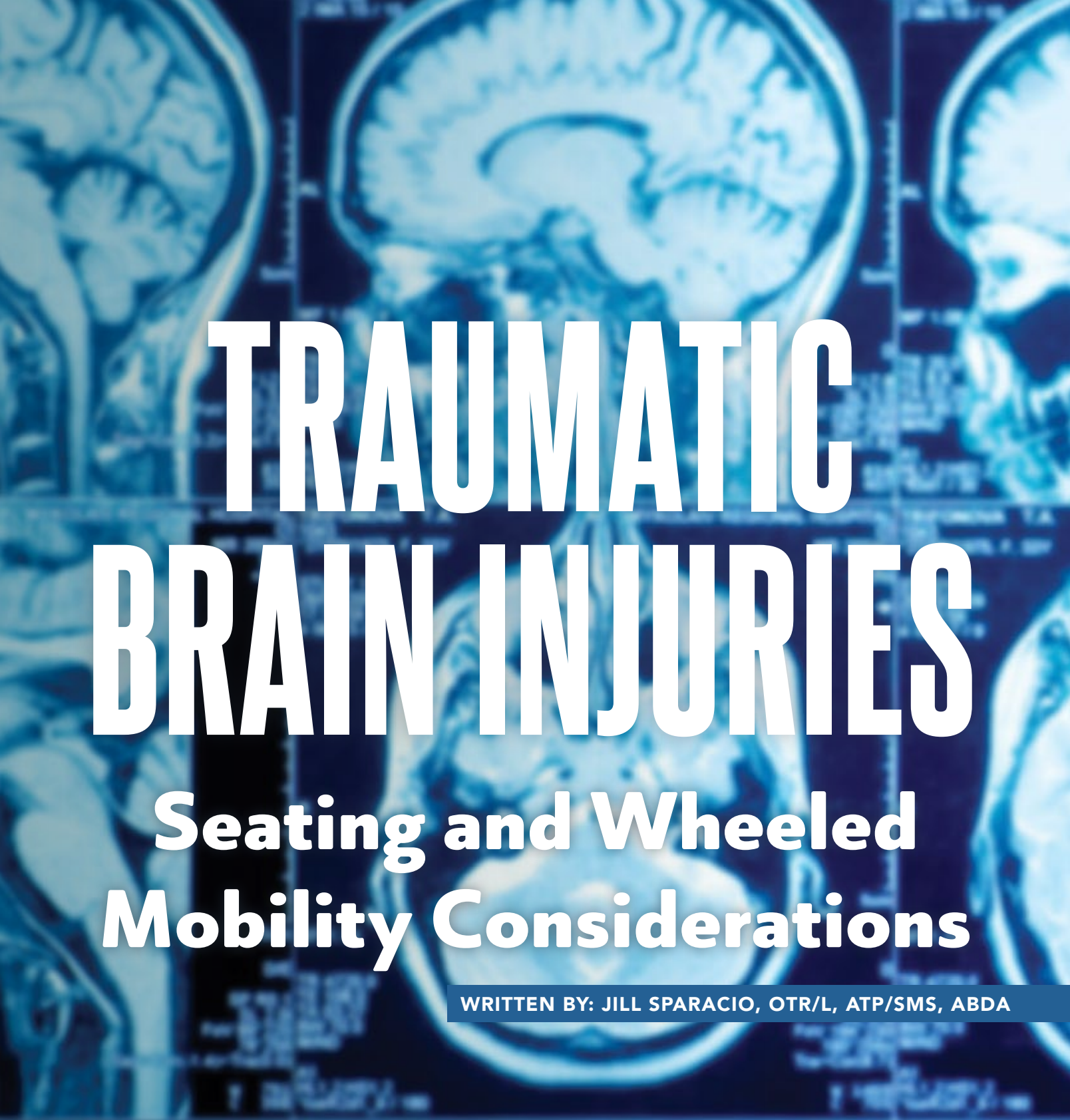


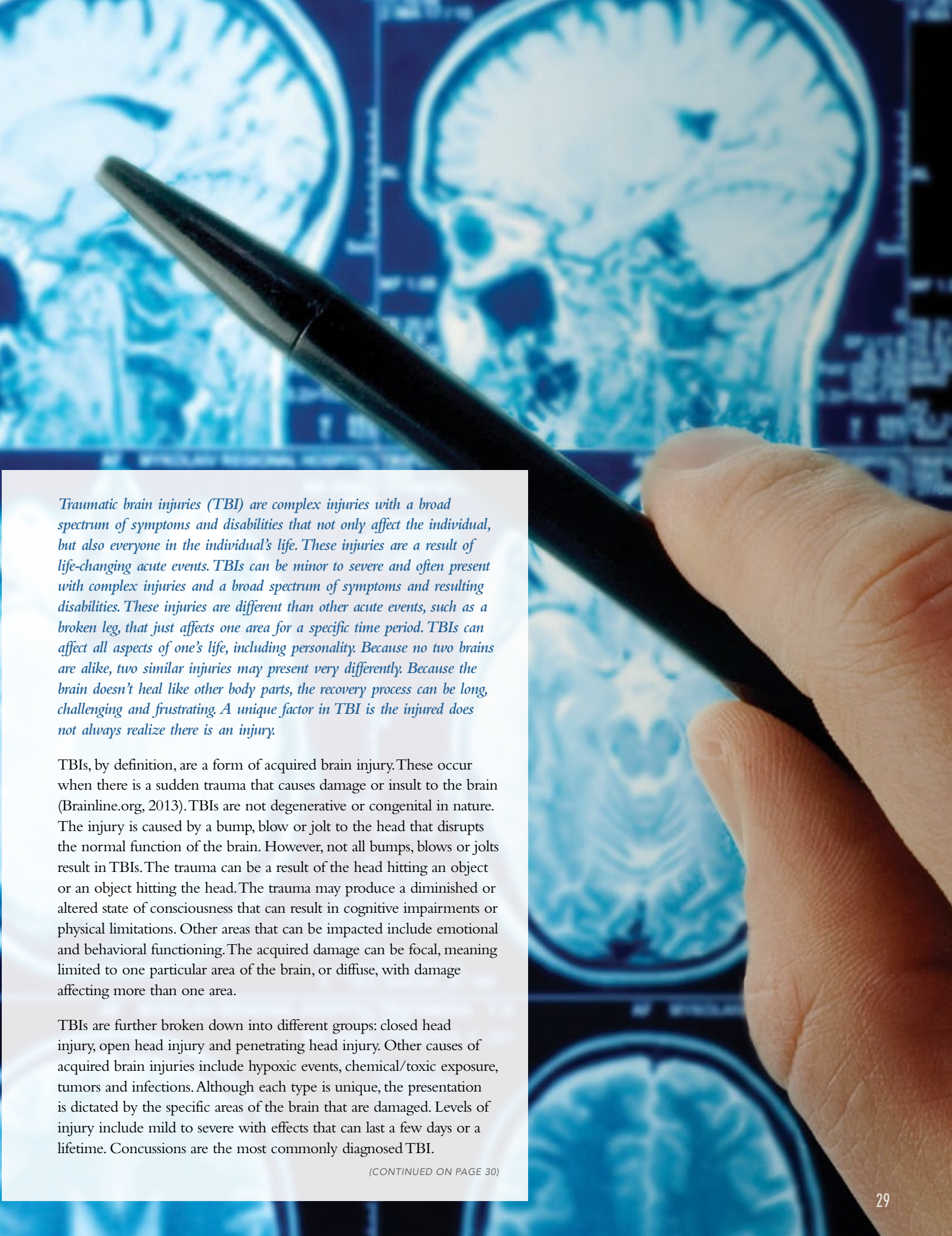
TRAUMATIC BRAIN INJURIES

Seating and Wheeled Mobility Considerations

WRITTEN BY: JILL SPARACIO, OTR/L, ATP/SMS, ABDA

CEU ARTICLE

NRRTS is pleased to offer anther CEU article. The following article is approved by NRRTS, as an accredited IACET provider, for .1 CEU (1 contact hour). After reading this article, please visit www.nrrts.org under continuing education to order the article. Upon passing the exam, you will be sent a CEU certificate.



Traumatic brain injuries (TBI) are complex injuries with a broad spectrum of symptoms and disabilities that not only affect the individual, but also everyone in the individual's life. These injuries are a result of life-changing acute events. TBIs can be minor to severe and often present with complex injuries and a broad spectrum of symptoms and resulting disabilities. These injuries are different than other acute events, such as a broken leg, that just affects one area for a specific time period. TBIs can affect all aspects of one's life, including personality. Because no two brains are alike, two similar injuries may present very differently. Because the brain doesn't heal like other body parts, the recovery process can be long, challenging and frustrating. A unique factor in TBI is the injured does not always realize there is an injury.

TBIs, by definition, are a form of acquired brain injury. These occur when there is a sudden trauma that causes damage or insult to the brain (Brainline.org, 2013). TBIs are not degenerative or congenital in nature. The injury is caused by a bump, blow or jolt to the head that disrupts the normal function of the brain. However, not all bumps, blows or jolts result in TBIs. The trauma can be a result of the head hitting an object or an object hitting the head. The trauma may produce a diminished or altered state of consciousness that can result in cognitive impairments or physical limitations. Other areas that can be impacted include emotional and behavioral functioning. The acquired damage can be focal, meaning limited to one particular area of the brain, or diffuse, with damage affecting more than one area.

TBIs are further broken down into different groups: closed head injury, open head injury and penetrating head injury. Other causes of acquired brain injuries include hypoxic events, chemical/toxic exposure, tumors and infections. Although each type is unique, the presentation is dictated by the specific areas of the brain that are damaged. Levels of injury include mild to severe with effects that can last a few days or a lifetime. Concussions are the most commonly diagnosed TBI.

(CONTINUED ON PAGE 30)

TRAUMATIC BRAIN INJURIES
(CONTINUED FROM PAGE 29)

TBI BY THE NUMBERS

TBIs are a major cause of death and disability in the United States (www.cdc.gov), making up 30 percent of all injury related deaths. The number of TBIs has increased drastically, in part due to sports related concussions. In 2013, it was reported that approximately 1.4 million people experience a TBI annually in the United States. Of those, approximately 50,000 people die as a result of their head injury. Over one million people seek emergency medical treatment and 230,000 are hospitalized each year.

Falls are the leading cause of TBIs that require hospitalization and primarily involve the youngest and the oldest age groups. Being struck by or against an object is the second leading cause and makes up 15 percent of TBI related emergency department visits, hospitalizations and deaths. Motor vehicle accidents make up 14 percent of TBIs. Intentional self-harm is the second leading cause of TBI related deaths. TBI related death rates are highest for persons 75 years and older. As a rule, more men acquire a TBI than women.

The cost of TBIs is staggering. Over $76.5 billion are spent annually for the care of individuals with TBIs (cdc.gov). Lifetime costs of a severe head injury can exceed $3 million and a moderate head injury can cost $1 million (Neuroskills.com, 2017).

TYPES OF TBIs

A basic understanding of brain anatomy is required to fully understand TBIs. The brain is part of the central nervous system (CNS), which includes the brain and spinal cord. The brain itself is made up of several lobes or sections. Brain tissue is made up of nerve (neuron) cells that communicate with one to another through long arms or axons. Each brain section has a specific role and function. Although these sections communicate with each other, their function cannot be duplicated by other sections. Therefore, if one area is damaged, another area cannot "take over" for the damaged area, nor can the damaged cells in the CNS regenerate or recover. The area of damage dictates the clinical presentation. To further complicate matters, if an area is not completely damaged, the remaining area may take over for the damaged area.

Surrounding the brain are layers of tissue called meninges. Three layers provide some space as well as protection of the brain tissue: the dura mater, the arachnoid, and the pia mater. These layers provide support, vascularization, hold cerebral spinal fluid and keep unwanted elements (bacteria) outside of the CNS. The dura mater is the outer layer, arachnoid is the middle layer, and the pia mater covers the brain itself. The brain is a self-contained and highly-controlled system that relies on many properly balanced systems to maintain an appropriate environment for function.

TBIs are a type of brain injury and can be classified by etiology (cause). Brain injuries fall into many different categories. These include closed head, open head, deceleration injuries (diffuse axonal injuries), chemical/toxic injuries, hypoxia, tumors, infections and strokes. TBIs fall into the first three categories.

- Closed head injuries occur when the head suddenly and aggressively strikes an object, but the skull remains intact. These can be caused by falls, motor vehicle accidents, etc. The effects can be either focal or diffuse, depending on where the impact occurred.

- Open head injuries include disruption of the skull and dura mater: the force of the "hit" is strong enough, or at just the correct angle, to cause the skull to fracture and the brain tissue to be exposed. These injuries result in focal or specific areas of damage and can be caused by objects that penetrate into the brain tissue. Penetrating head injuries occur when an object moves through the skull and into the brain tissue itself. Damage occurs at the location of penetration, as well as along the course of penetration. Some penetrating injuries include an exit wound, some do not. Examples of penetrating injuries include high-velocity causes, such as gunshot wounds, and low-velocity causes, including knife injuries or bone fragments that are forced inward from an open head injury.

- Deceleration injuries (also known as diffuse axonal injuries) occur when movement of the skull is abruptly stopped. As the deceleration of the movement occurs, the brain tissue moves at a different speed, resulting in direct brain injury due to diffuse axonal shearing, contusion and brain swelling. Inside the skull, the brain experiences movement resulting in compression of the protective layers of the surrounding tissue between the brain and the skull. The axons of the brain tissue are compressed and stretched. This "bouncing" can cause damage throughout the brain. Additional damage can occur as the brain rebounds from the impact (contra-coup injuries). For example, as the brain moves and compresses forward, momentum will cause backward movement, damaging brain matter toward the back of the brain. Examples of this type of injury include concussions and shaken baby syndrome (non-accidental trauma). Effects of this type of injury are usually diffuse, resulting in damage to many areas.

GLASGOW COMA SCALE INTERPRETATION

LEVEL	SCORE	CHARACTERISTICS
Mild	13-15	Minor limitations; potential for full recovery
Moderate	9-12	Benefits from rehab; presents with physical or cognitive impairments that may or may not resolve
Severe	3-8	Coma; no meaningful response; no voluntary activities
Vegetative	<3	Sleep/wake cycles; arousal but no interaction with environment
Persistent vegetative	No score	No arousal
Brain death	No score	

FIGURE 1

• Chemical/toxic injuries result from exposure to insecticides, solvents, carbon monoxide poisoning, lead poisoning or other toxic substances. The chemicals damage the neurons, resulting in the nerve's inability to function properly or at all. Metabolic injuries occur as a result of contact with unsafe chemicals (such as lead) or from the accumulation of chemicals manufactured within the body (such as those excreted from kidney disease).

• Hypoxic injuries result from a lack of blood flow to the brain tissue. Anoxia is a total lack of oxygen while hypoxia is decreased oxygen. Causes of this type of TBI can include respiratory failure, heart attack and exposure to low oxygenated environments.

• The presence of tumors invades brain space which causes damage to, or compression of, brain tissue. Surgical excision of tumors can lead to damage through the pathways the surgeon creates to access the tumor.

• Infections of the brain and the meninges can lead to brain injury. The brain and the meninges are prone to viral and bacterial infections, resulting in encephalitis or meningitis.

• Strokes or cerebral vascular accidents result from either a bleed or a vascular blockage in the brain. The lack of oxygen to the surrounding tissue can result in a brain injury. However, these injuries are defined and characterized differently than other types of brain injuries.

No two brain injuries are similar. Although many commonalities are observed, each presentation is specific and unique to the individual.

CLASSIFICATION TOOLS AND RECOVERY FOR TBIs

Due to the potentially complex presentation of TBIs, different scales have been developed to help identify an individual's level of injury with some projection of recovery. The most commonly used scale is the Glasgow Coma Scale (http://emedicine.medscape.com/article/326510-overview) (see Figure 1). This scale is used to define the severity of a TBI within 48 hours of the injury. Areas evaluated include eye opening, verbal abilities and motor skills. Responses are assigned numbers from 1-6 and simply describe the current condition. The lower the number, the more involved the injury. For example, if an individual does not open his eyes, he receives a score of 1. If his eyes open spontaneously, the score of 4 is assigned. In the verbal area, a score of 1 is assigned if the client makes no sounds, a score of 3 is given for uttering inappropriate words, and an oriented conversation is scored a 5. Following directions accurately for motor responses scores a 6 while a flexion response to painful stimulation scores a 3. No attempts at movement receives a score of 1. The top score is 15 and demonstrates no or minimal involvement, while a score of 3 (the lowest possible) demonstrates a lack of any response.

The potential for recovery is related to Glasgow scores. Recovery is also predicted by the duration of the post-traumatic amnesia; the location and size of contusions, hemorrhages and injuries in the brain; and the severity of other body system injuries sustained at the same time as the TBI.

(CONTINUED ON PAGE 32)

TRAUMATIC BRAIN INJURIES
(CONTINUED FROM PAGE 31)

TBIs are also classified by level of severity, referred to as mild, moderate and severe (http://www.neuroskills.com/education/definition-of-brain-injury.php).

- A mild TBI results in confusion or a loss of consciousness of less than 30 minutes and has a Glasgow Coma Scale score initially of 13-15. Post-traumatic amnesia clears in less than 24 hours.

- A moderate TBI results in a loss of consciousness of 30 minutes to 24 hours and has an initial Glasgow Coma Scale score of 9-12. Post-injury amnesia lasts between 2-7 days.

- An individual with a severe TBI experiences a loss of consciousness greater than 24 hours, initial Glasgow Coma Scale score of 3-8 and post-injury amnesia of greater than 7 days.

Studies have found that age can influence potential for recovery: individuals under 2 years of age and over 60 have more limited prognoses compared to those of other age groups. The largest recovery period for clients with TBIs occurs within the first two years after the injury, however that does not eliminate the potential for recovery after that point.

Phases of recovery include the initial, the surgical/acute and the rehab phases. The initial phase includes measures to sustain life where stabilization of vital function is the focus. The next phase includes the surgical/acute care and includes minimizing secondary injuries and continued provision of life support, if needed. Medical intervention can include controlling intracranial pressure and the provision of medications to manage muscle tone. Other medical care includes cleaning out the damaged area resulting from an open head injury. The focus of this period is to maintain life while managing all injuries that occurred with the TBI. Once the brain has been stabilized and damage maintained, the rehabilitation process starts. This is done through a multidisciplinary approach that focuses on restoring lost function and preventing secondary complications. Secondary complications include the development of pressure injuries, pneumonia/respiratory issues and loss of range of motion. Discharge planning is addressed throughout the rehab process to help the family and individual plan accordingly. The length of time spent in each phase of recovery is dependent upon the injury presentation and the response to intervention.

PATHOLOGY AND PRESENTATION OF TBIs

A wide variety of deficits can appear after a severe traumatic brain injury, including motor, sensory, cognitive and behavioral issues. Although the motor and sensory losses may be most apparent, the cognitive/behavioral changes influence every aspect of the individual as well as everyone in his life (http://www.neuroskills.com/education/characteristics-of-brain-injury.php).

Physically, abnormalities in muscle tone impact all motor skills. Tone presentation can change as the recovery progresses, as well as with the use of tone management medications. Tone can present as rigidity, spasticity and paralysis. Rigidity differs from spasticity, as it offers resistance to externally imposed movement in response to low speed movement. A simultaneous contraction of the agonistic and antagonistic muscle groups results in resistance to movement. The limb being moved does not return to a particular position. Spasticity is elicited by externally imposed movement in the form of a quick stretch. It is resistance to quick, imposed movement which occurs primarily in either the agonist or antagonist, rather than both. Rigidity is either demonstrated as cogwheel (intermittent resistance) or lead pipe (slow, consistent resistance). With spasticity, the limb often returns to a preferred position once the force is removed. Both spasticity and rigidity lead to decreased movement, which can lead to the development of joint contractures (joint limitations that restrict movement). If not addressed, contractures can become permanent, further limiting motor skills.

Changes in muscle tone also lead to limitations in motor skills, both fine and gross. If muscles cannot move freely, joint ranges lessen. Physical presentation can range from quadriplegia (paralysis) to quadriparesis (weakness) throughout the extremities, trunk and neck. The scope of involvement is dependent on the specific location of injury and might include all extremities, one side of the body or just the legs. The quality of movements can also be impacted by a TBI. Tremors can develop which interfere with both fine and gross motor performance. If specific areas of brain damage occur, ataxia and apraxia can also develop. Ataxia is a lack of body movement coordination. Apraxia presents as an inability to plan and carry out learned movements. Motor changes also impact functional skills. Oral motor involvement, such as dysarthria and oral apraxia, can be seen. Visual field cuts, limitations in ocular tracking and diplopia (double vision) can occur and further impact muscle movement, motor control and planning.

Sensory changes are also observed with TBIs. Sensory processing of stimulation may be altered, delayed or absent. This includes visual, auditory and tactile, as well as vestibular input. Limitations in these areas can influence and further limit motor performance.

Other medical issues may arise as a result of the TBI. A seizure disorder can develop any time the brain is injured. Internal injuries or skeletal fractures that may have occurred at the time of the TBI require time to heal.

BEHAVIORAL AND COGNITIVE ISSUES

Two of the most challenging areas impacted by a TBI are cognition and behavior. This is not only frustrating for the individual, but also for caregivers, family members and friends. The individual is no longer "the same" as he was prior to the injury. Personality changes often result. Cognitively, the client may have impaired ability to attend and concentrate; memory issues; impaired problem solving and decision making skills; slowed information processing; impulsive thinking without regard for consequences; poor organization, planning and sequencing abilities; difficulty with concept formation and abstract thinking; inflexible thinking/mental rigidity; and poor judgment across all settings. The need for increased processing time can interfere with all aspects of life. Oftentimes it is interpreted as a lack of ability or as disinterest, instead of a delayed response.

Behavioral challenges include disinhibition, the inability to engage in purposeful activity, inability to respond appropriately to environmental cues, socially inappropriate behavior, social skill deficits, impulsivity, poor initiation of tasks and interactions, lack of insight into behavior as well as the resultant consequences, inability to learn from an experience and then apply it to the next, denial of deficits, and poor self-esteem. These limitations tend to drive wedges into existing social and familial relationships, as the injured individual is so different post-injury. From a caregiver perspective, it can be very frustrating to deal with varying abilities due to behavioral issues. One day the individual can complete his typical routine without issues and the next day be unable to figure out how to brush his teeth.

"Appropriate" behavior may be limited without the ability to filter and adapt to different situations. The constant redirection toward appropriate behavior takes a toll on companions. Aggressive behaviors can occur without warning, placing others at risk of injury.

In attempting to deal with unwanted behaviors, there needs to be an understanding as to when and why they occur (Labovitz, A., 2017). Forethought is required when approaching an individual with a history of unwanted or aggressive behaviors to ensure everyone's safety. If the individual perceives fear in the caregiver, the situation can escalate quickly. Behaviors often happen for a reason and so the reason for the behavior needs to be explored. Consideration of pre-morbid issues can reveal personality and behavior issues that are not new, but now altered. Consider previous dementia, intellectual disabilities, psychiatric issues and drug reactions. Current issues that can interfere with behavior can include sleep disturbances, presence of pain (sometimes unidentified by the individual), fatigue and upsetting news. Throughout the recovery process, caregivers can be quick to label actions/reactions as behavior problems. This label sets up predisposed ideas regarding future interactions, making others hesitant to approach.

Undesirable behaviors impact all aspects of the individual's life, resulting in increased length of stay, as well as dictating the type of discharge setting. Behaviors interfere with nursing care, family interactions and treatment/therapy. Unwanted behaviors become stressors on families, disrupt marriages and limit interaction with loved ones.

It is important to differentiate between common behaviors associated with TBIs versus common unwanted behaviors. The first category includes difficulties with sleep/wake cycle; orientation to person, place and time; increased distractibility and impulsivity; decreased ability to concentrate; and decreased social boundaries. The second category includes irritability, agitation, aggression, cursing, yelling and screaming, and emotional lability. All of these can lead to a refusal to participate in requested tasks, avoidance, disinhibition, wandering and mood swings. If the extreme behaviors, especially agitation, cannot be modified or corrected, recovery will be significantly impacted. This can increase length of stay and, when it is time for discharge, the individual is more often discharged to a facility rather than home. To help control behaviors, patterns and possible antecedents need to be identified. If the trigger for the behavior can be identified, greater participation can occur during the recovery process.

In general, there are some specific guidelines of what not to say to someone who has acquired a TBI (Rowland, M., 2012). Avoid comments such as "you seem fine to me." Although the individual might look normal, he might be dealing with impaired memory, decreased concentration, insomnia, chronic pain, depression or anxiety. These are invisible to well-meaning family and friends. Studies show that 65 percent of individuals post-injury receive a psychiatric diagnosis; the most common is depression (45 percent), followed by anxiety (38 percent) and substance use disorder (21 percent) (Whelan-Goodinson, et al, 2009). Other comments like "maybe you're just not trying hard enough" imply laziness. Laziness is different than apathy, but presents as disinterest. Flippant comments such as "you're such a grump" are also harmful. Since irritability and grumpiness are a direct result of a TBI, others need

(CONTINUED ON PAGE 34)

TRAUMATIC BRAIN INJURIES
(CONTINUED FROM PAGE 33)

to remember that the individual's mood will change, sometimes rapidly, and without apparent cause.

Caregiver frustrations need to be carefully monitored. Comments such as "how many times do I have to tell you?" and "do you have any idea of how much I do for you?" only create more stress and guilt for the individual. Memory problems are common with TBIs and should not be interpreted as disregard on the individual's part. On the other hand, comments like "let me do that for you" imply that the individual cannot complete the task, impacting self-esteem and self-worth.

Finally, risk of suicide increases drastically post TBI. Per research, an individual post- TBI is six times more likely to have suicidal thoughts than someone without a brain injury. Comments like "you're lucky to be alive" may be misconstrued. The individual, whether they understand their condition or not, may feel very differently. Instead, encouragement regarding how strong or persistent the person is might be more beneficial.

MOBILITY NEEDS AND CONSIDERATIONS

As a health care provider, a basic understanding of possible rapidly changing needs is critical when addressing wheelchair seating and mobility for individuals with TBIs. Obviously during the initial and acute phase of recovery, the focus needs to be on life-sustaining measures. Once stable, seating and mobility needs to be evaluated. As previously discussed, muscle tone presentation changes throughout the recovery process. Therefore, seating and mobility needs might also change.

Funding options and limitations need to be discussed in order to use available funding dollars in the best manner.

Early mobility needs might be best accomplished through the use of a somewhat generic base and seating that includes a recline option. This can accommodate tone presentations that might require a more open thigh to pelvic or trunk angle. As recovery continues, the seat to back angle can be easily altered as the individual's presentation changes.

Once some recovery has been gained, a definitive wheelchair and seating system can be pursued. In addition to recovery, available funding will dictate equipment recommendation time frames, and some equipment options.

The evaluation process for a mobility system is similar whether the client has a TBI or other diagnosis (RESNA Wheelchair Service Provision Guide). A thorough history and interview is needed, discussing other medical conditions, medications and the prospect of surgical intervention for any remaining medical issues. Discussion regarding potential living situations can be difficult if those decisions have not yet been made. Other areas that warrant discussion include vocational issues, as well as participation in activities of daily living, community involvement, recreation and leisure, and vehicle transportation.

As in all seating and wheeled mobility evaluations, a full physical evaluation is required including sensory function, tone presentation and motor skills. The mat evaluation is valuable to show quality of movements, the ability to transfer and to determine the amount of support that the individual requires in order to maintain a functional position. More importantly, it can show the specific limitations that the individual may be dealing with.

Measurements need to be taken during the mat evaluation. Body segment measurements are needed to ensure a properly sized mobility system. Angles and orientation in space also need to be explored and evaluated. Abnormal tone presentation can result in range limitations that require accommodation, rather than correction (Waugh, K., 2013). For example, the seat to back angle of the system needs to correspond to the thigh to pelvis and thigh to trunk angle, and the leg rest angle needs to accommodate the thigh to lower leg angle.

Features of the mobility base need to be addressed throughout the evaluation process including the use of tilt or recline and choosing a dependent manual, self-propelling manual or power wheelchair. Power is not always a viable option due to cognitive and behavioral issues that can occur, however it should not be ruled out until discussed.

Features of seating are determined based on the findings of the physical and mat evaluation. The amount of support required, the skeletal asymmetries present and anticipated, and the tone presentation will direct the recommendation process. Equipment trials are vital to the process.

From a seating and mobility perspective, the evaluation process requires a thorough evaluation where abilities, needs and goals are discussed from the initiation of the process. If this is done, the individual with a TBI will be more likely to have a successful outcome.

(CONTINUED ON PAGE 36)

(CONTINUED FROM PAGE 34)

TAKE HOME

Traumatic brain injuries can be complex injuries with a broad spectrum of symptoms and resultant disabilities. TBIs result from an acute event where a bump, blow or jolt to the head disrupts the normal function of the brain. One minute, the individual has no issues; the next, the individual's life is completely changed from what it was. TBIs not only impact the individual, but also everyone who has a relationship with the injured individual. The spectrum of symptoms includes motor, sensory, cognitive and psychological issues ranging from mild to severe. Since no two TBI injuries present the same, the variations of presentation are numerous and directly related to the specific area and extent of damage. The presence of unwanted behaviors is one of the most frustrating factors for families and caregivers. From a seating and wheeled mobility standpoint, a thorough evaluation is needed to identify specific limitations, skills and needs. Once evaluation is complete, trials and recommendations can be made to ensure optimal alignment and ability to function.

CONTACT THE AUTHOR

Jill may be reached at
otspar@aol.com.