves but how they change in both the long- and short-term. Another purpose of creating a symptom

evaluation tool is to make it simple enough so that caregivers without medical trauma training would be able to easily comprehend and evaluate the care-recipient (Green, 2011). Ideally, this would allow for greater understanding between caregivers and healthcare providers on the needs of the patient. This compellation of symptoms and evaluation scales has yielded the result that a reevaluation or extension of existing TBI scales is in order. A scale that would be effective for this diagnosis would need to include a comprehensive overview of all potential symptoms divided into categories. This scale should also require an outline of a period of time during which the evaluation would need to be repeated, including a variety of times of the day. This would allow for a patient who is capable in the mornings but tires easily and becomes exhausted by the evening to maintain the possibility of a higher ranking for certain times of day than others. To use the example of changes related to the menstrual cycle, this would create the potential for an individual to rank in one ability level during some parts of the month and another ability during their menstrual cycle. This can widen the opportunity for patients experiencing symptoms of TBI but also open the potential for more possible therapeutic intervention based on ability level.

The current scales also leave a great deal of the evaluation up to interpretation. For example, to use the Modified Ranking Scale, this scale offers a numerical scoring system ranging from 0 – 6 with each number representing a different level of functionality. The scale can then be applied many functions to be performed by the patient to evaluate their level (Nuno, Bath, & Gray, 2016). However, it is possible that the individual evaluating their task can unintentionally influence the scoring process. An element as simple as patience can influence how an evaluation score comes out. In a functional scale such as the Modified Rankin Scale when evaluating a person's ability to dress themselves, waiting and giving the patient time can be necessary. For example, one evaluator may determine after a certain amount of time that the individual cannot

complete the task on their own and requires assistance however, another evaluator may wait longer and determine that the individual does not require assistance. This can produce different scores on the same evaluation. Therefore, a newly created or updated scale for future use in TBI would need to take interpretation into account. This could be accomplished by requiring multiple evaluators or determining time frames for which a task is to be completed that are related to the scoring system.

In a neuropsychiatric assessment, for example, signs and symptoms that are not recorded can be difficult to ascertain (McCallister, 2008). A patient with cognitive deficits may not be able to present a clear clinical picture of their current state as well as their history within an assessment period. This complete profile of information is critical in order to understand, not only what symptoms are present, but also what symptoms might be influencing other symptoms (McCallister, 2008).

A more complete profile of a patient can be presented by creating a scale that notes the baseline presence of symptoms. This scale would indicate whether symptom is present and a basic idea of how significant it is. This allows for further investigation into existing symptoms while creating a full picture of what other symptoms might be acting as influencers.

This scale can also develop over time with an individual's symptoms increasing or decreasing in the severity. The scale can be changed in the long-term and used as a tool to measure progression and regression. It can also be used in the short term to evaluate how symptoms are present at different times of day, when different stimuli are present, when hormonal fluctuations are occurring, etc.

Many patients with TBI also require 24-hour care, a care requirement that most often is filled by family members, typically spouses, parents, and siblings who have the most direct

information on how symptoms are changing and evolving (Qadeer, et al, 2017). A symptomatic evaluation tool that could be utilized both by caregivers and health care providers would help to bridge the gap between what is seen on a regular basis at home and what can be observed during clinical evaluations. This scale would allow for increased communication between patients and caregivers and their providers as well as increased ability to track progression and regression over time.

The proposed TBI Symptom Assessment Scale for Caregivers (Table 4.1) is intended to be simple enough to monitor if symptoms are present and/or are changing. This tool intends to allow for an understanding of the impact of symptoms and how symptoms may impact one another. This tool is also intended to lead toward the further evaluation of symptoms identified within the tool, if needed, to understand how those symptoms are impacting the individual. This tool is not fixed and can be customized to permit for the addition of more symptoms as they apply to the individual. This will aid in the tracking and understanding of how the symptomatic experience is changing. This tool can be utilized in the short term to see how symptoms change from one day to the next or from one time of day to another. It can also be utilized to evaluate how symptoms change in the long-term from months to years to decades to establish reference points. Additionally, this tool can be used to see how changing elements such as hormonal fluctuations, the time of day, seizure activity, amount of sleep, etc. can change how other symptoms are experienced.

The evaluation tool also contains a numerical system to increase the ease by which the scale can be tracked over time. If a symptom is not present the score is zero, mildly present score of one, moderately present a two, moderately to severely present a three and severely present a four. This can also allow for a total score to be evaluated and determine the overall impact of

symptoms. The higher the score the more detrimental symptomatic experience associated with the individual.

Table 4.1 – Proposed TBI Symptom Assessment Scale for Caregivers

Date completed:		Time of day completed:			AM/PM
Symptom	Not Present (0)	Mildly Present (1)	Moderately Present (2)	Moderate to Severely Present (3)	Severely Present (4)
Fatigue	No notable fatigue	Fatigue following 2 or more hours of moderate exertion (i.e. walking, reading)	Fatigue following less than 1 hour of exertion	Fatigue following less than 30 minutes of exertion	Fatigue following less than 15 minutes of exertion
Sensory Overall sensory ability	No notable sensory deficit	One sensory ability compromised	More than one sensory ability compromised	More than two sensory abilities compromised	No sensory ability or extremely compromised ability
Vision	No notable visual deficit	Occasional inconsistency in visual response to stimuli	Inconsistent response to visual stimuli or vision abnormality present	Severely inconsistent response to visual stimuli or vision abnormality present	No vision or no response to visual stimuli
Hearing	No notable hearing deficit	Occasional inconsistency in response to auditory stimuli	Inconsistent response to auditory stimuli (i.e. normal sound levels) or hearing abnormality present	Hearing extremely compromised or minimal to no response to auditory stimuli	No hearing ability

Smell	No notable smell deficit	Occasional inconsistent response to scent stimuli	Inconsistent response to scent stimuli or smell abnormality present	Sense of smell extremely compromised or minimal to no response to scent stimuli	No sense of smell
Physical					
Overall physical ability	No notable physical deficit	In need of assistance for less than 25% of physical tasks	In need of assistance for less than 50% of physical tasks	In need of assistance for more than 50% of physical tasks	Physical ability non-existent or in need of assistance for more than 75% of physical tasks
Walking	Able to walk independently	Able to walk with occasional assistance less than 25% of the time	Able to walk with some assistance less than 50% of the time	Able to walk with assistance more than 50% of the time	Unable to walk or only with complete assistance more than 75% of the time
Spasticity	Not present	Present occasionally in regular intervals	Present occasionally and/or irregularly	Present majority of the time or causing a deficit	Consistently present or causing significant deficit
Movement disorders	Not present	Present less than 25% of the time	Present less than 50% of the time	Present more than 50% of the time	Present more than 75% of the time or causing significant deficit
Primitive reflexes	Not present	Present less than 25% of the time	Present less than 50% of the time	Present more than 50% of the time	Present more than 75% of the time or causing significant deficit

Cognition					
Overall cognitive ability	No notable cognitive deficit	Cognition compromised less than 25% of the time	Cognition compromised less than 50% of the time	Cognition compromised more than 50% of the time	Cognitive compromised more than 75% of the time or causing significant deficit
Memory	No notable memory loss or impairment	Able to create new memories with occasional lapses	Short-term memory loss or inability to create new memories	Short-term memory loss and inability to create new memories	Short- and long-term memory loss and inability to create new memories
Attention	No notable impairment to attention	Inability to maintain attention for 2 hour or more	Inability to maintain attention for 1 hour or more	Inability to maintain attention for more than 30 minutes	Inability to maintain attention for more than 15 minutes or causing deficit in daily function
Concentration	No notable impairment to concentration	Inability to maintain concentration for more than 2 hours	Inability to maintain concentration for 1 hour or more	Inability to maintain concentration for 30 minutes or more	Inability to maintain concentration for more than 15 minutes or causing deficit to daily function
Communication disorders	No notable impairment	Impairments impacting less than 25% of function	Impairments impacting less than 50% of function	Impairments impacting more than 50% of function	Impairments impacting more than 75% of function
Overall communication ability			Impairments impacting less than 50% of function	Impairments impacting more than 50% of function	Impairments impacting more than 75% of function
Motor Skills	No notable impairment	Impairments impacting less than 25% of function	Impairments impacting less than 50% of function	Impairments impacting more than 50% of function	Impairments impacting more than 75% of function
Overall motor function					

Gross Motor	No notable deficit	Impairments impacting less than 25% of function	Impairments impacting less than 50% of function	Impairments impacting more than 50% of function	Impairments impacting more than 75% of function
Fine Motor	No notable deficit	Impairments impacting less than 25% of function	Impairments impacting less than 50% of function	Impairments impacting more than 50% of function	Impairments impacting more than 75% of function
Epilepsy Seizure activity	Not present	n/a	Infrequent and/or controlled seizure activity	n/a	Frequent and/or uncontrolled seizure activity
Emotions Overall emotional capacity	No notable impairment to appropriate emotionality	Notable impairment or inappropriate emotional expression less than 25% of the time	Notable impairment or inappropriate emotional expression less than 50% of the time	Notable impairment or inappropriate emotional expression more than 50% of the time	Severe impairment or severely inappropriate emotionality specifically that impacts daily function more than 75% of the time
Pseudobulbar affect	No notable pseudobulbar affect	n/a	Suspected or potential pseudobulbar affect	n/a	Pseudobulbar affect consistently present
Daily Function Overall daily life functional ability	No notable impairment to daily life functionality	In need of complete assistance for less than 25% of daily functioning	In need of complete assistance for less than 50% of daily functioning	In need of complete assistance for more than 50% of daily functioning	In need of complete assistance for more than 75% of daily functioning

Post Traumatic Headache	No notable impact from headache or no headache present	Less than 25% of functioning impacted	Less than 50% of functioning impacted	More than 50% of functioning impacted	More than 75% of functioning impacted
Overall impact of headache					
Sleep Disorders	No notable impact	Impact present less than 25% of the time	Impact present less than 50% of the time	Impact present more than 50% of the time	Impact present more than 75% of the time
Overall impact of sleep disorders	Not present	n/a	n/a	n/a	Present
Sleep Apnea	Not present	Present less than 25% of the time	Present less than 50% of the time	Present more than 50% of the time	Present more than 75% of the time
Insomnia	Not present	Present less than 25% of the time	Present less than 50% of the time	Present more than 50% of the time	Present more than 75% of the time
Circadian Rhythm Disorder	Not present	n/a	n/a	n/a	Present

To successfully utilize this evaluation tool, caregivers will be able to fill out the symptoms experienced by the individual with TBI. This will allow the symptoms to be tracked in both the short- and long-term for a more comprehensive understanding of how symptoms change over time. Putting this in the hands of caregivers will increase the ability to track these changes. Caregivers who spend the most time with the individual are more familiar with short- and long-term changes (Qadeer, et al, 2017).

Caregivers will be able to fill out the TBI Symptom Assessment Scale for Caregivers by observing the individual with TBI. Typically, healthcare professionals may only interact with patients for small periods of time, whereas caregivers are with the individual the majority of the time. This tool will provide valuable information to healthcare professionals while also allowing caregivers to more easily track symptom changes over time.

Categories on this scale can also benefit from the input of health professionals that are involved. For example, in the vision category, the scaling can be determined by what the caregiver observes of what the individual with TBI is seeing but also how their vision is evaluated in a medical examination. The caregiver's knowledge of the individual, along with the health professional's expertise in the specific field will make it more efficient to track-changes.

As previously stated, the symptoms reviewed here are not exhaustive, and there are many other symptoms that can be experienced in association with TBI. The overall category at the start of each section is intended to aid in filling in these gaps for the individual. If an overall category represents that the symptom is "severely present" but all subcategories represent a level less than severe; then this may be an indication that there is another symptom that could be causing a deficit in that category. The explanation of severity in the symptoms that are represented within this evaluation tool is intended to be a surface level understanding of the symptom. An individual

with TBI that ranks within a category that represents a symptom being present should potentially use this as an indicator that the symptom should be further explored.

The first line of this scale asks for the date and time that the scale was completed. This information is intended to aid in evaluating symptoms over time but also to evaluate how symptoms may change dependent on the time of day. The first symptom evaluated on this scale is fatigue. Fatigue is a difficult symptom for evaluation as there is no exact measurement for fatigue. That is typically left up to the individual, or in this case the caregiver, to determine fatigue levels (Harris, Mishkin, & Ross, 2012). The importance of measuring fatigue is to determine what the individual can handle before fatigue may become an influence on other symptoms. Fatigue is also important when considering the time of day that the scale is filled out in order to determine the influence it may have on other symptom experiences. The fatigue category is based solely on observation by the caregiver of how much activity causes fatigue for the individual. Examples of moderate exertion are provided however it may be beneficial for the caregiver to specify if there are activities that cause fatigue at a faster than normal rate.

Sensory problems are frequently found in association with brain injuries. Three of the primary sensory areas that are impacted are vision, hearing, and smell, however, other areas such as taste can be also be affected (Valente & Fisher, 2011). Testing this category as a part of the TBI Symptom Assessment Scale for Caregivers is important not only for the evaluation of sensory symptoms but also for understanding how sensory deficits may impact other symptoms. The vision, hearing, and smell categories are separated to look more in depth at these more common sensory deficits. The overall category helps to determine if there are other sensory deficits being experienced that are not represented on this scale. Caregivers will be able to utilize this section through observation and medical examinations. For example, the vision category can

be filled out by observation of visual acuity in the individual with TBI but can also be filled out by including results of vision exams.

The range of physical symptoms associated with TBI is vast and difficult to narrow down. The overall ability category in this section determines how much assistance the individual needs with any physical activity from movement to bladder control. This category is broad and can aid in informing the more specific categories as well as picking up on outlying symptoms that are not represented within this scale. Specific symptoms that are defined in this scale under the physical category are walking, spasticity, movement disorders, and primitive reflexes. Caregiver evaluation of these symptoms will be based on observation. The caregiver(s), as the person or people with the most direct knowledge of the individual, is in a unique position to evaluate how much assistance the individual needs as well as how much the symptom is impacting their ability to function. This category also benefits from administering the scale at different times of day to determine if functionality or symptom presence changes.

Some of the most common symptoms associated with TBI are related to cognition. Along with being common these symptoms are also often associated with causing some of the greatest deficits post-injury. The three most common cognitive impairments are memory, attention, and concentration deficits (Stocchetti & Zanier, 2016). Problems with cognition are particularly susceptible to change over time as age-related cognitive loss comes into play as well (Stocchetti & Zanier, 2016). As in other categories, the overall cognition category is placed in this section due to the vast number of other cognitive symptoms outside of memory, attention, and concentration. An individual scoring poorly in overall cognition that is not attributed to memory, attention, and concentration, may provide an indicator for further investigation into cognitive symptoms. This category relies on caregiver observation of how cognitive deficits impact the

individual. The information provided by a caregiver in this category can aid in determining how cognition changes in the long and short-term.

Communication disorders in relationship to TBI can range from a slight stutter to non-verbal. The impact that a communication disorder can have on an individual has a wide range. Caregivers can directly observe the impact of a communication disorder. Communication disorders have also been occasionally found to be a short-term symptom (Toshniwal & Joshi, 2010). This scale may be beneficial in the ability to track whether improvements are occurring.

Motor skills are a broad category that covers the expanse of fine and gross motor skills. These categories in some instances are cross-covered by other categories within this scale. However, due to the variety in symptoms associated with TBI this category is intended to aid in picking up on missed outlier symptoms. It is also intended to aid the caregiver and health professionals in general tracking of improvements or regressions that may occur in motor function.

Epilepsy is common following TBI, especially in cases of severe TBI. Epilepsy following TBI can occur for the first-time even years following the initial injury (Bramlett & Dietrich, 2015). The inclusion of this category is not only intended for evaluation of whether epilepsy is occurring in the individual, but also how seizure activity may impact other symptoms. This category is based on an evaluation of the individual's epileptic status and frequency of seizure activity.

The category of emotion is perhaps the broadest category within this scale. Emotions are often impacted by TBI through issues with emotional control, depression, and inappropriate emotional capacity. In evaluating emotions this scale can help to determine where a problem may be occurring as well as indicating if there is something that should be further investigated.

Pseudobulbar affect is separated into its own category to help identify if this condition may be impacting other emotional symptoms being experienced.

The two categories of daily function are intended to be used similarly to the existing functional scales. This category is a general outlook of how symptoms impact daily functionality and ability. This is based on observation by the caregiver and the ability level seen on a daily basis. This is also intended to be beneficial in the long-term to determine if this ability level is changing.

Post-traumatic headache is a symptom that is experienced by most individuals with TBI. This symptom can be problematic on its own but can also influence other symptoms (Hoffman, et al., 2011). This can be evaluated on this scale through observation of how often a headache is experienced and what impact it has on other functionality.

Sleep disorders are significantly more common in individuals with TBI than in the general population (Viola-Saltzman & Watson, 2012). Sleep disorders can make existing symptoms worse based on how the sleep disorder impacts the individual (Rao & Vaishnavi, 2015). Three of the most common sleep disorders have been separated into their own categories in order to identify if they are a contributing factor for the individual. This category is to be completed by utilizing caregiver observation as well as potentially by medical diagnosis.

The overall intention of the Proposed TBI Symptom Assessment Scale for Caregivers is to evaluate scales both in the long- and short-term and aid in tracking how symptoms may change. This scale is also intended to facilitate the caregiver's ability to work with health professionals and explain how symptoms are impacting the individual.

Chapter 5: Conclusion

The research for this study was compiled by conducting a thorough review of the existing and relevant literature that relates to traumatic brain injury, its symptoms, and diagnostic scales. The findings of this research present that there is an extraordinarily wide range of symptoms associated with traumatic brain injury that encompass nearly all categories of human function. TBI symptoms can root from the injury to the brain and the damage that occurs, from the impact that caused the TBI to occur, or from symptoms that cause secondary symptoms. Examining the different reasons that symptoms occur, makes it apparent that the number of symptoms associated with TBI can be seemingly infinite.

The limitations to the research are primarily based on the limitations of TBI. Traumatic brain injury, specifically mTBI, often goes unreported or undiagnosed. This means that many symptoms experienced may be under-recognized or not recognized as being associated with TBI. Additionally, this research is limited by the extent of the scope. The number of symptoms associated with TBI is extensive and this review only claims to approach the most common and most debilitating symptoms. In order to compile a more comprehensive review of symptoms, the types of TBI severity, and types of symptoms would need to be subdivided and investigated individually.

In the future, research on TBI, should involve more studies to determine the efficacy of a broader range scale for diagnostic use. This scale could be independently utilized or created as an extension to existing scales, such as the Glasgow Coma Scale which already holds a primary position in use for TBI diagnosis and severity level. More research is needed to study the entire range of symptoms that can occur with TBI, including subdivision by severity level. Research is also needed to determine which items in currently used scales are the most useful. This

information will fill in any gaps, and create a better understanding of each individual's presentation of TBI.

Future TBI scales require more specificity as the existing scales are far too vague and leave too much information unknown or up for interpretation. Along with being generally vague, the evaluation scales are also disjointed in that there are many options available in each evaluation category. This ambiguity can create problems not only in how the scales are individually evaluated but in which scale is selected to be used. A new scale would not only require a more in-depth look at symptoms and how the individual patient experiences the symptoms but also require a directional understanding of specifically how the test is to be performed. There would also be a need to explore the possibility of different tests for different age groups to avoid the problem experienced with the Glasgow Coma Scale in pediatrics and geriatrics in relation to the way that age impacts trauma response.

The existing TBI scales need to be updated or recreated to make them more comprehensive. The Glasgow Coma Scale continues to be useful for its simplicity in immediate evaluation. Its place as a triage tool is imperative, its simple approach and minimal categories make it ideal for a quick evaluation to determine immediate steps to be taken. Over time when immediacy is no longer the primary priority a scale needs to exist that allows for more than three categories of evaluation (verbal, motor, and eye-opening) and create more than three severity categories. The existing categories are too limiting and leave room for symptoms to go undocumented. The severity categories also have a limited scope making it difficult to specifically define what mild, moderate, and severe mean in individual cases.

It is possible to create a more comprehensive scale by combining the existing scales such as a hybrid scale created through a combination of the Glasgow Coma Scale, Modified Rankin

Scale, and a Quality of Life scale. The merger of these scales would also require the addition of more symptoms to be evaluated in order to be included. Due to the complexity, this scale would need to be simple in its original use and then would divide into more complex scales based on the results of the original evaluation. From the Modified Rankin, functionality scoring could be utilized and then applied to other symptoms experienced. The Glasgow Coma Scale provides an outlook on how to evaluate eye opening, verbal response, and motor response. The quality of life scales provide information on physical limitations, cognition, emotions, social ability, and prospects for the future. All these combined scales still lack information on hearing ability, specific outlook on physical deficits, specific outlook on cognition, communication disorders, psychological symptoms, headache, epilepsy, behavioral disorders, fatigue, and sleep disorders. With these categories, it would be difficult to combine one singular scale both for the evaluator and the person being evaluated. Preferably a stemmed scale would be produced where one set of symptoms is evaluated which leads to another set. For instance, psychological symptoms would be evaluated before emotions due to their potential to influence each other. Similarly, movement disorders would be evaluated prior to motor responses in order to evaluate if a condition such as hemi-dystonia is impacting the results of the motor response evaluation. Fatigue would need to be evaluated early in the process to determine the patient's ability to exert energy and therefore how much evaluation they may be able to withstand at one time.

The scale proposed here is intended primarily for use by caregivers but a similar scale for comprehensive review and tracking of symptoms would be beneficial in medical and rehabilitation settings as well. This would allow for a more across-the-board understanding of the symptoms experienced by the individual and how they change over time. This may help with increasing the quality of life by understanding times of day the impact of symptoms is more

intense or may help with understanding the connection between symptoms. The scale proposed here can aid caregivers' ability to track symptoms themselves as well as aid in their ability to communicate symptoms to health professionals as they change over time.

This scale would need to be tested and validated before it would be able to be used. A suggestion for testing the validity of this Proposed TBI Symptom Assessment Scale for Caregivers would be to follow the method used by Tadrissi, Bahari, Ebadi, and Madani (2012) to test the Four Score coma scale. This method used more than 100 patients who were each evaluated by nurses trained in evaluating using the Four Score at similar times of day to determine if each nurse scored the patient the same way. The scale proposed here is intended to utilize the expertise in the individual that a full-time caregiver uniquely possesses. A modification to this measurement technique for reliability would be to have a caregiver evaluate the individual at the same time of day repeatedly to determine if the symptom(s) is measured the same repeatedly. To further ensure reliability while testing the scale an inclusion criteria for individuals in the study would be that they have two or more caregivers that can evaluate them on the scale. In order to test reliability scores from each caregiver would be compared. This validity test could also be done by having caregivers evaluate individuals with similar symptom expression to the individual they care for. This would aid in determining if the caregiver objectively is able to measure the symptom whether it is the person they care for or not. This could also aide in ensuring that caregivers are able to objectively evaluate the symptom and their scoring is not skewed in their scoring based on their emotional connection. The method used to evaluate the Four Score also had nurses that were not trained in using the scale evaluate patients with the scale to determine if it was happenstance that the evaluations were done correctly (Tadrissi, Bahari, Ebadi, & Madani, 2012). This could also be done with this scale to determine if

the scale is in tune with the caregiver's unique ability to evaluate by using their extensive knowledge of the individual. By having people that do not know the individual with TBI also complete the scale at the same time as the caregivers it would increase the validity by ideally representing the caregivers unique knowledge. This study would also require using individuals with mild, moderate, and severe TBI in order to ensure that the scale is accurate for all three designations. The study would require a significant number of participants, no less than one hundred, within each severity classification. This would aide in determining not only the scales overall reliability and validity but the reliability and validity within each diagnostic designation.

References

- Adoni, A., & Mcnett, M. (2007). The pupillary response in Traumatic Brain Injury. *Journal of Trauma Nursing*, 14(4), 191-196.
doi:10.1097/01.jtn.0000318921.90627.fe
- Alberta Health Services. (n.d.). Barthel Index of Activities of Daily Living. Retrieved from <https://www.albertahealthservices.ca/assets/about/scn/ahs-scn-bjh-hf-barthel-index-of-adls.pdf>
- Appelbaum, H., & Acharya, S. (2011). Heavy menstrual bleeding in adolescents: Hormonal or hematologic? *Minerva Ginecologica*, 63(6), 547-561
- Baum, J., Entezami, P., Shah, K., & Medhkour, A. (2016). Predictors of outcomes in traumatic brain injury. *World Neurosurgery*, 90, 525-529.
doi:10.1016/j.wneu.2015.12.012
- Bohannon, R. W., & DePasquale, L. (2010). Physical functioning scale of the Short-Form (SF) 36: Internal consistency and validity with older adults. *Journal of Geriatric Physical Therapy*, 33(1), 16-18. doi:10.1097/JPT.0b013e3181d0735e
- Bose P, Hou J, & Thompson F. J. (2015). Traumatic Brain Injury (TBI)-Induced Spasticity: Neurobiology, Treatment, and Rehabilitation. Boca Raton: CRC Press/Taylor & Francis. <https://www.ncbi.nlm.nih.gov/books/NBK299194/>
- BrainLine. (2018). What Is the Glasgow Coma Scale? Retrieved from <https://www.brainline.org/article/what-glasgow-coma-scale>
- BrainLine. (2010). Traumatic brain injury: A guide for caregivers of service members and veterans. Retrieved from https://www.brainline.org/sites/default/files/DVBICFamilyCaregiverCurriculum_Full.pdf
- BrainLine. (2009). Memory and brain injury. Retrieved from <https://www.brainline.org/article/memory-and-brain-injury>
- BrainLine. (2008). What happens immediately after the injury? Retrieved from <https://www.brainline.org/article/what-happens-immediately-after-injury>
- Bramlett, H. M., & Dietrich, W. D. (2015). Long-term consequences of traumatic brain injury- current status of potential mechanisms of injury and neurological outcomes. *Journal of neurotrauma*, 32(23), 1834-48.
- Broderick, J. P., Adeoye, O., & Elm, J. (2017). Evolution of the modified Rankin Scale and its use in future stroke trials. *Stroke*, 48(7), 2007-2012.
doi:10.1161/strokeaha.117.017866
- Centers for Disease Control and Prevention. (2016). *Basic information about traumatic brain injury and concussion*. Retrieved from <https://www.cdc.gov/traumaticbraininjury/basics.html>
- The Center for Outcome Measurement in Brain Injury. (n.d.). Rancho Los Amigos Scale: Level of cognitive functioning scale. Retrieved from <http://www.tbims.org/combi/lcfs/lcfs.pdf>
- Channell, M. K., Mueller, L. L., & Hahn, R. (2009). Management of chronic post-traumatic headache: A multidisciplinary approach. *The Journal of the American Osteopathic Association*, 109(9), 509-513. Retrieved from <https://jaoa.org/article.aspx?articleid=2093827>.
- ClinMed International Library. (n.d.). SF-36 Questionnaire. Retrieved from <https://clinmedjournals.org/articles/jmndt/jmndt-2-023-figure-1.pdf>

- de Cassia Almeida Vieira, R., de Oliveira, D. V., Teixeira, M. J., & Paiva, W. (2015). Scales for assessment of patients with traumatic brain injury. *Patient preference and adherence*, 9, 1631-3. doi:10.2147/PPA.S97032
- Einarsen, C. E., Naalt, J. V., Jacobs, B., Follestad, T., Moen, K. G., Vik, A., Haberg, A. K., & Skandsen, T. (2018). Moderate traumatic brain injury: Clinical characteristics and a prognostic model of 12-month outcome. *World Neurosurgery*, 114. doi:10.1016/j.wneu.2018.03.176
- Engelman, W., Hammond, F., & Malec, J. (2014). Diagnosing pseudobulbar affect in traumatic brain injury. *Neuropsychiatric Disease and Treatment*, 10, 1903-1910. doi:10.2147/ndt.s63304
- Farahvar, A., Gerber, L. M., Chiu, Y., Carney, N., Härtl, R., & Ghajar, J. (2012). Increased mortality in patients with severe traumatic brain injury treated without intracranial pressure monitoring. *Journal of Neurosurgery*, 117(4), 729-734. doi:10.3171/2012.7.jns111816
- Fortin, A., Lefebvre, M. B., & Ptito, M. (2009). Traumatic brain injury and olfactory deficits: The tale of two smell tests! *Brain Injury*, 24(1), 27-33. doi:10.3109/02699050903446815
- Frei, K. (2017). Posttraumatic dystonia. *Journal of the Neurological Sciences*, 379, 183-191. doi:10.1016/j.jns.2017.05.040
- Gerber, L. M., Chiu, Y., Carney, N., Härtl, R., & Ghajar, J. (2013). Marked reduction in mortality in patients with severe traumatic brain injury. *Journal of Neurosurgery*, 119(6), 1583-1590. doi:10.3171/2013.8.jns13276
- Gieysztor, E. Z., Choińska, A. M., & Paprocka-Borowicz, M. (2016). Persistence of primitive reflexes and associated motor problems in healthy preschool children. *Archives of medical science : AMS*, 14(1), 167-173. doi:10.5114/aoms.2016.60503
- Godoy, D. A., Rubiano, A., Rabinstein, A. A., Bullock, R., & Sahuquillo, J. (2016). Moderate traumatic brain injury: The grey zone of neurotrauma. *Neurocritical Care*, 25(2), 306-319. doi:10.1007/s12028-016-0253-y.
- Green, S. M. (2011). Cheerio, laddie! Bidding farewell to the Glasgow Coma Scale. *Annals of Emergency Medicine*, 58(5), 427-430. doi:10.1016/j.annemergmed.2011.06.009
- Guilmette, T. J., & Paglia, M. F. (2004). The public's misconceptions about traumatic brain injury: A follow up survey. *Archives of Clinical Neuropsychology*, 19(2), 183-189. doi:10.1016/s0887-6177(03)00025-8
- Harris, J., Mishkin, L., & Ross, B. (2012). *Brain injury: A guide for educators*. Brain Injury Association of New Jersey, Inc. Retrieved from http://www.bianj.org/Websites/bianj/Images/BIANJ_Guide_For_Educators_1-2010.pdf
- Helmy, A., Kirkpatrick, P. J., Seeley, H. M., Corteen, E., Menon, D. K., & Hutchinson, P. J. (2012). Fixed, dilated pupils following traumatic brain injury: Historical perspectives, causes and ophthalmological sequelae. *Acta Neurochirurgica Supplementum Intracranial Pressure and Brain Monitoring XIV*, 295-299. doi:10.1007/978-3-7091-0956-4_57

- Hoffman, J. M., Lucas, S., Dikmen, S., Braden, C. A., Brown, A. W., Brunner, R., Diaz-Arrastia, R., Walker, W. C., Watanabe, T. K., ... Bell, K. R. (2011). Natural history of headache after traumatic brain injury. *Journal of neurotrauma*, 28(9), 1719-25. doi: [10.1089/neu.2011.1914](https://doi.org/10.1089/neu.2011.1914)
- Huijben, J. A., Wiegers, E. J., Keizer, N. F., Maas, A. I., Menon, D., Ercole, A., ... Lingsma, H. F. (2019). Development of a quality indicator set to measure and improve quality of ICU care for patients with traumatic brain injury. *Critical Care*, 23(1). doi:10.1186/s13054-019-2377-x
- Indorato, D. C. (2017). Catatonia following a traumatic brain injury: A case report with positive findings after an Ativan trial. *Physical Medicine and Rehabilitation - International*, 4(3). doi:10.26420/physmedrehabilint.2017.1120
- Krauss, J. K. (2015). Movement disorders secondary to craniocerebral trauma. *Traumatic Brain Injury, Part II Handbook of Clinical Neurology*, 475-496. doi:10.1016/b978-0-444-63521-1.00030-3
- Kocka, A., & Gagnon, J. (2014). Definition of impulsivity and related terms following traumatic brain injury: A review of the different concepts and measures used to assess impulsivity, disinhibition and other related concepts. *Behavioral sciences (Basel, Switzerland)*, 4(4), 352-70. doi:10.3390/bs4040352
- Langlois, J. A., Rutland-Brown, W., & Wald, M. M. (2006). The epidemiology and impact of traumatic brain injury. *Journal of Head Trauma Rehabilitation*, 21(5), 375-378. doi:10.1097/00001199-200609000-00001
- Lauterbach, M., Notarangelo, P., Nichols, S., Lane, K., & Koliatsos, V. (2015). Diagnostic and treatment challenges in traumatic brain injury patients with severe neuropsychiatric symptoms: Insights into psychiatric practice. *Neuropsychiatric Disease and Treatment*, 1601. doi:10.2147/ndt.s80457
- Li, M., & Sirko, S. (2018). Traumatic brain injury: At the crossroads of neuropathology and common metabolic endocrinopathies. *Journal of clinical medicine*, 7(3), 59. doi:10.3390/jcm7030059
- Lins, L., & Carvalho, F. M. (2016). SF-36 total score as a single measure of health-related quality of life: Scoping review. *SAGE open medicine*, 4, 2050312116671725. doi:10.1177/2050312116671725
- Lucke-Wold, B. P., Turner, R. C., Logsdon, A. F., Bailes, J. E., Huber, J. D., & Rosen, C. L. (2014). Linking traumatic brain injury to chronic traumatic encephalopathy: Identification of potential mechanisms leading to neurofibrillary tangle development. *Journal of Neurotrauma*, 31(13), 1129-1138. doi:10.1089/neu.2013.3303
- Macciocchi, S., Seel, R. T., Warshowsky, A., Thompson, N., & Barlow, K. (2012). Co-occurring traumatic brain injury and acute spinal cord injury rehabilitation outcomes. *Archives of Physical Medicine and Rehabilitation*, 93(10), 1788-1794. doi:10.1016/j.apmr.2012.01.022
- Maneewong, J., Maneeton, B., Maneeton, N., Vanityapong, T., Traisathit, P., Sricharoen, N., & Srisurapanont, M. (2017). Delirium after a traumatic brain injury: Predictors and symptom patterns. *Neuropsychiatric Disease and Treatment, Volume 13*, 459-465. doi:10.2147/ndt.s128138
- McAllister T. W. (2008). Neurobehavioral sequelae of traumatic brain injury: Evaluation and management. *World psychiatry : official journal of the World Psychiatric Association (WPA)*, 7(1), 3-10.

- McCabe, D. (2019). Katz Index of Independence in Activities of Daily Living (ADL). *The Hartford Institute for Geriatric Nursing*, (2).
- McMillan, T. M., Teasdale, G. M., & Stewart, E. (2012). Disability in young people and adults after head injury: 12–14 year follow-up of a prospective cohort. *Journal of Neurology, Neurosurgery & Psychiatry*, 83(11), 1086-1091. doi:10.1136/jnnp-2012-302746
- Menon, D. K., Schwab, K., Wright, D. W., & Maas, A. I. (2010). Position statement: Definition of traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 91(11), 1637-1640. doi:10.1016/j.apmr.2010.05.017
- Mlinac, M. E., & Feng, M. C. (2016). Assessment of activities of daily living, self-care, and independence. *Archives of Clinical Neuropsychology*, 31(6), 506-516. doi:10.1093/arclin/acw049
- Mossberg, K. A., Durham, W. J., Zgaljardic, D. J., Gilkison, C. R., Danesi, C. P., Sheffield-Moore, M., ... Urban, R. J. (2017). Functional changes after recombinant human growth hormone replacement in patients with chronic Traumatic Brain Injury and abnormal growth hormone secretion. *Journal of neurotrauma*, 34(4), 845–852. doi:10.1089/neu.2016.4552
- National Institute of Child Health and Human Development. (2016). How do health care providers diagnose traumatic brain injury (TBI)?. Retrieved from <https://www.nichd.nih.gov/health/topics/tbi/conditioninfo/diagnose>
- Opara, J. A., Małecka, E., & Szczygiel, J. (2014). Clinimetric measurement in traumatic brain injuries. *Journal of medicine and life*, 7(2), 124-7.
- Pagulayan, K. F., Temkin, N. R., Machamer, J., & Dikmen, S. S. (2006). A longitudinal study of health-related quality of life after traumatic brain injury. *Archives of Physical Medicine and Rehabilitation*, 87(5), 611-618. doi:10.1016/j.apmr.2006.01.018
- Ponsford, J. L. (n.d.). Fatigue following brain injury. Retrieved from <http://www.internationalbrain.org/pages/print-view/fatigue-following-brain-injury/>
- Post, M., Bruin, A., Witte, L., & Schrijvers, A. (1996). The SIP68: A measure of health-related functional status in rehabilitation medicine. *Archives of Physical Medicine and Rehabilitation*, 77(5), 440-445. doi:10.1016/s0003-9993(96)90031-3
- Prcic, A., Aganovic, D., & Hadziosmanovic, O. (2013). Sickness Impact Profile (SIP) score, a good alternative instrument for measuring quality of life in patients with ileal urinary diversions. *Acta informatica medica : AIM : journal of the Society for Medical Informatics of Bosnia & Herzegovina : casopis Drustva za medicinsku informatiku BiH*, 21(3), 160-5.
- Prince, C., & Bruhns, M. E. (2017). Evaluation and treatment of mild traumatic brain injury: The role of neuropsychology. *Brain sciences*, 7(8), 105. doi:10.3390/brainsci7080105
- Qadeer, A., Khalid, U., Amin, M., Murtaza, S., Khaliq, M. F., & Shoaib, M. (2017). Caregiver's burden of the patients with traumatic brain injury. *Cureus*, 9(8), e1590. doi:10.7759/cureus.1590
- Rao, V., & Vaishnavi, S. (2015). *The traumatized brain: A family guide to understanding mood, memory, and behavior after brain injury*. Baltimore: Johns Hopkins University Press.

- Salottolo, K., Levy, A. S., Slone, D. S., Mains, C. W., & Bar-Or, D. (2014). The effect of age on Glasgow Coma Scale score in patients With traumatic brain injury. *JAMA Surgery, 149*(7), 727. doi:10.1001/jamasurg.2014.13
- Schwarzbold, M., Diaz, A., Martins, E. T., Rufino, A., Amante, L. N., Thais, M. E., Quevedo, J., Hohl, A., Linhares, M. N., ... Walz, R. (2008). Psychiatric disorders and traumatic brain injury. *Neuropsychiatric disease and treatment, 4*(4), 797-816.
- Siponkoski, S., Wilson, L., Steinbüchel, N., Sarajuuri, J., & Koskinen, S. (2013). Quality of life after traumatic brain injury: Finnish experience of the QOLIBRI in residential rehabilitation. *Journal of Rehabilitation Medicine, 45*(8), 835-842. doi:10.2340/16501977-1189
- Ślusarz, R., Jabłońska, R., Królikowska, A., Haor, B., Barczykowska, E., Biercewicz, M., Głowacka, M., ... Szrajda, J. (2015). Measuring scales used for assessment of patients with traumatic brain injury: multicenter studies. *Patient preference and adherence, 9*, 869-75. doi:10.2147/PPA.S83551
- Stanly, S., Tejasree, T., Nandini, V., & Ponnusankar, S. (2018). Talk and die syndrome: An unending mystery. *Indian Journal of Pharmacy Practice, 10*(4), 248-250. doi:10.5530/ijopp.10.4.51
- Stocchetti, N., & Zanier, E. R. (2016). Chronic impact of traumatic brain injury on outcome and quality of life: A narrative review. *Critical Care, 20*(1). doi:10.1186/s13054-016-1318-1
- Stroke Center. (n.d.). Modified Rankin Scale (MDS). Retrieved from http://www.strokecenter.org/wp-content/uploads/2011/08/modified_rankin.pdf
- Tadrissi, S. D., Bahari, N., Ebadi, A., & Madani, S. J. (2012). Validity and reliability of coma scale (four score) in adult patient hospitalized in Critical Care Units. *Critical Care Nursing, 5*(13), 95-102.
- Teasdale, G., Allen, D., Brennan, P., McElhinney, E., & Mackinnon, L. (2014). The Glasgow Coma Scale: An update after 40 years. *Nursing Times, 110*: 12-16. Retrieved from <http://www.nursingtimes.net/Journals/2014/10/10/n/p/1/141015Forty-years-on-updating-the-Glasgow-coma-scale.pdf>
- Toshniwal, S. S., & Joshi, N. A. (2010). Residual speech impairment in patients with traumatic brain injury. *Indian Journal of Neurotrauma, 7*(1), 61-66.
- Uniform Data System for Medical Rehabilitation. (2014). The FIM® Instrument: Its Background, Structure, and Usefulness. Retrieved from https://www.udsmr.org/Documents/The_FIM_Instrument_Background_Structure_and_Usefulness.pdf
- Vakil, E. (2005). The effects of moderate to severe traumatic brain injury (TBI) on different aspects of memory- A selective review. *Journal of Clinical and Experimental Neuropsychology, 27*, 977-1021. doi-10.1080/13803390490919245
- Valente, S. M., & Fisher, D. (2011). Traumatic brain injury. *The Journal for Nurse Practitioners, 7*(10), 863-870. doi:10.1016/j.nurpra.2011.09.016
- Viola-Saltzman, M., & Watson, N. F. (2012). Traumatic brain injury and sleep disorders. *Neurologic clinics, 30*(4), 1299–1312. doi:10.1016/j.ncl.2012.08.008

- Williamson, D. R., Frenette, A. J., Burry, L., Perreault, M. M., Charbonney, E., Lamontagne, F., Potvin, M. J., Giguère, J. F., Mehta, S., ... Bernard, F. (2016). Pharmacological interventions for agitation in patients with traumatic brain injury: protocol for a systematic review and meta-analysis. *Systematic reviews*, *5*(1), 193. doi:10.1186/s13643-016-0374-6
- Wong, G. K., Lam, S. W., Ngai, K., Wong, A., Mok, V., & Poon, W. S. (2014). Quality of life after brain injury (QOLIBRI) overall scale for patients after aneurysmal subarachnoid hemorrhage. *Journal of Clinical Neuroscience*, *21*(6), 954-956. doi:10.1016/j.jocn.2013.09.010
- Yang, L., Huang, C., Chiu, W., Huang, L., Lo, W., & Wang, J. (2016). Association of traumatic brain injury in childhood and attention-deficit/hyperactivity disorder: A population-based study. *Pediatric Research*, *80*(3), 356-362. doi:10.1038/pr.2016.85
- Yao, S., Song, J., Li, S., Cao, C., Fang, L., Wang, C., & Xu, G. (2017). Helsinki computed tomography scoring system can independently predict long-term outcome in traumatic brain injury. *World Neurosurgery*, *101*, 528-533. doi:10.1016/j.wneu.2017.02.072

Appendix A
Symptoms Reviewed

Symptom	Sub-Symptoms
Sensory	Vision Hearing Smell
Physical	Spasticity Movement Disorders
Primitive Reflexes Cognition	Memory Attention Concentration
Communication Disorders	Aphasia
Post Traumatic Headache Psychological Changes	Depression
Behavioral Disorders	Impulsivity Agitation Pseudobulbar Affect
Fatigue Sleep Disorders	Circadian Rhythm Disorder Insomnia Sleep Apnea
Talk and Die/Deteriorate Post Traumatic Epilepsy Endocrinopathies Multiple Organ Trauma Traumatic Lung Injury Fatality	

Appendix B
Katz Index of Independence in Activities of Daily Living

Activities Points (1 or 0)	Independence (1 Point) No supervision, direction, or personal assistance	Dependence (0 Points) With supervision, direction, personal assistance, or total care
Bathing Points: _____	Bathes self completely or needs help in bathing only a single part of the body such as the back, genital area, or disable extremity	Needs help with bathing more than one part of the body, getting in or out of the tub or shower. Requires total bathing
Dressing Points: _____	Gets clothes from closets and drawers and puts on clothes and outer garments complete with fasteners. May have help tying shoes.	Needs help with dressing self or needs to be completely dressed
Toileting Points: _____	Goes to toilet, gets on and off, arranges clothes, cleans genital area without help	Needs help transferring to the toilet, cleaning self or uses bedpan or commode
Transferring Points: _____	Moves in and out of bed or chair unassisted. Mechanical transferring aides are acceptable	Needs help in moving from bed to chair or requires a complete transfer
Continenence Points: _____	Exercises complete self control over urination and defecation	Is partially or totally incontinent of bowel or bladder
Feeding Points: _____	Gets food from plate into mouth without help. Preparation of food may be done by another person	Needs partial or total help with feeding or requires parenteral feeding

Total Points = _____

6 = High (patient independent) 0= Low (patient very dependent)

Note. McCabe, D. (2019). Katz Index of Independence in Activities of Daily Living (ADL). *The Hartford Institute for Geriatric Nursing*,(2).

Appendix C
Barthel Index

Ability	0	1	2	3
Bowels	Incontinent	Occasional accident (once/week)	Continent	N/A
Transfer	Unable - No sitting balance	Major help, can sit	Minor help (verbal or physical)	Independent
Bladder	Incontinent, or catheterized and unable to manage	Occasional accident (max once per 24 hours)	Continent (for over 7 days)	N/A
Mobility	Immobile	Wheelchair independent, including corners, etc.	Walks with help of one person	Independent (but may use any aid, e.g. stick)
Grooming	Needs help with personal care	Independent face/hair/teeth/shaving	N/A	N/A
Dressing	Dependent	Needs help, but can do about half unaided	Independent (including buttons and zips)	N/A
Toilet Use	Dependent	Needs some help, but can do something alone	Independent (on and off)	N/A
Stairs	Unable	Needs help	Independent	N/A
Feeding	Unable	Needs help cutting, spreading, etc.	Independent	N/A
Bathing	Dependent	Independent	N/A	N/A

Note. Alberta Health Services. (n.d.). Barthel Index of Activities of Daily Living. Retrieved from <https://www.albertahealthservices.ca/assets/about/scn/ahs-scen-bjh-hf-barthel-index-of-adls.pdf>

Appendix D
Functional Independence Measure

Item	Admission	Discharge	Goal
<u>Self-Care</u>			
Eating			
Grooming			
Bathing			
Dressing – Upper			
Dressing – Lower			
Toileting			
<u>Sphincter Control</u>			
Bladder			
Bowel			
<u>Transfers</u>			
Bed, Chair, Wheelchair			
Toilet			
Tub, Shower			
<u>Locomotion</u>			
Walk/Wheelchair			
Stairs			
<u>Communication</u>			
Comprehension			
Expression			
<u>Social Cognition</u>			
Social Interaction			
Problem Solving			
Memory			

Note. Uniform Data System for Medical Rehabilitation. (2014). The FIM® Instrument: Its Background, Structure, and Usefulness. Retrieved from https://www.udsmr.org/Documents/The_FIM_Instrument_Background_Structure_and_Usefulness.pdf

Appendix E
Sickness Impact Profile

Question	Yes (1 Point)	No (0 Point)
<u>Somatic Autonomy</u>		
1. I get around in a wheelchair		
2. I get dressed only with someone's help		
3. I do not move into or out of bed by myself, but am moved by a person or mechanical aide		
4. I stand up only with someone's help		
5. I do not fasten my clothing, for example require assistance with buttons, zippers, shoelaces		
6. I do not walk at all		
7. I do not use stairs at all		
8. I make difficult moves with help, for example, into or out of cars, bathtubs		
9. I do not bathe myself completely, for example, require assistance with bathing		
10. I do not bathe myself at all, but am bathed by someone else		
11. I do not have control of my bladder		
12. I am very clumsy in body movements		
13. I do not have control of my bowels		
14. I feed myself with help from someone else		
15. I do not maintain balance		
16. I use a bedpan with assistance		
17. I am in a restricted position all the time		
<u>Mobility Control</u>		
1. I go up and down stairs more slowly, for example, on step at a time, stop often		
2. I walk shorter distances or stop to rest often		
3. I walk more slowly		
4. I use stairs only with mechanical support, for example, handrail, cane, crutches		
5. I walk by myself but with some difficulty, for example, limp, wobble, stumble, have stiff leg		
6. I kneel, stoop, or bend down only by holding on to something		
7. I do not walk up or down hills		
8. I get in and out of bed or chairs by grasping something for support or using a cane or walker		
9. I stand only for short periods of time		
10. I dress myself, but do so very slowly		
11. I have difficulty doing handwork, for example, turning faucets, using kitchen gadgets, sewing, carpentry		
12. I move my hands or fingers with some limitation or difficulty		

Psychic autonomy and communication

1. I have difficulty reasoning and solving problems, for example, making plans, making decisions, learning new things
2. I have difficulty doing activities involving concentration and thinking
3. I react slowly to things that are said or done
4. I make more mistakes than usual
5. I do not keep my attention on any activity for long
6. I forget a lot, for example, things that happened recently, where I put things, appointments
7. I am confused and start several actions at a time
8. I do not speak clearly when I am under stress
9. I have difficulty speaking, for example, get stuck, stutter, stammer, slur my words
10. I do not finish things I start
11. I am having trouble writing or typing

Social behavior

1. My sexual activity is decreased
2. I am cutting down the length of visits with friends
3. I am drinking less fluids
4. I am doing fewer community activities
5. I am doing fewer social activities with groups of people
6. I am going out for entertainment less often
7. I stay away from home only for brief periods of time
8. I am eating much less than usual
9. I am not doing heavy work around the house
10. I do my hobbies and recreation for shorter periods of time
11. I am doing less of the regular daily work around the house than I would usually do
12. I am cutting down on some of my usual inactive recreation and pastime, for example, watching TV, playing cards, reading

Emotional stability

1. I often act irritable toward those around me, for example, snap at people, give sharp answers, criticize easily
 2. I act disagreeably to family members, for example, I act spiteful, I am stubborn
 3. I have frequent outbursts of anger at family members, for example, strike at them, scream, throw things at them
 4. I act irritable and impatient with myself, for example, talk badly about myself, swear at myself for things that happen
 5. I am not joking with family members as I usually do
 6. I talk less with those around me
-

Mobility range

1. I am not doing any of the shopping I usually do
 2. I am not going into town
 3. I am not doing any of the house cleaning that I would usually do
 4. I am not doing any of the regular work around the house that I would usually do
 5. I stay at home most of the time
 6. I am not doing any of the clothes washing that I would usually do
 7. I am not going out to visit people at all
 8. I am getting around only within one building
 9. I have given up taking care of personal or household business affairs, for example, paying bills, banking, working on budget
 10. I do not get around in the dark or in unlit places without someone's help
-

Note. Post, M., Bruin, A., Witte, L., & Schrijvers, A. (1996). The SIP68: A measure of health-related functional status in rehabilitation medicine. *Archives of Physical Medicine and Rehabilitation*, 77(5), 440-445. doi:10.1016/s0003-9993(96)90031-3

Appendix F
Short-Form 36

Instruction: Answer the 36 questions of the survey completely, honestly, and without interruption

General Health:

In general, would you say your health is:

- Excellent
- Very Good
- Good
- Fair
- Poor

Compared to one year ago, how would you rate your health in general now?

- Much better now than one year ago
- Somewhat better now than one year ago
- About the same
- Somewhat worse now than one year ago
- Much worse than one year ago

Limitations of Activities

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

Vigorous activities, such as running, lifting heavy objects, participating in strenuous sports

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

Lifting or carrying groceries

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

Climbing several flights of stairs

- Yes, limited a lot
- Yes, limited a little
- No, not limited at all

Climbing one flight of stairs

- Yes, limited a lot
 - Yes, limited a little
 - No, not limited at all
-

Bending, kneeling, or stooping

Yes, limited a lot

Yes, limited a little

No, not limited at all

Walking more than a mile

Yes, limited a lot

Yes, limited a little

No, not limited at all

Walking several blocks

Yes, limited a lot

Yes, limited a little

No, not limited at all

Walking one block

Yes, limited a lot

Yes, limited a little

No, not limited at all

Bathing or dressing yourself

Yes, limited a lot

Yes, limited a little

No, not limited at all

Physical Health Problems

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

Cut down the amount of time you spent on work or other activities

Yes

No

Accomplished less than you would like

Yes

No

Were limited in the kind of work or other activities

Yes

No

Had difficulty performing the work or other activities (for example, it took extra effort)

Yes

No

Emotional Health Problems

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

Cut down the amount of time you spent on work or other activities

Yes

No

Accomplished less than you would like

Yes

No

Didn't do work or other activities as carefully as usual

Yes

No

Social Activities

Emotional problems interfered with your normal social activities with family, friends, neighbors, or groups?

Not at all

Slightly

Moderately

Severe

Very Severe

Pain

How much bodily pain have you had during the past 4 weeks?

None

Very mild

Mild

Moderate

Severe

Very severe

During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework

Not at all

A little bit

Moderately

Quite a bit

Extremely

Energy and Emotions

These questions are about how you feel and how things have been with you during the last 4 weeks. For each question, please give the answer that comes closest to the way you have been feeling

Do you feel full of pep?

All of the time

Most of the time

A good bit of the time

Some of the time

A little bit of the time

None of the time

Have you been a very nervous person?

All of the time

Most of the time

A good bit of the time

Some of the time

A little bit of the time

None of the time

Have you felt so down in the dumps that nothing could cheer you up?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

Have you felt calm and peaceful?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

Did you have a lot of energy?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

Have you felt downhearted and blue?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

Did you feel worn out?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

Have you been a happy person?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

Did you feel tired?

- All of the time
- Most of the time
- A good bit of the time
- Some of the time
- A little bit of the time
- None of the time

Social Activities

During the past four weeks, how much of the time has your physical health or emotional problems interfered with you social activities (like visiting with friends, relatives, etc.)?

- All of the time
- Most of the time
- Some of the time
- A little bit of the time
- None of the time

General Health

How true or false is each of the following statements for you?

I seem to get sick a little easier than other people

- Definitely true
- Mostly true
- Don't know
- Mostly false
- Definitely false

I am as healthy as anybody I know

- Definitely true
- Mostly true
- Don't know
- Mostly false
- Definitely false

I expect my health to get worse

- Definitely true
- Mostly true
- Don't know
- Mostly false
- Definitely false

Note. ClinMed International Library. (n.d.). SF-36 Questionnaire. Retrieved from <https://clinmedjournals.org/articles/jmdt/jmdt-2-023-figure-1.pdf>

Appendix G
Quality of Life after Brain Injury Scale

Scale	Item
Cognition	Concentrate
	Express yourself
	Remember
	Plan and problem solve
	Decisions
	Find way
	Speed of thinking
Self	Energy
	Motivation
	Self-Esteem
	Way you look
	Achievements
	Self-perception
	Own future
Daily life	Independence
	Get out and about
	Domestic activities
	Run personal finances
	Participation work
	Social and leisure activities
	In charge of life
Social	Affection
	Family members
	Friends
	Partner
	Sex life
	Attitudes of others
Emotions	Loneliness
	Boredom
	Anxiety
	Depression
	Anger/Aggression
Physical	Slow/clumsiness
	Other injuries
	Pain
	See/hear
	TBI effects

Note. Siponkoski, S., Wilson, L., Steinbüchel, N., Sarajuuri, J., & Koskinen, S. (2013). Quality of life after traumatic brain injury: Finnish experience of the QOLIBRI in residential rehabilitation. *Journal of Rehabilitation Medicine*, 45(8), 835-842. doi:10.2340/16501977-1189